# User Manual

English


# Data Acquisition System

# GEN series

I2704-6.1 en

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*References made to the Perception software are for version 6.52 or higher.*

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## Table of Contents

# 1 About this Manual

## 1.1 Symbols used in this manual

The following symbols are used throughout this manual to indicate warnings and cautions.

**WARNING**

**Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

**WARNING**

**Indicates an electrical shock hazard which, if not avoided, could result in death or serious injury.**

**CAUTION**

**Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury; or alerts against unsafe practices; or alerts against actions which could damage the product, or result in a loss of data.**

**CAUTION**

**The ESD susceptibility symbol indicates that handling or use of an item may result in damage from ESD if proper precautions are not taken.**

**HINT/TIP**

The info icon indicates sections which provide additional information about the product. This information is not essential for correct operation of the instrument, but provides knowledge to make better use of the instrument.

## 1.2 Manual conventions

When the wording “Click Start ...” is used, this refers to the Windows Start button. Compared to Windows XP, in Windows Vista and Windows 7 the Start Menu has undergone some significant changes. The taskbar icon is no longer labeled "Start" and is now simply the pearl icon (of the window-frame in an orb).

For clarity and convenience, these conventions are used throughout this manual:

- **Menu names** from the display appear in bold, blue lettering.
- **Settings** within a menu appear in bold, red lettering.
- **Front panel controls** and **control names** appear in bold, black lettering.

# 2 Safety Messages

## 2.1 Introduction

**IMPORTANT**

**Read this section before you start using this product!**

This instrument is mains powered and protective ground connections are required (unless otherwise specified for certain parts).

This manual contains information and warnings that must be observed to keep the instrument in a safe condition. The instrument should not be used when environmental conditions are exceeding the instruments specifications (e.g. damp, high humidity) or if the unit is damaged.

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

Whenever it is likely that safety protection has been impaired, the instrument must be made inoperative and secured against any unintended operation. Qualified maintenance or repair personnel should be informed. Safety protection is likely to be impaired if, for example, the instrument shows visible damage or fails to operate normally.

**Appropriate use**
This instrument and the connected transducers may be used for measurement and directly related control tasks only. Any other use is not appropriate. To ensure safe operation, the instrument may only be used as specified in this user manual.

- The covers protect the user from live parts and should only be removed by suitably qualified personnel for maintenance and repair purposes.
- The instrument must not be operated with the covers removed.
- This instrument must not be used in life support roles.
- There are no user serviceable parts inside.

It is also essential to follow the respective legal and safety regulations for the application concerned during use. The same applies to the use of accessories. Additional safety precautions must be taken in setups where malfunctions could cause major damage, loss of data or even personal injury.
Some examples of precautions are: mechanical interlocking, error signaling, limit value switches, etc.

**Maintenance and cleaning**
The instrument is a maintenance-free product. However in case one wants to clean the housing please note the following:

- Before cleaning, disconnect the instrument completely.
- Clean the housing with a soft, slightly damp (not wet!) cloth. Never use solvents, since these could damage the display or the labeling on the front panel.
- When cleaning, ensure that no liquid gets into the housing or connections.

**General dangers, failing to follow the safety instructions**
This instrument is a state of the art device and as such is fail-safe. This instrument may give rise to dangers if it is inappropriately installed and operated by untrained personnel. Any person instructed to carry out installation, commissioning, maintenance or repair of the unit must have read and understood the User Manual and in particular the technical safety instructions.

**Remaining dangers**
The scope of supply and performance of this instrument covers only a small area of measurement technology. In addition, equipment planners, installers and operators should plan, implement and respond to the safety engineering considerations of measurement technology in such a way as to minimize remaining dangers. Prevailing regulations must be complied with at all times. There must be reference to the remaining dangers connected with measurement technology.

**Conversions and modifications**
This instrument must not be modified from the design or safety engineering point of view except with our prior express written agreement. Any modification shall exclude all liability on our part for any resultant damage. In particular, any repair or soldering work on motherboards (replacement of components) is prohibited. When exchanging complete units, use only original parts from HBM. The unit is delivered from the factory with a fixed hardware and/or software configuration. Changes should only be made within the possibilities documented in this manual.

**Qualified personnel**
People entrusted with the installation, fitting, commissioning and operation of the product must have the appropriate qualifications. The product may only be installed and used by qualified personnel, strictly in accordance with the specifications and the safety rules and regulations. This includes people who meet at least one of the three following qualification levels:

- Project personnel: Have a working knowledge of the safety concepts of automation and test and measurement technology.
- Automation plant or test and measurement operating personnel: Have been instructed how to handle the equipment and are familiar with the operation of the cards and technologies described in this documentation.
- Commissioning engineers or service engineers: Have successfully completed the training how to repair the automation systems. They are also authorized to activate, to ground and to label circuits and equipment in accordance with safety engineering standards. It is essential to comply with the legal and safety requirements for the product and any accessories during use.

## 2.2 FCC and general

The first WARNING note below is required by the FCC (Federal Communications Commission) and relates only to the interference potential of this equipment. This message is a direct quotation.

**WARNING**

**The equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart B or Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.**

## 2.3 Grounding

The instrument must be used with a protective ground connected via the conductor of the supply cable. This is connected to the instrument before the line and neutral connections when the supply connection is made. If the final connection to the supply is made elsewhere, ensure that the ground connection is made before line and neutral.

**WARNING**

**Any interruption of the ground connection inside or outside is likely to make the instrument dangerous. Intentional interruption is prohibited.**

For protection against electric shock, all external circuits or equipment shall have a safe insulation. Therefore it is not permitted to connect peripheral equipment to the system with a power supply without SELV (Separated Extra Low Voltage) rating unless explicitly mentioned.

Signal connections to the instrument should be connected after the ground is made and disconnected before the ground connection is removed, i.e. the supply lead must be connected whenever signal leads are connected.

**WARNING**

**For safety, it is essential that the protective ground connector of the instrument is used, whenever voltages greater than 33 V RMS, 46.7 V PEAK or 70 V DC (IEC 61010-1:2010) are connected. This is to prevent the instrument's case becoming live in the event of a protective ground interruption, which could occur if the supply connector is accidentally disconnected from the instrument.**

The primary purpose of protective grounding is to provide adequate protection against electric shock causing possible death or injury to personnel while working on de-energized equipment. This is accomplished by grounding and bonding, to limit the body contact or exposure to voltages at the work-site to a safe value, if the equipment were to be accidentally energized from any source of hazardous energy. The greatest source of hazardous energy in most cases is direct energizing of the equipment from a power-system or source.

**WARNING**

| |
|---|
| **If connection to a protective ground is not possible for any reason then please refer to the international safety standard EN 50191:2000** |

## 2.4 Instrument symbols

On the system a variety of symbols can be found. Below is a list of symbols and their meaning.

This symbol is used to denote the measurement ground connection. This point is not a protective ground.

This symbol is used to denote a protective ground connection.

This symbol is used to denote a frame or chassis ground connection. This point is not a protective ground.

Where caution is required, this symbol refers to the user manual for further information.

This symbol warns that high voltages are present close to this symbol.

This symbol shows that the switch is a power switch. When it is pressed the instrument state toggles between the operating and power-off mode. When in power-off mode all electronics are disconnected from the power except for a small circuit used to detect the switch state.

## 2.5 Protection and isolation

### 2.5.1 Measurement categories

- The international standards for test equipment safety are the IEC 61010-1 and the IEC 61010-2-030.
- IEC 61010-1 defines three overvoltage categories (CAT II, CAT III, and CAT IV) on the power supply side of an instrument.
- IEC 61010-2-030 defines three measurement categories (CAT II, CAT III, and CAT IV) on the measurement input side of an instrument, for measurement inputs which can be directly connected to mains.
- All measurement inputs, which are not specified to be connected to mains, have no CAT rating and are referred to as O (like Others).

**Categories according to IEC 61010-2-030:2010**
Electrical equipment, specifically measurement tools can according to IEC 61010-2-030:2010 be assigned into 4 categories. These measurement categories are indicated with the terms O (previously CAT I), CAT II, CAT III and CAT IV. Originally these categories are used to indicate the overvoltage or surge voltage that is likely to occur and can be sustained by the equipment. Actually the category indicates the amount of energy that can be released in the event of a short circuit. A higher category number indicates a higher energy level that can occur and can be sustained by the equipment.

**O** (Other) (previously referred to as **CAT I**): This category is for measurements not directly connected to mains. Think of measurement of: signal levels, regulated low voltage circuits or protected secondary circuits. For this category there are no standard over voltage or surge impulse levels defined.

**CAT II**: This category is for measurements directly connected to low-voltage mains. Think of measurement of: mains sockets in household applications or portable tools. This category is expecting to have a minimum of three levels of over current protection between the transformer and connection point of the measurement. (See Figure 2.1).

**CAT III**: This category is for measurements directly connected to the distribution part of a low-voltage mains installation. Think of measurement of: circuit breakers, wiring, junction boxes etc. This category is expecting to have a minimum of two levels of over current protection between the transformer and connection point of the measurement. (See Figure 2.1).

**CAT IV**: This category is for measurements directly connected to the source of a low-voltage mains installation. Think of measurement of: over current protection devices, ripple control units etc. This category is expecting to have a minimum of one level of over current protection between the transformer and connection point of the measurement circuit. (See Figure 2.1).

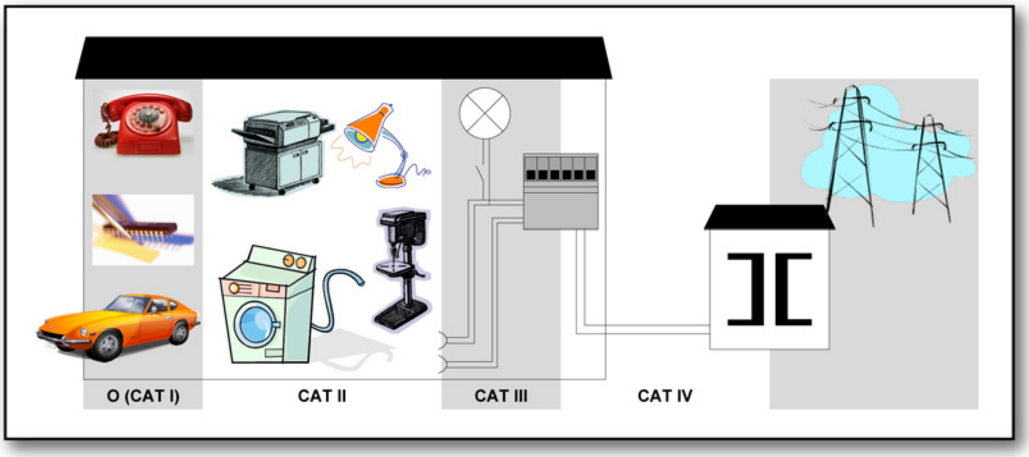



**Figure 2.1:** Category indication according to IEC 61010-2-030:2010

**Example:** A measurement device is specified as 600 V CAT II, maximum input voltage 1000 V DC.

*Table 2.1: Insulation test voltages according to IEC 61010-2-030:2010*

| Nominal Voltage (V RMS or V DC) | IEC 61010-2-030:2010 | | | | | |
|---|---|---|---|---|---|---|
| | 5 sec. AC test (V RMS) | | | Impulse test (V) | | |
| | CAT II | CAT III | CAT IV | CAT II | CAT III | CAT IV |
| ≤ 150 | 840 | 1.390 | 2.210 | 1.550 | 2.500 | 4.000 |
| > 150 ≤ 300 | 1.390 | 2.210 | 3.310 | 2.500 | 4.000 | 6.000 |
| > 300 ≤ 600 | 2.210 | 3.310 | 4.260 | 4.000 | 6.000 | 8.000 |
| > 600 ≤ 1 000 | 3.310 | 4.260 | 6.600 | 6.000 | 8.000 | 12.000 |

Using the above table one can deduct that this specification informs the user the device passed the insulation tests; 5 sec at 2.210 V RMS and impulse 4.000 V. The maximum operating input voltage is 1000 V DC. This device is to be used to measure CAT II circuitry up to 600 V.

**WARNING**

**Measurement inputs of this instrument should not be used to measure high-energy signals of measurement categories CAT II, CAT III or CAT IV (IEC 61010-2-30:2010) (e.g. mains measurements) , unless specifically stated for the specific input.**

### 2.5.2 Basic versus reinforced insulation

For reference below one can find the basic insulation and supplementary insulation as well as the reinforced insulation test values for CATII.

*Table 2.2: Test voltages for testing electric strength of solid insulation in measuring circuits of measurement category II (IEC 61010-2-30:2010)*

| Nominal voltage line to neutral a.c r.m.s. or d.c. of MAINS being measured. (V) | Test voltage | | | |
|---|---|---|---|---|
| | 5 s a.c. test V a.c. r.m.s. | | Impulse test V peak | |
| | Basic insulation and supplementary insulation | Reinforced insulation | Basic insulation and suplementary insulation | Reinforced insulation |
| ≤ 150 | 840 | 1390 | 1550 | 2500 |
| > 150 ≤ 300 | 1390 | 2210 | 2500 | 4000 |
| > 300 ≤ 600 | 2210 | 3510 | 4000 | 6400 |
| > 600 ≤ 1000 | 3310 | 5400 | 6000 | 9600 |

To protect a user from hazardous voltages there are several means of protection possible. As one can see below basic insulation + supplementary insulation is a possibility but also reinforced isolation is a means of protection. The test voltages are different per means as can be found in the above table.

**Additional means of protection in case of single fault conditions**
Accessible parts shall be prevented from becoming HAZARDOUS LIVE IN SINGLE FAULT CONDITION. The primary means of protection (see Figure 2.2) shall be supplemented by one of **A**, **B**, **C** or **D**. Alternatively one of the single means of protection **E** or **F** shall be used. See Figure 2.2.

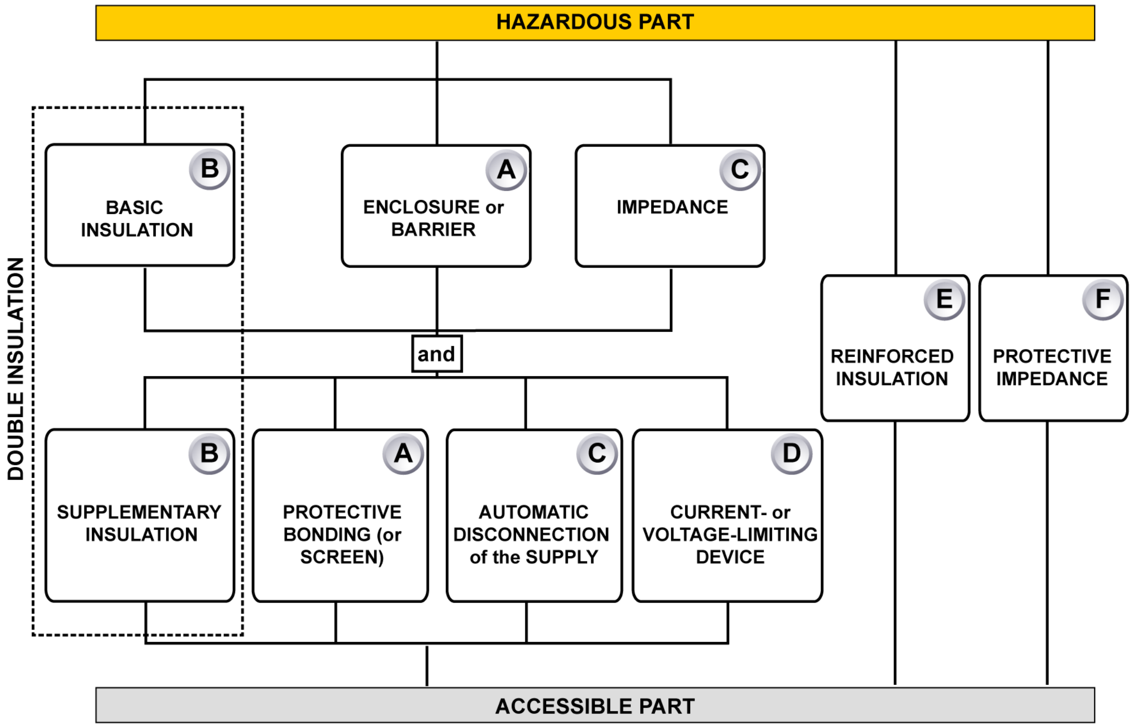



**Figure 2.2:** Acceptable arrangement of protective means against electric shock

Example: A measurement device is specified as 600 V CAT II reinforced insulation, maximum input voltage 1000 V DC.
Using the above information one can deduct that this specification informs the user that the measurement device is tested on input to chassis ground 5 s at 3.510 V RMS and impulse 6.400 V. The maximum operating input voltage is 1000 V DC. This device is to be used to measure CAT II circuitry up to 600 V.

### 2.5.3 Protection

**WARNING**

**ELECTRICAL SHOCK HAZARD!**
**Any interruption of the protective conductor inside or outside the apparatus is likely to make the apparatus dangerous. Intentional interruption is prohibited.**
**When the apparatus is connected to its supply, terminals may be live, and the opening of covers for removal of parts is likely to expose live parts.**

Whenever it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

The protection is likely to be impaired if, for example, the apparatus shows visible damage or has been subjected to severe transport stresses.

It is the responsibility of the user to ensure the safety of any accessories, such as probes, used with the equipment.

**WARNING**

**ELECTRICAL SHOCK HAZARD! Do not remove covers. Refer servicing to qualified individuals.**

Proper use of this device depends on careful reading of all instructions and labels.

If the instrument is used in a manner not specified by HBM, the protection provided by the instrument can be impaired.

**WARNING**

**This instrument must not be operated in explosive atmospheres.**

**WARNING**

**This instrument and related accessories are not designed for biomedical experimentation on humans or animals and should not be directly connected to human or animal subjects or used for patient monitoring.**

### 2.5.4 Overvoltage/current protection

All signal inputs are protected against overloads and transients. Exceeding the limits stated in the specifications, particularly when connected to potentially high-energy sources, can cause severe damage that is not covered by the manufacturer's warranty.

**WARNING**

| **Do not remove covers. Refer for servicing to qualified individuals.** |
|---|

The covers protect the user from live parts and should only be removed by suitably qualified personnel for maintenance and repair purposes.

The instrument must not be operated with the covers removed.

There are no user serviceable parts inside.

### 2.5.5 Isolation

**CAUTION**

| **For input channels with plastic BNCs (galvanically isolated from the chassis), the input conductors including the BNC shell may carry hazardous voltages. Only appropriate insulated BNC connectors should be used.** |
|---|

It is the responsibility of the user to ensure the safety of any accessories, such as probes, used with the instrument.

**CAUTION**

| **Even low voltage inputs may contain high voltage fast transients (spikes), which could damage the input. For this reason it is not safe, for instance, to make direct connections to an AC line supply, unless specifically stated otherwise for the specific input.** |
|---|

## 2.6 Environment

The instrument should be operated in a clean, dry environment with an ambient temperature of between 0 °C and +40 °C.

The instrument is specified for use in a Pollution Degree II environment, which is normally nonconductive with temporary light condensation, but it must not be operated while condensation is present. It should not be used in more hostile, dusty or wet conditions.

Humidity should be between 0 % and 80 %. When moving the device from a cold to a warm environment the equipment has to be left turned off for a period of 30 minutes to avoid short circuits by condensation.

**Note** *Direct sunlight, radiators and other heat sources should be taken into account when assessing the ambient temperature.*

If the instrument has a fan installed, leave space around the equipment for unrestricted ventilation.

Do not store the equipment in hot areas. High temperatures can shorten the life of electronic devices and damage batteries.

Do not store the equipment in cold areas. When the equipment warms up to its normal operating temperature, moisture can form inside the equipment, which may damage the equipment's electronic circuit boards.

Do not drop, knock or shake the equipment. Rough handling can break internal circuit boards.

Do not use harsh chemicals, cleaning solvents or strong detergents to clean the instrument. To clean the instrument, disconnect all power sources and clean the housing with a soft, slightly damped (not wet!) cloth.

It is the responsibility of the user to ensure the safety of any accessories, such as probes, used with the instrument.

## 2.7 Laser Safety

Some of the GEN series cards or systems use lasers. All laser products used are classified as a **Class 1 laser product**. It does not emit hazardous light but it is recommended to avoid direct exposure to the beam.


The built-in laser complies with laser product standards set by government agencies for Class 1 laser products:

- In the USA, the GEN series products are certified as a Class 1 laser product conforming to the requirements contained in the Department of Health and Human Services (DHHS) regulation CDRH 21 CFR, Chapter I Subchapter J Part 1040.10.
- Outside the USA, the GEN Series products are certified as a Class 1 laser product conforming to the requirements contained in IEC/EN 60825-1:1994+A1+A2 and IEC/EN 60825-2.

## 2.8 Manual handling of loads

The Manual Handling of Loads Directive 90/269/EEC from the European Community lays down the minimum health and safety requirements for the manual handling of loads where there is a risk particularly of back injury.

Before lifting or carrying a heavy object, the following questions should be asked:

- Can one person lift this load safely, or is it a two-person lift?
- How far will the load have to be carried?
- Is the path clear of clutter, cords, slippery areas, overhangs, stairs, curbs or uneven surfaces?
- Will closed doors be encountered that need to be opened?
- Once the load is lifted, will it block the carrier's view?
- Can the load be broken down into smaller parts?
- Should the carrier wear gloves to get a better grip and protect hands?

Contact the "Occupational Health and Safety" organization, or equivalent, in your country for more information.

The GEN series tower model (GEN7t) weights approximately 20-25 kg:

The GEN series rack model (GEN16t) model weights approximately 25-30 kg:

**DO NOT LIFT ALONE**

## 2.9 International safety warnings

Dansk

**SIKKERHEDSADVARSEL**
Dette instrument skal anvendes med en sikkerhedsjordforbindelse, som er tilsluttet via lysnetkablets beskyttelsesjordledning eller via en sikkerhedsjordklemme, hvis instrumentet er forsynet hermed. Hvis sikkerhedsjordforbindelsen afbrydes, inden i eller uden for instrumentet, kan instrumentet udgøre en farekilde. Sikkerhedsjordforbindelsen må ikke afbrydes. Der skal desuden tilsluttet en signaljordforbindelse, hvis et indgangssignal overstiger 33 V RMS, 46,7 V PEAK eller 70 V DC (IEC 61010-1:2010).

Dækslerne må ikke fjernes.

Hvis netsikringen springer som følge af en fejl, er instrumentets vekselstrømsafbryder muligvis blevet beskadiget og skal derfor kontrolleres af en kvalificeret tekniker.

Afbryd instrumentet fra lysnettet ved at fjerne IEC-stikket. Instrumentets vekselstrømsafbryder er kun beregnet til funktionelle formål. Den er ikke beregnet eller egnet til at afbryde instrumentet fra lysnettet.

Hvis målingerne et omfattet af EN 50110-1 og EN 50110-2, skal alle kort med en driftsspænding på mere end 50 V AC RMS eller 120 V DC tilsluttes af en kvalificeret tekniker eller en elektriker, og arbejdet skal kontrolleres af en kvalificeret tekniker. (En kvalificeret tekniker er en person, som i kraft af sin specialuddannelse, sin viden og erfaring samt sit kendskab til relevante bestemmelser kan vurdere omfanget af det arbejde, de skal udføre, og afdække de potentielle risici, og som er blevet udpeget som kvalificeret tekniker af deres arbejdsgiver).

## Nederlands

**VEILIGHEIDSWAARSCHUWING**
Dit instrument mag uitsluitend worden gebruikt als een beschermde massa (aarde) is aangesloten via de beschermde massageleider van de voedingskabel, of indien het instrument daarvan is voorzien via de veiligheids-massa-aansluiting. Als de beschermde massa, binnen of buiten het instrument, wordt onderbroken, dan kan dat hierdoor uitermate gevaarlijk worden. Het opzettelijk onderbreken van de massa is verboden. Indien er een signaal wordt aangeboden van meer dan 33 V RMS, 46.7 V (top-top) of 70 V DC (IEC 61010-1:2010) dient eveneens een signaalaarding aangesloten te zijn.

De deksels mogen nooit worden verwijderd.

Als de zekering doorbrandt als gevolg van een storing of een defect is het mogelijk dat de wisselstroom-schakelaar van het instrument beschadigd is en dient deze door een daarvoor gekwalificeerde en deskundige monteur te worden gecontroleerd.

Om dit instrument los te koppelen van de wisselstroomvoeding dient de IEC-aansluiting er uit te worden getrokken. De wisselstroom-voedingsschakelaar op dit instrument is uitsluitend bestemd voor functionele doeleinden. Het is niet bedoeld of geschikt als een ontkoppelingsapparaat.

Voor metingen die binnen de EN 50110-1 en EN 50110-2 vallen: let op dat alle panelen met bedrijfsspanningen van meer dan 50 V AC RMS of 120 V DC alleen door een gekwalificeerde technicus mogen worden aangesloten of door een persoon die is opgeleid in de elektrotechniek en onder toezicht van een gekwalificeerde technicus staat. (Gekwalificeerde technici zijn personen, die op basis van hun specialistische opleiding, kennis en ervaring als ook hun kennis van de betreffende voorzieningen, in staat zijn om het werk dat aan hen is toevertrouwd te beoordelen en mogelijke gevaren te ontdekken en door hun werkgever zijn aangewezen als gekwalificeerde technici).

## Suomi

**TURVAOHJEITA**
Tätä laitetta käytettäessä sen tulee olla suojamaadoitettu joko verkkojohdon suojajohtimen tai erillisen suojamaadoitusliitännän kautta, mikäli laitteeseen on sellainen asennettu. Suojamaadoituksen katkaiseminen laitteen sisä- tai ulkopuolelta tekevät siitä vaarallisen. Tahallinen katkaisu on kiellettyä. Lisäksi signaalimaa on oltava kytkettynä, jos jokin tulosignaali ylittää tehollisarvon 33 V, huippuarvon 46,7 V tai 70 V DC (IEC 61010-1:2010).

Älä poista suojakansia.

Mikäli laitteen verkkosulake palaa vian seurauksena, on mahdollista, että laitteen verkkokytkin on vaurioitunut ja se tulee tällöin tarkastuttaa ammattihenkilöllä.

Katkaise laitteen käyttöjännite irrottamalla IEC-liitin. Laitteen verkkokytkimellä on ainoastaan toiminnallinen tarkoitus. Sitä ei ole tarkoitettu, eikä se sovellu laitteen erottamiseen käyttöjännitteestä.

Mittauksissa, jotka kuuluvat EN 50110-1- ja EN 50110-2-standardien soveltamisalaan, huomaa, että kortit, jotka toimivat tehollisarvojännitteellä yli 50 V AC tai 120 V DC, saa kytkeä vain pätevä asentaja tai sähköteknisen koulutuksen saanut henkilö pätevän asentajan valvonnassa. (Pätevät asentajat ovat henkilöitä, jotka erikoiskoulutuksensa, tietojensa ja kokemuksensa sekä asiaan kuuluvien määräysten tuntemuksensa ansiosta pystyvät arvioimaan heille annettuja töitä ja havaitsemaan mahdolliset vaarat ja jotka heidän työnantajansa on nimennyt ammattitaitoisiksi asentajiksi).

Français

**ATTENTION - DANGER!**
Lorsqu'il est en fonctionnement, cet instrument doit impérativement être mis à la masse par le conducteur de terre du câble d'alimentation ou, si l'instrument en comporte une, par la borne de terre. Il peut être dangereux en cas de coupure du circuit de terre, que ce soit à l'intérieur ou à l'extérieur de l'instrument. Il est formellement interdit de couper intentionnellement le circuit de terre. De plus, une masse signal doit être connectée si l'un des signaux d'entrée, quel qu'il soit, dépasse 33 V RMS (valeur efficace), 46,7 V PEAK (valeur de crête) ou 70 V DC (courant continu) (CEI 61010-1:2010).

Ne pas déposer les panneaux de protection.

Le fait que le fusible d'alimentation saute par suite d'une anomalie risque de détériorer l'interrupteur d'alimentation secteur de l'instrument ; dans ce cas , le faire contrôler par un technicien qualifié.

Pour couper l'alimentation secteur de cet instrument, débrancher le cordon secteur. L'interrupteur d'alimentation secteur sur cet instrument est purement fonctionnel. Il ne s'agit pas d'un dispositif de coupure du courant, et n'est pas conçu pour cette fonction.

Pour les mesures entrant dans le champ d'application des normes EN 50110-1 et EN 50110-2, veuillez noter que tous les panneaux avec des tensions de service supérieures à 50 V AC RMS (tension efficace) ou 120 V DC (courant continu) ne peuvent être connectés que par un technicien qualifié ou une personne formée en ingénierie électrique et supervisée par un technicien qualifié. (Les techniciens qualifiés sont des personnes qui, du fait de leur formation, leurs connaissances et leur expérience spécialisées ainsi que leur connaissance des dispositions réglementaires appropriées, sont capables d'évaluer le travail qui leur est confié et détecter les risques possibles, et qui ont été désignées comme techniciens qualifiés par leur employeur).

Deutsch

**WARNHINWEIS!**
Dieses Gerät muss mit einer Schutzerde betrieben werden, die über den Schutzleiter des Speisekabels oder über die Erdungsklemme des Gerätes (falls vorhanden) anzuschließen ist. Bei einer Unterbrechung der Schutzerde außerhalb oder innerhalb des Gerätes kann eine Gefahr am Gerät entstehen. Eine beabsichtigte Unterbrechung ist nicht zulässig. Achtung! Bei Signalspannungen über 33 V Effektivwert, 46,7 V Spitzenwert oder 70 V Gleichstrom (IEC 61010-1:2010) muss die Signalmasse angeschlossen sein.

Die Schutzabdeckung nicht entfernen.

Wenn die Sicherung der Versorgung infolge eines Defektes durchbrennt, besteht die Möglichkeit einer Beschädigung des Wechselstromversorgungs-Schalters des Gerätes. Der Schalter muss dann von einem qualifizierten Elektriker geprüft werden.

Zum Trennen des Gerätes von der Wechselstromversorgung den IEC-Stecker abziehen. Der Wechselstromversorgungs-Schalter dient bei diesem Gerät nur für Funktionszwecke. Er ist nicht als Trennvorrichtung bestimmt bzw. geeignet.

Für Messungen gemäß EN 50110-1 und EN 50110-2 bitte berücksichtigen, dass alle Platinen mit Betriebsspannungen über 50 V AC RMS oder 120 V DC nur durch einen qualifizierten Elektriker oder einer elektrotechnisch unterwiesenen Person unter Aufsicht eines qualifizierten Technikers durchgeführt werden dürfen. (Qualifizierte Techniker sind aufgrund ihrer fachlichen Ausbildung, Kenntnisse und Erfahrungen sowie Kenntnis der einschlägigen Bestimmungen in der Lage, die ihnen anvertrauten Arbeiten zu beurteilen und mögliche Risiken zu erkennen, sowie Personen, die durch ihren Arbeitgeber zu qualifizierten Technikern ernannt worden sind).

Italiano

**AVVISO DI SICUREZZA**
Questo strumento deve esser utilizzato con un collegamento protettivo di messa a terra tramite il filo di messa a terra del cavo di alimentazione o tramite il terminale di messa a terra in sicurezza, nel caso in cui lo strumento ne sia dotato. Qualsiasi interruzione della messa a terra di protezione, sia all'interno che all'esterno dello strumento, lo renderà pericoloso. È vietata qualsiasi interruzione causata intenzionalmente. Inoltre, la connessione di terra deve essere collegata se ad uno qualsiasi degli ingressi viene applicato un segnale superiore a 33 V rms, 46,7 V di picco o 70 V c.c. (IEC 61010-1:2010).

Non aprire lo strumento.

Nel caso in cui il fusibile dell'alimentazione dovesse scattare a causa di un guasto, è possibile che l'interruttore dell'alimentazione a corrente alternata dello strumento possa essere danneggiato e dovrà pertanto essere controllato da un tecnico specializzato e qualificato.

Per disinnestare questo strumento dall'alimentazione a corrente alternata, levare il connettore IEC. L'interruttore dell'alimentazione a corrente alternata di questo strumento viene fornito esclusivamente per scopi operativi e non viene inteso, né è adatto, per essere utilizzato come dispositivo di disinnesto.

Si noti che per le misurazioni che rientrano nell'ambito di applicazione delle norme EN 50110-1 ed EN 50110-2, tutte le schede con tensioni di esercizio superiori a 50 V c.a. rms o 120 V c.c. possono essere collegate esclusivamente da un tecnico qualificato o da una persona in possesso di una formazione specifica nel campo dell'ingegneria elettrica sotto la supervisione di un tecnico qualificato. (Per tecnico qualificato si intende una persona che, in virtù della propria formazione , preparazione ed esperienza specialistica, nonché conoscenza delle disposizioni di settore, è in grado di valutare il lavoro che gli viene assegnato e di individuare possibili rischi, oltre ad essere stato nominato tecnico qualificato dal proprio datore di lavoro).

Norsk

**ADVARSEL!**
Dette instrument må betjenes med beskyttelsesjord tilkoblet via beskyttelsesjordlederen til tilførselskabelen eller via beskyttelsesjordklemmen, hvis instrumentet er utstyrt med en slik. Ethvert brudd i beskyttelsesjorden inni eller utenpå instrumentet kan føre til at instrumentet blir farlig. Tiltenkt brudd er tillatt. I tillegg må en signaljord tilkobles hvis et inngangssignal overskrider 33 V RMS, 46,7 V PEAK eller 70 V DC (IEC 61010-1:2010).

Ikke fjern dekslene.

Hvis tilførselssikringen går som følge av en feil, kan det hende at instrumentets AC-tilførselsbryter vil bli skadet, og den må sjekkes av en kvalifisert ingeniør.

For å koble dette instrumentet fra AC-tilførselen trekker du ut IEC-kontakten. AC-tilførselsbryteren på dette instrumentet er kun for funksjonelle formål. Den er ikke beregnet for, eller egnet til frakoblingsenhet.

For målinger som faller innenfor EN 50110-1 og EN 50110-2 må man være oppmerksom på at alle kort med arbeidsspenninger over 50 V AC RMS eller 120 V DC kun kan kobles til av en kvalifisert tekniker eller elektriker og overvåket av en kvalifisert tekniker. (Kvalifiserte teknikere er personer som på grunn av sin spesialistopplæring, kunnskap og erfaring, samt sin kunnskap om relevante bestemmelser, er i stand til å gå inn i arbeidet som de har fått i oppdrag å utføre og detektere mulige farer, og som er blitt utnevnt som kvalifiserte teknikere av sin arbeidsgiver.

## Português

**AVISO DE SEGURANÇA**
Este instrumento deve funcionar com uma terra de proteção conectada através do condutor da terra de proteção do cabo de alimentação ou, caso o instrumento esteja equipado com um, através do terminal da terra de proteção. Qualquer interrupção da terra de proteção, no interior ou no exterior do instrumento, poderá tornar o instrumento perigoso. A interrupção intencional é proibida. Além disso, deve ser conectado um sinal de terra se qualquer sinal de entrada exceder 33 V RMS, 46,7 V PICO ou 70 V CC (IEC 61010-1:2010).

Não retirar as tampas.

Se o fusível de alimentação fundir devido a uma falha, é possível que o interruptor de alimentação CA do instrumento seja danificado, devendo ser verificado por um engenheiro com qualificação adequada.

Para desconectar este instrumento da alimentação CA, retire o conector IEC da ficha. Neste instrumento, o interruptor de alimentação CA é fornecido apenas para fins funcionais. Não se destina a, nem é adequado para, ser utilizado como dispositivo de desconexão.

Para medições abrangidas pelas normas EN 50110-1 e EN 50110-2, tenha em atenção que todos os quadros com tensões de funcionamento superiores a 50 V CA RMS ou 120 V CC apenas poderão ser conectados por um técnico qualificado ou por alguém com formação em engenharia elétrica e supervisionados por um técnico qualificado. (Técnicos qualificados são pessoas que, devido à sua formação especializada, ao conhecimento e à experiência, bem como ao seu conhecimento das disposições relevantes, são capazes de avaliar o trabalho que lhes é confiado e detetar possíveis riscos e são pessoas que foram nomeadas técnicos qualificados pelo seu empregador.)

Português (Brasil)

**AVISO DE SEGURANÇA**
Este instrumento deve ser operado com um terra de proteção conectado por meio do condutor do terra de proteção do cabo de alimentação ou, se o instrumento estiver equipado com um, por meio do terminal de aterramento de segurança. Qualquer interrupção do terra de proteção, no interior ou no exterior do instrumento, poderá tornar o instrumento perigoso. A interrupção intencional é proibida. Além disso, deve ser conectado um sinal de terra se qualquer sinal de entrada exceder um máximo de 33 V RMS, 46,7 V PICO ou 70 V CC (IEC 61010-1:2010).

Não retirar as tampas.

Se o fusível de alimentação fundir como resultado de uma falha, é possível que o interruptor de alimentação CA do instrumento seja danificado, devendo este ser verificado por um engenheiro com qualificação adequada.

Para desconectar este instrumento da alimentação CA, desconecte o conector IEC. Neste instrumento, o interruptor de alimentação CA é fornecido somente para fins funcionais. Não se destina a, nem é adequado para, ser usado como dispositivo de desconexão.

Para medições no escopo das normas EN 50110-1 e EN 50110-2, note que todos os quadros com tensões de funcionamento superiores a 50 V CA RMS ou 120 V CC poderão somente ser conectados por um técnico qualificado ou por alguém com formação em engenharia elétrica e supervisionados por um técnico qualificado. (Os técnicos qualificados são pessoas que, devido à sua formação acadêmica, conhecimento e experiência, bem como ao seu conhecimento das provisões relevantes, são capazes de avaliar o trabalho que lhes é confiado e detectar possíveis riscos e são pessoas que foram nomeadas técnicos qualificados por seu empregador.)

## Español

**ADVERTENCIA SOBRE SEGURIDAD**
Este instrumento debe utilizarse conectado a tierra a través del conductor de puesta a tierra del cable de alimentación o de la borna de seguridad, si dicho instrumento estuviera equipado con ella. Cualquier interrupción de esta puesta a tierra, dentro o fuera del instrumento, hará que el manejo del mismo resulte peligroso. Queda terminantemente prohibido dejar en circuito abierto dicha puesta a tierra. Además, debe conectarse una señal de tierra si cualquier señal de entrada sobrepasa los 33 V eficaces, los 46,7 V de PICO o los 70 V de CC (IEC 61010-1:2010).

No quite las tapas.

Si se fundiera el fusible de alimentación como consecuencia de una avería, cabe la posibilidad de que el interruptor de encendido del equipo esté dañado y sea necesario comprobarlo por personal técnico especializado y autorizado al efecto.

Para desconectar este instrumento de la red, desenchufe el conector IEC. El interruptor de entrada de CA (encendido) se incluye solo para fines funcionales. No está pensado para utilizarse como medio de desconexión, ni tampoco es adecuado para ello.

En cuanto a las mediciones que se clasifiquen bajo el alcance de las normas EN 50110-1 y EN 50110-2, tenga en cuenta que los cuadros con tensión de funcionamiento por encima de los 50 V de CA eficaces o los 120 V de CC solo puede conectarlos un técnico cualificado o una persona con formación en ingeniería eléctrica y supervisada por un técnico cualificado. (Los técnicos cualificados son personas que, debido a su formación especializada, conocimientos y experiencia, así como por su conocimiento de los suministros pertinentes, son capaces de evaluar el trabajo encomendado y detectar posibles riesgos, al igual que personas nombradas como técnicos cualificados por la empresa contratadora).

Svenska

**SÄKERHETSVARNING**
Detta instrument måste användas med jordad anslutning via strömkabelns ledare eller, om sådan finns, via en isolerad jordterminal. Avbrott i den isolerande jordningen inuti eller utanför instrumentet kan göra instrumentet farligt. Avsiktligt avbrott är förbjudet. Dessutom måste en signaljordning anslutas om någon ingångssignal överskrider 33 V RMS, 46.7 V PEAK eller 70 V DC (IEC 61010-1:2010).

Ta inte bort höljet.

Om säkringen utlöses som ett resultat av ett fel är det möjligt att instrumentets strömförsörjningsbrytare skadas och ska därför kontrolleras av en kvalificerad ingenjör.

För att kopplas loss detta instrument från strömförsörjningen, dra ut IEC-kontakten. Brytaren för växelströmförsörjningen på detta instrument är endast avsedd för funktionella syften. Den är inte avsedd eller lämplig som frånkopplingsenhet.

För mått inom intervallen som anges i EN 50110-1 och EN 50110-2, observera att alla kort med arbetsspänning över 50 V AC RMS eller 120 V DC kan endast anslutas av en kvalificerad tekniker eller en person som är utbildad i elteknik och övervakas av en kvalificerad tekniker. (Kvalificerade tekniker är personer som på grund av sin specialistutbildning, kunskap och erfarenhet liksom sin kunskap om relevanta enheter kan utvärdera arbetet som tilldelas dem och göra kvalificerade riskbedömningar samt utses av sina arbetsgivare till kvalificerade tekniker).

English

**SAFETY WARNING**
This instrument must be operated with a protective ground (earth) connected via the protective ground conductor of the supply cable or, if the instrument is fitted with one, via the protective ground terminal. Any interruption of the protective ground, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited. In addition, a signal ground must be connected if any input signal exceeds 33 V RMS, 46.7 V PEAK or 70 V DC (IEC 61010-1:2010).

Do not remove the covers.

If the supply fuse blows as the result of a fault, it is possible that the instrument's AC supply switch will be damaged and should be checked by a suitably qualified engineer.

To disconnect this instrument from the AC supply, unplug the IEC connector. The AC supply switch on this instrument is provided for functional purposes only. It is not intended, or suitable, as a disconnecting device.

For measurements falling within the scope of the EN 50110-1 and EN 50110-2, please note that all cards with working voltages above 50 V AC RMS or 120 V DC may only be connected by a qualified technician or a person trained in electrical engineering and supervised by a qualified technician. (Qualified technicians are persons who, due to their specialist training, knowledge and experience as well as their knowledge of the relevant provisions are able to assess the work with which they are entrusted and detect possible risks and who have been nominated as qualified technicians by their employer).

日本語

**安全上の警告**
本機器の操作は、電源ケーブルの保護接地線で接地（アース）を施した上で行ってください。また、安全接地用端子が存在する場合は、これを経由して本機器を接地してください。機器の内部または外部にある保護接地線が遮断されると、機器が危険な状態に陥る可能性があります。故意に保護接地線を遮断することを禁止します。また、入力信号が 33V RMS、ピーク時に 46.7V RMS、または 70V DC を超える場合は、信号接地線を接続してください（IEC 61010-1:2010）。

カバーは取り外さないでください。

電源ヒューズが故障により飛んだ場合、機器の AC 電源スイッチが損傷するおそれがあるため、然るべき認定を受けた適任者による点検を受けてください。

本機器を AC 電源から遮断するには、IEC コネクターを抜きます。本機器の AC 電源スイッチは、機能上の目的のためだけに提供しています。したがって、機器の主電源遮断用として意図されていないか、適応していません。

EN 50110-1 と EN 50110-2 の適用範囲に該当する測定を行う際、使用電圧が 50 V AC RMS または 120 V DC を超えるすべての基板の接続作業は、適正な資格を持つ技術者が、または電気工学の訓練を受けた者が適正な資格を持つ技術者の監督の下、行わなければなりませんのでご注意ください。(適正な資格を有する技術者とは、専門技術者に向けた訓練を受け、知識と経験を有し、該当する規定についても熟知しているため、委託された作業の内容を評価し、存在する可能性のあるリスクを特定することができ、雇用主により適正な資格を有する技術者として任命されている者を指します。)

## 中文

**安全警告**
该仪器必须通过电源电缆的保护接地线连接到保护接地（接地），如果该仪器已配备了安全接地端子，则通过该端子接地。断开仪器内外的任何保护接地可能使设备存在危险。严禁有意断开。此外，若任何输入信号高于 33 V RMS, 46.7 V 峰或 70 V DC，则必须将信号接地 (IEC 61010-1:2010)。

不要取下保护盖。

如果电源保险丝因故障而熔断，则有可能损坏仪器的交流电源开关并应由具备资格的工程师检查。

拔下仪器上的 IEC 接头即可断开交流电源。仪器上的交流电源开关仅用于功能性目的。而不是用于或适用于断开设备。

对于 EN 50110-1 和 EN 50110-2 中的测量，请注意：所有工作电压高于 50 V AC RMS 或 120 V DC 的板卡只能由合格的技术人员或在由受过电气工程培训的人员在合格技术人员的监督下进行连接。（合格技术人员指的是其专业培训、知识和经验以及相关规定的指示能够胜任委托给他们的工作并能检查出可能风险的人，这些人会被其雇主指定为合格技术人员）

РУССКИЙ

**ПРЕДУПРЕЖДЕНИЕ**
Для эксплуатации данного прибора необходимо использовать защитное заземление, подключенное через проводник заземления кабеля питания или через терминал защитного заземления, если прибор оснащен таковым. В случае прерывания защитного заземления (внутри или снаружи прибора) прибор может стать травмоопасным. Преднамеренное прерывание заземления запрещено. Кроме того, необходимо подключить сигнальное заземление, если напряжение входного сигнала превышает 33 В среднеквадр. знач., 46,7 В пиков. знач. или 70 В пост. тока (IEC 61010-1:2010).

Не снимать крышки.

Если в результате неисправности перегорает предохранитель, существует вероятность повреждения переключателя сети переменного тока прибора. В таком случае переключатель должен быть проверен квалифицированным инженером.

Для отключения данного прибора от сети переменного тока отсоедините разъем IEC. Переключатель питания переменного тока данного прибора предусмотрен только для функциональных целей и не должен использоваться в качестве устройства отключения.

Для проведения измерений в соответствии со стандартами EN 50110-1 и EN 50110-2 следует учесть, что подключение всех плат, рабочее напряжение которых превышает 50 В перемен. тока среднеквадр. знач. или 120 В пост. тока, может выполнять только квалифицированный технический персонал или сотрудники, прошедшие курс обучения по электротехнике, под наблюдением квалифицированного персонала. (Квалифицированным техническим персоналом считаются сотрудники, которые после специальной подготовки, получения требуемых знаний и опыта, а также знакомые с основными процедурами, способны оценить доверенную им работу, определив возможные риски. При этом назначение на должность квалифицированного технического работника осуществляет работодатель.)

## 안전 경고

**안전 경고**
본 장비는 반드시 보안용 접지(접지)가 전원 공급 장치 케이블의 보안용 접지 도체를 통해 연결된 상태에서 작동해야 하며, 접지가 장착된 경우에는 보안용 접지 터미널을 통해 작동해야 합니다. 장비 내부 혹은 외부적으로 접지 방해 요인이 있는 경우 사용자에게 위험할 수 있습니다. 고의적인 방해는 금지됩니다. 또한, 입력 신호가 **33 V RMS, 46.7 V** 피크 또는 **70 V DC(IEC 61010-1:2010)**를 초과하는 경우 신호 접지를 연결해야 합니다.

덮개를 제거하지 마십시오.

결함으로 인해 공급 퓨즈가 끊어진 경우, 장비의 **AC** 전원 공급 스위치가 손상될 수 있으므로 반드시 검증된 전문 기사에게 이상 유무를 의뢰하도록 합니다.

**AC** 공급 전원으로부터 장비를 분리하려면, **IEC** 커넥터를 뽑으십시오. 본 장비의 **AC** 전원 공급 스위치를 장비 작동 외에 다른 용도로 사용하지 마십시오. 본 스위치는 단절 용도로 설계되지 않았으며, 이에 적합하지도 않습니다.

**EN 50110-1** 및 **EN 50110-2** 범위에 속한 측정값의 경우, **50 V AC RMS** 또는 **120 V DC** 를 초과하는 작동 전압의 모든 보드는 검증된 전문 기사 또는 전기 공학 교육을 받고 검증된 전문 기사의 감독을 받는 사람만이 연결할 수 있습니다. (검증된 전문 기사는 전문가 교육, 지식 및 경험뿐만 아니라 관련 규정의 지식을 보유하고 있어 그들에게 위임된 작업을 수행하고 가능한 위험을 탐지할 수 있으며 고용주가 자격을 갖춘 기술자로 지명한 사람입니다.)

## 2.10 Operation of electrical installations

Working on, with, or near electrical installations implies certain dangers. These electrical installations are designed for the generation, transmission, conversion, distribution and use of electrical power. Some of these electrical installations are permanent and fixed, such as a distribution installation in a factory or office complex, others are temporary, such as on construction sites and others are mobile or capable of being moved either whilst energized or whilst not energized nor charged.

The European Standard EN 50110-1 sets out the requirements for the safe operation of and work activity on, with, or near these electrical installations. The requirements apply to all operational, working and maintenance procedures. The European Standard EN 50110-2 is a set of normative annexes (one per country) which specify either the present safety requirements or give the national supplements to these minimum requirements at the time when this European Standard was prepared.

**WARNING**

| High Voltage and qualified personnel |
|---|

For measurements falling within the scope of the EN 50110-1 and EN 50110-2, please note that all cards with working voltages above 50 V AC RMS or 120 V DC may only be connected by a qualified technician or a person trained in electrical engineering and supervised by a qualified technician. (Qualified technicians are persons who, due to their specialist training, knowledge and experience as well as their knowledge of the relevant provisions are able to assess the work with which they are entrusted and detect possible risks and who have been nominated as qualified technicians by their employer).

# 3 Normative Documents and Declarations

## 3.1 Electrical

### 3.1.1 Electro Static Discharge (ESD)

When handling disconnected devices, electrostatic discharge (ESD) can cause damage if discharged into or near sensitive components on the device. Take steps to avoid such an occurrence.

**CAUTION**

**HBM uses state-of-the-art electronic components in its equipment. These electronic components can be damaged by discharge of static electricity (ESD). ESD damage is quite easy to induce, often hard to detect, and always costly. Therefore we must emphasize on the importance of ESD preventions when handling a GEN series system, its connections or a plug-in card.**

**Description of ESD**

Static electricity is an electrical charge caused by the buildup of excess electrons on the surface of a material. To most people, static electricity and ESD are nothing more than annoyances. For example, after walking over a carpet while scuffing your feet, building up electrons on your body, you may get a shock - the discharge event - when you touch a metal doorknob. This little shock discharges the built-up static electricity.

**ESD-susceptible equipment**

Even a small amount of ESD can harm circuitry, so when working with electronic devices, take measures to help protect your electronic devices, including your GEN series data acquisition system, from ESD harm. Although HBM has built protections against ESD into its products, ESD unfortunately exists and, unless neutralized, could build up to levels that could harm your equipment. Any electronic device that contains an external entry point for plugging in anything from cables to acquisition cards is susceptible to entry of ESD.

**Precautions against ESD**

Any built-up static electricity should be discharged from the user and the electronic devices before touching an electronic device, before connecting one device to another, or replacing acquisition cards. This can be done in many ways, including the following:

- Grounding oneself by touching a metal surface that is at earth ground. For example, if the computer has a metal case and is plugged into a standard three-prong grounded outlet, touching the case should discharge the ESD on the body.
- Increasing the relative humidity of the environment.
- Installing ESD-specific prevention items, such as grounding mats and wrist straps.

While appropriate precautions to discharge static electricity should always be taken, if ESD events are noticed in the present environment, the user may want to take extra precautions to protect the electronic equipment against ESD.

**The use of wrist straps**
Use an ESD wrist strap whenever you open a chassis, particularly when you will be handling circuit cards and components. In order to work properly, the wrist strap must make good contact at both ends (with your skin at one end, and with the chassis at the other).

**WARNING**

**The wrist strap is intended for static control only. It will not reduce or increase your risk of receiving an electric shock from electrical equipment. Follow the same precautions you would use without a wrist strap.**

**WARNING**

**Wrist straps should only ever be used in situations where no direct power is connected to the circuit or system being handled.**

### 3.1.2 Electro-Magnetic Compatibility (EMC)

EMC stands for Electro-Magnetic Compatibility. The overall intention is that electronic equipment must be able to co-exist with other electronic equipment in its immediate vicinity and neither emits large amounts of electromagnetic energy. Thus there are two distinct requirements for electromagnetic compatibility: Emission and Immunity.

This instrument generates, accepts and can radiate radio frequency energy and, if not installed and used in accordance with the operator manual, may cause harmful interference to other equipment. However, there is no guarantee that interference will not occur in a particular installation.

Immunity test: All immunity tests are done with the failure criterion being a change of the instrument's control settings. Any of these tests may produce a spurious trigger. Measurements are not valid during and immediately after the immunity tests.

In demanding applications, if this instrument does cause minor harmful interference to other equipment, which can be determined by turning this instrument off and on, the user is encouraged to try to reduce the interference by one or more of the following measures:

- Re-orient or relocate the affected equipment.
- Increase the distance between the instrument and the affected equipment.
- Re-orient or relocate interface cables.
- Connect the instrument to an outlet on a different supply circuit to the affected equipment.

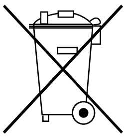
Supply cables, interface cables and probes should be kept as short as practical, preferably a maximum of 1 m. Interface cables should be screened and interface cables longer than 3 m are not acceptable in terms of interference port immunity.

## 3.2 Environment

### 3.2.1 WEEE - Waste Electrical and Electronic Equipment

Since February 2003, European Union legislation has been in force stating that EU members are now restricting the use of hazardous substances in electrical and electric equipment (Directive 2002/95/EC) as well as promoting the collection and recycling of such electrical equipment (Directive 2002/96/EC).

**Statutory waste disposal mark**



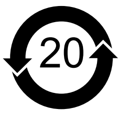
The electrical and electronic devices that bear this symbol are subject to European waste electrical and electronic equipment directive 2002/96/EC. The symbol indicates that the device must not be disposed of as household garbage.

In accordance with national and local environmental protection and material recovery and recycling regulations, old devices that can no longer be used must be disposed of separately and not with normal household garbage. If you need more information about waste disposal, please contact your local authorities or the dealer from whom you purchased the product. As waste disposal regulations within the EU may differ from country to country, we ask that you contact your supplier as necessary.

**Packaging**

The original packaging of HBM devices is made from recyclable material and can be sent for recycling. For ecological reasons, empty packaging should not be returned to us.

**Environmental protection**




The product will comply with general hazardous substances limits for at least 20 years, and will be ecologically safe to use during this period, as well as recyclable. This is documented by the 20 years symbol on the system as statutory mark of compliance with emission limits in electronic equipment supplied to China.

## 3.3 Declaration of conformity

For information about the CE Declaration refer to www.hbm.com/highspeed.

# 4 Batteries

## 4.1 General

The GEN series Data Acquisition System has internal batteries.

**Battery life time**

A batteries life time depends on how they are handled. High temperature, super-fast charging and harsh discharges are conditions that harm batteries. Repeated full discharge cycles also stress the battery.

**Precautions and warnings when using batteries**

- Use the battery only for its intended purpose.
- Do not take batteries apart or modify them. The batteries must not be damaged, crushed, pierced or exposed to high temperatures. In case of inappropriate handling of a battery there could be a risk of combustion or explosion.
- Do not leave the batteries in hot or cold places, as you will reduce the capacity and lifetime of the batteries. Always try to keep batteries at room temperature. A system with hot or cold batteries may temporarily not work, even if the batteries are fully charged.
- Do not short-circuit the battery. Accidental short-circuit can occur when a metallic object causes a direct connection between the + (plus) and - (minus) terminals of the battery, for example when you carry a spare battery in a pocket or bag. Short-circuiting the terminals may damage the battery or the object causing the short-circuiting.

**WARNING**

**If leaked battery fluid comes into contact with your eyes, immediately flush your eyes with water and consult a doctor, as it may result in blindness or other injury. If leaked battery fluid comes in contact with your body or hands, wash thoroughly with water.**
**If leaked battery fluid comes into contact with the instrument, carefully wipe the instrument, avoiding direct contact with your hands.**

### 4.2 Removing and replacing

The GEN series Data Acquistion System interface/controller module includes a non-user replaceable battery please contact your local dealer for more information.

**WARNING**

| |
|---|
| **Danger of explosion if battery is incorrectly replaced.** |

## 4.3 Recharging

The GEN series Data Acquisition System does not use rechargeable batteries. When batteries are depleted dispose of the batteries.

## 4.4 Disposal

Dispose of used batteries in accordance with local chemical waste regulations only. Always recycle.

If you need more information about waste disposal, please contact your local authorities or the dealer from whom you purchased the product.
As waste disposal regulations within the EU may differ from country to country, we ask that you contact your supplier as necessary.

# 5 Mains Power

## 5.1 Power and frequency requirements

To connect or disconnect the instrument from the AC supply, plug or unplug the IEC connector from the instrument. The instrument should be positioned to allow access to the AC connector. The front power switch on the instrument is not a disconnecting device. When the instrument is connected some power will be consumed.

See "Connecting power" on page 62 for more details.

The GEN7t uses up to 450 VA and operates from line voltages from 85 V AC to 264 V AC at 47-63 Hz. The power connection of the GEN DAQ is via a standard IEC 320 EN 60320 C14 (male) appliance inlet, 2-pole, 3-wire designed for 250 V at 10 A. The GEN DAQ AC supply has no replaceable fuses installed. The power supply uses a build in resettable power shut down protection.

The GEN16t uses up to 1200 VA and operates from line voltages from 100 V AC to 240 V AC at 47-63 Hz. The power connection of the GEN DAQ is via a standard IEC 320 EN 60320 C20 (male) appliance inlet, 2-pole, 3-wire designed for 250 V at 16 A. The GEN16t AC supply has no replaceable fuses installed. The power supply uses an automatic circuit breaker as protection.

Both the GEN7t and GEN16t also operate with 400 Hz input power with slightly higher leakage current.

**CAUTION**

| |
|---|
| **Do not position the GEN7t or GEN16t so that it is difficult to remove the power input cable.** |

The GEN7t or GEN16t must be used with a ground connection through the conductor of the supply cable. This is to ensure that all electromagnetic Compatibility (EMC) requirements are met.

## 5.2 Connecting power

### 5.2.1 Connecting the power on a GEN7t tower model

The power outlet and the chassis ground lug are located on the bottom rear of the GEN series unit.

**WARNING**

**ELECTRICAL SHOCK HAZARD!**
**Connect a Chassis Ground wire to prevent electric shock or damage to the GEN series.**

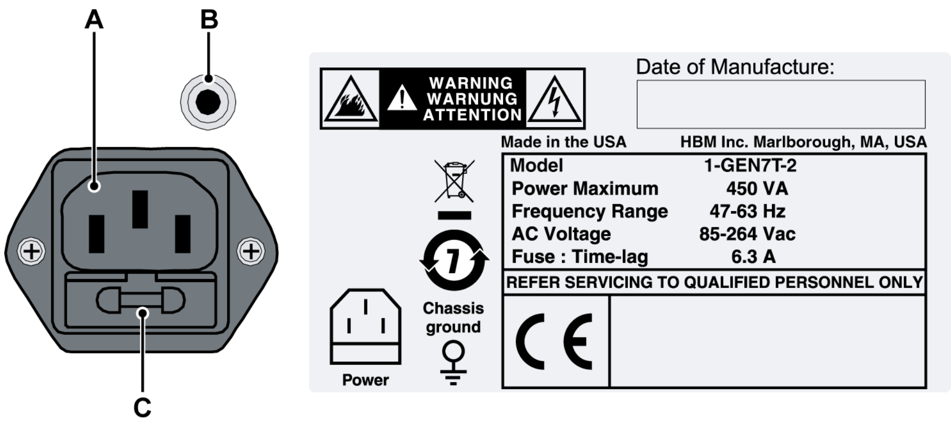



**Figure 5.1:** Connecting power (Tower model)

**A** Power

**B** Protective ground

**C** Fuses

### 5.2.2 Connecting the power on a GEN16t rack model

The power outlet and the chassis ground lug are located on the bottom rear of the GEN series unit.

**WARNING**

**ELECTRICAL SHOCK HAZARD!**
**Connect a Chassis Ground wire to prevent electric shock or damage to the GEN series.**

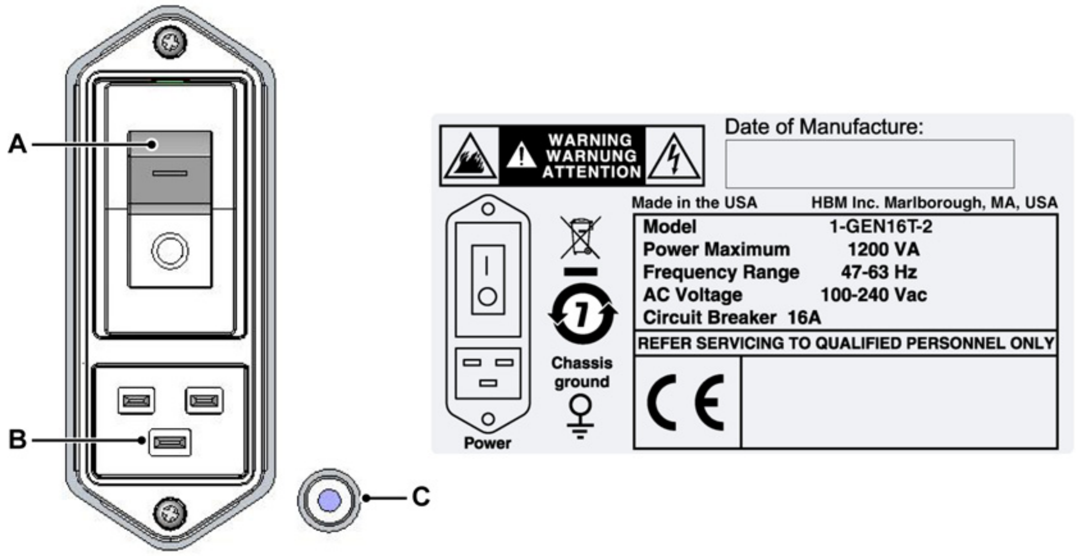



**Figure 5.2:** Connecting power (Rack model)

**A** Switch

**B** Power

**C** Protective ground

## 5.3 Fuse requirements and protection

The GEN7t is equipped with replaceable fuses. The fuse arrangement stated in this manual and on the GEN7t must be followed and, additionally, in the UK a fuse must be fitted in the line supply plug.

The GEN16t is equipped with an automatic circuit breaker and has no additional fuses. In the UK a fuse must be fitted in the line supply plug.

**WARNING**

**Any interruption of the protective conductor inside or outside the apparatus is likely to make the apparatus dangerous. Intentional interruption is prohibited.**

**When the apparatus is connected to its supply, terminals may be live, and the opening of covers for removal of parts is likely to expose live parts.**

Whenever it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

The protection is likely to be impaired if, for example, the apparatus shows visible damage or has been subjected to severe transport stresses.

It is the responsibility of the user to ensure the safety of any accessories, such as probes, used with the equipment.

**WARNING**

**ELECTRICAL SHOCK HAZARD! Do not remove covers. Refer servicing to qualified individuals.**

Proper use of this device depends on careful reading of all instructions and labels.

If the instrument is used in a manner not specified by HBM, the protection provided by the instrument can be impaired.

## 5.4 Fuse replacement

The GEN series rack model is equipped with a 2-pole, rocker actuated circuit breaker type TA 45 (16 A) and has no additional fuses.

For the tower model defective fuses must be replaced with an identical 6.3 A slow blow type only, see Figure 5.1 "Connecting power (Tower model)" on page 62.

**To replace the fuse:**

**1** Power the system down and remove the power cord. This will enable access the groove on the fuse holder.
**2** Use a small flat-head screwdriver to pry out the fuse holder.

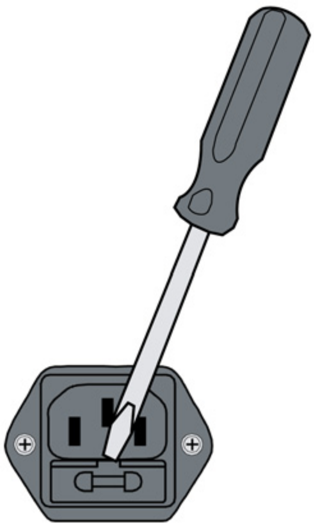


**Figure 5.3:** Fuse and location to open by

**3** Remove the defective fuse and replace with an identical 6.3 A slow blow type only.

# 6 Introduction

## 6.1 Introducing the GEN series

The GEN series system is “future-proof”, modular and easily extendable. Using the basic data acquisition building blocks - Signal Conditioning, Acquisition, Storage, Analysis and Control you can determine what capabilities are required and maintain a system that is right for you. Some of the main features include:

- Combined transient recorder and data acquisition system
- Combined time domain and frequency domain performance
- 200 kS/s to 100 MS/s sample rates provided
- 800 MS Transient RAM per channel
- Isolated and non-isolated channels
- Unlimited recording size and duration, using direct streaming to disk
- High fidelity signal conditioning
- View and control anywhere on your network
- CAT II and CAT III isolated channels

Setup, real-time monitoring and control can be done from any Windows PC using the Perception software, including wired, wireless and fiber optic networks. HBM's exclusive StatStream® processing minimizes network traffic to assure quick updates and instant responsiveness even with thousands of channels enabled.

The GEN series Data Acquisition System consists of:

- GEN series mainframe with Input cards and on-board signal conditioning
- Perception software
- An optional interface

Perception control software which requires:

- PC running Microsoft® Windows XP, Vista, 7 or later

**HINT/TIP**

Perception software automatically detects all available GEN series systems and can report their configuration.
References made in this manual to Perception are based on Perception version 6.14. As from version 6.02 (Perception and GEN series firmware) the Diagnose menu item on the front panel display control has been added.

## 6.2 Mainframe overview

There are several different GEN series mainframes available:

| Model | Slots | Design | Comments |
|---|---|---|---|
| GEN 7t | 7 | Mobile/Tower | Best for smaller channel count applications and easy to be transported |
| GEN 16t | 16 | Rack | Offers higher channel counts and can be mounted in a rack or used stand alone |
| GEN 2i | 2 | Portable | Replaced by GEN3i end of 2013 |
| GEN 3i | 3 | Portable | An integrated all-in-one portable data recording solution suitable for field use. Also suitable for rack mount use. |
| GEN 3t | 3 | Portable/Rack | Tethered portable data recording solution suitable for field use. Also suitable for rack mounted use. |
| GEN 5i | 5 | Mobile | Replaced by GEN7i approx. mid 2014 |
| GEN 7i | 7 | Mobile | A larger transportable unit intended for lab use |

All mainframes share many of the GEN series features. Besides the listed differences in the above table other differences are mechanical form factor, power consumption, integrated PC or tethered PC use etc. See individual mainframe data sheets for technical details.

## 6.3 Hardware

The acquisition section of the GEN7t and GEN16t are based on the successful and proven GEN series Data Acquisition System.

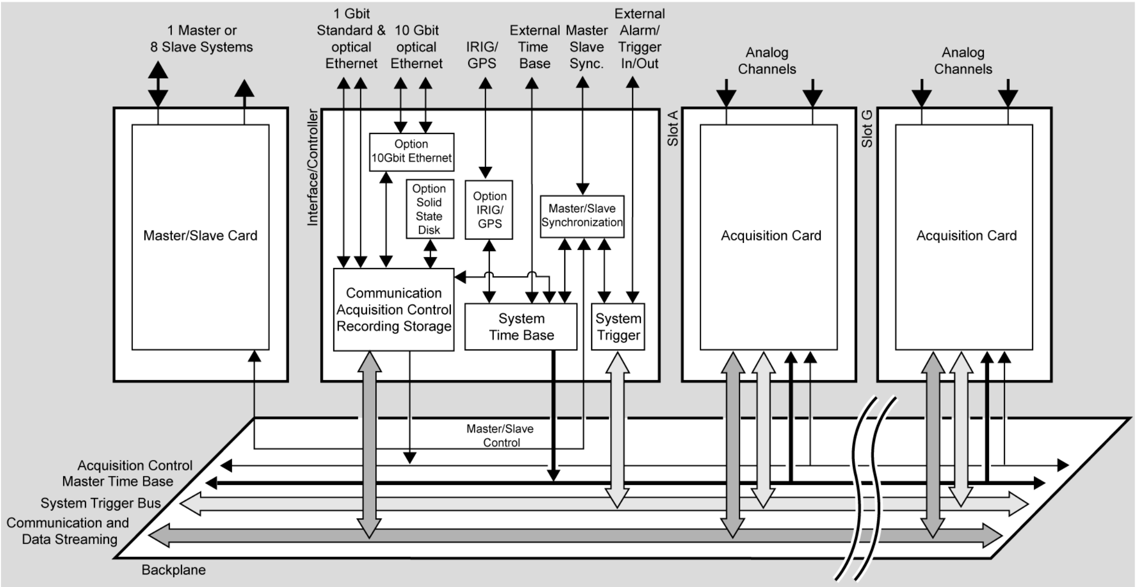



**Figure 6.1:** Block Diagram GEN7t Data Acquisition System

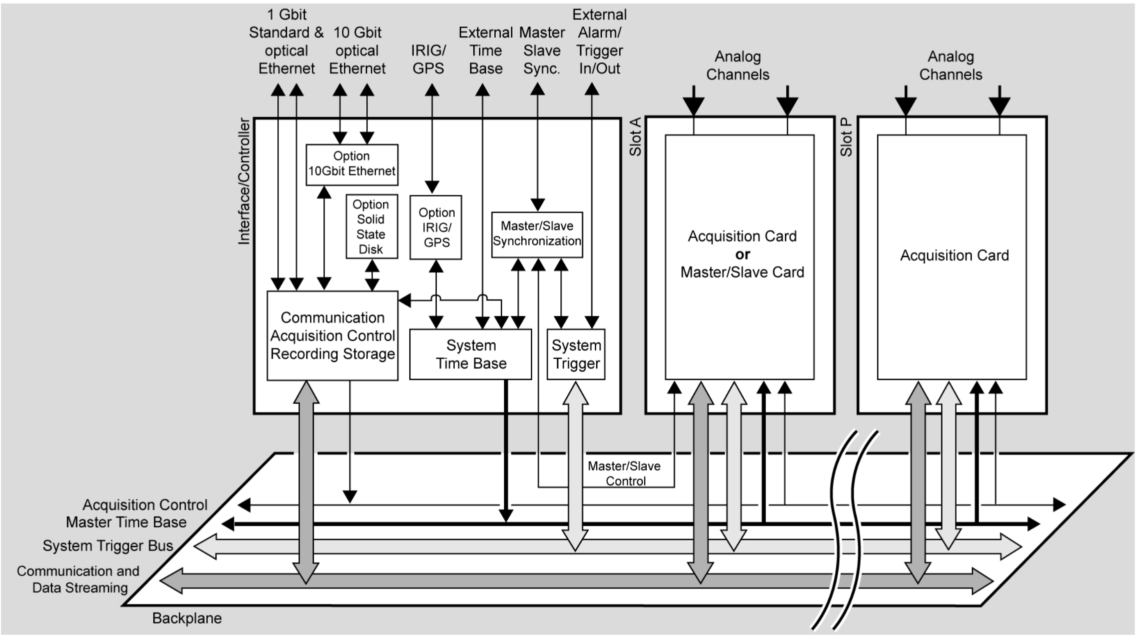



**Figure 6.2:** Block Diagram GEN16t Data Acquisition System

### 6.3.1 Backplane

The CPCI (Compact Peripheral Component Interconnect) backplane can transfer data at high speed to assure the highest system throughput.

### 6.3.2 Interface/Controller module

The Interface/Controller module runs a high-end CPU with an embedded real-time operating system. It can store to hard disk or Solid State Disk (SSD), or stream directly to an external connected PC. For more information see “Interface Module/System Controller” on page 175.

### 6.3.3 Input cards

The GEN7t can accept up to seven input cards. The GEN16t can accept up to 16 input cards. Each input card includes one or more digitizers, powerful filtering and intelligent triggering, and acquisition management. For the analog input section the GEN series input modules use signal conditioners that are daughter cards mounted integrally with the input module in the same slot. For more information on the various modules see "Available input cards" on page 269.

**Note** *Before changing or removing input cards, always check your warranty information. Changing input cards will void the tight calibration of the input card. Wider tolerance have to be considered when exchanging input cards. See individual specification of input cards used in appendix A “Specifications” "B3705-1.0 en (GEN series GEN7t Transient Recorder and Data Acquisition System)" on page 378.*

### 6.3.4 Master/Slave Card

The GEN series can be operated as a fully synchronized Multi-Mainframe system with multiple mainframes using the Master/Slave card.

With the Master/Slave card you can:

- connect one GEN series “Master” to up to eight “Slaves”
- fully synchronize up to nine mainframes
- record up to 1080 channels with 1 MS/s sampling speed each by using all slots
- or record up to 540 channels with 100 MS/s per channel by using all slots
- use the fiber optic link with up to a 500 m cable between the master and each slave

And the Master/Slave option provides:

- the sampling clock, absolute time info, trigger and start/stop signals between the mainframes, creating a real high channel synchronized system out of the nine mainframes
- a timing accuracy between the mainframes better than 100 ns
- an automatic cable length detection and compensation

### 6.3.5 Thermal protection

Every GEN series mainframe supports a feature called Thermal Shutdown. For this the mainframe and acquisition cards have built-in digital thermocouples to measure local temperatures. The GEN series embedded software reads these values every minute and monitors the system internal temperature for overheating.

Automatic user warnings are initiated using the following diagram (see Figure 6.3).

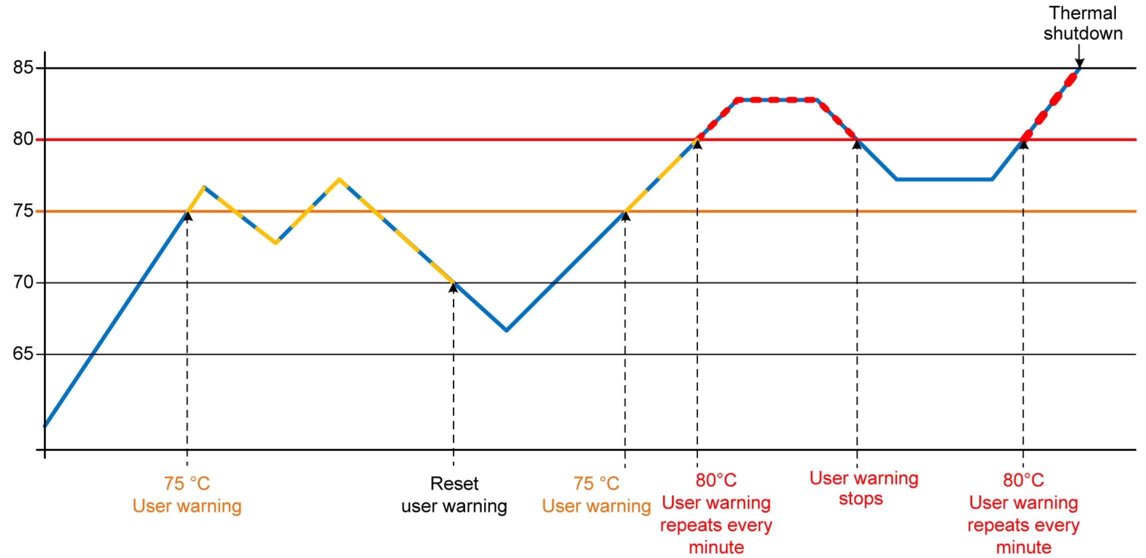



**Figure 6.3:** Thermal protection - Automatic user warnings

- As soon as one of the internal thermocouples measures a temperature above +75 °C for the first time, a single user warning is initiated. As long as the highest measured temperature measured is above +70 °C and below 80 °C no additional user warnings are initiated.
- If the internal temperature after reaching +75 °C drops below +70 °C, this is considered as a user action to reduce internal temperatures. If the internal temperature reaches 75 °C again, this is considered to be a new thermal problem and a new user warning will generated.
- If the internal temperature keeps rising and reaches +80 °C, it is considered to have reached a critical zone. User warnings will be send every minute as long as the measured temperatures are above +80 °C. If the temperature drops below +80 °C the minute warnings stop. If the temperature rises above + 80 °C again user warnings are initiated every minute.

- If by any chance the internal temperature keeps rising and reaches +85 °C an automatic thermal system shutdown user warning is generated, the automatic thermal shutdown event is logged in the systems error log and the system will shutdown.

At next power-on of the GEN series system, the automatic thermal shutdown event will be presented to the user again and can be found in the error diagnostics of the mainframe.

### 6.4 Module and card slot placement

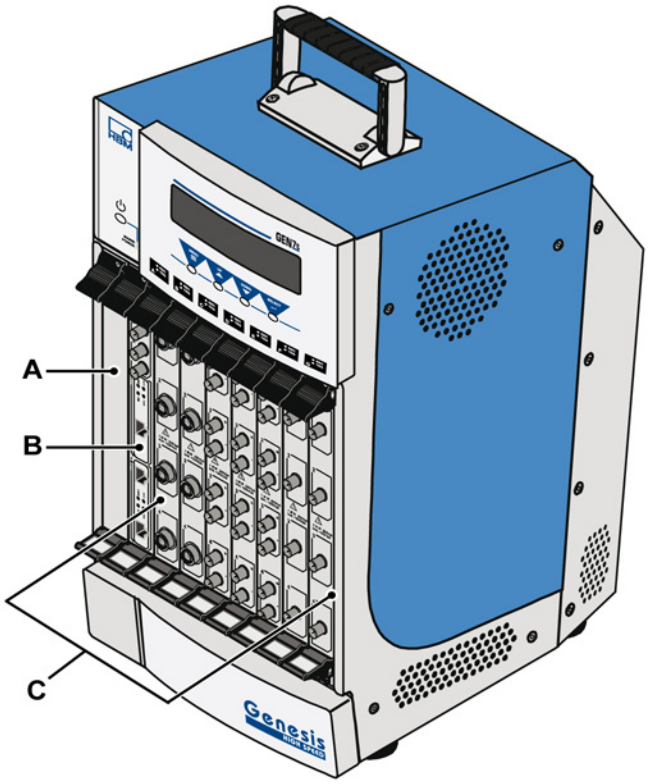



**Figure 6.4:** GEN series tower model (GEN7t)

**A** Master Slave slot only

**B** Interface/Controller module only

**C** Acquisition cards

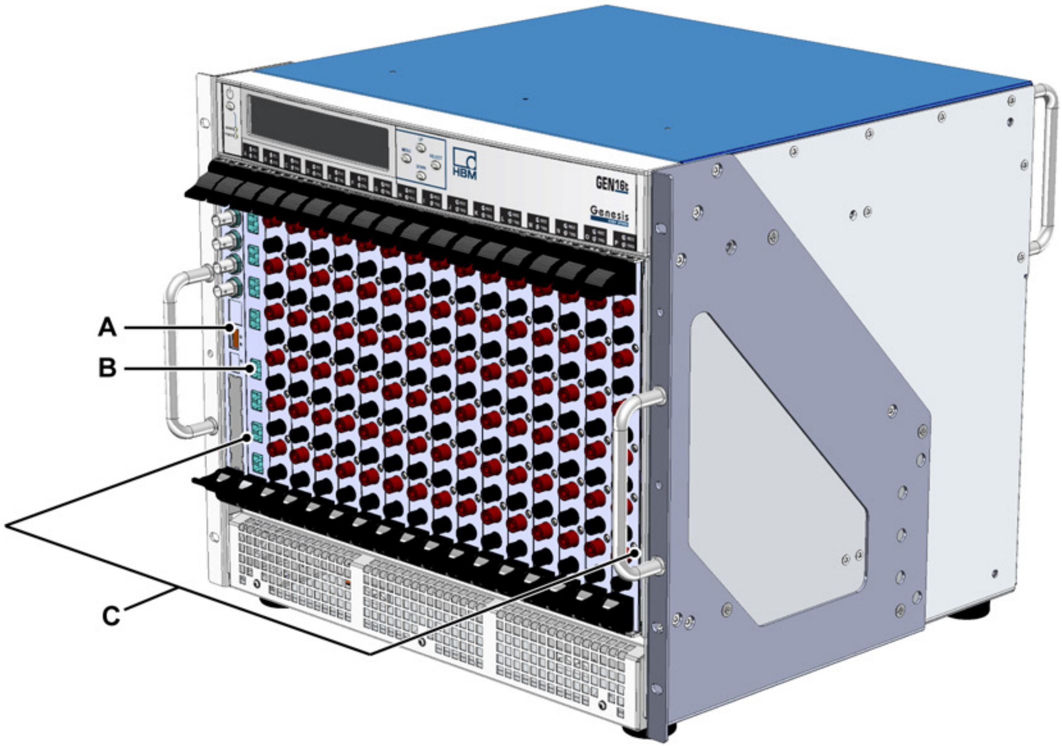



**Figure 6.5:** GEN series tower model (GEN16t)

**A** Interface/Controller module only

**B** Master Slave or Acquisition cards

**C** Acquisition cards

### 6.4.1 Interface/Controller module

The Controller/interface module IM1 and IM2 run on a high-end CPU with an embedded realtime operating system. The IM1 and IM2 can stream data across an on-board Ethernet connection. The IM1 has the ability to store data to a local SCSI drive while the IM2 can store data to a local SSD.

Communication as well as data transfer is through the available through a copper or fiber optic Ethernet interface.

The IM1 and IM2 Module can house one option like SCSI or IRIG for more information see “GEN series Options” on page 214.

**Note** *The Interface/controller module has a dedicated slot in any mainframe.*

### 6.4.2 Acquisition cards

The GEN series tower mainframe can accept up to seven input cards. The 19” version can accommodate 16 cards. Each input card includes one or more digitizers, a powerful DSP for filtering and intelligent triggering, and a CPU running a real-time operating system for acquisition management. For the analog input section the GEN series input cards use signal conditioners that are integrated with the input card. For more information on the various cards see “Input cards” on page 269.

### 6.4.3 Master/slave card

For fully synchronous operation between multiple mainframes the master/slave module is used.

**Note** *The master slave card has it's own slot depending on mainframe check the images Figure 6.4 and Figure 6.5 above for details.*

The master/slave module synchronizes clocks, triggering, pause/stop and start signals between all connected mainframes. Connections are made using fiber optic cables.

This option allows for a multi-mainframe configuration to work as a single unit. Within a combination of mainframes, one mainframe is used as a master that can drive up to eight slaves.

## 6.5 Acquisition

The GEN series is a multi-channel modular Data Acquisition System. It provides real-time data for waveform and meter displays. At streaming rate determined by your PC and your network, it allows unlimited recording duration and file size. Statistics are performed in real-time. Its extreme-performance signal conditioning includes both Bessel and Butterworth anti-alias filters to provide excellent response.

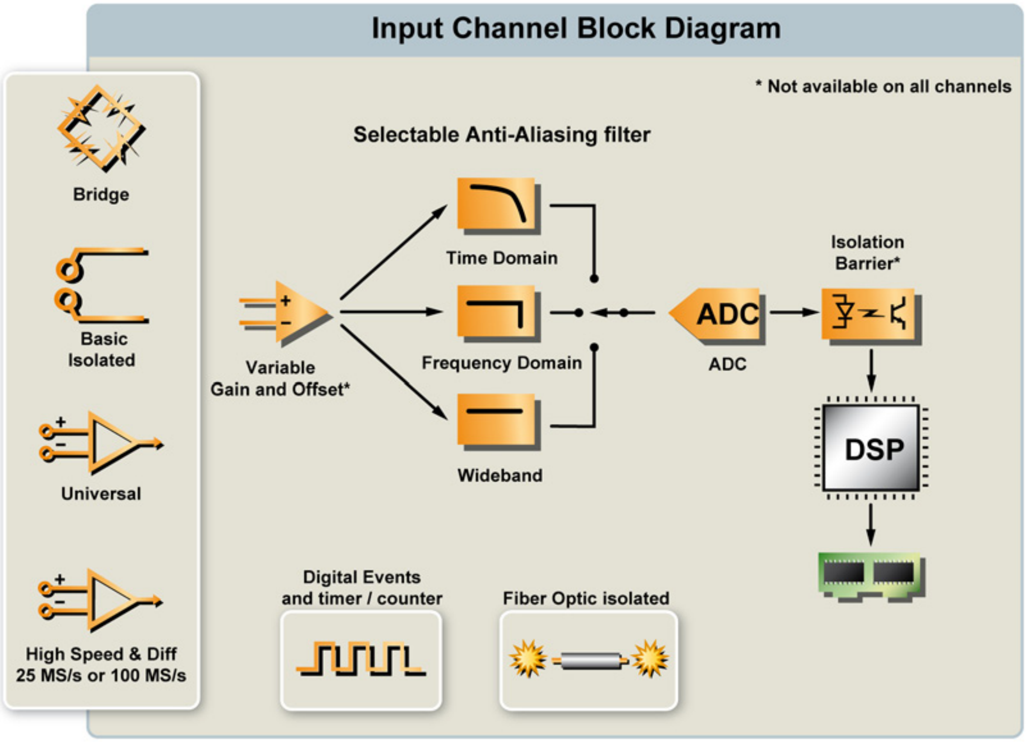



**Figure 6.6:** Input channel block diagram

**A** Acquisition card types

It also functions as a transient recorder with a hardware trigger on all channels with hysteresis, delay and logic features. Transient memory is huge and can capture minutes of data at 1 MS/s up to 100 MS/s on all channels. Segmented sweeps are displayed with no dead time and the recorder has a wide analog bandwidth.

### 6.5.1 StatStream®

Most PC-based DAQ systems can easily acquire megabytes of data. But even the most powerful PC is poorly equipped to display and process files of megabytes or gigabytes. In fact, most DAQ systems fail to display over 99% of your live data! The exclusive StatStream® technology accelerates all aspects of your measurement task with dedicated hardware and firmware.

While recording, StatStream® pre-processes a display summary at the full resolution of your PC monitor. Even a single transient point on any channel is accurately displayed.

In addition, StatStream® continuously calculates parameter values on blocks of data. You know the vital statistics at every moment, including warnings if any channel goes off scale. The Perception software offers a variety of meters to display these on-line parameters.

When reviewing your stored files, the embedded StatStream® data enables an accurate, detailed overview of any size file in seconds. Unlike competitive systems, your PC has no need to inspect gigabytes of information just to display the last kilobyte. As you zoom in, more detail is displayed while always maintaining the highest visible resolution.

## 6.6 Signal conditioning

The GEN series system supports common analog sensors with the highest performance signal conditioning available. All inputs are sampled simultaneously for exact time correlation, and the front ends deliver a typical maximum static error of 0.1%.

Typical inputs and sensors supported are:

- Voltage (single-ended and differential)
- Current
- Strain gages in any configuration
- IEPE (Integrated Electronics Piezo Electric, for example ICP®, CCLD, Isotron®, Deltatron®, Piezotron® and others)
- Resistive sensors (e.g. displacement, temperature)
- Binary and frequency (counter/timer)
- Charge

Plug-and-play hardware discovery with scalability lets you configure any number of channels. Perception software can group and outline similar amplifiers for one-click settings. Extensive diagnostics give you the confidence of correctly wired and working sensors before running your test.

## 6.7 Data storage

In addition to mega samples of on-board RAM, you can record directly to your PC hard drive, removable disk, or network server over the Gigabit Ethernet. The GEN series system always stores to on-board high-speed RAM. Recorded data is then automatically stored to your PC at the maximum speed of your network and hard disk at rates up to megabytes per second (dependent upon your PC). Storage to the PC is continuous and unlimited duration recordings can be made.

The GEN series Interface/Controller module 2 can be factory-equipped with an optional SSD. The SSD option provides expansion and flexibility of recordings. For details on the SSD option see “GEN series Options” on page 214.

Recorded files are standard Windows files with extension pNRF (Perception Native Recording File).

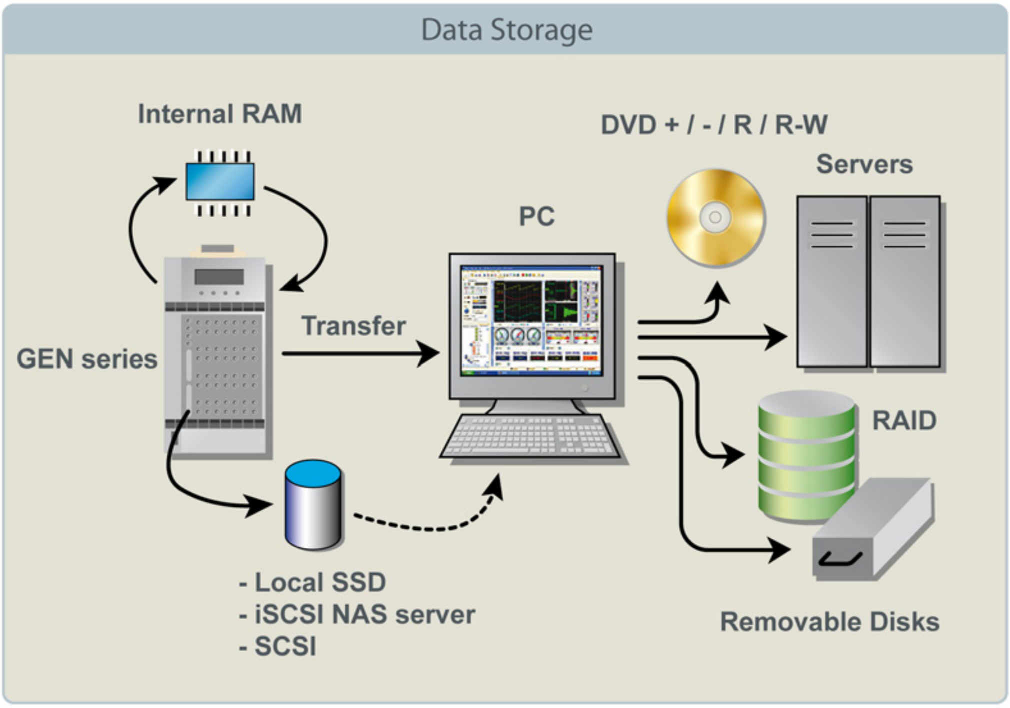



**Figure 6.7:** Data storage options

# 7 Setting up the GEN series

## 7.1 Connecting the GEN series to a network

The GEN series uses standard TCP/IP protocol over Ethernet to communicate with your PC. The Interface/Controller module provides access to the Ethernet network.

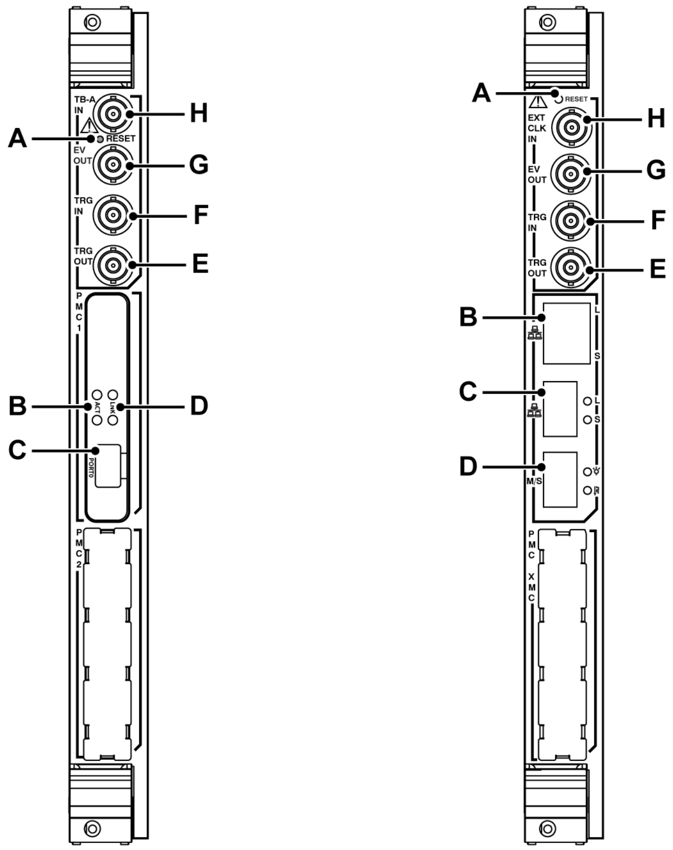



**Figure 7.1:** Interface/Controller modules (IM1-left) (IM2-right)

| | IM1 | | IM2 |
|---|---|---|---|
| **A** | Recessed CPU Reset Switch | **A** | Recessed CPU Reset Switch |
| **B** | Activity detected | **B** | Standard 1 Gbit Ethernet port |
| **C** | RJ-45 Connector/Ethernet Port | **C** | Optical 1 Gbit Ethernet port |
| **D** | Link detected | **D** | Synchronized recording M/S |
| **E** | External Trigger Out | **E** | External Trigger Out |
| **F** | External Trigger In | **F** | External Trigger In |
| **G** | External Event Out | **G** | External Event Out |
| **H** | External Time base In | **H** | External Time base In |

You can connect your GEN series in either of two ways:

- Directly to your PC, or
- To your company network

The GEN series is an extremely high-performance acquisition system that is capable of transferring Megabytes of data at high speed to your PC. For the best performance and fastest throughput, HBM strongly recommends the GEN series be connected directly to an Intel© Core i5 or i7 third generation based PC (or equivalent) with the CPU operating at a clock frequency of 2.5 GHz or greater and a 1 Gigabit Ethernet adapter.

If your PC also connects to your company network, a second hardware Ethernet adapter in your PC is recommended for this purpose. A second adapter preserves your Gigabit connection for the fastest possible data transfer, while preventing GEN series network traffic from potentially interfering with the company network performance.

### 7.1.1 Connecting the GEN series directly to your PC

You can connect the GEN series directly to your PC, at the same time you can also connect your PC to a corporate network. For this you will need a PC with two Ethernet NICs (Network Interface Cards.) The one for the GEN series must be at least 1 Gbit for the best performance. You will require either a Cat5e Ethernet cable or an optical cable from your PC to the GEN series depending on options installed.

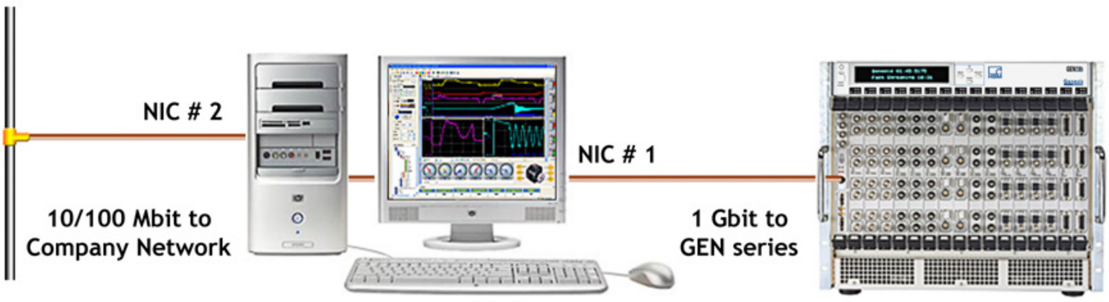



**Figure 7.2:** Direct connection to PC

Since NIC #1 in the illustration is not on the company network, your PC and your GEN series cannot automatically obtain network IP addresses from a server as they normally would. After a one-minute time-out period waiting for a server response, they will both assign themselves a network IP address in the range of 169.254.xxx.xxx with a subnet mask of 255.255.0.0. This is called "Automatic Private IP Addressing" and is built into Microsoft Windows. Therefore it is not necessary to make any network settings on the GEN series or your PC. **However, you must wait a minute or two after powering up the GEN series before you can communicate.** If you prefer to avoid the one minute wait, you may manually assign a fixed IP address and subnet mask in both the PC and the GEN series.
See "Settings Menu iSCSI IP Address" on page 115 for further information.

### 7.1.2 Connecting the GEN series to your company network

If you do not want to use a PC with two Ethernet cards, you can connect the GEN series to an Ethernet port on your local network. HBM recommends adding a 1 Gigabit autosensing Ethernet switch for this purpose. Low-cost compact switches with four to eight ports are readily available at any computer store, sufficient for connecting a number of instruments to your PC. Unlike a hub, a switch allows your PC to communicate with your instrument(s) locally with a dedicated high-speed connection, without burdening the company network with possibly high data rates. It simply plugs in and requires no network configuration.

Your network could look like Figure 7.3.

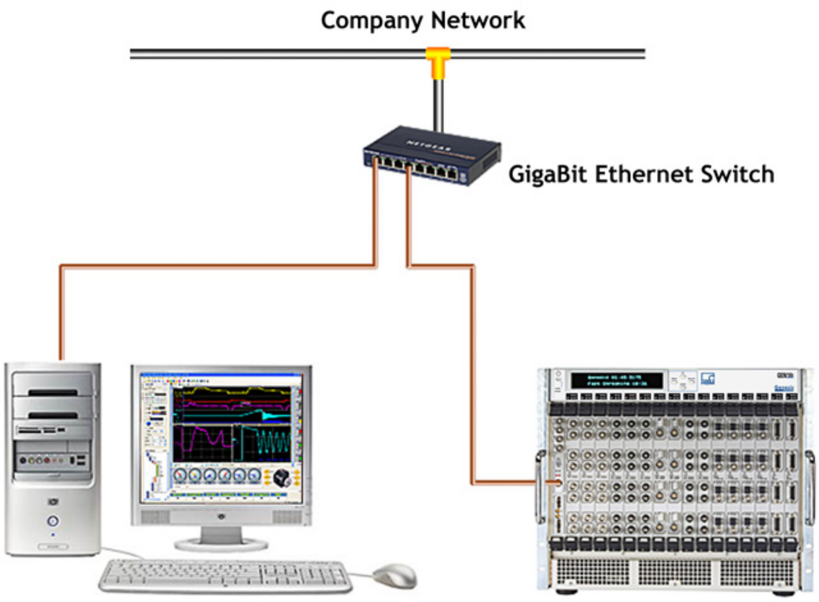



**Figure 7.3:** Connection to corporate network

The GEN series is pre-set for DHCP to automatically obtain a network IP address from your company server, just as your PC does. There is no need to make any network settings on the GEN series or your PC.

### 7.1.3 Note on IP address and DHCP

An IP address is like your telephone number or your home address -- each one is entirely unique. Every computer on the Internet or a local network has its very own IP address. The standard format is four groups of numbers separated by periods, and each number is an integer between 0 and 255.

IP addresses can be divided into two groups: static and dynamic. Computers that run important tasks all day, every day, such as servers and mail servers, have static IP addresses -- their addresses never change.

DHCP operates like any other client-server relationship. When your PC or GEN series connects to a DHCP server, the server leases the machine a private IP address. The machine lives at that address until the lease expires, at which point you are given a new IP address. When your system administrator configures your DHCP server, he can set the leases to time out at different intervals. The most common lease duration among ISPs and other large networks is three days. DHCP servers can be located within a PC or a network router.

When you want to use static IP addresses, you must set the GEN series network setting **Use DHCP** to **False**.
When there is a DHCP server you can set the GEN series network setting **Use DHCP** to **True**. For details see "Network Interface Use DHCP" on page 108.

**WARNING**

**When Use DHCP is set to False and when you are using multiple mainframes you must set a different IP address for each mainframe. For details see "Network Interface IP address" on page 103.**

### 7.1.4 Network testing and troubleshooting

**To test your network environment:**

1. If your GEN series is correctly connected to the Ethernet, the LINK LED on the front panel will illuminate within a few seconds to indicate a hardware interface is recognized. If the LINK LED does not light, your Ethernet cable is not connected or incorrectly wired (straight instead of cross-over or vice versa). Hold the two ends of the cable side by side with the retainer tab downward. A straight cable has the orange wires on the left side at both ends. A crossover cable has the orange wires on opposite sides. Also check that all eight conductors are present in the connector. Some inexpensive cables contain only four conductors. These cables are not compatible with your GEN series.
2. If the LINK LED is lit but the Perception software cannot find the GEN series system, check the TCP/IP network settings on the GEN series and on your PC. See Chapter 5 on page 89 to see how to display the GEN series IP address and mask. On your PC in Windows select Start in the task bar, click Run… and type "CMD" without quotation marks. This opens a command window. In the command window type IPCONFIG or optional IPCONFIG /ALL to view your settings. Some of the most common problems are:
   - IP addresses that are not in the same range. Normally the first three octets are the same and the fourth one varies, such as 169.254.10.252 and 169.254.10.200.
   - Identical IP addresses. Your PC and the GEN series must have at least one digit different in the fourth octet.
   - IP addresses that use the reserved numbers 0 or 255. All digits should be between 1 and 254.
   - The Subnet masks are not completely identical.

## 7.2 Removing and installing input cards

All of the cards/modules are removed and installed the same way. Acquisition cards can be freely interchanged and installed in any acquisition card slot, A through G (A through P for 19” rack). They are automatically recognized without any configuration, jumpers or switch settings.

**Note** *The Interface/Controller module can only be installed in the first or left-most slot of any mainframe.*

**CAUTION**

**HBM uses state-of-the-art electronic components in its equipment. These electronic components can be damaged by a discharge of static electricity (ESD). Therefore, we must emphasize the importance of ESD preventions when removing or installing cards/modules.**

**CAUTION**

**The GEN series Data Acquisition System is factory-calibrated as delivered to the customer. Swapping, replacing or removing of cards/modules may result in minor deviations to the original calibration. The GEN series system should be tested and if necessary, calibrated, at one-year intervals or after any major event that may affect calibration. When in doubt, consult your local supplier.**

**CAUTION**

**Heatsink and other parts of the card/module may be hot when removed just after switch-off.**

### 7.2.1 Removing cards/modules

To remove a card/module:

**1** Shut down the GEN series and remove the power input cable.
**2** Loosen the small set screw on both ejectors on the card/module:

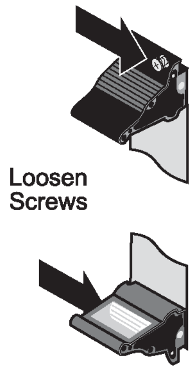



**Figure 7.4:** Card/module ejectors with screws

**3** Press the inner grey button on each ejector to release the catch.


**Figure 7.5:** Card/module ejectors

**4** Press both ejectors outward to release the card/module. They act as levers to gently pull the card/module from its backplane sockets.

**5** Slide the card/module out of the GEN series unit.

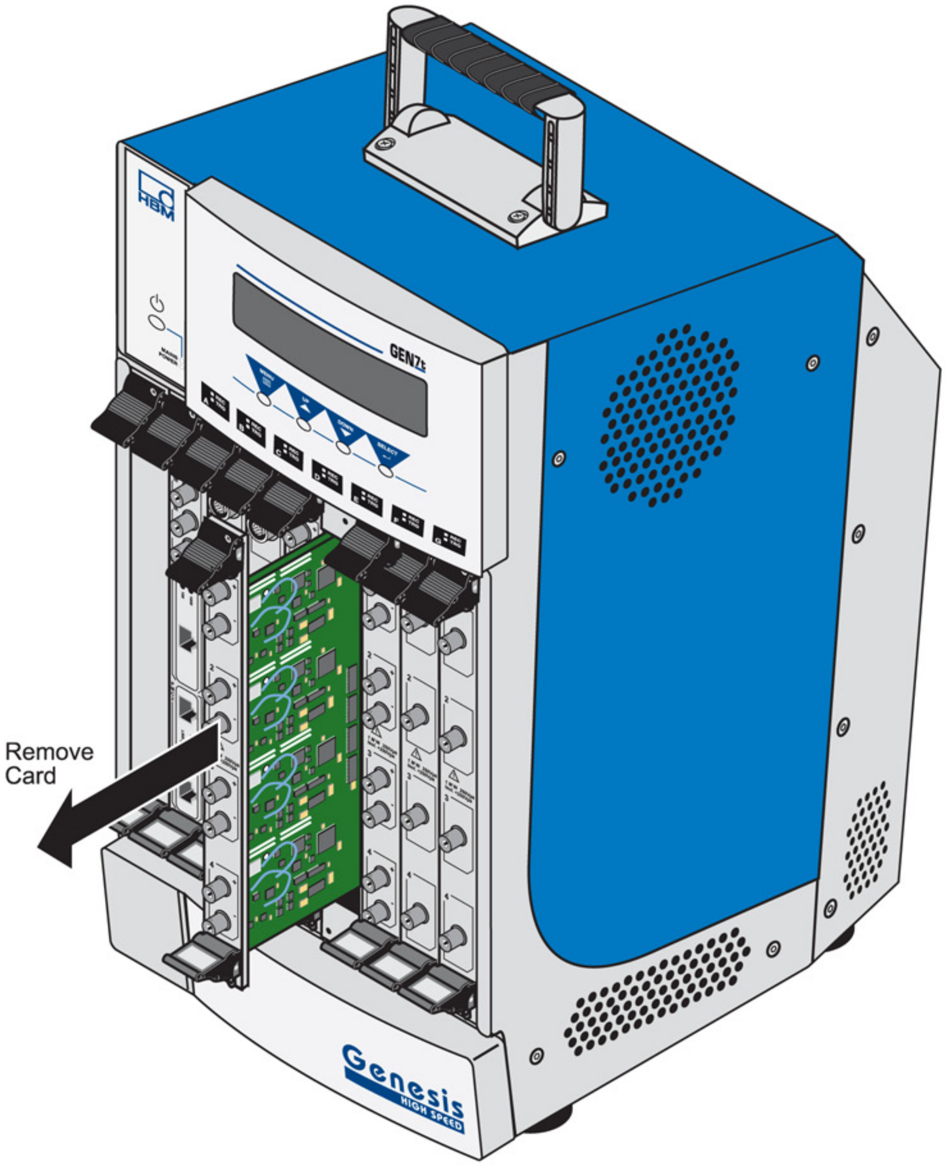



**Figure 7.6:** GEN7t (with removed card)

### 7.2.2 Installing cards/modules

**To install cards/modules proceed as follows:**

**1** Shut down the GEN series and remove the power input cable.
**2** Ensure the ejector levers are in the farthest outermost position, tilting away from the module.
**3** Slide the module into its guide rails until the ejectors contact the perforated metal strips at top and bottom.
**4** Press both ejectors inward to seat the module. They act as levers to gently pull the module into its backplane sockets. The gray button should snap to its default position and lock the ejectors.

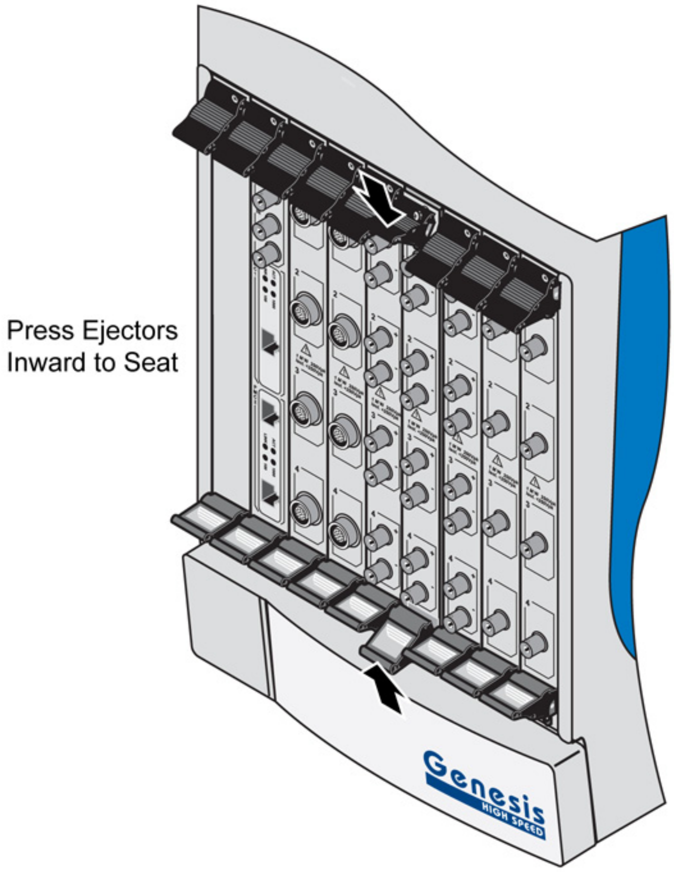



**Figure 7.7:** GEN7t (seating the card/module)

**5** Tighten the small set screw on both ejectors on the of the card/module:

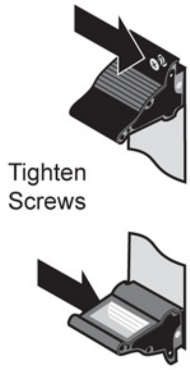



**Figure 7.8:** Card/module ejectors with screws

**WARNING**

**Screws must be locked to meet CE emissions.**

**WARNING**

**Any empty slots must be covered with a blind panel with thermal strip on the back to meet the cooling requirements of the mainframe.**

# 8 Using the Front Panel

## 8.1 Introduction

The GEN DAQ systems come with firmware installed that allows you to set up the network and other functions via the local display and touch keys on the front panel of the unit. In addition to these controls, the front panel contains the Power On/Off touch key, indicators for Mains and Power for the system, and Record and Trigger indicators for each card. The GEN series rack model has a slightly different front panel layout compared to the GEN series tower model, however with the same functionality.

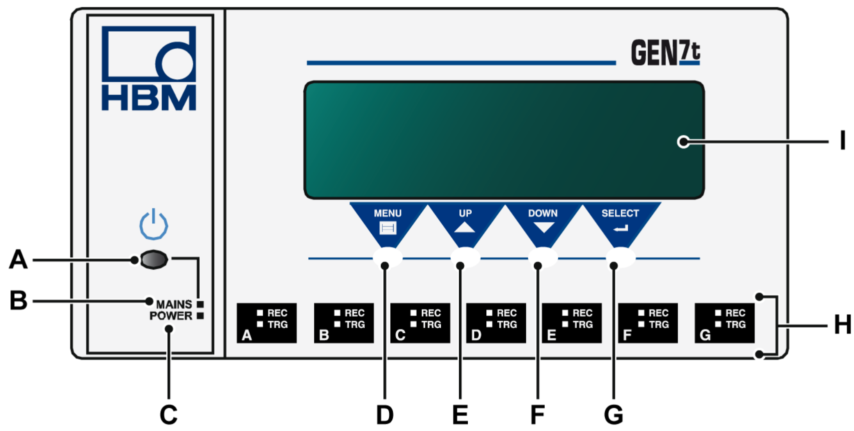



**Figure 8.1:** Front panel layout (tower model)

**A** Power On/Off

**B** Mains Indicator

**C** Power Indicator

**D** Menu

**E** Up

**F** Down

**G** Select

**H** Acquisition and Trigger Indicators for each Module

**I** Display

## 8.2 Power Control and Indicators

**IMPORTANT**

**If you are connecting your system directly to your PC with a crossover cable, you must assign a suitable IP address and subnet mask before your PC can communicate with it.**

The GEN series remains in a low-power standby state whenever power is applied. The "Mains" indicator being lit indicates this state.

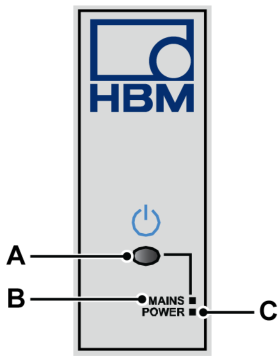



**Figure 8.2:** Front panel power controls

**A** Power On/Off

**B** Mains Indicator

**C** Power Indicator

To turn power ON, briefly press the **Power On/Off** button. After about a minute, the display will report that GEN series is **Ready** or **Fast Streaming**.

To turn power OFF, again, briefly press the **Power On/Off** button. The display will request confirmation:


Briefly press the **Select** button to **Confirm** and complete the shutdown procedure.

**Note** *Forced Power Off!*
*In the rare event that the GEN series stops responding, such as in the case where the network connection is lost during a communication, power can be forced off by holding the Power On/Off button down for five seconds.*

**IMPORTANT**

**If you are connecting your system directly to your PC with a crossover cable, you must assign a suitable IP address and subnet mask before your PC can communicate with it.**

## 8.3 Card indicators

For each acquisition card there are two status feedback LEDs. The tower model has 7 groups of indicators, the rack version provides 16 groups of such indicators.

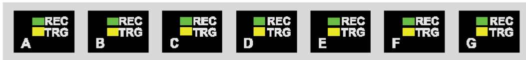



**Figure 8.3:** Front panel card indicators (tower model)

If both LEDs are off, the card is in an idle or signal monitoring state without recording.

The REC LED indicates the card is currently recording data, either pre-trigger or post-trigger.

The TRG LED additionally indicates the card has recognized a valid trigger, and is now collecting post-trigger data.

## 8.4 Using the Front Panel Controls

The character display is used for network and other settings and to display system alerts such as **overtemperature**. Most settings can be made and viewed at any time. The Menu, Up, Down and Select touch keys on the front panel below the Display allow you to navigate through the software menus and enter settings for your system.

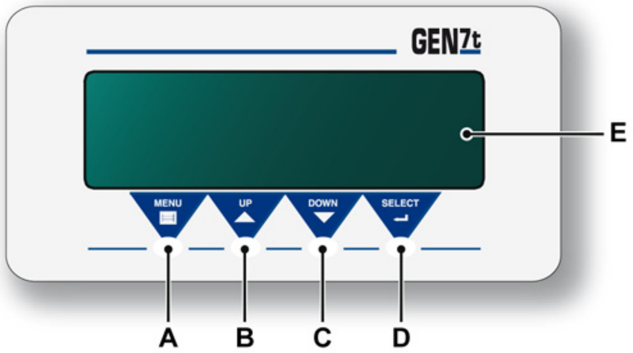



**Figure 8.4:** Front panel display controls (tower model)

| | | |
|---|---|---|
| **A** | Menu | Access the Menu functions or to enter/save a selection and navigate back through the Main Menu options |
| **B** | Up | Navigate up through menu items and alphanumeric input |
| **C** | Down | Navigate down through menu items and alphanumeric input |
| **D** | Select | Edit selected menu item, navigate further into menu items or select next item during edit |
| **E** | Display | Feedback of menu position and device status |

Normally the display shows the mainframe name and the time. Also the firmware version contained in the mainframe is shown. Whenever a PC with Perception software is connected to the system, an asterisk appears in the upper right corner to show a network connection is established.

The active display alternates between the Firmware version and the size of the internal disk. Size in GB is displayed when the SSD is installed, Disk 0GB is displayed when no SSD is installed.

The touch keys below the display allow you for example to set the Ethernet network properties of your system. Standard TCP/IP Ethernet requires an IP address and subnet mask to uniquely identify each network device. If you are on a company network these are normally assigned automatically by your company server.

### 8.4.1 Front Panel menu map

The following table shows a complete overview of all menu items in the front panel display and a short description of their contents.

| Menu Level (map) | Description |
|---|---|
| **Menu** | **Press the menu key once to access the main menu** |
| **Settings** | **Settings:** |
| Net RJ45 /<br>Net SFP /<br>Net Ext1 /<br>Net Ext2<br>IpAddr<br>Cur IP<br>IpMask<br>CurMask<br>Name<br>Use DCHP<br>DCHP Time<br>Gateway<br>MAC Addr<br>Preferred | Net or Network Interface: Includes the network and network-accessory related settings. Use this menu for determining any network interface related set-up or state. Note: **Net EXT1** and **Net EXT 2** are only available with the 10Gbit Ethernet option. |
| iSCSI 1/iSCSI 2<br>Network<br>DNS<br>IPAddr<br>NetwPort<br>Target*<br>UserName<br>PassWord | The iSCSI is an IM2 network accessory and needs careful manual setup to be able to function correctly. This is not an interface but contains settings related to the interfaces that this accessory is connected to. |

| Menu Level (map) | Description |
|---|---|
| **Menu** | **Press the menu key once to access the main menu** |
| **Settings** | **Settings:** |
| Enabled<br>Status | |
| **UserInfo** | **User Info:** |
| UserName<br>Station<br>ResetPwd | Includes set up information about the User and login details |
| **Status** | **Status:** |
| Version<br>DateTime<br>SyncSrc<br>Speed<br>LocDisk<br>TotSize<br>SCSIMODE<br>Disk(1)<br>Format(1) | Includes information related to general administration and the current specifications or state of the unit and its connected accessories |
| **Diagnose** | **Diagnose:** |
| MemTest<br>DiskPerf<br>DiskItg | Includes performance and integrity tests related to memory and disk |
| **Alerts** | **Alerts:** |
| See "Alerts" on page 139 | Current system alerts |
| **Errors** | **Errors:** |
| See "Errors" on page 140 | Current system errors |

(1) Only available when SSD option is installed (for IM2 only).

### 8.4.2 Menu Map Settings Overview

The following tables in this section show the available options for each menu item and also the display format **(Value)** of that option.

| **Settings / Network menu** | | |
|---|---|---|
| **Sub menu** | **Setting** | **Value** |
| IpAddr | IP address | Automatic<br>xxx.xxx.xxx.xxx |
| Cur IP | Current IP address | xxx.xxx.xxx.xxx |
| IpMask | IP address mask | Automatic<br>xxx.xxx.xxx.xxx |
| Cur Mask | Current IP address mask | xxx.xxx.xxx.xxx |
| Name | System name | <literal text> |
| Use DHCP | Use DHCP | TRUE<br>FALSE |
| DHCPTime | Negotiation time | Short<br>Medium<br>Long |
| Gateway | Gateway IP address | xxx.xxx.xxx.xxx |
| MAC Addr | Interface MAC address | ## - ## - ## - ## - ## - ## |
| Port | Front panel port | n |
| Preferred | Preferred Perception interface | TRUE |
| | DNS server | FALSE |
| DNS Server | | xxx.xxx.xxx.xxx |

For more information please refer to "Front Panel - Network Interface Settings" on page 102.

| **Settings / iSCSI 1/2 menus** | | |
|---|---|---|
| **Sub menu** | **Setting** | **Value** |
| Network | iSCSI interface | RJ45, SFP, Ext1, Ext2 |
| IPAddr | iSCSI IP address | xxx.xxx.xxx.xxx |
| NetwPort | Network port number | xxxx |
| Target* | Target IQN name | iqn.yyyy-<br>mm.domain:device.ID |
| UserName | User name (CHAP) | <literal text> |
| PassWord | Password (CHAP) | <literal text> |
| Enabled | iSCSI enabled | TRUE, FALSE |
| Status | iSCSI status | |

* For more information please refer to "Front Panel - Network Interface Settings" on page 102.

| UserInfo menu | | |
|---|---|---|
| **Sub menu** | **Setting** | **Value** |
| UserName | Name of system user | Not connected<br><literal text> |
| Station | Name of system controller | Not connected<br><literal text> |
| ResetPwd | Reset password | quit<br>ok |

For more information please refer to "Menu - User Info" on page 122.

| Status menu | | |
|---|---|---|
| **Sub menu** | **Setting** | **Value** |
| Version | Firmware version | M.mm.bbbbb |
| DateTime | Current date and time | dd mmm yyyy |
| SyncSrc | Synchronization source | RTC + <sync><br>IRIG + <sync><br>GPS + <sync><br><source>+ Synced<br><source>+ Not Synced<br><source> + Syncing |
| Speed | Data transfer speed | Standard<br>Fast Streaming |
| LocDisk | Local Disk status | DiskAvailable<br>NoDrive<br>NotFormatted<br>WrongFormat |
| TotSize | Total size of disk | <numeric value> |
| SCSIMODE | Type of SCSI mode | SCSI160<br>SCSI320 |
| Disk | Type of internal disk | SATA 1.5 |
| Format | Format internal disk | Disk Format Busy |

For more information please refer to "Menu - Status (IM1 only)" on page 125.

| Diagnose menu | | |
|---|---|---|
| **Identifier** | **Full name / Description** | **Functions** |
| Memtest | Memory test results | Module n Waiting \| <info><br>Module n Running \| <info><br>Module n Succeeded <date><br>Module n Failed <date><br><status active><br>Previous:Succeeded<br><status active><br>Previous:Failed<br><status result> dd mmm yyyy hh:mm |
| DiskPerf | Disk performance | BUSY<br><numeric value> MB/s<br>DskFull<br>AcqBusy<br>Timeout<br>Failed |
| DiskItg | Test disk integrity | None<br>Timeout<br>Succeed<br>AcqBusy<br>ReadErr<br>WrtErr<br>VfyErr<br>InitErr<br>RestErr<br>Failed |

For more information please refer to "Menu - Diagnose" on page 131.

| Alerts menu | | |
|---|---|---|
| **Sub menu** | **Setting** | **Value** |
| | Warning messages | Module Version Error<br>SCSI Mode Error<br>Network Speed xxx MB |

For more information please refer to "Menu - Alerts" on page 139.

| Errors menu | | |
|---|---|---|
| **Sub menu** | **Setting** | **Value** |
| | Error messages | Overtemp X/Y <value><br>Overvolt X/Y <value><br>Undervolt X/Y<value> |

For more information please refer to "Menu - Errors" on page 140.

### 8.4.3 Entering and exiting the menus

To enter the GEN series menu, briefly press the **Menu** key below the display. All network controls are located in the first menu, **Settings**. This menu is where the TCP/IP address, subnet mask and network name are entered.

To exit the GEN series menu, press **Menu** again.


From the **Settings** screen you can press the **Down** key to view the **User Info** menu. When you or another user are connected to the system through HBM's Perception software, it displays the user name and workstation that is controlling the system.


Here you can also reset the system password to the factory default.

From the **User Info** screen you can press the **Down** key to view the **Status** menu.


Here you can find information about the local disk and other options.

From the **Status** screen you can press the **Down** key to view the **Diagnose** section.


Here you can perform various diagnostic tests for your local memory and local disk (if applicable).

From the **Diagnose** screen you can press the **Down** key to view the **Alerts** section.


The Alerts section is used to read system messages.

From the **Alerts** screen you can press the **Down** key to view the **Errors** section.


The Errors section is used to read error messages.

**Note** *All menu changes take effect immediately on entry. There is no need to turn power off and back on after changing network settings.*

## 8.5 Front Panel - Network Interface Settings

**Menu > Settings**

The **Settings** menu provides access to the interface and network controls.

In this section we will refer only to the RJ45 Network for reference since all of the Net Interface menus, shown below, have the same menu structure.

**How to Access the Network Interface Settings:**

1. Press the **Menu** key.
2. Press the **Select** key. Now the **Settings** menu will come up. The settings menu includes the following Network Interfaces menus.


**Note** *Net EXT 1 and Net EXT 2 are only available with the 10Gbit Ethernet option installed.*

3. Press the **Up** and **Down** keys and select the desired **Network** interface.
4. Press the **Select** to access the network settings of the selected interface.
5. As you press the **Up** and **Down** keys, you can access each of the following settings as shown in the table below.

*Table 8.1: Network settings summary*

| MENU | FUNCTION |
|---|---|
| **IpAddr** | Here you can set the manual IP address (used only if DHCP is False or if a DHCP server cannot be found) |
| **Cur IP** | Displays the current IP address being used, whether manual or automatic |
| **IpMask** | Here you can set the manual IP subnet mask (used only if DHCP is False) |
| **Cur Mask** | Displays the current IP subnet mask being used, whether manual or automatic |
| **Name** | You can enter the name of the GEN series here to be used for identification on the network |

| MENU | FUNCTION |
|---|---|
| **Use DHCP** | Selects between Automatic (TRUE) or Manual (FALSE) IP addressing |
| **DHCP Time** | When using DHCP sets the time allowed to negotiate (receive) an address from the DHCP server |
| **Gateway** | Here you can set the IP address of your default gateway - if any. A gateway is a network point that acts as an entrance to another network |
| **MAC Addr** | The MAC (Media Access Control) address is your system's Ethernet interface unique hardware number |
| **Preferred** | Preferred interface used for Perception (information only) |
| **DNS Server** | Here you can set the DNS (Domain Name System) server setting |

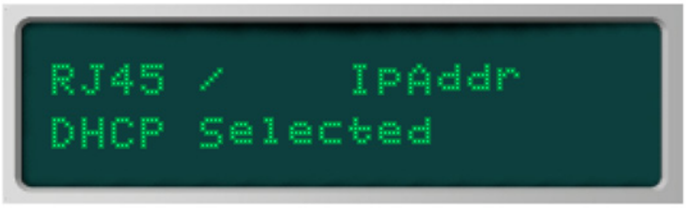
Just as with your PC, the network settings must be adjusted correctly or your system will not be able to communicate on the network. If you are not familiar with configuring TCP/IP Ethernet networks, we recommend you request assistance from your company's IT or network support team.

### 8.5.1 Network Interface IP address

**Menu > Settings > Net RJ45 > IpAddr**

This setting allows you to manually set the IP Address used by the system.


If you have previously selected **Use DHCP** as **TRUE**, this field will display **DHCP Selected** as shown below and cannot be changed. In this case a server assigns the IP address and subnet mask automatically.




**How to set a Network Interface IP Address:**
First see section "Network Interface Use DHCP" on page 108, follow this procedure first so that DCHP is set to **FALSE** and the IP address is editable.

**1** Press the **Menu** key.
**2** Press the **Select** key. Now the **Settings / Net RJ45** menu will come up.
**3** Press the **Select** key again to access the various network settings.
**4** Press the **Up/Down** keys until you see **RJ45 / Use DHCP** on the display.
**5** Press the **Select** key to edit the settings.
**6** Use the **Up/Down** key to set **Use DHCP** to **FALSE**.
**7** Press the **Menu** key to return to the previous menu level.
**8** Press the **Up/Down** keys until you see **RJ45 / IPAddr** on the display.
**9** Press the **Select** key to edit the settings:


**10** An underlined cursor is shown on the first digit of a octet that you can modify. Use the **Up/Down** key to increase/decrease the octet value.
**11** Use the **Select** key move to the next octet.
**12** When done use the **Menu** key to set and return to the previous menu level.

The IP address consists of four numbers, each from 1 to 254. Your GEN series system and your PC must have different addresses, but within the same range, in order to communicate. HBM recommends addresses in the range of 169.254.xxx.xxx, as this is what Windows assigns itself after a one-minute time-out when no DHCP server is found.

**Note** ***For system administrators:*** *APIPA (Automatic Private IP Addressing) is supported by the GEN series. If DHCP is TRUE and no DHCP server is found, the GEN series will revert to APIPA. APIPA will then assign one free IP address.*

### 8.5.2 Network Interface Current IP address

**Menu > Settings > Net RJ45 > Cur IP**

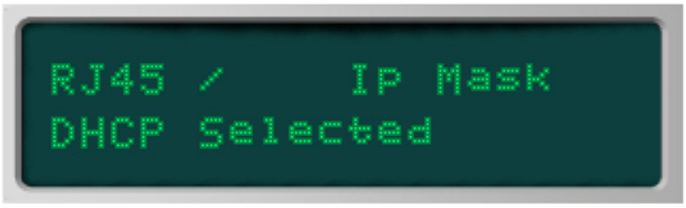
This screen is for information only. It displays the actual IP address currently in use. When **Use DHCP** is set to **FALSE**, it displays the IP address you set manually. When **Use DHCP** is set to **TRUE**, it displays the IP address your server has assigned and confirms the communication was successful.


### 8.5.3 Network Interface IP Mask

**Menu > Settings > Net RJ45 > Ip Mask**

This setting allows you to manually set the IP Mask (subnet mask) used by the system. IP masks consist of four groups of digits (usually 0 or 255) and are used to indicate which devices on the network can communicate with each other. Your system and your PC must have exactly the same mask to communicate properly.


If you have previously selected **Use DHCP** as **TRUE**, this field will display **DHCP Selected** as shown below and cannot be changed. In this case a server assigns the IP address and mask automatically.




**How to set the IP Mask:**

1 Press the **Menu** key.
2 Press the **Select** key. Now the **Settings / Net RJ45** menu will come up.
3 Press the **Select** key again to access the various network settings.
4 Press the **Up/Down** keys until you see **RJ45 / Use DHCP** on the display.
5 Press the **Select** key to edit the settings.
6 Use the **Up/Down** key to set **Use DHCP** to **FALSE**.
7 Press the **Menu** key to return to the previous menu level.
8 Press the **Up/Down** keys until you see **RJ45 / IPMask** on the display.
9 Press the **Select** key to edit the settings:

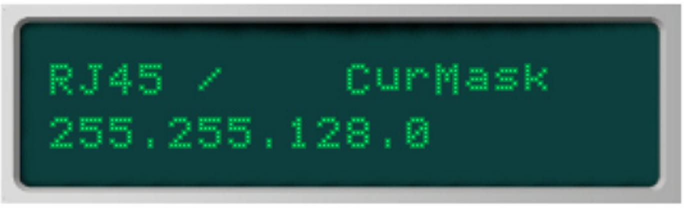

10 An underlined cursor is shown on the first digit of an octet that you can modify. Use the **Up/Down** key to increase/decrease the octet value.
11 Use the **Select** key to move to the next octet.
12 When done use the **Menu** key to set and return to the previous menu level.

**Note** *The IP mask consists of four numbers, usually either 255 or 0. Your GEN series and your PC must have exactly the same Mask in order to communicate properly.*

### 8.5.4 Network Interface Current IP Mask

**Menu > Settings > Net RJ45 > CurMask**

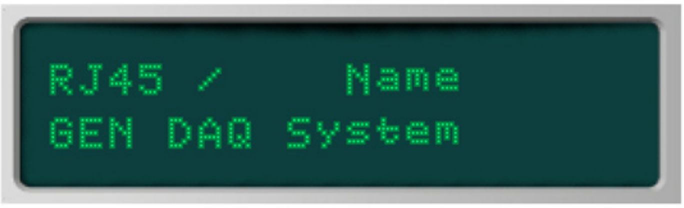
This screen is for information only. It displays the actual IP Mask (subnet mask) currently in use. When **Use DHCP** is set to **FALSE**, it displays the Mask you set manually. When **Use DHCP** is set to **TRUE**, it displays the Mask your server has assigned and confirms the communication was successful.




### 8.5.5 Network Interface Network Name

**Menu > Settings > Net RJ45 > Name**

This control allows you to set the **Network Name** of your system. The Perception software uses this name to identify the system in its menus and sheets. You can enter any name that has significance to you or simply leave the default name in place. If you have multiple GEN series mainframes, you must give each a unique name so you can easily tell them apart in the menus.




**Note** *This name is used only by Perception software. It does not appear in the Windows "Network Places" listing.*

**How to modify the network name proceed as follows:**

**1** Press the **Menu** key.
**2** Press the **Select** key. Now the **Settings / Net RJ45** menu will come up.
**3** Press the **Select** key again to access the various network settings.
**4** Press the **Up/Down** keys until you see **RJ45 / Name** on the display.
**5** Press the **Select** key to edit the settings:

6 An underlined cursor is shown on the first character that you can modify. Use the **Up/Down** key to step through the available (special) characters.
7 Use the **Select** key to move to the next characters.
8 When done use the **Menu** key to set and return to the previous menu level.

The name you enter can be up to 32 characters long.

### 8.5.6 Network Interface Use DHCP

**Menu > Settings > Net RJ45 > Use DHCP**

To set up the system for network communication, your first selection should be whether or not to use DHCP (Dynamic Host Configuration Protocol) to automatically manage IP addresses.

**How to modify the DHCP setting:**

1 Press the **Menu** key.
2 Press the **Select** key. Now the **Settings / Net RJ45** menu will come up.
3 Press the **Select** key again to access the various network settings.
4 Press the **Up/Down** keys until you see **RJ45 / Use DHCP** on the display.
5 Press the **Select** key to edit the settings:


6 Use the **Up/Down** key to step through the two options.
7 Press the **Menu** key to enter your selection when you are finished. The display will show your selection.

If you are on a company network, select **TRUE**. Most company networks provide a DHCP server, which will automatically assign your system a suitable IP address and subnet mask. Check with your IT department if you are not sure. If DHCP is used there is no need to make any further network settings.

If you are connecting the system directly to your PC and there is no server available, select **FALSE**. This might be the case if you are making measurements in the field or in a test bay without network access. You must then assign compatible IP addresses and subnet masks on both the GEN series system and on your PC. Use the **IP Address** and **IP Mask** menus to do this in the GEN series.

### 8.5.7 Network Interface DHCP search time

**Menu > Settings > Net RJ45 > DCHP Time**

Set the time allowed by the GEN series system to negotiate an IP-address.

**How to modify the DHCP Time setting:**

1. Press the **Menu** key.
2. Press the **Select** key. Now the **Settings / Net RJ45** menu will come up.
3. Press the **Up/Down** keys to navigate to the network that needs changing.
4. Press the **Select** key again to access the various network settings.
5. Press the **Up/Down** keys until you see **RJ45 / DHCPTime** on the display.
6. Press the **Select** key to edit the settings:


7. Use the **Up/Down** key to step through the possible options.
8. Press the **Menu** key to enter your selection when you are finished. The display will show your selection.

Set the time you allow the system to negotiate (receive) an IP-address from a DHCP server. Select **Short** for approximately 15 seconds, select **Medium** for approximately 30 seconds and **Long** for approximately 60 seconds.

### 8.5.8 Network Interface Gateway

**Menu > Settings > Net RJ45 > Gateway**

This setting allows you to manually set the IP Address of your **Gateway**. A gateway is a network point that acts as an entrance to another network. In the network for an enterprise, a computer server acting as a gateway is often also acting as a proxy server and a firewall server. When you are not sure about your gateway (if any), you should contact your system administrator.


**How to set the Gateway IP address:**

1 Press the **Menu** key.
2 Press the **Select** key. Now the **Settings / Net RJ45** menu will come up.
3 Press the **Up/Down** keys to navigate to the network interface that needs changing.
4 Press the **Select** key again to access the various network interface settings.
5 Press the **Up/Down** keys until you see **RJ45 / DHCPTime** on the display.
6 Press the **Select** key to edit the settings.


7 An underlined cursor is shown on the first digit of an octet that you can modify. Use the **Up/Down** key to increase/decrease the octet value.
8 Use the **Select** key to step through the octets.
9 When done use the **Menu** key to set and return to the previous menu level.

The IP address consists of four numbers, each from 1 to 254.

### 8.5.9 Network Interface MAC Address

**Menu > Settings > Net RJ45 > MAC addr**

This setting is for information only, it has no controls. The MAC address is typically used for restricting access in sensitive networks where only certain MAC addresses are allowed access.

In a local area network (LAN) or other network, the **MAC (Media Access Control)** address is your system's Ethernet interface unique hardware number. Your IP address is translated into a MAC address for communication with security protocols on your network.


### 8.5.10 Network Interface Preferred Network

**Menu > Settings > Net RJ45 > Preferred**

This setting determines the preferred network for connection to Perception.


Select between **True** or **False** to set the current interface to the preferred network for communications with Perception.

**How to modify the Preferred network setting of a specific interface:**

1 In **Menu / Settings / Net RJ45 / Preferred** press the **Select** key.


2 Use the **Up/Down** key to select **True** or **False**.

3 Press the **Menu** key to enter your selection and step back to the previous menu. the display will show your selection.

### 8.5.11 Network Interface DNS Network Settings

Menu > Settings > Net **RJ45 > DNS** - (for further details ask your system administrator).


Used when DNS server (Domain Name System) is present. Typically this is used when a GEN DAQ system is in a corporate network.

1 In Menu / Settings / Net RJ45 / **DNS** press the **Select** key.


2 Press the **Up/Down** keys to select digits from 0-255.
3 Press the **Menu** key to select, and return to the previous menu level.

## 8.6 Settings Menu iSCSI 1/2 (IM2 only)

**Menu > Settings > iSCSI 1**

The **iSCSI 1** and **iSCSI 2** menus provides access to several controls for the network.

**Note** *Please read the the “iSCSI” section on page 183 for more background information.*

**To access iSCSI 1 or iSCSI 2 settings:**

1 Press the **Menu** key.
2 With **Menu / Settings** displayed, press the **Select** key.
3 Navigate using the arrows to the **Settings / iSCSI 1** menu.


… and Press **Select** key.

4 Now press the **Up** and **Down** keys to navigate the following settings in turn.

*Table 8.2: Network settings summary*

| MENU | FUNCTION |
|---|---|
| **Network** | Select the interface the network is connected to<br>Select between: **RJ45, SFP, EXT2(1), EXT1(1)** |
| **IpAddr** | Set the IP address manually |
| **NetwPort** | Set the Network interface address manually |
| **Target** | Set the iSCSI target name |
| **UserName** | Enter the user name of the iSCSI here, if set in the iSCSI setup software |
| **PassWord** | Enter the password of the iSCSI here, if set in the iSCSI setup software |
| **Enabled** | If FALSE, this must be set as TRUE for the iSCSI to be detected by the GEN series |
| **Status** | OK is displayed if the iSCSI is configured correctly |

(1) EXT 1 and EXT 2 interfaces are available with the 10Gbit option.

### 8.6.1 Settings Menu iSCSI Network Interface

Menu > Settings > iSCSI 1 > **Network**

The Network settings contain all the settings that make up system connections to and from the interfaces on-board the GEN DAQ. In this selection we will choose the network interface that the iSCSI is connected to.


This setting allows you to manually set the network interface on the IM2 that's connected to the iSCSI. Please check carefully and select the interface that the iSCSI is connected to.

**To set the Network connector:**

**1** In Menu / Settings / iSCSI 1 / **Network** press the **Select** key.


**2** Press the **Up/Down** keys to select the correct Network connection.

The following table shows the naming convention differences between the GENDAQ front panel and the Perception software control.

Select between the following connectors:

| Front panel | Software control |
|---|---|
| RJ45 | Standard 1 Gbit |
| SFP | Optical 1 Gbit |
| EXT 1(1) | Optical 10 Gbit NIC1 |
| EXT 2(1) | Optical 10 Gbit NIC2 |

(1) EXT 1 and EXT 2 are available with the 10 Gbit Ethernet option.

**3** Press the **Menu** key to select, and return to the previous menu level.

### 8.6.2 Settings Menu iSCSI IP Address

Menu > Settings > iSCSI 1 > **IPAddr**

This setting allows you to manually set the IP Address for the iSCSI used by the system.The iSCSI address may already be correct, please check first before changing.


Input the IP address used in the NAS server setup for the iSCSI. More information on the iSCSI host can be found in sections "Setup an iSCSI NAS connected without an Ethernet switch" on page 196 and "Setup an iSCSI NAS connected to a corporate network – basic setup" on page 200.

**How to set the iSCSI IP address:**

**1** In Menu / Settings / iSCSI 1 / **IPAddr** press the **Select** key.


2 Press the **Up/Down** keys to key to increase/decrease the selected octet.
3 Use the **Select** key to step through the octets one by one.
4 Press the Menu key to set, and return to the previous menu level

The IP address consists of four octets, each from 1 to 254. Your GEN series system and iSCSI NAS server will have the same addresses programmed, in order to communicate.

### 8.6.3 Settings Menu iSCSI Network Port Address

Menu > Settings > iSCSI 1 > **NetwPort**

This setting allows you to manually set the Network Port number used by the iSCSI protocol. The iSCSI port address may already be correct, please check first before changing.


The default value of the **Net**work port is **3260**. Only change the port number if the NAS uses as different or manually set number. More information on the iSCSI host can be found in sections "Setup an iSCSI NAS connected without an Ethernet switch" on page 196 and "Setup an iSCSI NAS connected to a corporate network – basic setup" on page 200.

**How to set the iSCSI Network Port address:**

1 In Menu / Settings / iSCSI / **NetwPort** press the **Select** key.


2 Press the **Up/Down** keys to key to increase / decrease the selected digit.
3 Use the **Select** key to step through the digits one by one.
4 Press the **Menu** key to set, and return to the previous menu level.

### 8.6.4 Settings Menu iSCSI Target IQN Name

Menu > Settings > iSCSI 1 > **Target**

This setting allows you to manually set the Target IQN name used by the iSCSI.


The name is a unique identifier and is in the following format:
**iqn.yyyy-mm.domain:device.ID**

Refer to chapter "Target Name (IQN)" on page 188 for further information on IQN name.

**How to set the iSCSI Target IQN name:**

1 In Menu / Settings / iSCSI / **Target** press the **Select** key.

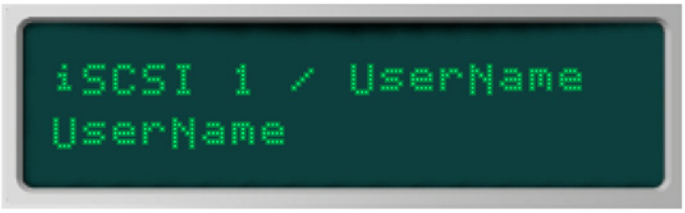

2 Press the **Up/Down** keys to key to increase/decrease the selected alpha numeric character.

**Note** *Take care to program in the IQN name correctly, without this the iSCSI will not function.*

3 Use the **Select** key to step through the characters one by one.
4 Press the **Menu** key to set, and return to the previous menu level.

### 8.6.5 Settings Menu iSCSI Username

Menu > Settings > iSCSI 1 > **UserName**




This setting allows you to manually set the Username used by the iSCSI as defined in the setup procedure of the NAS server. When using a Synology NAS this is referred to as the CHAP Username as shown in Figure H.7 "Create a new iSCSI target dialog" on page 724.

**How to set the iSCSI UserName:**

**1** In Menu / Settings / iSCSI / **UserName** press the **Select** key.


**2** Press the **Up/Down** keys to key to increase / decrease the alpha numeric character.

**3** Use the **Select** key to step through the characters one by one.

**4** Press the **Menu** key to set, and return to the previous menu level.

### 8.6.6 Settings Menu iSCSI Password

Menu > Settings > iSCSI 1 > **Password**

This setting allows you to manually set the Password used by the iSCSI as defined in the setup procedure of the NAS server. In the case of Synology this is referred to as the CHAP Password as shown in Figure H.7 "Create a new iSCSI target dialog" on page 724.

**How to set the iSCSI Password:**

1 In Menu / Settings / iSCSI 1/ **PassWord** press the **Select** key.

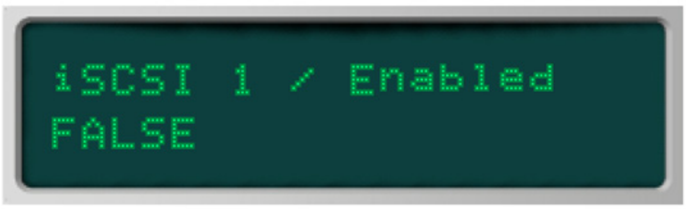

2 Press the **Up/Down** keys to key to increase / decrease the alpha numeric character.

3 Use the **Select** key to step through the characters one by one.

4 Press the **Menu** key to set, and return to the previous menu level.

### 8.6.7 Settings Menu iSCSI Enabled

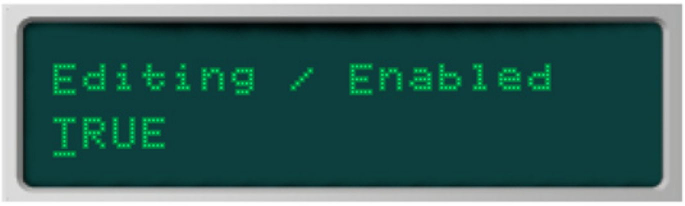
Menu > Settings > iSCSI 1 > **Enabled**




This setting allows you to manually enable or disable the iSCSI. This is the same function as the the **Enable** check box as shown in Figure H.7 "Create a new iSCSI target dialog" on page 724.

**How to enable the iSCSI :**

1 In Menu / Settings / iSCSI 1/ **Enabled** press the **Select** key.




2 Press the **Up/Down** keys to select between **True** (enabled) or **False** (not enabled).
3 Use the **Select** key to step through the characters one by one.
4 Press the **Menu** key to set, and return to the previous menu level.

### 8.6.8 Settings Menu iSCSI Status

Menu > Settings > iSCSI 1 > **Status**

This function gives the user feedback on the Status of the iSCSI.


The figure above shows the status as **OffLine**, this is the case when the iSCSI is disabled. If the iSCSI is enabled the status message should read as shown in figure below.

## 8.7 Menu - User Info

The **User Info** menu provides information and allows you to reset the system password. It allows you to view the user name and computer name that are controlling the GEN series DAQ system.

**How to access User Info:**

1. Press the **Menu** key.
2. Press the **Up/Down** key until the **Menu / User Info** comes up:


3. Press the **Select** key to access the various **User Info** settings.
4. As you press the **Up** and **Down** keys, you can access each of the following settings in turn.

*Table 8.3: User Info settings summary*

| MENU | FUNCTION |
|---|---|
| **UserName** | When a PC with Perception software is currently connected to the GEN series, the PC user name from the Windows Logon screen is shown. |
| **Station** | When a PC is connected the station name is displayed, this is the same name Windows uses to identify the computer in the Network Places listing. |
| **ResetPwd** | Use this entry to reset the system password. |

### 8.7.1 User Menu - User name

**Menu > User Info > UserName**

If the system is powered but idle, the **User Name** screen displays **Not Connected**. If a PC with Perception software is currently connected to the system, the PC user name from the Windows Log-on screen is shown. This is useful to inform you who is using the system at present, and also to confirm that Perception's software connection and log-on to the system was successful.


### 8.7.2 User Menu - User station

**Menu > User Info > Station**

In addition to the **User Name**, the system can also display the network name of the PC workstation that is currently connected. The workstation name (**Station**) is the same name Windows uses to identify the computer in the Network Places listing. The message **Not Connected** indicates no one is connected to the system at present.


### 8.7.3 User Menu - Reset password

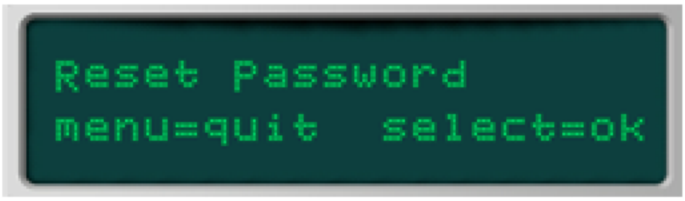
**Menu > User Info > ResetPwd**

Network access to the GEN series data acquisition system is password protected. By default this password is “genesis” for a GEN series system. You can modify this password only through the Perception software.

**How to reset the password to the factory default:**

1. Press the **Menu** key.
2. Press the **Up/Down** key until the **Menu / User Info** comes up.
3. Press the **Select** key to access this menu.
4. Press the **Up/Down** key until the **User Info / ResetPwd** comes up:


**5** Press **Select.** You are now presented two options:




**6** Press **Select** to choose **ok** to reset the password, or **Menu** to **quit** and abort this process. When cancelled, the current password remains in effect.

**7** Click **Menu** twice to exit the menu.

## 8.8 Menu - Status (IM1 only)

The **Status** menu provides information about network transfer speed as well as local disk usage. When a local disk is available you can format this disk. A local disk can be connected to the GEN series through an optional SCSI interface.

**Note** *IM2 has a built in disk.*

**How to check the Status:**

**1** Press the **Menu** key.

**2** Press the **Up / Down** key until the **Menu / Status** comes up:


**3** Press the **Select** key to access the various status settings.

**4** As you press the **Up** and **Down** keys, you can access each of the following settings in turn.

*Table 8.4: Status settings summary*

| MENU | FUNCTION |
|---|---|
| **Version** | Firmware version. |
| **DateTime** | Current system date and time. |
| **SyncSrc** | Synchronization source for internal clock. |
| **Speed** | This setting informs about the transfer speed capabilities over the Ethernet. |
| **LocDisk** | This menu item informs about the status of a local hard disk drive. |
| **TotSize** | When a local disk is available, this item informs about the disk size. |
| **SCSIMODE** | Informs about the SCSI mode of the connected drive. |
| **Disk** | Type of internal disk (IM2 only) |
| **Format** | Allows you to quick format the drive. |

### 8.8.1 Status Menu - Version

**Menu > Status > Version**

The **Version** menu item informs about the currently installed firmware version.


### 8.8.2 Status Menu - Date and Time

**Menu > Status > DateTime**

The **DateTime** menu item informs about the current system date and time. Depending on the selected synchronization source (see next section) the date and time are controlled by either the PC, or an installed IRIG or IRIG/GPS card.


### 8.8.3 Status Menu - Syncronization Source

**Menu > Status > SyncSrc**

The **SyncSrc** menu item informs about the currently selected synchronization source for the internal clock. Depending on the selected synchronization source the date and time are controlled by either the PC (**RTC**), or an installed IRIG (**IRIG**) or IRIG/GPS (**GPS**) card. The system can be either synchronized (**Synced**), not synchronized (**Not Synced**) or trying to synchronize (**Syncing**). The source is selected in Perception (settings sheet).


### 8.8.4 Status Menu - Speed

**Menu > Status > Speed**

The **Speed** menu item informs about the transfer speed capabilities over the Ethernet. As standard the speed is set to **Standard**. When the additional option is installed, the speed is set to **Fast Streaming**.


### 8.8.5 Status Menu - LocDisk (IM1 only)

**Menu > Status > LocDisk**

The **LocDisk** (Local Disk) menu item informs about the status of a local hard disk drive. A local hard disk can be connected to the GEN series system when the optional SCSI interface is installed or when the IM2 is installed.

When available the status is set to **DiskAvailable.**

Other status messages are:

*Table 8.5: Status messages*

| MESSAGE | MEANING |
|---|---|
| **Disk Available** | Storage drive connected |
| **NoDrive** | No drive connected |
| **NotFormatted** | Disk is not formatted or formatted in an unknown format. |
| **WrongFormat** | The disk is formatted, but not using a 512 byte sector size or there is an invalid file system. |

### 8.8.6 Status Menu - Total Local Disk Size

**Menu > Status > TotSize**

The **TotSize** (total size) menu item informs about the total size of the local hard disk in Bytes. E.g. the display below shows **133 939 200** Bytes which equals 130 800 (binary) KiloBytes or (binary) 127.7 MegaBytes.


**Note** *Hard disk drive manufacturers state capacity in decimal units. Since most computer operating systems report drive usage and capacity in binary units, the difference causes an apparent loss between the advertised capacity and the formatted, usable capacity.*

Modern-day PC users, of course, regard both RAM and disk as kinds of storage and expect their capacities to be measured in the same way. Operating systems usually report disk space using the binary version. To the purchaser of a "30 GB" hard drive, rather than reporting either "30 GB", Microsoft Windows reports "28 GB".

### 8.8.7 Status Menu - SCSIMODE (IM1 only)

**Menu > Status > SCSIMODE**

The **SCSIMODE** menu item informs about the transfer mode used by the SCSI drive interface. This mode depends on the SCSI interface of the hard disk drive. Refer to the specifications of the interface for details. The GEN series interface supports up to Ultra 320 SCSI.


Typical supported modes include:

- Ultra 160 SCSI (**SCSI160**): 160 MByte/s on a 16-bit (wide) bus
- Ultra 320 SCSI (**SCSI320**): 320 MByte/s on a 16-bit (wide) bus

When the connected drive has an interface less than Ultra 320 SCSI, an alert is generated. For details see “Menu: Alerts” on page 139.

### 8.8.8 Status Menu - Disk Type (IM2 only)

**Menu > Status > Disk**

**Note** *The iSCSI format procedure is not available from the front panel. For more information please refer to "Menu - Alerts" on page 139.*

The **Disk** menu item informs you about the type of internal disk installed.

### 8.8.9 Status Menu - Format Disk (IM2 only)

**Menu > Status > Format**

**Note** *The iSCSI format proceedure is not available from the front panel. For more information please refer to chapter “How to format the iSCSI” on page 189.*

When the IM2 is installed you can quick format the internal drive using the **Format** command. **This allows you to erase all data without connecting to a PC.**

**How to format the internal IM2 drive:**

1. Press the **Menu** key.
2. Press the **Up/Down** key until the **Menu/Status** comes up.
3. Press the **Select** key to access this menu.
4. Press the **Up/Down** key until the **Status/Format** comes up:


5. Press **Select.** You are now presented two options:


6. Press Select to choose **ok** to format, or **quit** to abort this process. After confirmation the system will reboot.

When using an IM1 with SCSI option the same format procedure is followed as in "Status Menu - Format Disk (IM2 only)" on page 130. The drive is formatted using the internal firmware of the SCSI interface. When the disk is used only together with the GEN series this imposes no problems. However, when you use this disk also in combination with a PC, HBM advises to format the disk only through the PC’s operating system.

## 8.9 Menu - Diagnose

The **Diagnose** menu gives you access to a variety of tests that allow you to verify correct operation and integrity of your storage devices: internal RAM on each card and local disk (when available).

**How to use the Diagnose Menu:**

**1** Press the **Menu** key.

**2** Press the **Up/down** key until the **Menu / Diagnose** comes up:


**3** Press the **Select** key to access the various functions.

**4** As you press the **Up** and **Down** keys, you can access each of the following settings in turn.

*Table 8.6: Diagnose functions summary*

| MENU | FUNCTION |
|---|---|
| **Memtest** | Test RAM memory on each card |
| **DiskPerf** | Test disk performance (throughput) of local disk when available |
| **DiskItg** | Test disk integrity of local disk when available **WARNING: this will erase all data on your local GEN series system disk!** |

### 8.9.1 Diagnose Menu - Memory test

**Menu > Diagnose > MemTest**

The **MemTest** function automatically tests the on-board memory of a selected card.

Memory tests occur cyclically and automatically after successive 24 hour time-periods. If a machine is turned off beyond this time period a test will start as soon as it is turned on.

**How to check a memory test:**

1 Press the **Menu** key.
2 Press the **Up/down** key until the **Menu / Diagnose** comes up.


3 Press the **Select** key. Now the **Diagnose / MemTest** option will come up.
4 Press the **Up/down** key to select a card to view.

When you select this option, the display shows:

- Current status
- Previous result
- Up/down arrows to step through the available cards

When a memory test is running the following front panel message will be displayed.


Status messages before and during a test can be:

*Table 8.7: Status messages (Part 1)*

| MESSAGE | MEANING |
|---|---|
| **Module 'n' Not Tested** | So far no test has been performed. |
| **Module 'n' Waiting** | Memory test wants to start, but can't. Typically because an acquisition (recording) is active. Check the Acquisition indicator of the specific module/card. |
| **Module 'n' Running** | Test is busy |

When available the result of the previous test is shown.

At the end of the test one of the following messages is displayed:

*Table 8.8: Status messages (Part 2)*

| MESSAGE | MEANING |
|---|---|
| **Module 'n' Succeeded** | Memory test passed. No problems detected. |
| **Module 'n' Failed** | Memory test failed. Consult HBM technical support for options. |


Press the **Up/down** key to view another card or press the **Menu** key to return to the **Menu / Diagnose** menu.

When a test fails the following message is displayed.

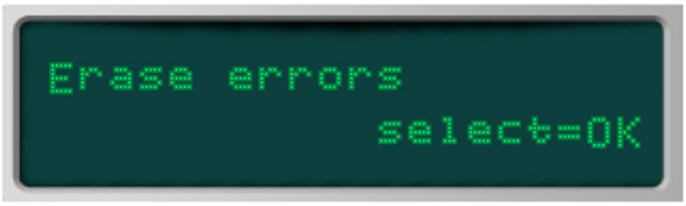

If a test fails and you want to repeat the test you must first clear the error.

To clear the error so that the test will repeat:

**1** Navigate to the **Error** window.
**Menu / Errors**

**2** Errors are listed, as shown in the image below.


Press the **Up** or **Down** key until you see the following screen.




**3** To erase all errors press the **Select** key.
Once this is done the card with the error will repeat the memory test.

### 8.9.2 Diagnose Menu - Disk performance

**Menu > Diagnose > DiskPerf**

The **DiskPerf** function tests the performance of the local SCSI disk when available. The result is expressed in MegaBytes per second as an indication of the possible throughput. This result is obtained by performing a mix of read and write operations, both random and sequential.

**How to perform a disk performance test:**

1 Press the **Menu** key.
2 Press the **Up/down** key until **Menu / Diagnose** comes up.
3 Press the **Up/down** key until you see the **Diagnose / Diskperf** option.
4 Press the **Select** key to start the disk performance test


5 While active you can press the **Select** key to abort the process:


6 When ready the result is displayed:


7 Press the **Select** key to start the test again or press the **Menu** key to return to the menu.

The result can be one of the following messages:

*Table 8.9: Status messages (Part 3)*

| MESSAGE | MEANING |
|---|---|
| **xx MB/s** | Disk test passed. Average throughput is displayed in MegaBytes per second. |
| **DskFull** | Disk test failed due to a full disk. Remove some data files to create space for temporary files. |
| **AcqBusy** | Disk test failed because an acquisition was active or has been started while testing. This also includes Pause mode. |
| **TimeOut** | Test is taking too long. Probably the disk speed is too low. |
| **Failed** | Any other (read/write) error has been encountered. Use the DiskItg test to verify. Save your data before doing so. |

### 8.9.3 Diagnose Menu - Disk Integrity

**Menu > Diagnose > DiskItg**

**WARNING**

**Before you start to use the DiskItg function make sure you have made a backup of all your data! DskItg will erase the complete local SCSI disk.**

**IMPORTANT**

**This test will take a long time to complete. Depending on your disk size this test may take up several hours.**

The **DiskItg** function serves two purposes:

- Verify the local disk integrity.
- Create a fresh directory structure for recordings.

This function first erases all data, and then fills the complete disk with files with known data patterns. These files are then read back and verified. Finally a blank new directory structure for data files is created.

**How to perform a disk integrity test:**

1 Press the **Menu** key.

**2** Press the **Up/down** key until the **Menu / Diagnose** comes up.

**3** Press the **Up/down** key until you see the **Diagnose / DiskItg** option.

**4** Press the **Select** key to enter the disk performance test:


**5** From here you first need to confirm the operation: press the **Menu** key to **start** the operation or press the **Select** key to select **no** and abort the operation and return to the menu. Once confirmed the test starts. A percentage indicator gives an idea of the progress.


You can press the **Select** key to **abort** the process. This will complete the process in a proper way.

**6** When the process is complete the result is displayed:


**7** Press the **Select** key to start the test again or press the **Menu** key to return to the menu.

The result can be one of the following messages:

*Table 8.10: Status messages (Part 4)*

| MESSAGE | MEANING |
|---|---|
| **Succeed** | Disk integrity test passed. |
| **AcqBusy** | Disk test failed because an acquisition was active or has been started while testing. |
| **ReadErr** | A read error has been encountered |
| **WrtErr** | A write error has been encountered |
| **VfyErr** | A verification error has been encountered |
| **InitErr** | Could not empty the disk initially |
| **RestErr** | Could not remove test files and create new directory |
| **TimeOut** | Test is taking more than eight (8) hours |
| **Failed** | Any other error has been encountered. |

## 8.10 Menu - Alerts

The **Alerts** menu provides information on various topics.

**How to access to the Alerts information:**

- Press the **Menu** key.
- Press the **Up / Down** key until the **Menu / Alerts** comes up:


- Press the **Select** key to access the various messages.
- Press **Menu** twice to quit.

The following is a list of possible alerts:

*Table 8.11: Alert messages*

| MESSAGE | PROBLEM |
|---|---|
| **Module Version Error** | Cards are installed with incompatible firmware versions. Contact your local dealer or visit the HBM website. |
| **SCSI Mode Error** | This message is displayed with the **Instrument Module 1 (IM1)** only, when the connected SCSI drive has a lower transfer speed than the interface supports. E.g. a SCSI160 drive is connected to the GEN series SCSI320 interface. This will lead to a decrease of throughput and published specifications may not be met. You can find the current mode in the **Status / SCSIMODE** section. |
| **Network Speed xxx MB** | The current network speed is lower than the interface supports. E.g. 100 MB/s for the GEN series 1 Gbit/s interface. This will lead to a decrease of throughput and published specifications may not be met. |

## 8.11 Menu - Errors

The **Errors** menu provides error information.

**How to access to the Errors information:**

- Press the **Menu** key.
- Press the **Up / Down** key until the **Menu / Errors** comes up:


- Press the **Select** key to access the various messages.
- Press **Menu** twice to quit.

The following is a list of possible errors:

*Table 8.12: Error messages*

| MESSAGE | PROBLEM |
|---|---|
| **Overtemp X/Y value** | High temperature:<br>X = slot number<br>Y = element/component<br>value = value, e.g. 70.5 C |
| **Overvolt X/Y value** | High voltage:<br>X = slot number<br>Y = element/component<br>value = value, e.g. 24.27 V |
| **Undrvolt X/Y value** | Low voltage:<br>X = slot number<br>Y = element/component<br>value = value, e.g. 0.22 V |

The element/component number is an integer value in range 0 through 17, and for service purposes only.

# 9 Acquisition and Storage

## 9.1 Introduction

Data acquisition hardware within the GEN series is based on the concept of a **recorder**. A recorder consists of a number of acquisition **channels** that share the same basic recording parameters: sample rate, sweep length and pre- and post-trigger length. Usually a single recorder is physically identical to a single acquisition card. Multiple recorders can be placed in a single **mainframe**. The mainframe is the housing for the recorders, provides the power and includes the interface for the local area network. A mainframe has its own network address (IP address).

For the sake of simplicity we will consider a single channel in this section.

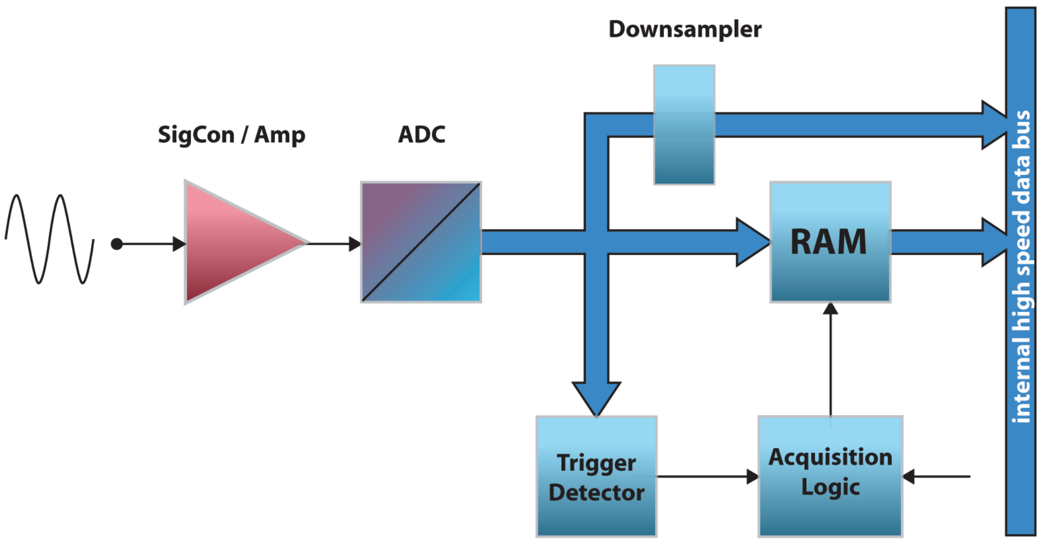



**Figure 9.1:** Simplified generic single channel data acquisition system

In the GEN series data acquisition system and the Perception software that goes with it, a separation is made between acquisition and storage. **Acquisition** is the act of digitizing analog data and making it available for monitoring or storage. **Storage** is the actual archiving of digitized data. **Recording** (verb) is acquisition + storage.

## 9.2 Recording

Since many of the features that are described here are controlled from within the Perception software, it is advised to read this section in combination with the corresponding sections in the Perception manual.

The GEN series/Perception combination provides the following acquisition controls:

- **RUN** The run command starts recording of data. Now the recorder(s) record(s) data until a stop command is issued. This stop command can be manually or triggered (when in sweep storage mode).
- **STOP** To stop or abort a recording. The current recording will be closed.
- **PAUSE** This mode has two options:
  1. When no recording is active it will place the recorder in the pause or stand-by mode. Although the recorder is digitizing, no data is stored in memory or disk. This is useful for monitoring purposes.
  2. When a recording is active, it will place the recorder in a hold mode: although the recorder is digitizing, no data is stored in memory or disk. At this point when RUN is selected, the current recording continues, when STOP is selected, the recording is finished.

These recording controls are combined with the various storage modes.

## 9.3 Storage

The GEN series provides two storage paths as shown in Figure 9.1 on page 141:

- Store data in on-board RAM at high speed
- Transfer data directly at reduced speed to the controlling PC or (when installed) to a local disk.

In addition to these storage paths the GEN series provides two fundamental storage modes:

- **Sweeps:** data storage of predefined length. Sweeps typically use a trigger to define the start and end of the sweep.
- **Continuous:** data storage of undefined length. The end of this storage mode can be defined by various events as described later.

When data is stored, this data is organized in recordings. A recording (noun) is defined as all the data that has been stored between the start of acquisition (Record command) and the end of acquisition. The end can be defined in various ways. A recording can have one or multiple sweeps, a continuous data stream or a combination of both.

From within Perception a recording is organized as a pNRF file (Perception Native Recording File).

**CAUTION**

**The GEN series RAM is volatile. Wait until all data is transferred to the recording file before closing Perception or switching off the instrument.**

The storage mode defines how data is digitized and saved. The continuous storage mode will store all data. The Sweep storage mode will store only the sweeps. However, the resulting file - or recording - will be different for the various storage modes.

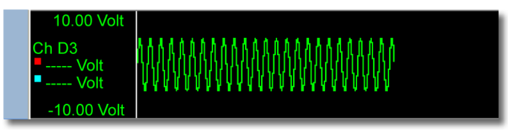



**Figure 9.2:** Run - Storage: Continuous

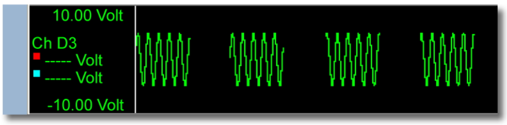



**Figure 9.3:** Run - Storage: Sweeps only

The basic storage modes can be combined to create more advanced storage modes:

**Dual** In this mode, sweeps as well as continuous data is stored. Therefore the end result is a recording that comprises the higher speed sweeps as well as the lower speed continuous data in between the sweeps.

**Slow-Fast Sweep** In this mode sweep data with different sample rates are stored. The difference with the dual mode is the fact that the slower data stream is now actually a slower speed sweep, i.e. it has a predefined length and requires a trigger. The trigger position is the same as the trigger of the first high-speed sweep.

### 9.3.1 More on sweeps

Figure 9.1 "Simplified generic single channel data acquisition system" on page 141 is a very simplified block diagram of the general concept of a single channel digitizer. Once the analog values have been converted by the ADC into binary codes, they are stored in successive order in a buffer memory, the on-board RAM. This memory can be divided into multiple segments to allow for the storage of multiple sweeps.

If the last storage location of a segment is filled and acquisition is still taking place, the first storage location is overwritten with a new sample, followed by the second storage location, etc.

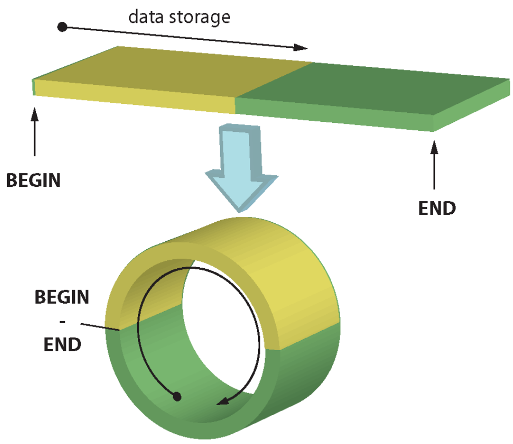



**Figure 9.4:** Ring buffer operation of memory

The physical memory therefore forms a ring buffer, into which information can be continuously added (Figure 9.4). This process of filling the ring buffer memory terminates only when the recording logic indicates that the sweep must be ended. Once the sweep recording has stopped, the content of the buffer memory becomes available to the control PC for processing. This is also called **circular recording**. Sweep data is automatically moved from onboard RAM memory to the recording file.

### Pre-trigger sweeps

As we have seen, data emerging from the ADC is stored in the buffer memory. When recording, the memory is continuously refreshed with new sample values, until storage is halted. The information available in the memory is a **history** of the recorded signal up to the moment of 'end-of-sweep'. The extent of this history depends on the sample rate and the data storage capacity (length) of the memory. If we assume a memory length of 40 000 samples and a sample rate of 10 000 samples per second, then the time window of the history will be:

**(EQ 1)**

$$t_{window} = \frac{40000}{10000} = 4 \text{ seconds}$$

Storage into the ring buffer can be stopped only by a 'stop' signal from the recorder. This signal is called the "trigger". For full details on triggering see chapter “Digital Trigger Modes” on page 153.

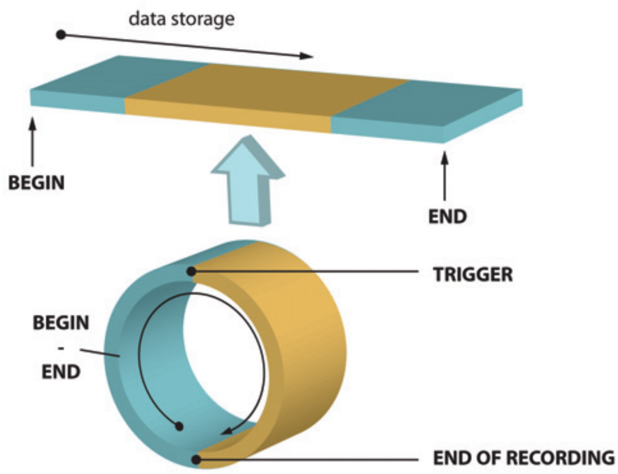



**Figure 9.5:** Ring buffer with trigger and end-of-recording

Since the trigger stops the storage, all stored information is termed pre-trigger information. When storage stops because the acquired signal has met a trigger condition, only pre-trigger information is available - information recorded before the signal met the trigger condition.


**Figure 9.6:** Full pre-trigger storage: pre-trigger = 100%

More often one is interested in what happened just before and after the condition was met. To achieve this aim, a delay is introduced. Once the trigger condition is met, storage is stopped - not immediately, but only after a programmable delay counter has counted out. The memory now contains pre-trigger information and post-trigger information.

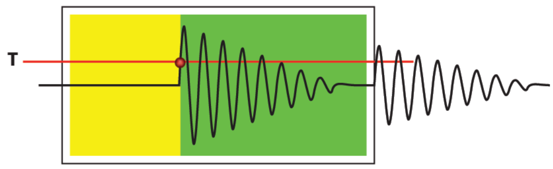



**Figure 9.7:** Pre-trigger / post-trigger storage: 0% < pre-trigger < 100%

The usage of a variable delay counter allows for a user-definable pre-trigger length. The length of the pre-trigger segment equals the length of the memory segment minus the delay. When the length of the delay is equal to, or exceeds, the length of the memory segment, only post-trigger information is available.

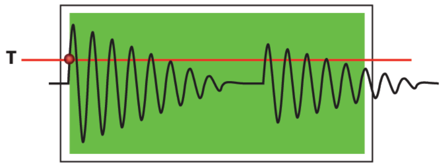



**Figure 9.8:** Full post-trigger storage: pre-trigger = 0%

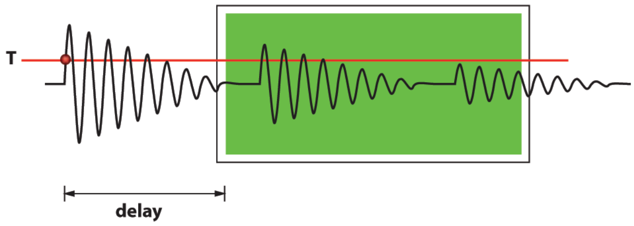


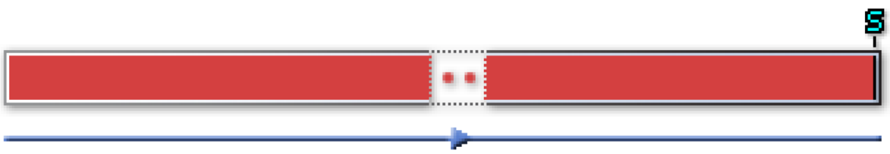

**Figure 9.9:** Delayed trigger storage: pre-trigger < 0%

### 9.3.2 More on continuous data storage

The most important difference between continuous data storage and sweeps in a GEN series is the fact that sweeps are stored in on-board volatile RAM, while continuous storage takes place on the controlling PC's hard disk (or local hard disk when installed).

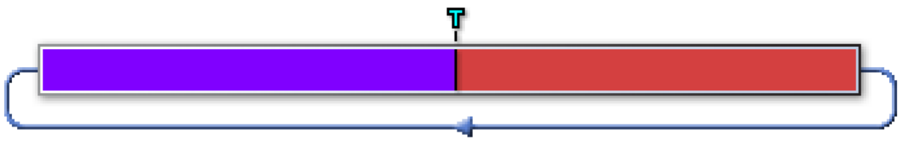
The continuous data storage provides three modes:

- **Standard** The continuous mode is standard when storage is started and stopped manually as depicted below:



- **Circular** The continuous mode is circular when storage is started and stopped manually AND the length of the buffer is defined. Operation is now similar to standard sweep storage, but storage is on PC hard disk and not in volatile memory. In this mode the **lead-out** is specified which is basically the same as the post-trigger segment in a sweep recording.


- **Stop on trigger** The continuous mode now operates like a pre-trigger sweep, but with storage on the PC hard disk, not in volatile memory.



## 9.4 Time base

The power of modern data acquisition techniques is achieved by *digitizing* analog information. Digitizing is the conversion of the instantaneous value of an analog signal (static or dynamic) into a numeric value. When the signal varies, *sampling* the instantaneous amplitude at sufficiently rapid intervals converts this signal into a series of numbers that can represent the original analog signal.

### 9.4.1 Real-time sampling and time base

Real-time sampling is a straightforward sampling method and is the only method to record non-periodical phenomena. In this method, the intervals between the samples taken of the original signal are as short as possible and equidistant. If the sample rate used is high enough, the original signal can be reconstructed without any additional processing.

The sample rate is determined by the time base: the time base is a clock that generates pulses used to drive the A-to-D Convertor. Within the GEN series you have the following time base options:

- **Internal time base** When you select the internal time base, the clock used to drive the ADC's is the built-in clock.
- **External time base** When you select the external time base, the clock used to drive the ADC's is the clock signal presented at the external clock input BNC on the GEN series Controller/Interface module. When you select this mode, the interval between two consecutive samples may not be equidistant. This all depends on the accuracy of the supplied clock signal. For more details see "I/O connectors (IM1)" on page 211 and "I/O connectors (IM2)" on page 178.

When internal time base is selected there are two related options:

- **Internal Clock Base Decimal** This setting is used to create time base values that are base 10, e.g. 1 MHz, 100 kHz, 50 kHz, 2.5 Hz, etc. These values are derived from a main oscillator that operates at a base 10 frequency, e.g. 1 MHz.
- **Internal Clock Base Binary** This setting is used to create time base values that are base 2, e.g. 1.024 MHz, 512 kHz, 64 Hz, etc. These values are derived from a main oscillator that operates at a base 2 frequency, e.g. 1.024 MHz.

The above selections are made in the Perception software in the Settings Sheet ► Memory&Timebase ► Mainframe ► Clock Base and is therefore mainframe-wide, i.e. the same for all recorders.

A binary clock base is a useful time base settings when doing FFT’s (frequency domain analysis).

### 9.4.2 Time base settings for FFT’s

When doing FFT’s there are two topics that affect the acquisition:

**1** It makes life easier when the final FFT yields spectral lines with a distance ∆ **f** that is a "nice" value. Otherwise stated: the FFT bin size should preferably be a nice value. Sometimes this is also called the "frequency resolution". The bin size is determined by the actual frame size or frame length: **bin size = 1 / T** in which T is the total frame size time. E.g. a one-second frame size will result in a 1 Hz bin size, a 0.5 second frame size results in a 2 Hz bin size.

**2** Preferably the frame size in samples is equal to a power of two. Fundamentally most FFT algorithms work on data sets with a length of 2^N.

The binary clock base of the internal time base in combination with the division factors allow for a broad range of values that meet both requirements. In the table below various sample rates are given as well as the corresponding division factor (divisor). The table shows the bin sizes that result from these sample rates in combination with various sweep lengths.

Example: from the table you can read that a sample rate of 40.960 kHz and a frame length of 8192 samples result in a 5 Hz bin size, i.e. the spectral lines are 5 Hz from each other.

"Nice" values are considered to be "minor" values that easily fit in "major" values for (grid) display purposes.

In the table below the values are in the colored cells and basically comprise the range 1.25, 2.5, 5, 10, 20.

*Table 9.1: Examples of FFT Bin sizes*

| TIME BASE MAIN = 1.024 MHZ | | FFT SIZE (FRAME LENGTHS) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 256 | 512 | 1024 | 2048 | 4096 | 8192 |
| SMP/S | DIVI-SOR | FFT BIN SIZE IN HZ | | | | | |
| 1024000 | 1 | 4000 | 2000 | 1000 | 500 | 250 | 125 |
| 512000 | 2 | 2000 | 1000 | 500 | 250 | 125 | 62.5 |
| 256000 | 4 | 1000 | 500 | 250 | 125 | 62.5 | 31.25 |
| 204800 | 5 | 800 | 400 | 200 | 100 | 50 | 25 |
| 128000 | 8 | 500 | 250 | 125 | 62.5 | 31.25 | 15.625 |
| 102400 | 10 | 400 | 200 | 100 | 50 | 25 | 12.5 |
| 51200 | 20 | 200 | 100 | 50 | 25 | 12.5 | 6.25 |
| 40960 | 25 | 160 | 80 | 40 | 20 | 10 | 5 |
| 25600 | 40 | 100 | 50 | 25 | 12.5 | 6.25 | 3.125 |
| 20480 | 50 | 80 | 40 | 20 | 10 | 5 | 2.5 |
| 12800 | 80 | 50 | 25 | 12.5 | 6.25 | 3.125 | 1.5625 |
| 1024 | 100 | 40 | 20 | 10 | 5 | 2.5 | 1.25 |
| 5120 | 200 | 20 | 10 | 5 | 2.5 | 1.25 | 0.625 |
| 4096 | 250 | 16 | 8 | 4 | 2 | 1 | 0.5 |
| 2560 | 400 | 10 | 5 | 2.5 | 1.25 | 0.625 | 0.3125 |
| 2048 | 500 | 8 | 4 | 2 | 1 | 0.5 | 0.25 |
| 1280 | 800 | 5 | 2.5 | 1.25 | 0.625 | 0.3125 | 0.0156 |
| 1024 | 1000 | 4 | 2 | 1 | 0.5 | 0.25 | 0.125 |

**Additional information**
The Nyquist frequency (f/2) is the maximum frequency that can be accurately measured by a digitizer sampling at a rate of (f). Otherwise stated: a digitizer sampling at a rate of (f) cannot measure an input signal with frequency components exceeding f/2 without experiencing "aliasing" inaccuracies.

Nyquist's theorem determines the range of frequencies that can be measured. They range from DC to one half the sampling rate at which the data was captured. An FFT of a sweep of N points produces N/2 frequency domain data points within the range of frequencies between DC and the Nyquist frequency. So the frequency resolution is:

**(EQ 2)**

$$\Delta \mathrm{f} = \frac{samplerate\ /\ 2}{N\ /\ 2}$$

As an example assume a frame of 8192 points (N=8192) and a sample rate of 40.96 kHz. This will yield the following:

- Frequency resolution Δf = (½ * 40960) / (½ * 8192) = 5 Hz
- Number of frequency domain points: N/2 = 4096
- The minimum frequency component that can be measured is equal to the frequency resolution Δf = 5 Hz
- The maximum frequency component that can be measured is 40.96 kHz / 2 = 20.48 kHz

The FFT X-scale (frequency) will start at 5 Hz, end at 20480 Hz, and has 4096 points.

# 10 Digital Trigger Modes

## 10.1 Introduction

Within the GEN series data acquisition system, each and every channel is equipped with a **trigger detector**, which makes it possible to record just the phenomenon of interest, instead of having to search the full memory to find it. The trigger detector gives the system the power to capture elusive, short and unpredictable events. It determines how easily you can extract the event of interest.

The word **trigger** has a dual meaning in recording techniques. In the active sense, the instrument has triggered, indicating that the instrument has responded to a certain stimulus. In the passive sense, as in trigger point, it indicates the point (in time) where the instrument has triggered. In both cases, trigger refers to a known, pre-defined situation.

The trigger can be generated in several ways:

- by the user, i.e. **manually**
- using an externally applied signal, i.e. **external** trigger
- when the acquired **signal** complies with a certain condition: the trigger condition. Each channel within a recorder can trigger this recorder.

For transient recording this last option is of great importance. The trigger facilities determine to a large extent the application capabilities of the data acquisition system - i.e. how effectively the data can be captured.

In this chapter the trigger capabilities of the GEN series data acquisition system will be explained in full detail.

Each channel within a recorder can trigger this recorder. This functionality is realized by combining all channel triggers into a logical OR combination: When one of the channels (or multiple channels) generates a trigger, the complete recorder triggers. Each channel's trigger detector can be switched off or set to one of the modes described in this chapter.

**Note** *This chapter describes all GEN series trigger options. However not every acquisition card will support each described option. Check the specifications of each acquisition card to find out what options are supported for this specific card.*

## 10.2 Understanding digital triggering

Technically speaking, there are two approaches to determine the known, pre-defined situation of the signal: analog or digital.

Each channel in the GEN series system is equipped with a digital trigger detector, because it has stable vertical reference levels, because it does not encounter horizontal jitter, and because it is frequency independent.

A disadvantage of a digital trigger detector is its inability to detect events between two consecutive samples. This does not usually interfere with normal operation because the event is not recorded anyway.

### 10.2.1 Digital trigger detector

Figure 10.1 shows a simplified diagram of a **single-level** digital trigger detector. Digitized values coming from the ADC are fed into an Arithmetic (and) Logic Unit – ALU. The value that comes out of the ALU is then referenced against a preset value (trigger level). The result can be either positive, i.e. the value is larger, or negative, i.e. the value is smaller. Based on this information the level crossing detector verifies if a level crossing in the correct direction has occurred and if so, sends out a trigger.

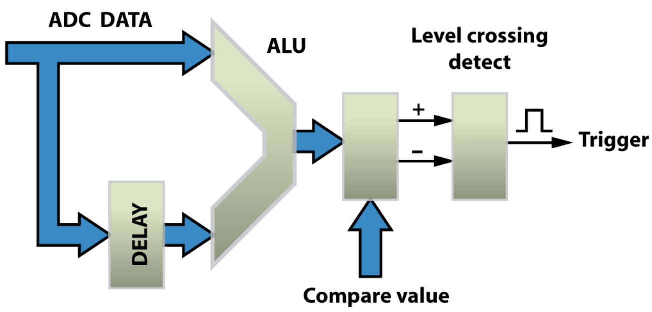



**Figure 10.1:** Single level trigger detector

The delay register in front of the ALU is used to compare the ADC value with “older” values. This means that triggering is not reacting to specific levels, but to the differential signal or **slope**.

As explained later in this chapter, a signal must actually cross the preset level. This is to avoid erroneous triggering on a small amount of noise on the signal. To make the trigger detector even more stable when noisy signals are used, the single-level trigger detector has been expanded with a **hysteresis**. As soon as the level detector signals a level crossing a new level crossing will only be signaled if the input signal has been outside the hysteresis band.
For the advanced trigger modes the single-level trigger detector with programmable hysteresis has been implemented twice to provide a **dual-level** trigger detector. Levels are usually referenced as *primary* trigger level and *secondary* trigger level.

### 10.2.2 Valid trigger conditions

Trigger detection is based on level crossing: A signal has to cross a specified level to be considered a trigger condition. As a consequence, reaching the required level is not a valid trigger condition. Since trigger detection is digital, inter-sample analog values are omitted.

In the following graphs these conditions are shown.

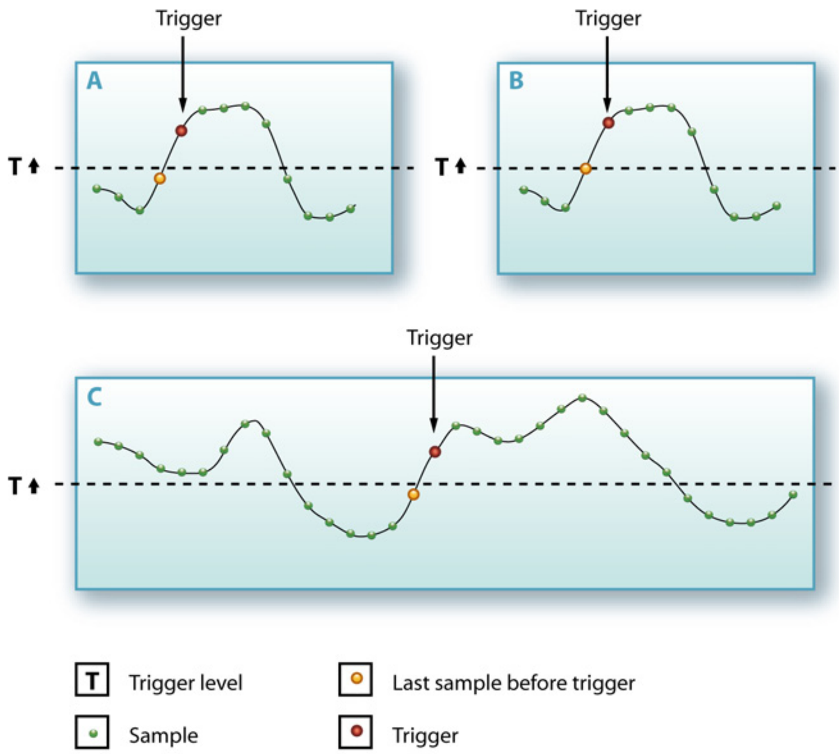



**Figure 10.2:** Level crossing detector

Figure 10.2 shows the basic trigger mode with a specified level (**T**), and a level crossing in positive direction. In Figure 10.2 **(A)** the trigger occurs on the first sample after the level crossing. Figure 10.2 **(B)** shows the situation in which a sample equals the set level. Trigger does not occur until a sample is actually above the required level.

Since the trigger detector requires a level crossing, no trigger occurs when a signal is above the set level when recording starts. This is depicted in Figure 10.2 **(C)**.

Figure 10.3 shows the influence of the additional hysteresis. Fundamentally all is the same as described earlier. The only difference now is that a second level (H) is used to 'arm' the level trigger detector. Otherwise stated, the trigger level has been expanded to be a trigger zone that spans multiple levels.

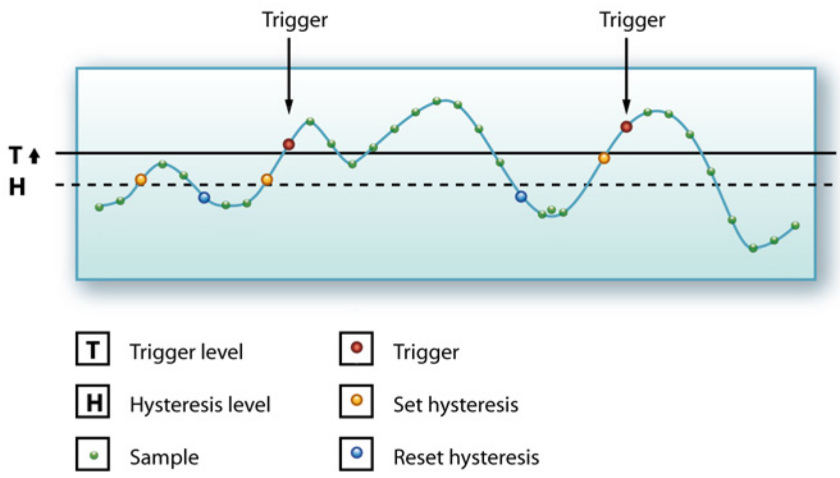



**Figure 10.3:** Trigger level hysteresis

## 10.3 Trigger modes

Using the various trigger modes, your GEN series data acquisition system is expanded to an extremely versatile transient recorder. The trigger circuits may be configured to trigger on many types of phenomena. In this section the different trigger modes and their extensions are discussed in detail.

### 10.3.1 Basic trigger mode

The basic trigger mode can be compared with the trigger mode available when using an analog trigger detector, for example as found on a classic scope.

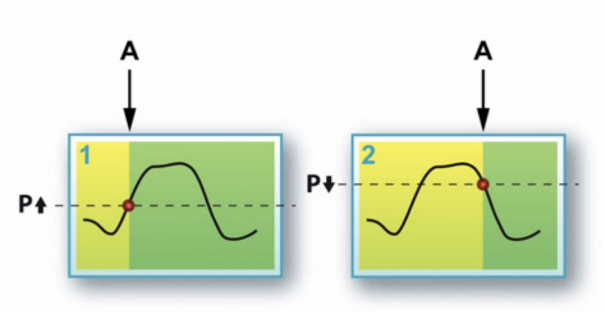



**Figure 10.4:** Basic trigger mode

**A** Trigger

In this mode a single-level trigger detector is active: the primary level. As mentioned previously, the signal must actually cross the preset level. Both level and direction of crossing are selectable.

Relevant settings for this mode:

- Mode: Basic
- Primary level: any value within the input range
- Direction: positive or negative
- Hysteresis: any relevant value

### 10.3.2 Dual trigger mode

In dual trigger mode two detectors are active and working in parallel: the primary level **P** and the secondary level **S**. With two levels it is possible to define a range the input signal must be within. As soon as the signal becomes larger than the upper level, or smaller than the lower level, the detector will generate a trigger. By inverting the slopes of both detectors, the trigger will be generated when the signal returns into the specified range.

Figure 10.5 shows the various possibilities.

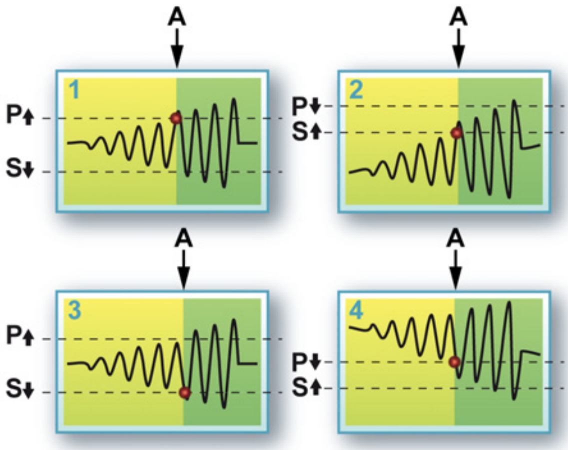



**Figure 10.5:** Dual trigger mode

**A** Trigger

You can select any value for each level and the slope of the primary level. The slope of the secondary level is automatically set to the opposite direction.

Diagrams **1** and **3** show a signal that exits the range, diagrams **2** and **4** show signals that enter the range.

Relevant settings for this mode:

- Mode: Dual
- Primary level: any value within the input range
- Secondary level: any value within the input range
- Direction: positive or negative for primary level, secondary level is automatically set to the opposite
- Hysteresis: any relevant value is used for both levels.

### 10.3.3 Window trigger mode

For the window trigger mode both levels are used. One of them has a dual function: arm and trigger, the other is used as a disarm level. To generate a trigger, the trigger detector must be armed. This is done by crossing the arm/trigger level in the opposite direction. Once armed, the trigger is generated by crossing the arm/trigger level in the set direction, unless a crossing of the disarm level has occurred after the arm condition.

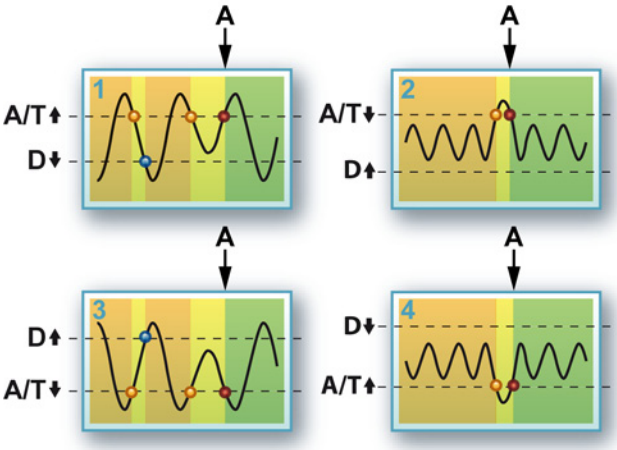



**Figure 10.6:** Window trigger mode

**A** Trigger

Diagrams **1** and **3** show the intended use of the window trigger mode: detecting a dip in a repetitive signal. Diagrams **2** and **4** show alternatives: detecting a peak pulse in a repetitive signal.

The Window trigger mode is very useful if a periodic signal is monitored and the GEN series must be triggered on peak level changes. This mode is most effective on uni-polar signals, e.g. a TTL level pulse train. For bi-polar signals the dual-window trigger mode is more suited as described in the following section.

Relevant settings for this mode:

- Mode: Window
- Primary level: any value within the input range
- Secondary level: any value within the input range
- Direction: positive or negative for primary level, secondary level is automatically set to the opposite
- Hysteresis: any relevant value is used for both levels.

### 10.3.4 Dual-window trigger mode

The dual-window trigger mode is a more sophisticated version of the window trigger mode. Now both levels are used as an arm/trigger/disarm level. This allows the trigger detector to react on a dip in both directions.

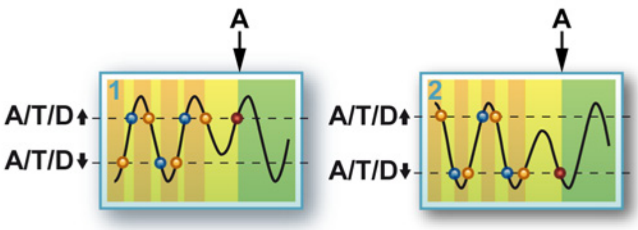



**Figure 10.7:** Dual-window trigger mode

**A** Trigger

Diagram **1** shows one situation, diagram **2** the other situation with the same settings. Here the following conditions determine the trigger result:

- Level crossing in opposite set direction = arm level
- Level crossing in set direction = disarm when other level is armed
- Level crossing in set direction = trigger when level is armed

Since this is true for both levels, a “dip” in both directions is detected as shown in diagram **1** and **2**.

Relevant settings for this mode:

- Mode: Dual-window
- Primary level: any value within the input range
- Secondary level: any value within the input range
- Direction: positive or negative for primary level, secondary level is automatically set to the opposite
- Hysteresis: any relevant value is used for both levels.

### 10.3.5 Sequential trigger mode

The two level comparators are set in a sequence in this mode. One is used to arm the trigger detector while the other is used to actually generate the trigger: if the incoming signal crosses the level of the first comparator, the second is activated (armed).

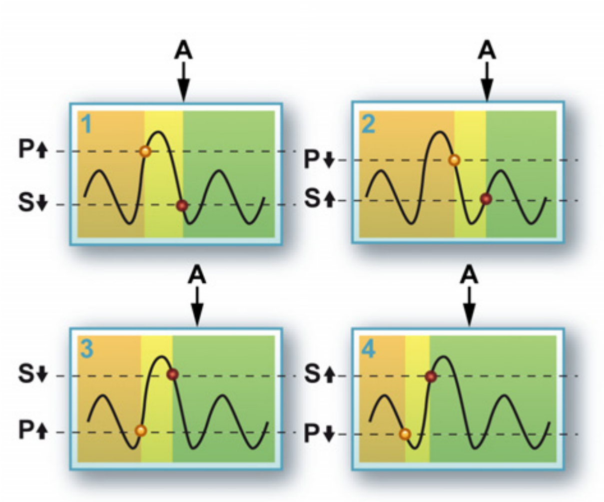



**Figure 10.8:** Sequential trigger mode

**A** Trigger

This mode can be used to help eliminate false triggering due to noise or hysteresis. The concept is sometimes also referred to as sensitivity window.

Although not very common, you can also set the level of the primary detector to a lower value than the secondary detector. This will give you the options shown in diagrams **3** and **4**.

Relevant settings for this mode:

- Mode: Sequential
- Primary level: any value within the input range
- Secondary level: any value within the input range
- Direction: positive or negative for primary level, secondary level is automatically set to the opposite
- Hysteresis: any relevant value is used for both levels.

### 10.3.6 Trigger qualifier

The trigger detectors of a channel can also be used as a qualifier. A trigger qualifier is a situation that enables (arms) the recorder trigger features. The recorder trigger features are a combination of various channel, external, between-recorders and other trigger options.

There are two qualifier modes:

- Basic single-level qualifier. Level detector operates identical to "Basic trigger mode" on page 158.
- Dual-level qualifier. Level detector operates identical to "Dual trigger mode" on page 159.

When in qualifier mode, the output of the trigger detector is sent to a qualifier line of the recorder trigger logic. For a full description of the recorder trigger features see "Recorder and system trigger" on page 172.

## 10.4 Trigger add-ons

The mentioned trigger modes can be combined with a variety of extra features, allowing to trigger on almost any signal.

Some of these extras are used to fine-tune the selected trigger mode, other features expand the capabilities of the basic trigger detector.

The following simplified diagram is from the settings sheet and shows the building blocks that make the complete channel trigger logic.

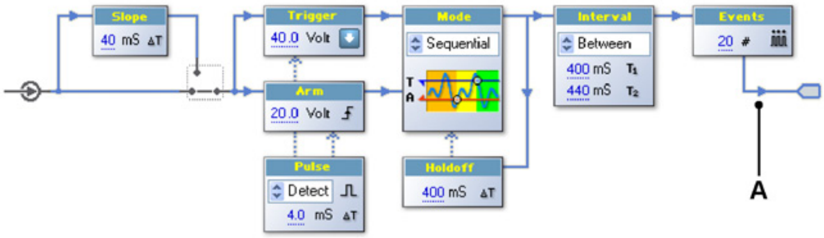



**Figure 10.9:** Channel trigger logic

**A** To recorder trigger

From left to right the following add-ons are available:

- **Slope** detector: allows to trigger on a slope instead of level
- **Pulse** qualifier: detects or rejects trigger conditions that meet a specific time frame
- **Holdoff:** disables the trigger detector for a set period of time after a trigger condition
- **Interval:** defines a time interval between two consecutive trigger conditions
- **Events:** counts the number of trigger conditions before an actual trigger is generated

### 10.4.1 Slope detector

All trigger functions described so far work on the absolute level of the incoming signal. The slope detector allows the same functions to work on the *difference* between samples. This means that the triggering is not reacting to specific levels but to the differentiated signal or slope. The slope detector is also known as differentiator or dY/dt detector. The output of the slope detector is the difference between the newest sample and the sample that was recorded the given number of sample intervals ago.

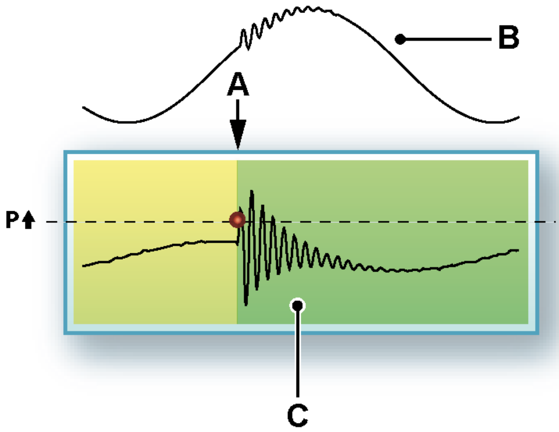



**Figure 10.10:** Slope trigger

**A** Trigger

**B** Original signal

**C** Differentiated signal

With the slope triggering it is possible to trigger on a specific change in slope of the signal, for example on a spike on a repetitive signal: if the slope (or frequency) of the signal exceeds the specified level, a trigger will be generated.

### 10.4.2 Pulse detector

The pulse detector can be used together with the basic (slope) trigger level detector. It can be used for two opposite purposes:

- Detect trigger conditions smaller than a set period of time: **pulse detect**
- Detect trigger conditions larger than a set period of time: **pulse reject**

All operations of the trigger detector are the result of crossing the level of a comparator.

**Pulse detect**

If, after crossing, the condition of the comparator is stable for at least a specified period of time, the crossing is not a valid trigger condition, i.e. it is not a short enough pulse (or noise) that can be omitted, and no trigger is generated.

**Pulse reject**

If, after crossing, the condition of the comparator is stable for at least a specified period of time, the crossing is a valid trigger condition, i.e. it is a long enough pulse that must be recorded, and a trigger is generated.

The pulse detector operates on samples. In the Perception software this is translated into time.

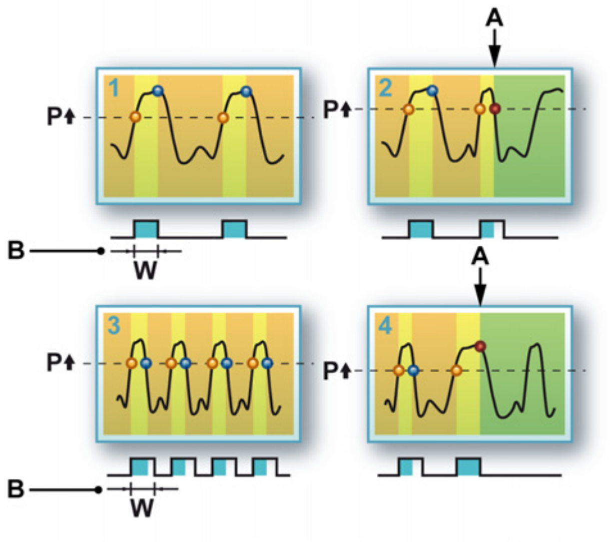



**Figure 10.11:** Pulse detect/reject methods

**A** Trigger

**B** Width

Figure 10.11: In diagrams **1** and **2** the pulse detection is depicted. In diagram **1**, when the trigger level is crossed, the signal remains above the trigger level for a time interval larger than pulse width **W**. In diagram **2** there is a situation in which the signal returns through the trigger level within pulse width **W**. A trigger is generated on a “small” pulse.

In diagrams **3** and **4** the opposite situation is depicted: pulse reject. Now “small” pulses are not recognized as trigger condition, while a wider pulse generates a trigger.

The pulse detector can be used for both trigger levels. Combined with a hysteresis setting, the pulse detector is less sensitive to noise on the signal.

### 10.4.3 Holdoff

The trigger holdoff feature is used to disable the trigger detector for a period of time after a trigger condition was met.

This can be used to generate only one trigger on a slowly decaying repetitive signal, or eliminate the effect of after-ringing. Using a 16-bit counter triggering can be disabled for as long as 6.5535 seconds when sampling at 10 kS/s.

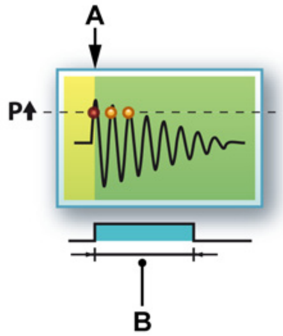



**Figure 10.12:** Trigger holdoff

**A** Trigger

**B** Holdoff

The feature is most useful in combination with the interval timer and/or the event counter.

### 10.4.4 Interval timer

A highly sophisticated trigger add-on is the interval timer. The interval timer is used to define a time relation between two trigger events. When the time relation is correct, a trigger is generated.

The following relations are possible:

- **Less:** The time interval between two consecutive trigger events is less than the specified time interval.
- **More:** The time interval between two consecutive trigger events is more than the specified time interval.
- **Between:** The time of the second trigger event is within a specified time interval that starts a specified time after the first trigger event.
- **NotBetween:** The time of the second trigger event is not within a specified time interval that starts a specified time after the first trigger event.

The interval timer operates on samples (2 to 65535). In the Perception software this is translated into time. At 1 MS/s sample rate this results in a maximum of 65.535 millisecond.

**Interval timer - Less**

This interval time mode is fairly straight forward. When the second trigger event is within the set time interval, a trigger is generated.

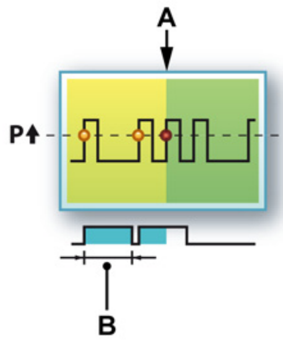



**Figure 10.13:** Interval timer - Less

**A** Trigger

**B** Interval

The time interval is reset on the first new trigger event. This feature allows you to detect additional pulses in a standard train of pulses for example.

**Interval timer - More**

This interval timer mode is more complicated. When the second trigger event is within the set time interval, no trigger is generated and the time interval is reset on each trigger event. When a new trigger event occurs after the specified time interval, i.e. the interval is not reset in time, then a trigger is generated at the end of the specified time interval.

In the reset moments are denoted with a dotted line, the actual trigger moment with a straight line.

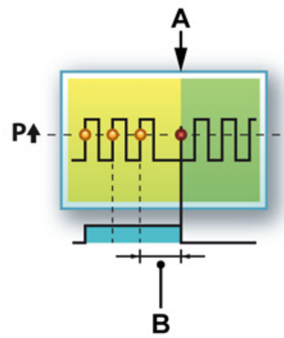



**Figure 10.14:** Interval timer - More

**A** Trigger

**B** Interval

This function allows you to detect a “missing” pulse in a standard pulse train for example.

**Interval timer - Between**
For the Between mode basically two timers are used: one to set the start of a time window and a second to set the width of the time window. The second trigger event must be within this time window.

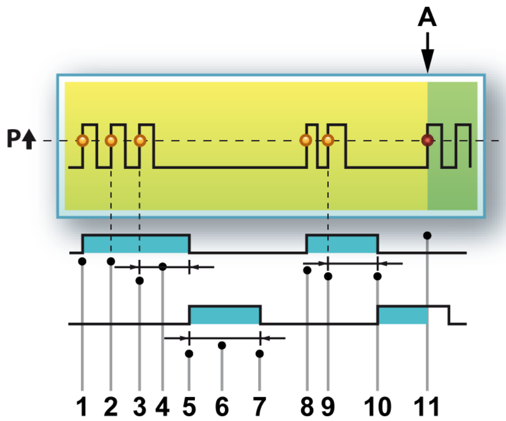



**Figure 10.15:** Interval timer - Between

The following sequence explains what happens:

**1** The first trigger event starts interval timer 1.

**2** A second trigger event occurs before interval timer 1 has expired, the timer is reset.

**3** A third trigger event occurs before interval timer 1 has expired, the timer is reset.

**4** Interval 1

**5** Interval timer 1 expires and interval timer 2 is started.

**6** Interval 2

**7** Interval timer 2 expires while no trigger event occurred within the set period. The complete trigger logic is reset.

**8** The first new trigger event starts interval timer 1.

**9** A second trigger event occurs before interval timer 1 has expired, the timer is reset.

**10** Interval timer 1 expires and interval timer 2 is started.

**11** A trigger event occurs before interval timer 2 expires: a trigger is generated.

**A** Trigger

The first interval timer can be compared to the trigger holdoff feature described earlier. The second interval timer defines a period in which a trigger event must occur. If not, it is not a related trigger event.

**Interval timer - NotBetween**
The inverse function of the Between mode of the interval timer is the NotBetween mode. Now the second interval is not used to define a trigger-safe area, but to denote a trigger-restricted area. A trigger event within the first interval is valid. A trigger event within the second interval resets the trigger logic. A trigger is also generated when both interval timers expire. Typical use of this mode is to detect changes in the interval between pulses ("too early" / "too late" detection).

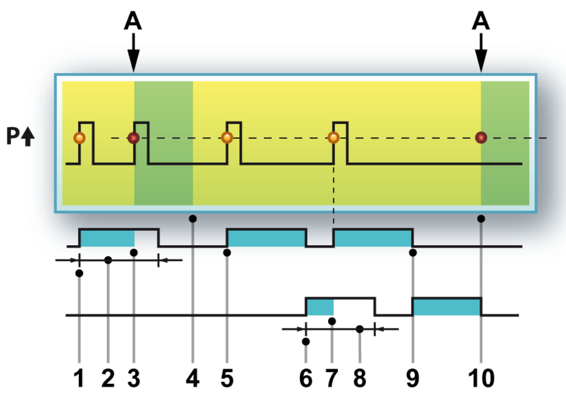



**Figure 10.16:** Interval timer - NotBetween

The following sequence explains how this mode functions:

- **1** The first trigger event starts interval timer 1.
- **2** Interval 1
- **3** If a trigger event occurs within the first interval, a trigger is generated.
- **4** End of sweep.
- **5** The first new trigger event starts interval timer 1.
- **6** Interval timer 1 expires and interval timer 2 is started.
- **7** A trigger event occurs within the second interval. Interval timer 1 is restarted.
- **8** Interval 2
- **9** Interval timer 1 expires and interval timer 2 is started.
- **10** Interval timer 2 expires and a trigger is generated.
- **A** Trigger

### 10.4.5 Event counter

Sometimes it is not possible to trigger on a specified condition using a selected trigger mode alone, because several events meet the required situation. So far we have seen “filters” that can be used to narrow the range of trigger candidates, like holdoff and interval timer.

As a last resource the event counter can be used. The event counter counts all generated triggers and generates a final trigger when the count equals a preset value ranging typically from 1 to 256.

## 10.5 Recorder and system trigger

The trigger modes and features described so far are channel-based. Each analog channel within a GEN series system has a digital trigger detector. The trigger signals of all channels of a single recorder are combined through a logical OR to generate a combined trigger. This trigger can be combined with an external trigger and qualifiers. The final result is a recorder trigger. The triggers that are generated by individual recorders can be distributed to other recorders and mainframes.

The following simplified diagram is from the Perception software and shows the building blocks that make the complete recorder trigger logic. Please note that - depending on your exact hardware - not all features may be available.

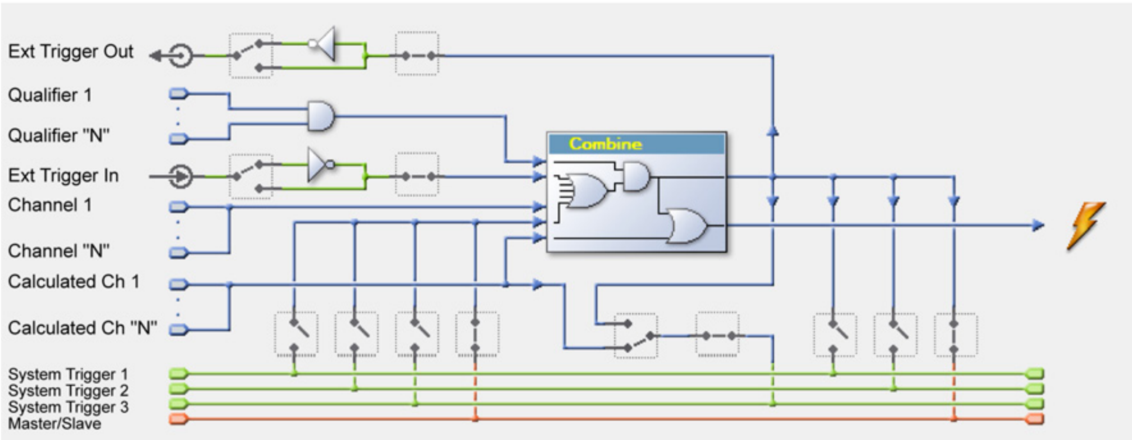



**Figure 10.17:** Recorder trigger logic

The heart of the recorder trigger logic is the “Combine” block. Here all trigger sources come together and, depending on their setting, can generate a recorder trigger. This can be blocked, however, by qualifiers: If one of the qualifiers is not armed, no recorder trigger can be generated.

- **Channel 1 through N:** These are the channel triggers as described earlier. Refer to chapter Introduction of Digital Trigger Modes on page 153.
- **External Trigger In:** This is an external trigger signal that is mainframe-related: The input connector is placed on the mainframe controller. Used to select rising or falling edge, all input cards in the mainframe will use the same edge. Each input card can select to use the external trigger as a trigger source or not.
- **Qualifier 1 through N:** These are the qualifiers as described earlier: See "Trigger qualifier" on page 163.

- **External Trigger Out:** The recorder trigger can be used to send a trigger signal to the outside world. The output connector is placed on the mainframe controller. Used to select active High or Low level output, all input cards in the mainframe will use the same output level. Each input card can select to send the trigger to the external trigger output or not.
- **Internal Trigger Line 1 through 3:** There are three internal trigger lines. These are used to transfer recorder triggers from one recorder to another. Each recorder can select to set its recorder trigger on one or more lines. It can also pick up a trigger from one or more lines.
- **Master/Slave:** Multiple mainframes can be synchronized by using the Master/Slave function. When in use, a recorder can put the recorder trigger on the Master/Slave trigger line and/or pick up the trigger from the Master/ Slave trigger line. When Master/Slave operation is not used, this line functions just like the other three trigger lines.

## 10.6 Channel alarm

Each channel has the capability to generate an alarm. An alarm situation is detected with a basic dual level detector.

There are two alarm modes:

- Basic single-level alarm. The alarm line is active as long as the signal exceeds the level in the specified direction. For details on the level comparator see "Basic trigger mode" on page 158.
- Dual-level alarm. The alarm line is active as long as the signal exceeds one of the two levels in the specified direction. For details on the level comparators see "Dual trigger mode" on page 159.

The output of the alarm detector is sent to an alarm line and combined (OR-ed) with alarm conditions of the other channels and recorders. The result is available as an external output located on the mainframe controller.

# 11 Interface/Controller Module

## 11.1 Introduction

The Interface/Controller Module uses a high-end CPU with an embedded real-time operating system. It can store data to local (RAM) memory, optional extras are available for storage and communication.
Each complete mainframe houses an Interface/Controller Module which enables data input and output so that the mainframes can be connected together in a Network.
Starting January 2012 an upgraded Interface/Controller Module (IM2) is shipped as standard with all mainframes, thus there will be two different Interface Modules in use and documented:

- Interface/Controller Module 1 (IM1)
- Interface/Controller Module 2 (IM2)

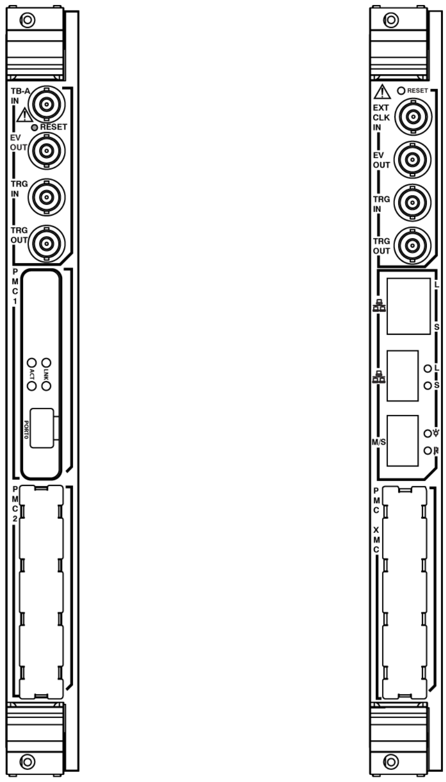



**Figure 11.1:** Interface modules (IM1-left) (IM2-right)

If you are not sure which Interface/Controller Module you have in your mainframe please contact your local sales representative or send an email to info@hbm.com. In both cases please provide us with the serial number of your mainframe. You will find this number at the label on the rear side of the mainframe.

## 11.2 IM1 and IM2 Slot locations

The IM1 and IM2 use a specific slot in the GEN series units, for the GEN7t and GEN16t is different. The following section shows the specific placement of the IM1 and IM2 in the different GEN series machines. The Master/Slave also has specific slot placement depending on which unit it is placed in.

### 11.2.1 GEN7t and the Interface/Controller module

When placing the IM1/2 in the GEN7t, make sure that it is placed in the second slot from the left as shown in Figure 11.2. This is the only slot available which will seat the module properly. The slot to the left of the IM1/2 is **reserved** for the Master/Slave card, only use the Master/Slave card in this slot.

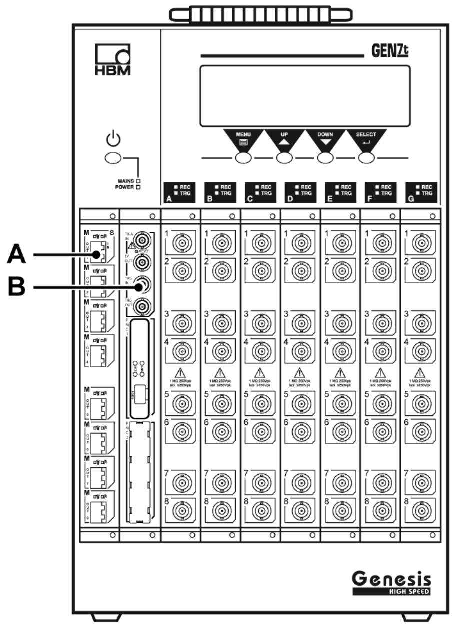



**Figure 11.2:** GEN7t IM1/IM2 and M/S slot position

**A** Master/Slave card

**B** Slot for IM1/2 modules

### 11.2.2 GEN16t and the Interface/Controller module

When placing the IM1/2 in the GEN16t, make sure that it is placed in the slot on the left as shown Figure 11.3 "GEN16t IM1/IM2 and M/S slot position" on page 177. This is the only slot available which will seat the module properly. The slot to the right of the IM1/2 is the only slot compatible with the Master/ Slave card.

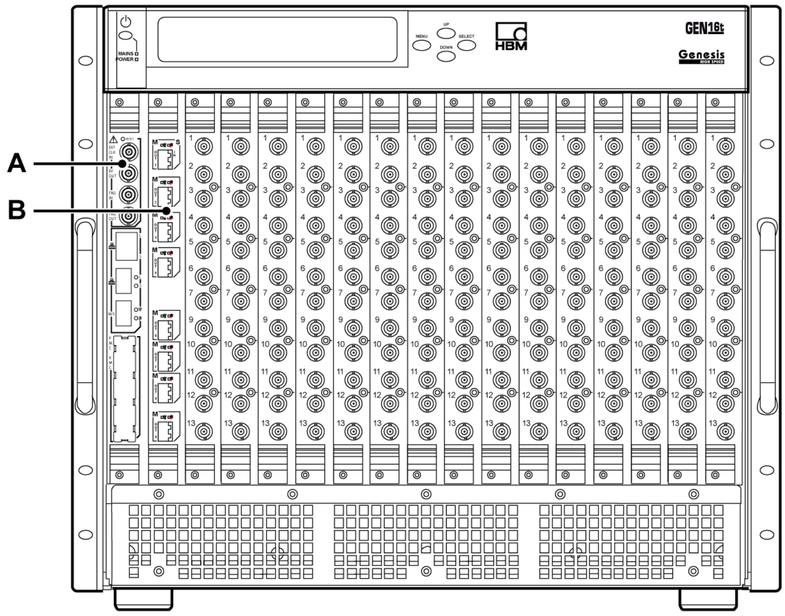



**Figure 11.3:** GEN16t IM1/IM2 and M/S slot position

**A** Slot for IM1/2 modules

**B** Master/Slave card

### 11.3 Interface/Controller Module 2 (IM2)

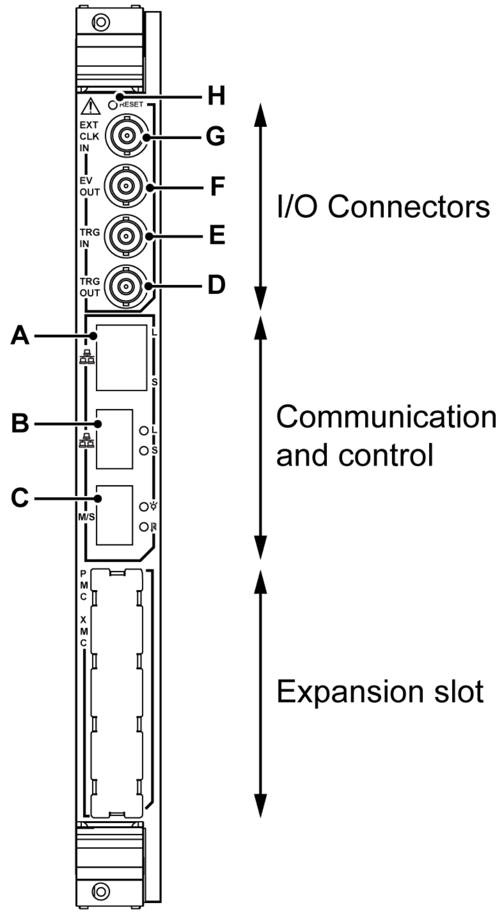



**Figure 11.4:** Interface/Controller module IM2

**A** Standard 1 Gbit Ethernet Interface

**B** Optical 1 Gbit Ethernet Interface

**C** Master/Slave Synchronization

**D** External Trigger Out

**E** External Trigger In

**F** External Event Out

**G** External Time base In

**H** Recessed Mainframe Reset Switch

The CPU **Reset** Switch can be used to reset the controller/interface in the rare event of a system malfunction. To reset the unit carefully press the recessed switch with a small screwdriver or equivalent.

The IM2 has a unique Communication section with 1 Standard Ethernet Interface, 1 Optical Ethernet Interface with 2 activity LEDs and a Master Slave Interface with 2 activity LEDs. The 4 I/O connectors are very similar to the IM1 connectors however the reset switch on the IM2 is above the first connector on this module. The first connector on this module is labeled EXT CLK IN.

The IM2 is built from three main sections; the I/O Connectors, the Communication section and the Expansion slot.

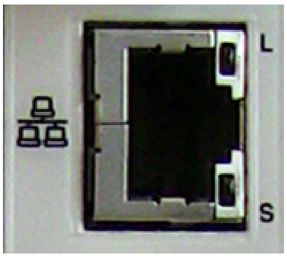
### 11.3.1 IM2 - Communication and Control

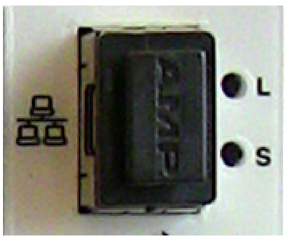
The GEN series uses standard TCP/IP protocol over Ethernet to communicate with your PC. The Interface/Controller Module 2 provides access to the Ethernet network.

The module is equipped with:

- 1 Standard copper Ethernet interface with 100/1000 Base-T Gigabit support (connect to the RJ-45 Interface).
- 1 Fiber optic interface (Install and connect to the SFP module option).
- 1 M/S Master Slave interface (Connect to the SC Interface).

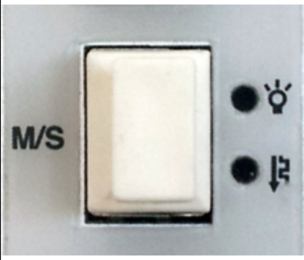
LED’s are used to indicate activity as well as connection. The following describes the LED activity of the front panel of the IM2.

| | | |
|---|---|---|
| | **Standard Interface (RJ45)** Cat 5e UTP, 1 Gbit/s | |
|  | **L = Link up/active (green)**<br>On; Link up<br>Off; Link down<br>Blinking; Active | **S = Speed (yellow)**<br>On; 100 Mbit<br>Off; 1000 Mbit |

| | | |
|---|---|---|
| | **1 Gbit Optical SFP Interface** | |
|  | **L = Link up/active (green)**<br>On; Link up<br>Off; Link down<br>Blinking; Active | **S = Speed (yellow)**<br>On; 100 Mbit<br>Off; 1000 Mbit |

**Using the 1 Gbit Option Connections**

| | |
|---|---|
|   | **LC Connection Using the SFP + Option**<br>LC optical connections that need an SFP device to enable their use with LC connected optical cable. |

| | | |
|---|---|---|
|   | **Master Slave Synchronization** | |
| | **= Link up/ active(green)**<br>On; Link up, correct Synchronized Recording (M/S) link, fiber cable connected<br>Off; Link down, No Fiber cable connected | **= Receiver enable (green)**<br>On; Active<br>Off; Inactive |
| | Flashing; Fiber cable connected, on-board Synchronized Recording (M/S) disabled (Disabled by user or by present Master/Slave card). | |

## 11.3.2 IM2 - Master/Slave Synchronization

The IM2 module has built-in synchronization capability for GEN2i systems only. The following table shows the various supported configurations with the IM1, IM2 and Master/Slave (M/S) cards installed.

| IM2 - Master/Slave Synchronization Support | | | |
|---|---|---|---|
| | **IM2** | **IM1 + Master/ Slave card** | **IM2 + Master/ Slave card** |
| GEN16t, GEN7t, GEN5i<br>(16t, 7t, 5i) | ✗ | ✓ | ✓ |
| GEN2i | ✓✓ | ✓ | ✓ |

Legend:

✗ Not supported.

✓ **Standard Synchronization:** Synchronizes the first sample in the recording for each mainframe, prevents frequency drift of the sample rates within each mainframe, synchronously exchanges every channel trigger connected to the Master/Slave trigger bus to/from each connected mainframe and automatic cable length delay compensation.

**Extended Synchronization:** Standard synchronization and Start/Stop and Pause of a recording across multiple mainframes each controlled by a separate Perception. (Stop recording is a non synchronous action). Synchronous manual trigger exchange (user software action to trigger all mainframes synchronously. Calculated channel trigger exchange (requires Perception V6.50 or higher).

### 11.3.3 IM2 - I/O connectors

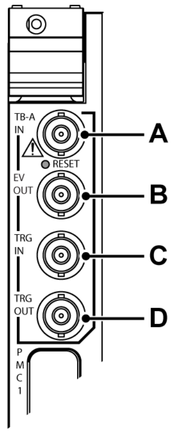



**Figure 11.5:** Interface/Controller Module IM1 - (BNC connectors)

**A** External Time base In - (EXT CLK IN)

**B** External Event Out - (EV OUT)

**C, D** External Trigger In/Out - (TRG IN/TRG OUT)

The controller/interface provides 4 BNC connectors with the following functions:

**A** **External Time base In - (EXT CLK IN)**
This input can be used to provide another time base for the ADC rather than the internal one. Typically used in combination with rotating machinery where the ADC clock is synchronized with the revolutions. In the Perception software the selection between external and internal time base is made in the Mainframe section of the Settings.

**B** **External Event Out - (EV OUT)**
This output is software selectable between **Alarm Out** and **Recording Active Out.** When *alarm* is selected, the output is driven by channel alarm detectors. When *recording active* is selected, the output is "high" when a recording is in progress.

**C/D External Trigger In/Out - (TRG IN/TRG OUT)**
This input and output are related to the recorder trigger logic. For details see "Recorder and system trigger" on page 172.

### 11.3.4 IM2 - Expansion slot

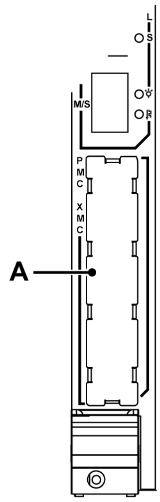



**Figure 11.6:** Expansion slot on Interface/Controller Module IM2

**A** Free space for option

**Note** *For more details see “Interface/Controller Module options” on page 214.*

## 11.4 IM2 - iSCSI based storage

**What is iSCSI?**

- iSCSI; Internet SCSI (Small Computer System Interface).
- SCSI is an older standard used by storage devices to communicate with PC’s to exchange the data. Specifically, iSCSI is a TCP/IP based communication protocol.
- Specifically, iSCSI is a TCP/IP based communication protocol.

**Note** *The iSCSI is for use with the Interface/Controller Card IM2 only. (Mainframes shipped before January 2012 are equipped with the Interface/ Controller Card IM1.)*

Using iSCSI gives you total freedom of placement of the storage device as long as your existing network topology allows you to reach the destination of your storage device.

Since iSCSI is a communication protocol, it requires two parties; The Initiator and the Target.

- **Targets:** Typically **N**etwork **A**ttached **S**torage devices (NAS).
- **Initiators:** Typically computers or in our case the GEN DAQ systems.

### 11.4.1 Introduction: iSCSI NAS with GEN DAQ network

By supporting the iSCSI protocol the GEN DAQ systems can directly store the recorded data on a storage device attached to your network.

The basic setup will look like this:

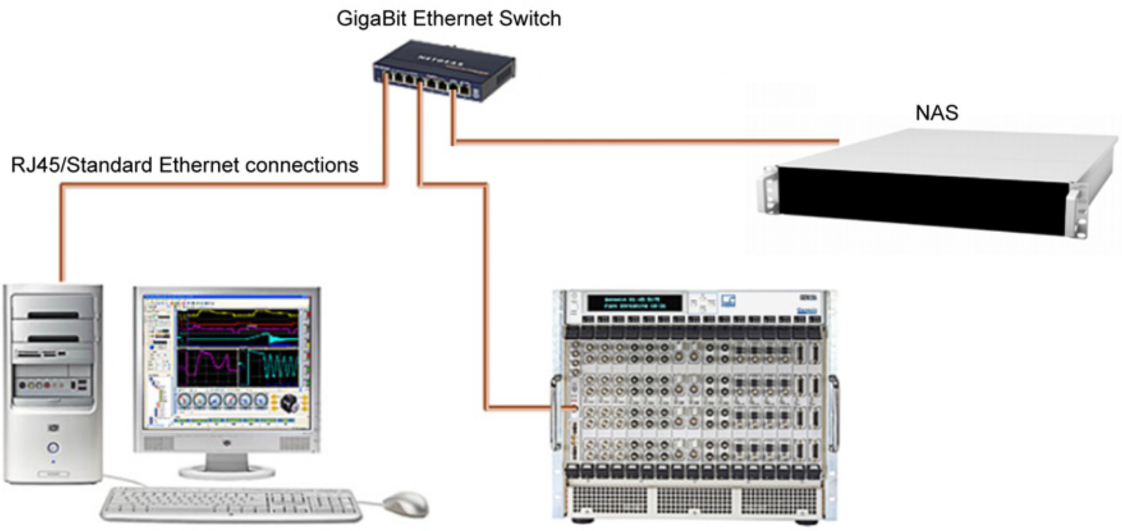



**Figure 11.7:** iSCSI setup with local NAS

In Figure 11.7 a networked PC is attached to a GEN DAQ system to control and setup the GEN DAQ system connections. By instructing the GEN DAQ system to store its recorded data, not on the PC but on an externally attached NAS, supporting the iSCSI protocols, the GEN DAQ system will transfer all recorded data (without the support of the PC) directly on the NAS.

**WARNING**

**In this setup, one GEN DAQ connection is used for communication with Perception and storage on the NAS. When possible avoid using live data and recording functions simultaneously.**

To enable the GEN DAQ system to communicate with the storage device, several *layers* of communication need to be established.

### 11.4.2 TCP/IP connection with an NAS

To enable the GEN DAQ system to communicate with the storage device, several layers of communication need to be established.

There are several ways to make these connections with different setups. When using a dedicated network as shown in Figure 11.7 with no other systems attached, a fixed IP address must be setup on your NAS. As a result it is highly recommended to also have the PC and GEN DAQ system set to fixed IP address setup. Other ways to setup this configuration are described in examples later in this chapter.

**Note** *Setting up the network interface on the NAS server can be found in the manufacturers NAS server handbook. An example of the Synology® NAS server setup is given in appendix "Setting up the iSCSI using Synology® NAS" on page 718.*

Make sure that the GEN DAQ system and the NAS server are within the same network range using shared netmask and IP ranges so they can communicate with each other.

### 11.4.3 External Storage Setup dialog - Perception

To setup a NAS device in software Perception, first connect to the GEN DAQ system used for iSCSI storage, open Perception and navigate to the **Settings** menu and click **External Storage Setup**.

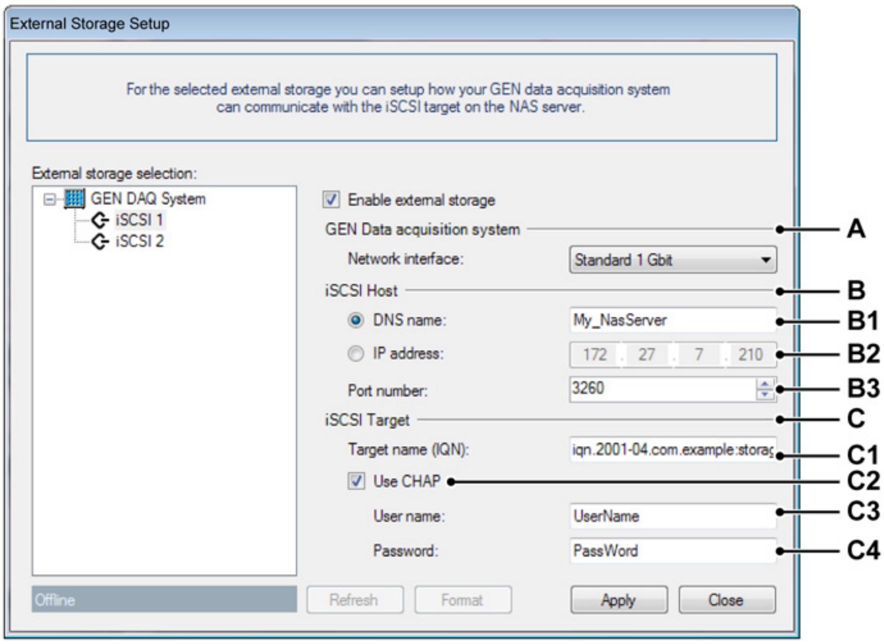



**Figure 11.8:** External Storage Setup dialog

**A** GEN Data acquisition system

**B** iSCSI Host

**C** iSCSI Target

This setup dialog shows the connected mainframes and their available external storage sources. If supported these storage sources will show up here. Click on the iSCSI label to select one.

### 11.4.4 GEN Data acquisition system (See Figure 11.8 - A)

This selection box shows the available network interfaces that are installed on the GEN DAQ system. Click the drop-down box and then select the correct network interface that your NAS is connected to, this setting must be correct for any of the further settings to take effect.

It is possible to connect a NAS server on iSCSI 1 and iSCSI 2 at the same time but not possible to use them both at the same time.

**Note** *Do not select the same Network Interface for both iSCSI 1 and iSCSI 2.*

### 11.4.5 iSCSI Host **(See Figure 11.8 - B)**

These settings are input manually and are used to locate your NAS on your network. There are two ways to find your NAS server, listed below. Select either DNS name or IP address.

**B1 DNS name:** (ask your system administrator)
Used when DNS server (Domain Name System) is present. Typically this is used when using GEN DAQ systems in a *corporate* network. If no DNS server is found or if the returned network name did not resolve, the iSCSI will not connect.

**B2 IP address:**
Used when DNS (Domain Name Server) is not available. Typically this is selected when using GEN DAQ systems in an *isolated* network set-up. Input the same IP address as the one used in the setup of the NAS.

**B3 Port number:**
Typically for iSCSI this number is fixed at **3260**.
Only change this if the NAS server uses a different port.

### 11.4.6 iSCSI Target **(See Figure 11.8 - C)**

These settings are used to locate your iSCSI LUN on your NAS server.

The iSCSI protocol works with the iSCSI LUN (Logical Unit Number) system. An iSCSI LUN is a virtual-disk made up of a number of physical disks. They can be any size, and span multiple physical disks within the NAS system or vise-versa; use 1 physical disk for multiple iSCSI LUNs.

Simplified, the NAS server looks like this:

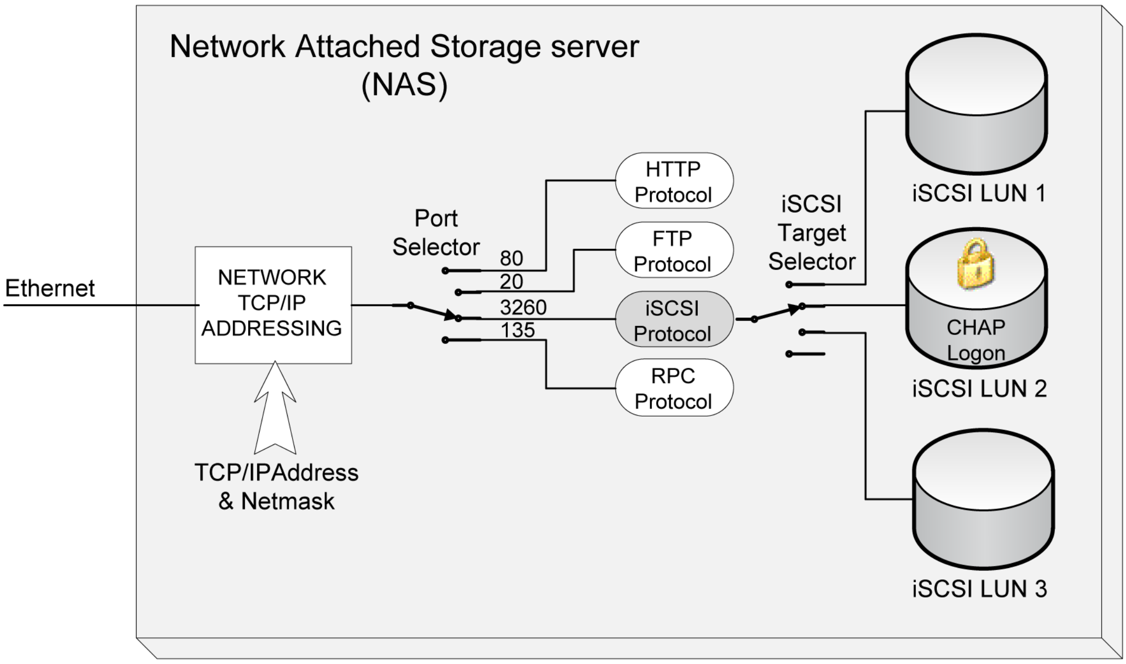



**Figure 11.9:** NAS server - Overview

### 11.4.7 Target Name (IQN) (See Figure 11.8 - C1)

The target name is used in the selection process to identify the correct iSCSI LUN setup inside your NAS server. The Target Name must match the IQN Name setup in your NAS server software.

### 11.4.8 What is CHAP? (See Figure 11.8 - C2)

GEN DAQ systems support the iSCSI defined user logon protocol CHAP. This allows to block your iSCSI storage device from unwanted access. Select **Use CHAP** if CHAP password protection was selected during the setup of your NAS server.

- **User Name:**
  The same name that was defined during the NAS setup process, for reference see Figure H.1 "Synology Assistant" on page 718.

**Note** *Make sure you have full read/write and modify access on your iSCSI storage device*

- **Password:**
  The same password that was defined during the NAS setup process, for reference see Figure H.7 "Create a new iSCSI target dialog" on page 724.

**Refresh/Format the iSCSI**

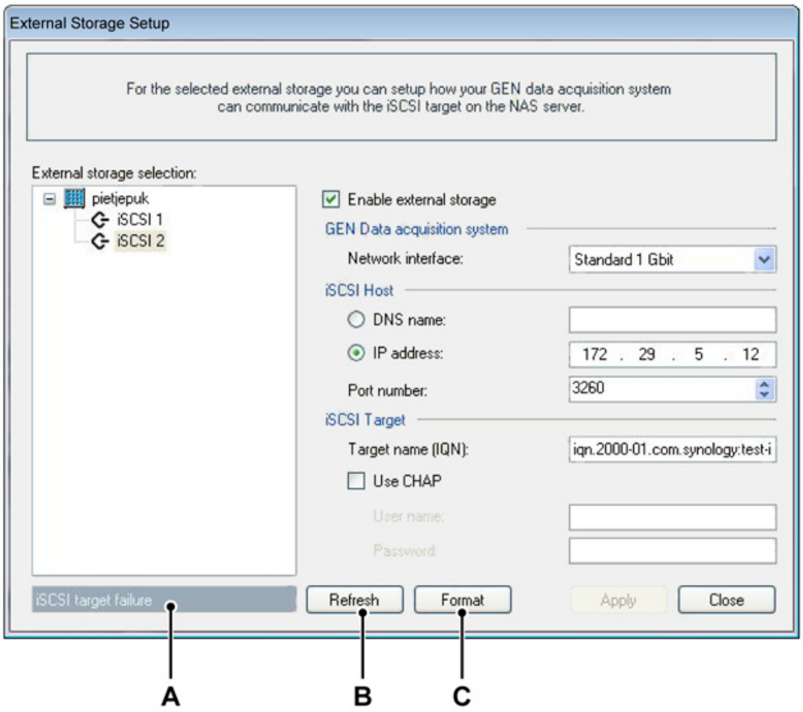



**Figure 11.10:** External Storage Setup - Refresh/Format option

**A** Status message

**B** Refresh

**C** Format

Click **Refresh (B)** to force the status message to read the most current real time message. Click **Refresh** also when the iSCSI has been turned off and then on again, this will force the iSCSI to remount.

### 11.4.9 How to format the iSCSI (See Figure 11.10 - C)

**Note** *The **Format** option is not available from the front panel.*

To format the iSCSI for the first time click **Format**.

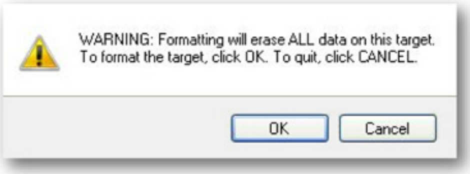



**Figure 11.11:** iSCSI Format option - Warning dialog

A Warning dialog (Figure 11.11) will appear asking if you'd like to format, click **OK** to start the procedure or **Cancel** to quit.

Once formatted the iSCSI should be ready to use by Perception.

### 11.4.10 Status messages/troubleshooting (See Figure 11.10 - A)

Standard operating feedback is given in the **Status** box.

| Status | Meaning |
|---|---|
| **Connecting to iSCSI server** | The iSCSI protocol is busy attempting to connect to the server |
| **Offline** | iSCSI is currently offline or not enabled |
| **Ok** | The iSCSI is mounted successfully |

**Error massages:**
The Status box also shows errors as detailed below.

| Status | Meaning | Check solution |
|---|---|---|
| **Host unreachable** | Cannot communicate with iSCSI | • GEN DAQ interface cable not connected<br>• NAS is turned off<br>• Wrong or missing Default gateway<br>• DNS name didn't resolve and Fixed IP address is incorrect<br>• Cables connected incorrectly |

| Status | Meaning | Check solution |
|---|---|---|
| **No iSCSI host found** | Connection to NAS succeeded, Can't find an iSCSI on host port | • TCP/IP host was not configured as iSCSI server<br>• NAS uses a different iSCSI Port number |
| **Unknown target** | iSCSI protocol connection made but iSCSI target name not found | • Check the iSCSI target name |
| **Login failed** | Could not log in on iSCSI target | • Login details incorrect. Check the user name and password<br>• Disk in use by another system |
| **Mount failed** | iSCSI connection was made, but mount failed | • Check iSCSI formatted correctly in ext4 format |
| **In Use** | This Network interface is already being used by another iSCSI | • Select a different iSCSI interface<br>• Disable one of the iSCSI connections |

When connected correctly and if configured properly using the manufacturer's setup procedure, the iSCSI should be available from Perception.

**WARNING**

**During the manufacturers setup of the iSCSI the disk should be formatted correctly in the ext4 file system, this information is not covered in the Synology® appendix. If the iSCSI has not been formatted correctly in ext4 format according to the manufacturer's instructions the GEN DAQ system will not detect the iSCSI.**

### 11.4.11 Setup an iSCSI NAS connected across an Ethernet switch

This is the simplest setup of a GEN DAQ system with the NAS connected through an Ethernet switch on the same network as the control PC and GEN DAQ system.

This setup can be used in situations where the individual components of the system are all connected to the same network via an Ethernet switch, this allows freedom of placement of each component in the system. This setup enables network access to configure the NAS and GEN DAQ and to read the data on the iSCSI storage device.

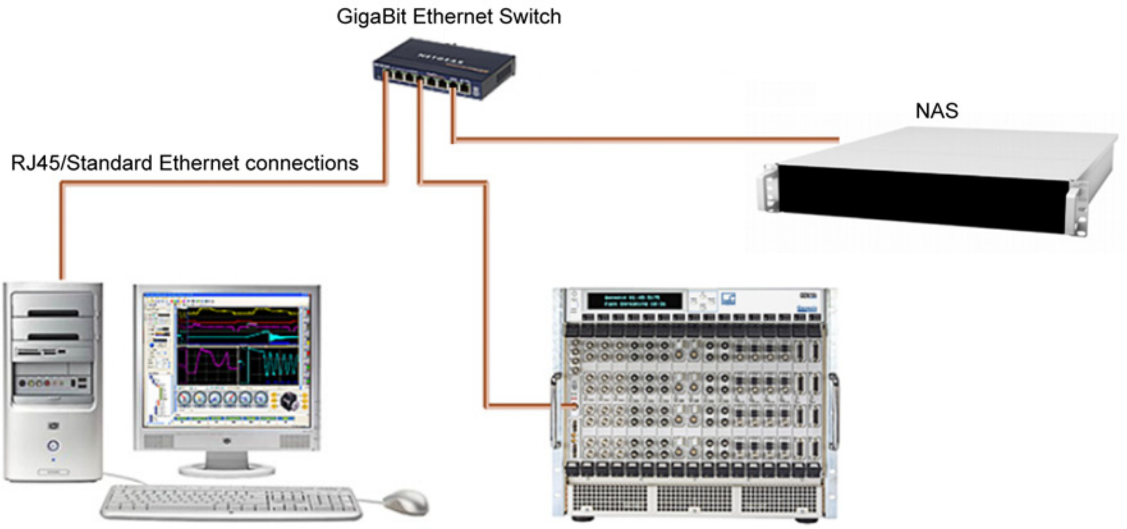



**Figure 11.12:** GEN DAQ with iSCSI NAS connected across an Ethernet switch

**1 Connect the equipment**

- Connect the PC via a standard RJ45 Ethernet connection to the Ethernet switch.
- Connect the GEN DAQ via a standard RJ45 Ethernet connection to the Ethernet switch.
- Connect the NAS via a standard RJ45 Ethernet connection to the Ethernet switch.

At this stage you should make sure all connections and configurations are correct.

After the GEN DAQ is configured the NAS should be configured. To configure the NAS, use the manufacturers guides. An example of further Synology® configuration is given in the appendix “Setting up the iSCSI using Synology® NAS” on page 718. If you have a Synology® system you can follow the steps in the Appendix.

**Note** *All IP addresses are best set to Fixed IP to avoid changing IP addresses when a system performs a power cycle.*

**2 Setup in Perception:**

Start Perception and navigate to the **Settings** menu via the **Settings** tab and select **External Storage Setup**.
Please make sure you have read section Explaining the **External Storage Setup Dialog** (see Figure 11.13) before executing this procedure.

**The External Storage Setup dialog:**
The information in this dialog must match the information defined in the configuration of the connected NAS. Refer to the appendix “Setting up the iSCSI using Synology® NAS” on page 718 when necessary for an example using Synology®.

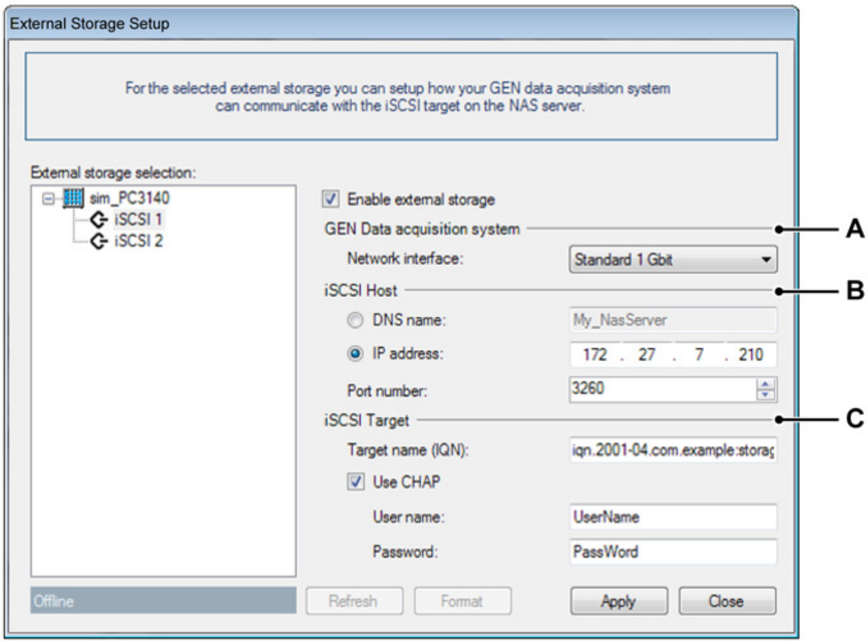



**Figure 11.13:** External Storage Setup (Setup an iSCSI NAS connected across an Ethernet switch)

**A** GEN Data acquisition system

**B** iSCSI Host

**C** iSCSI Target

3 **GEN Data acquisition system -** Network interface: **(See Figure 11.13 - A)**

Select the Standard 1 Gbit Ethernet port that is connected to the Ethernet switch.

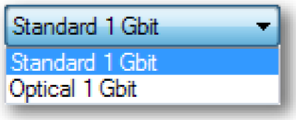



**Figure 11.14:** Network interface connections/Standard 1 Gbit option

4 **iSCSI Host** **(See Figure 11.13 - B)**

- **DNS Name/IP Address:**
  A DNS setting is not used in this setup. When DNS is not available the IP address must be filled in, therefore select the IP address option and use the same IP address that was used in the setup of the NAS. Make sure the IP address of the NAS is a fixed IP address so it does not change after reboot.
  *When using a Synology® NAS, the IP address is displayed in the in the Synology® Assistant software. This software displays all the known connected Synology® devices. See details: “Setting up the iSCSI Synology® NAS” on page 718.*
- **Port number:**
  Default: **3260**
  Can sometimes be found in the NAS configuration of the manufacturers software.

**Note** *When using a Synology® NAS the port number must be set on the default of 3260.*

5 **iSCSI Target** **(See Figure 11.13 - C)**

- **Target name (IQN):**
  This is the IQN name, it can be found by looking at the manufacturers software supplied with the NAS. *An example for Synology® iSCSI setup is in appendix “Setting up the iSCSI using Synology® NAS” on page 718.*
- **Use CHAP:**
  Select **Use CHAP** if CHAP password protection was selected during the setup of your NAS server. *When using a Synology® NAS, CHAP password protection can be selected.*
  (For more information, please refer to Figure H.7 "Create a new iSCSI target dialog" on page 724).

- **User name:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.
- **Password:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

Click **Apply** when done to set the new settings and then click **Close**.

The NAS should now be available in the setup of your GEN series mainframe.

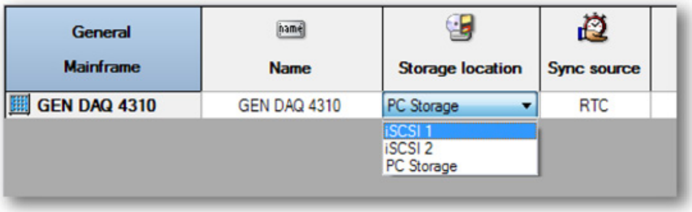



**Figure 11.15:** Storage location with options

### 11.4.12 Setup an iSCSI NAS connected without an Ethernet switch

This is basic setup of a GEN DAQ system with a NAS connected directly at the GEN DAQ system. A Ethernet switch is not required. All components are locally based and can be connected to one host PC. This ensures that there is only one way to communicate with the device which is through the host PC. This is therefore the most secure way to set up the NAS storage device.

This setup however does not provide the network connection to be able to configure the NAS storage device.

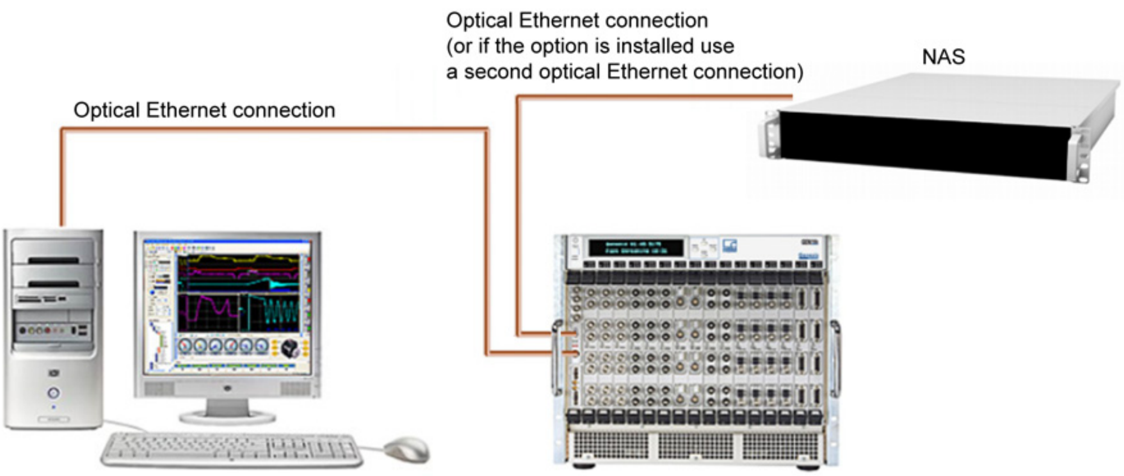



**Figure 11.16:** GEN DAQ with directly attached iSCSI NAS

**WARNING**

**The NAS in this setup is NOT configurable. The unit will therefore have to be connected to PC first to assign an IP address manually, alternatively create a connection to the company network which you can then remove later if needed.**

1 **Connect Equipment** **(See Figure 11.16)**

Connect the PC via an Optical Ethernet connection to the optical Ethernet connector of the GEN DAQ system. Connect the NAS to the GEN DAQ system via the Standard RJ45 connection or if the option is installed use a second optical Ethernet connection.
**OR**
Connect the PC via a standard RJ45 Ethernet connection to the GEN DAQ system's standard RJ45 connector. Connect the GEN DAQ system via the Optical Ethernet connection to the NAS servers Optical Ethernet connector.
Please read "Connecting the GEN series directly to your PC" on page 80 for GEN DAQ setup.

At this stage you should make sure all connections and configurations are correct. The GEN DAQ should resolve an auto IP address in a few moments after being turned on. Then we should configure the NAS with Perception. To configure the NAS, please connect a network cable or connect the NAS to a network temporarily and then follow the manufacturers guides, this will enable you to determine an IP address for the NAS server.

**Note** *All IP addresses are best set to Fixed IP.*

2 **Setup in Perception:** **(See Figure 11.17)**

Start Perception and navigate to the **Settings** menu and select **External Storage Setup**.

Please make sure you have read section Explaining the External Storage Setup Dialog (see Figure 11.13) before executing this procedure.

**The External Storage Setup dialog:**
The information in this dialog must match the information defined in the configuration of the connected NAS. Refer to the appendix “Setting up the iSCSI using Synology® NAS” on page 718 when necessary for an example using Synology®.

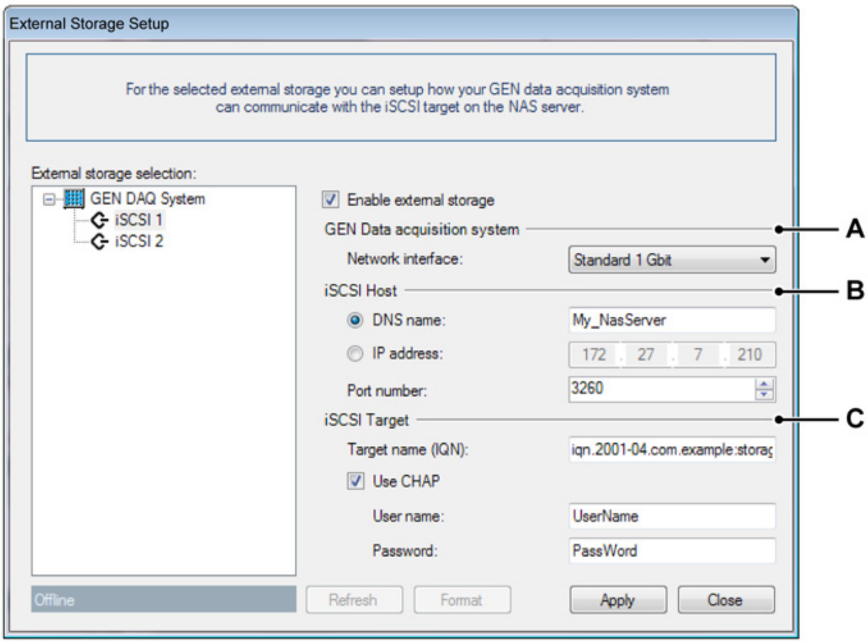



**Figure 11.17:** External Storage Setup dialog (Setup an iSCSI NAS connected without an Ethernet switch)

**A** GEN Data acquisition system

**B** iSCSI Host

**C** iSCSI Target

3 **GEN Data acquisition system** - Network interface: **(See Figure 11.13 - A)**

If you have connected the NAS server to the RJ45 connector of the GEN series mainframe then select the Standard 1 Gbit Ethernet.

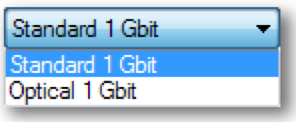



**Figure 11.18:** Network interface connections/Standard 1 Gbit option

**Or**
If you have connected the NAS server to the Optical network connector of the GEN series mainframe then select the Optical 1 Gbit Ethernet.


**Figure 11.19:** Network interface connections/Optical 1 Gbit option

4 **iSCSI Host** **(See Figure 11.13 - B)**

- **DNS name/IP address**
  A DNS setting is not used in this setup. When DNS is not available the IP address must be filled in. Therefore select the IP address option and use the same IP address that was used in the setup of the NAS.
  *When using a Synology® NAS, the IP address is displayed in the in the Synology® Assistant software. This software displays all the known connected Synology® devices.*
  (For more information, please refer to Figure H.1 "Synology Assistant" on page 718).
- **Port number:**
  Default: **3260**
  Can sometimes be found in the NAS configuration of the manufacturers software.
  *When using a Synology® NAS the port number must be set on the default of 3260.*

5 **iSCSI Target** **(See Figure 11.13 - C)**

- **Target name (IQN):**
  This is the IQN name, it can be found by looking at the manufacturers software supplied with the NAS. *An example for Synology® iSCSI setup is in appendix "Setting up the iSCSI using Synology® NAS" on page 718.*
- Select **Use CHAP** if CHAP password protection was selected during the setup of your NAS server.*When using a Synology® NAS, CHAP password protection can be selected.*
  (For more information, please refer to Figure H.7 "Create a new iSCSI target dialog" on page 724).
- **User name:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

- **Password:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

Click **Apply** when done to set the new settings and then click **Close**.

The NAS should now be available in the setup of your GEN series mainframe.

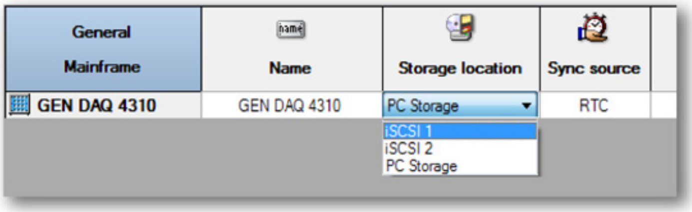



**Figure 11.20:** Storage location with options

### 11.4.13 Setup an iSCSI NAS connected to a corporate network – basic setup

This is a setup of a GEN DAQ system with the NAS connected through an Ethernet switch on a company network.

The NAS location is not restricted and allows freedom of placement of each component in the system. This setup enables network access to configure the NAS or GEN DAQ and to read the data on the iSCSI storage device via the GEN DAQ system.

**Note** *Data on the iSCSI storage device is only readable on PC when using a GENDAQ system to do so.*

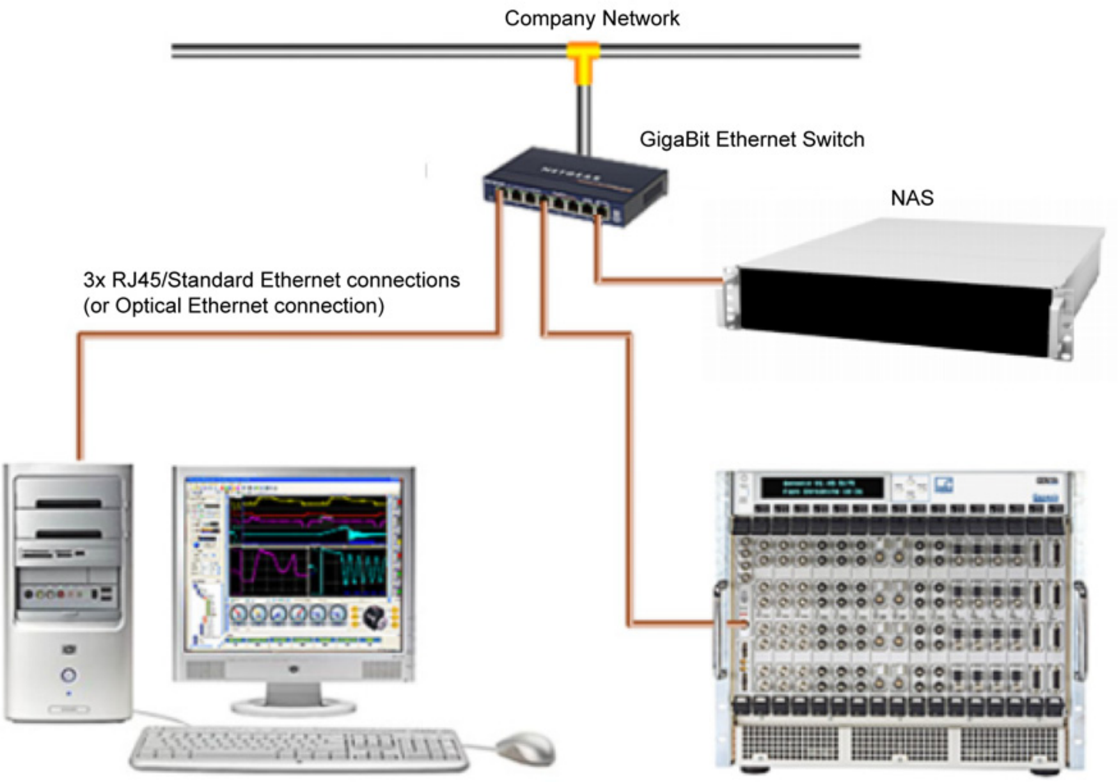



**Figure 11.21:** GEN DAQ with iSCSI NAS connected across an Ethernet switch and connected to a corporate network

1 **Connect Equipment:**

The Ethernet switch should be connected to the Company network.

- Connect the PC via a standard RJ45 Ethernet connection to the Ethernet switch. If an optical Ethernet interface is available, use this.
- Connect the GEN DAQ system via a standard RJ45 Ethernet connection to the Ethernet switch. If an Optical Ethernet interface is available, use this.
- Connect the NAS via a standard RJ45 Ethernet connection to the Ethernet switch. Some NAS servers also support optical connections in which case they can be used.

Please read "Connecting the GEN series to your company network" on page 81 for GEN DAQ setup.

At this stage you should make sure all connections and configurations are correct. The GEN DAQ should resolve an auto IP address in a few moments after being turned on. Then we should configure the NAS with Perception. To configure the NAS, please connect a network cable or connect the NAS to a network temporarily and then follow the manufacturers guides, this will enable you to determine an IP address for the NAS server.

**2 Setup in Perception:**
Start Perception and navigate to the **Settings** menu and select **External Storage Setup**.

Please make sure you have read section Explaining the External Storage Setup Dialog (see Figure 11.22) before executing this procedure.

**The External Storage Setup dialog:**
The information in this dialog must match the information defined in the configuration of the connected NAS. Refer to appendix “Setting up the iSCSI using Synology® NAS” on page 718 when necessary for an example using Synology®.

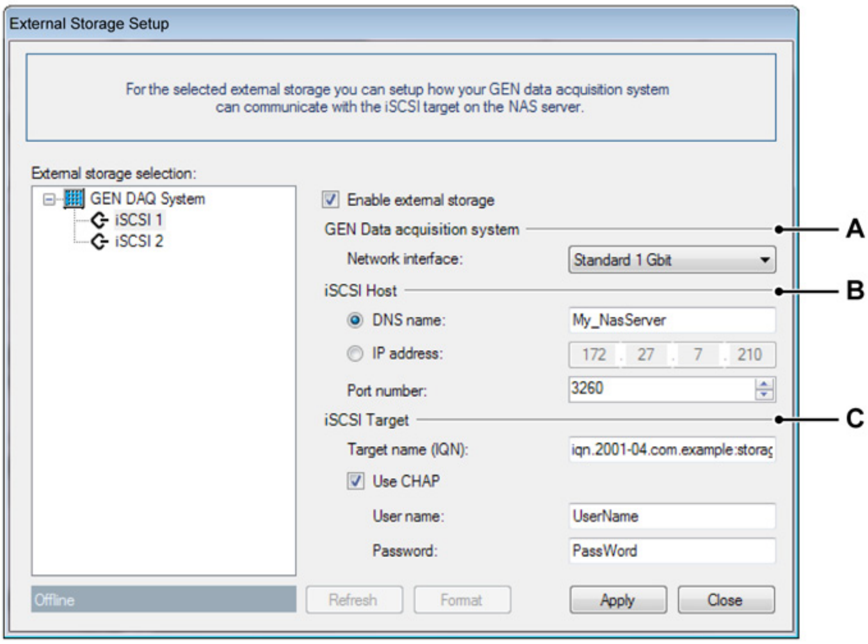



**Figure 11.22:** External Storage Setup dialog (Setup an iSCSI NAS connected to a corporate network – basic setup)

**A** GEN Data acquisition system

**B** iSCSI Host

**C** iSCSI Target

3 **GEN Data acquisition system -** Network interface: **(See Figure 11.22 - A)**

Select the Standard 1 Gbit Ethernet port that is connected to the Ethernet switch.

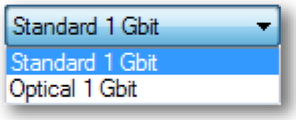



**Figure 11.23:** Network interface connections/Standard 1 Gbit option

4 **iSCSI Host** **(See Figure 11.22 - B)**

- **DNS Name/IP Address**
  As the setup is part of a corporate network, a DNS setting should be used in this setup. Therefore select the DNS name option and use the same DNS name as was used in the setup of the NAS.
  *When using a Synology® NAS, the IP address is displayed in the in the Synology® Assistant software. This software displays all the known connected Synology® devices.*
  (For more information, please refer to Figure H.1 "Synology Assistant" on page 718).
- **Port number:**
  Default: **3260**
  Can sometimes be found in the NAS configuration of the manufacturers software.
  *When using a Synology® NAS the port number must be set on the default of 3260.*

5 **iSCSI Target** **(See Figure 11.22 - C)**

- **Target name (IQN):**
  This is the IQN name, it can be found by looking at the manufacturers software supplied with the NAS.
  *An example for Synology® iSCSI setup you can find on page 718.*
- **Use CHAP:**
  Select **Use CHAP** if CHAP password protection was selected during the setup of your NAS server. *When using a Synology® NAS, CHAP password protection can be selected.*
  (For more information, please refer to Figure H.7 "Create a new iSCSI target dialog" on page 724).
- **User name:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

- **Password:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

Click **Apply** when done to set the new settings and then click **Close**.

The NAS should now be available in the setup of your GEN series mainframe.

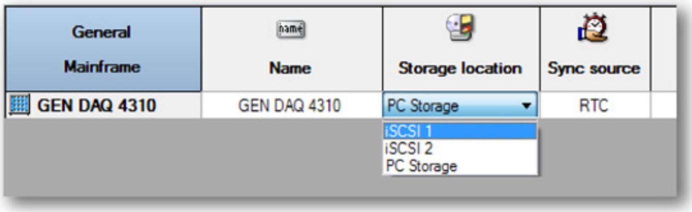



**Figure 11.24:** Storage location with options

### 11.4.14 Setup an iSCSI NAS connected to a corporate network – advanced setup

This setup of a GEN DAQ system with the NAS connected through an Ethernet switch on a corporate network.

Compared to the example 3 ("Setup an iSCSI NAS connected without an Ethernet switch" on page 196) this setup allows you to separate the network data from the PC to your GEN DAQ system from the network data from the NAS to you GEN DAQ system. This setup is recommended if you want to use high streaming rates to the NAS system and using a lot of live displays to view the data on the controlling PC.

The NAS location is not restricted and allows freedom of placement of each component in the system. This setup enables network access to configure the NAS and GEN DAQ and to read the data on the iSCSI storage device.

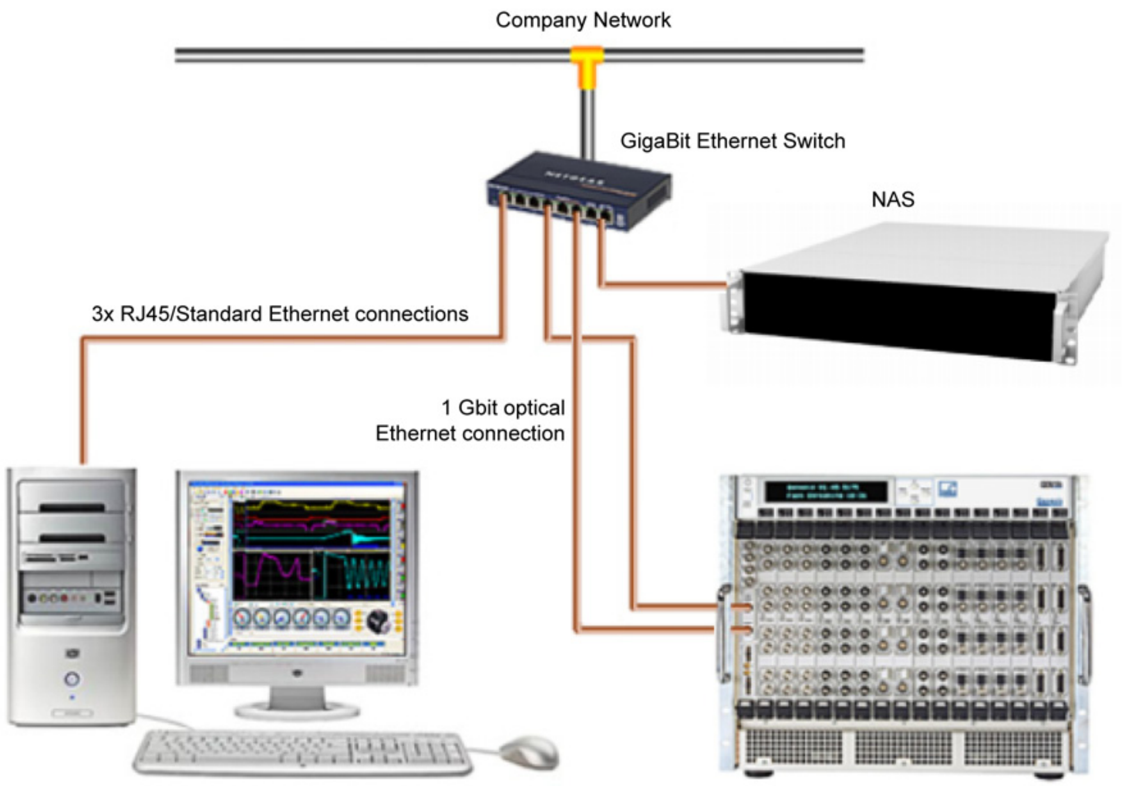



**Figure 11.25:** GEN DAQ with iSCSI NAS connected across an Ethernet switch and connected to a corporate network (Advanced Setup)

1 **Connect equipment** **(See Figure 11.25)**

- Connect the PC via standard RJ45 Ethernet connection to the Ethernet switch.
- Connect the GEN DAQ system by using both the standard RJ45 Ethernet and the 1 Gbit optical Ethernet interface to the Ethernet switch.
- Connect the NAS by using a standard RJ45 cable to the Ethernet switch.
- Connect the Ethernet switch to your company network using a standard RH45 cable.

Please read "Connecting the GEN series to your company network" on page 81 for GEN DAQ setup.

At this stage you should make sure all connections and configurations are correct. The GEN DAQ should resolve an auto IP address in a few moments after being turned on. Then we should configure the NAS with Perception. To configure the NAS, please connect a network cable or connect the NAS to a network temporarily and then follow the manufacturers guides, this will enable you to determine an IP address for the NAS server.

2 **Setup in Perception:** **(See Figure 11.26)**

Start Perception and navigate to the **Settings** menu and select **External Storage Setup.**

Please make sure you have read section Explaining the External Storage Setup Dialog (see Figure 11.26) before executing this procedure.

**The External Storage Setup dialog:**
The information in this dialog must match the information defined in the configuration of the connected NAS. Refer to appendix “Setting up the iSCSI using Synology® NAS” on page 718 when necessary for an example using Synology®.

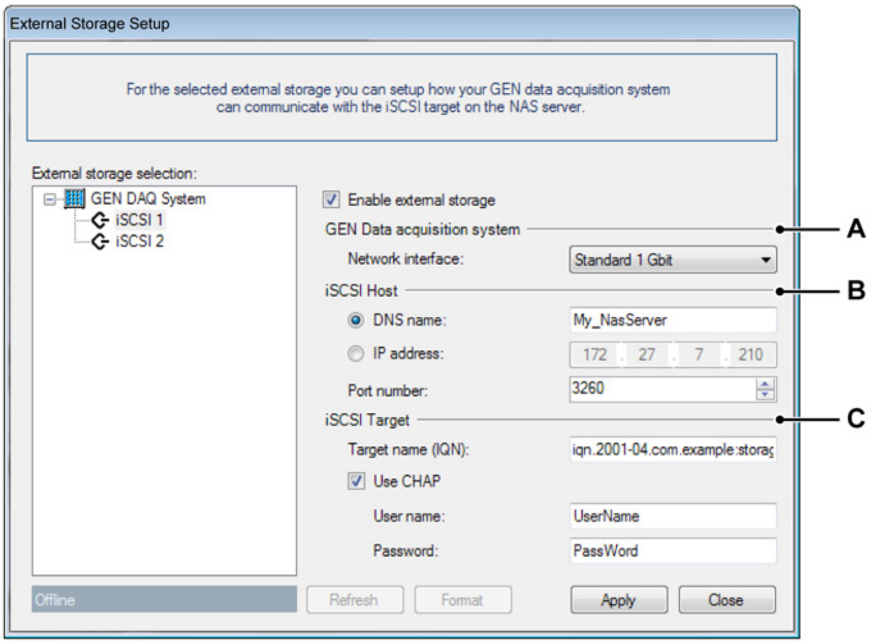



**Figure 11.26:** External Storage Setup dialog (Setup an iSCSI NAS connected to a corporate network – advanced setup)

**A** GEN Data acquisition system

**B** iSCSI Host

**C** iSCSI Target

3 **GEN DAQ -** Network interface: **(See Figure 11.26 - A)**

If you have connected the NAS server to the RJ45 connector of the GEN series mainframe then select the Standard 1Gbit Ethernet.

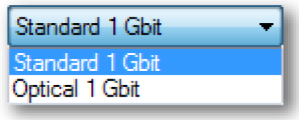



**Figure 11.27:** Network interface connections/Standard 1 Gbit option

**Or**

If you have connected the NAS server to the Optical network connector of the GEN series mainframe then select the Optical 1Gbit Ethernet.


**Figure 11.28:** Network interface connections/Optical 1 Gbit option

4 **iSCSI Host** **(See Figure 11.26 - B)**

- **DNS Name/IP Address**
  As the setup is part of a corporate network, a DNS setting should be used in this setup. Therefore select the DNS name option and use the same DNS name as was used in the setup of the NAS.
  *When using a Synology® NAS, the IP address is displayed in the in the Synology® Assistant software. This software displays all the known connected Synology® devices.*
  (For more information, please refer to Figure H.7 "Create a new iSCSI target dialog" on page 724).
- **Port number:**
  Default: **3260** *When using a Synology® NAS the port number must be set on the default of 3260.* Can sometimes be found in the NAS configuration of the manufacturers software.

5 **iSCSI Target** **(See Figure 11.26 - C)**

- **Target name (IQN):**
  This is the IQN name, it can be found by looking at the manufacturers software supplied with the NAS. *An example for Synology® iSCSI setup is in appendix “Setting up the iSCSI using Synology® NAS” on page 718.*

- **Use CHAP:**
  Select **Use CHAP** if CHAP password protection was selected during the setup of your NAS server. *When using a Synology® NAS, CHAP password protection can be selected.*
  (For more information, please refer to Figure H.7 "Create a new iSCSI target dialog" on page 724).
- **User name:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.
  *When using a Synology® NAS, CHAP password protection can be selected.*
  (For more information, please refer to Figure H.7 "Create a new iSCSI target dialog" on page 724).
- **Password:**
  Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

Click **Apply** when done to set the new settings and then click **Close**.

The NAS should now be available in the setup of your GEN series mainframe.

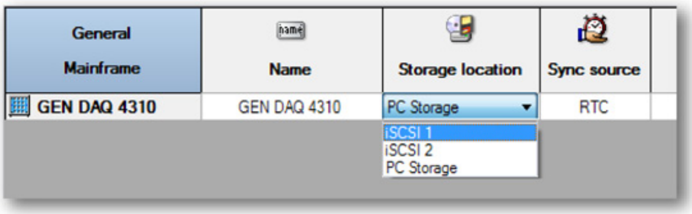



**Figure 11.29:** Storage location with options

### 11.5 IM1 - Interface/Controller Module 1

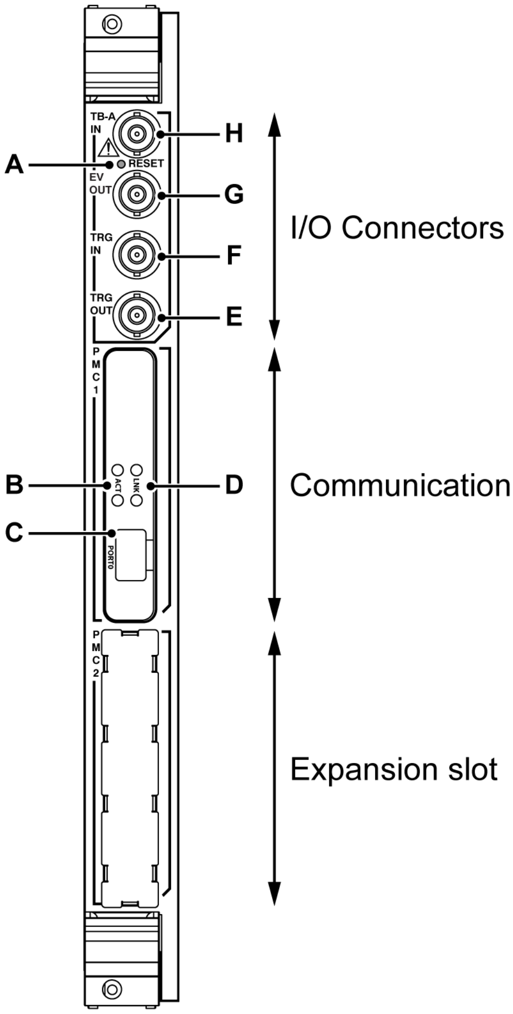



**Figure 11.30:** Interface/Controller Module IM1

**A** Recessed CPU Reset Switch

**B** Activity detected

**C** Standard 1 Gbit Ethernet Interface

**D** Link detected

**E** External Trigger Out

**F** External Trigger In

**G** External Event Out

**H** External Time base In

The CPU **Reset** Switch can be used to reset the controller/interface in the rare event of a system malfunction. To reset the unit carefully press the recessed switch with a small screwdriver or equivalent.

The IM1 has a unique Communication section with 1 Standard Ethernet Interface and 4 activity LED's. The 4 I/O connectors are very similar to the IM2 connectors however the reset switch on the IM1 is between the first and second I/O connector on this module. The first connector on this module is labeled the TB-A IN.

The IM1 is built from three main sections; the I/O Connectors, the Communication section and the Expansion slot.

### 11.5.1 IM1 - Communication and Control - Standard Ethernet Interface

The GEN series uses standard TCP/IP protocol over Ethernet to communicate with your PC. The System Interface/Controller Module provides access to the Ethernet network.

The module is equipped with an interface with 100/1000 Base-T Gigabit support. You must connect to the RJ-45 connector.

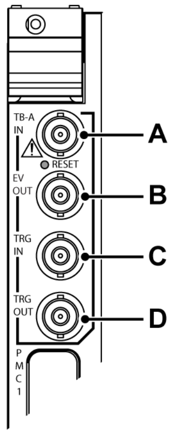
For full details on how to connect the GEN series with a PC see "Connecting the GEN series directly to your PC" on page 80.

LED's are used to indicate activity as well as connection.

**WARNING**

**The IM1 communication and control interface supports 1000 Base-T gigabit Ethernet just like the IM2 interface/controller module. However the IM2 supports a higher continuous streaming rate. When using mainframes with IM1 and IM2 in a mixed setup the higher performance of the IM2 based system will negatively impact the IM1 on its streaming rates. As a result the system using the IM1 interface/controller module will not be able to stream as much data as systems using the IM2.**

### 11.5.2 IM1 - I/O connectors




**A** External Time base In (TB-A IN)
**B** External Event Out (EV OUT)
**C, D** External Trigger In/Out (TRG IN/TRG OUT)

The controller/interface provides 4 BNC connectors with the following functions:

**A** **External Time base In (TB-A IN)**
This input can be used to provide another time base for the ADC rather than the internal one. Typically used in combination with rotating machinery where the ADC clock is synchronized with the revolutions. In the Perception software the selection between external and internal time base is made in the Mainframe section of the Settings.

**B** **External Event Out (EV OUT)**
This output is software selectable between **Alarm Out** and **Recording Active Out.** When *alarm* is selected, the output is driven by channel alarm detectors. When *recording active* is selected, the output is “high” when a recording is in progress.

**C, D** **External Trigger In/Out (TRG IN / TRG OUT)**
This input and output are related to the recorder trigger logic. For details see "Recorder and system trigger" on page 172.

### 11.5.3 IM1 - Expansion slot

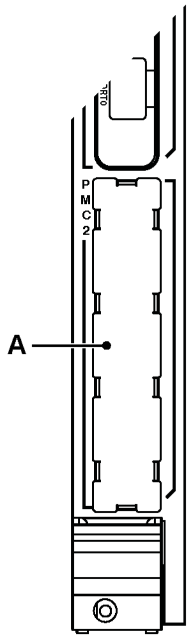



**Figure 11.31:** Free slot on Interface/Controller Module IM1

**A** Free space for option

## 11.6 IM2 - Interface/Controller Module options

Your GEN series data acquisition system can be equipped with a variety of options. Most options are factory-installed, i.e. you must choose an option at the time of ordering or return the instrument to a qualified service point for upgrade.

The IM2 Interface/Controller modules of the GEN series mainframe have one expansion slot that can be used for one of the following options:

| Option (for IM2) | Uses expansion slot |
|---|---|
| SSD (1-G061-2) | No(1) |
| SFP 1 Gbit (1-G062-2, 1-G063-2) | No |
| 10 Gbit Ethernet (1-G064-2)(2) | Yes(1) |
| IRIG (1-G001-2) | Yes(1) |
| IRIG/GPS (1-G002-2) | Yes(1) |

(1) Factory installed option only.

(2) To complete this option the following is needed SFP+ 10 Gbit (1-G065-2, 1-G066-2)

### 11.6.1 Option - Solid State Disk (SSD)

This is an on-board factory installed option and needs to be ordered at the time of purchase.

**Figure 11.32:** Solid state disk (SSD)

When this option is ordered an SSD is included on board the IM2 ready to be used when you plug in the IM2 into a mainframe. The SSD is a non-removable item.

For specifications and ordering information see "B3705-1.0 en (GEN series GEN7t Transient Recorder and Data Acquisition System)" on page 378 and "B3720-1.0 en (GEN series GEN16t Transient Recorder and Data Acquisition System)" on page 392.

### 11.6.2 Option - Optical 1 Gbit Ethernet interface

The Interface/Controller Module IM2 supports an optical 1 Gbit Ethernet interface by means of a user installed SFP module. An SFP module is a small form-factor pluggable transceiver that supports direct optical network connections.

**WARNING**

**Laser Safety**
**The system is classified as a Class 1 laser product. The SFP uses optical light source for data and command communication. It does not emit hazardous light but it is recommended to avoid direct exposure to the beam.**

This simple and powerful plug-in-and-use option enables the use of the Optical Network connection on the IM2. There are 2 models available to choose from:

- 1 Gbit (850 nm) - Multi Mode
- 1 Gbit (1310 nm) - Single Mode

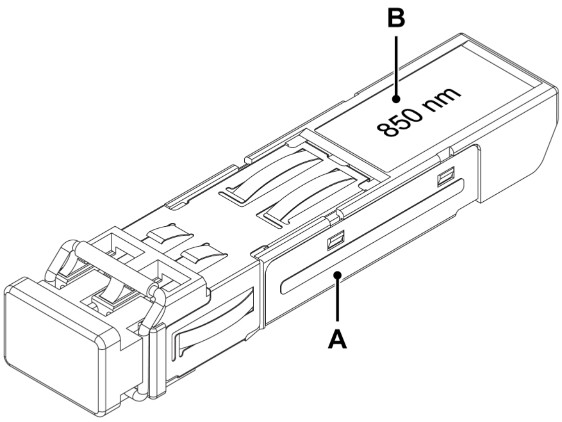



**Figure 11.33:** SFP Optical Network devices

**A** SFP shown with dust-cap and removal bar

**B** SFP label - 850 or 1310 nm

**Note** *1310 nm Single Mode (SM) and 850 nm Multi Mode (MM) optical fiber transceivers use specific cables and connectors therefore please check the correct mode/specification of fiber optic cable is used.*

**Cable selection and lengths:**
Cables require different properties when they exceed certain lengths based on the properties of light in an optical fiber.

**Single Mode** Cable is a type of cable that has a relatively small light carrying core and therefore makes fewer internal reflections so that the path of light is closer to a straight line and thus can travel further distances.

**Multi Mode** Cable is a type of cable that has a relatively thicker light carrying core. Light in a thicker core makes more reflections and is therefore only suited to shorter distances. The following table shows what mode of fiber is required for each distance covered.

For specifications and ordering information see "B3705-1.0 en (GEN series GEN7t Transient Recorder and Data Acquisition System)" on page 378 and "B3720-1.0 en (GEN series GEN16t Transient Recorder and Data Acquisition System)" on page 392.

For Installation and removal of the SFP module Please see section "Installation of 1 Gbit SFP/10 Gbit SFP+ Module" on page 223.

### 11.6.3 Option - 10 Gbit Ethernet interface

The 10 Gbit Ethernet option is a Factory installed, ready to use Ethernet option with two available Ethernet interfaces.

The 10 Gbit Ethernet Card can be installed in addition to the standard on-board 1 Gbit Ethernet connection. The 10 Gbit Ethernet Card allows you to double the throughput speed of communication when compared to the standard 1 Gbit Ethernet. If installed, the 10 Gbit Ethernet option can replace the use of the standard 1 Gbit Ethernet connection.

**WARNING**

| |
|---|
| **Laser Safety**<br>**The system is classified as a Class 1 laser product. The SFP uses optical light source for data and command communication. It does not emit hazardous light but it is recommended to avoid direct exposure to the beam.** |

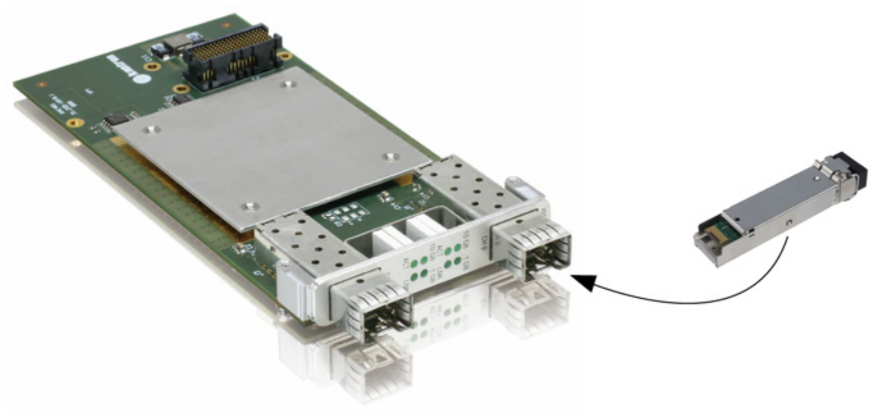


**Figure 11.34:** 10 Gbit Ethernet card - with SFP+ module

**Note** *The maximum 10 Gbit throughput speed is per-card. Throughput speed is therefore a shared specification for both interfaces combined. It is possible that two interfaces can be used at the same time but only when one interface is used for communication and the other is used for storage. Two interfaces cannot be used at the same time for storage purposes nor can they be used at the same time for communication purposes.*

### Connections and using the 10 Gbit Option

| | |
|---|---|
|  | **A 10Gbit LC Connection Using the SFP+ Option**<br>10Gbit LC optical connections need an SFP+ module to enable their use with LC connected optical cable. |

**Note** *(1) The 10 Gbit speed rating can be achieved with* ***optimized settings*** *using compatible equipment and devices of similar speed ratings. Please see appendix “Optimal Windows® settings for 10 Gbit Ethernet Card” on page 710 for further details on the specific* ***optimized settings****.*

**Front panel layout**
The front panel of the 10 Gbit Ethernet option has the following layout:

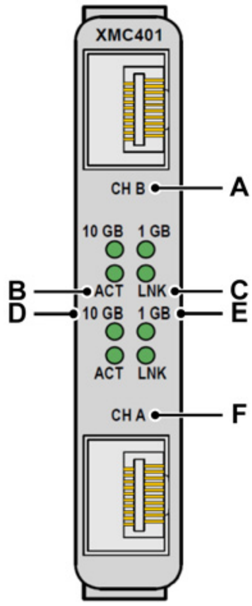



**Figure 11.35:** Front panel of XMC401 10 Gbit Ethernet Card

**A** **CH B** = **NIC2** (Requires SFP+ module, not shown)

**B** ACT (green): Ethernet Activity (on when active)

**C** LNK (green): Ethernet Link (on when active)

**D** 10 Gbit (green): Ethernet Speed 10 Gigabit (always on)

**E** 1 Gbit (green): Ethernet Speed 1 Gigabit (always on)

**F** **CH A** = **NIC1** (Requires SFP+ module, not shown)

Figure 11.35 shows the two interfaces of this option without installed SFP+ option, for further details on the SFP+ options please see the next section .

Once the SFP+ option is installed in the 10 Gbit Ethernet interface, an LC optical cable can be connected.

**10 Gbit Ethernet Option accessories**
The 10 Gbit Ethernet card supports two (10 Gbit) SFP+ modules which are separately available, see options in the specifications sheet of this section for ordering.

The two types of 10 Gbit SFP+ module that are used with this Ethernet card are:

- 10 Gbit (850 nm) - Multi Mode
- 10 Gbit (1310 nm) - Single Mode

**Note** ***SFP*** *modules rated at 1 Gbit and are not suitable for this card. Please select the* ***SFP+*** *modules which are rated at 10 Gbit.*

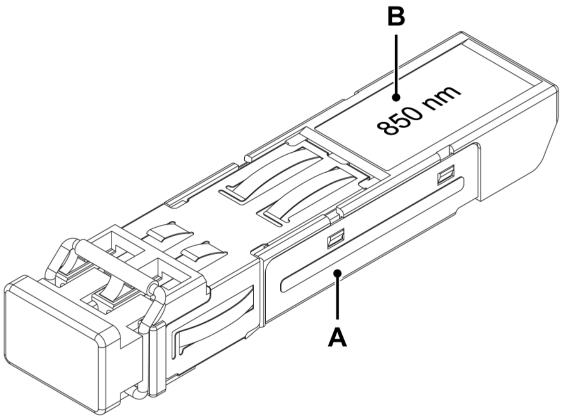



**Figure 11.36:** SFP Optical Network devices

**A** SFP shown with dust-cap and removal bar

**B** SFP label - 850 or 1310 nm

**Note** *1310 nm Single Mode (SM) and 850 nm Multi Mode (MM) optical fiber transceivers use specific cables and connectors therefore please check the correct mode/specification of fiber optic cable is used.*

**Cable selection and lengths:**
Cables require different properties when they exceed certain lengths based on the properties of light in an optical fiber.

**Single Mode** Cable is a type of cable that has a relatively small light carrying core and therefore makes fewer internal reflections so that the path of light is closer to a straight line and thus can travel further distances.

**Multi Mode** Cable is a type of cable that has a relatively thicker light carrying core. Light in a thicker core makes more reflections and is therefore only suited to shorter distances. The following table shows what mode of fiber is required for each distance covered.

For Installation and removal of the SFP+ module see section "Installation of 1 Gbit SFP/10 Gbit SFP+ Module" on page 223.

**10 Gbit Ethernet Card in GENDAQ series networks**

There are several different ways to connect individual components together when using the 10 Gbit Ethernet card therefore this card allows the user more freedom to set up their system with different configurations.

The 10 Gbit Ethernet card can essentially be used to communicate at double the throughput speed of the standard 1 Gbit Ethernet or with more advanced setups can act as a manually switchable storage selector or even a dual communication and storage interface.

The following Figure 11.37 shows a simple setup using the 10 Gbit Ethernet Card. A PC with an optical Ethernet interface which has SFP+ support is connected via optical cable to the interface of the 10 Gbit Ethernet card option of the GENDAQ unit. This setup utilizes the higher speed communication of the 10 Gbit Ethernet Card for communication with Perception.

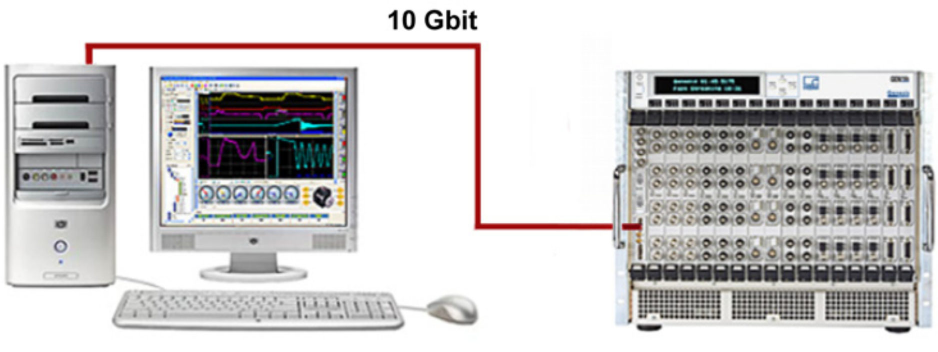



**Figure 11.37:** Basic setup - 10 Gbit Ethernet to PC

**Connecting the 10 Gbit Ethernet Option to a PC**

To be able to use this option you also need the correct connection or interface attached to your PC. The correct connection is not always an SFP+ module but there must be a network card or adaptor installed that supports the same specifications as the SFP+ modules used on the GENDAQ side.

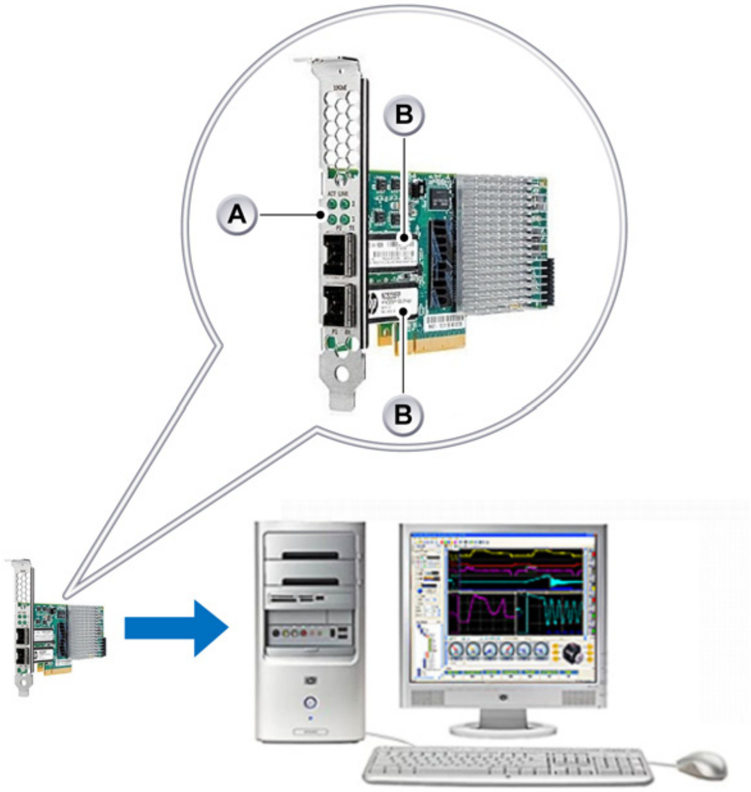



**Figure 11.38:** Connect the 10 Gbit Ethernet Option to a PC

**A** 10 Gbit Ethernet card

**B** SFP+ modules

A 10 Gbit PC network card without SFP+ modules inserted and Ethernet switch with an SC optical connection can be used to communicate with the 10 Gbit Ethernet card.

**Network Interface selection in Perception**
With the 10 Gbit Ethernet option installed and ready to go you will be provided with the two following interfaces for selection:

- Optical 10 Gbit NIC1
- Optical 10 Gbit NIC2

In Perception these interfaces are available in the **Settings** menu > **Mainframe Network Setup** see Figure 11.39 below.

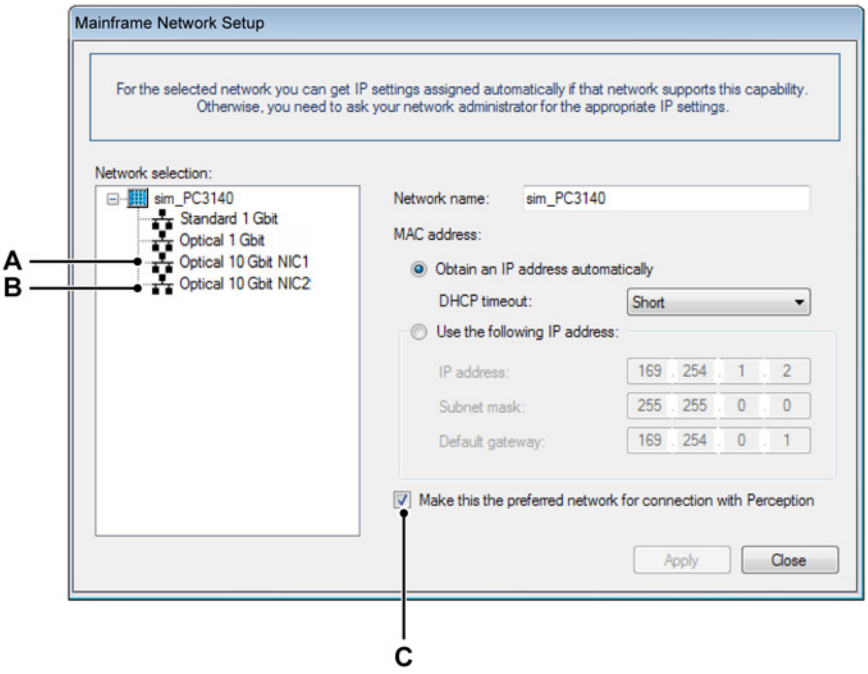



**Figure 11.39:** Mainframe Network Setup

**A** Optical 10 Gbit NIC1

**B** Optical 10 Gbit NIC2

**C** Make this the preferred network for connection with Perception

In **Mainframe Network Setup** you can define the IP address of each individual interface if needed.

If Perception finds more than one interface for **Network Selection** as shown in Figure 11.39, then the interface that has a Check in the box **Make this the preferred network connection with Perception** will be the interface used for communication with Perception. For the 10 Gbit Ethernet card check the box for the **Optical 10 Gbit NIC1 or 2**.

Click **Apply** then **Close** when done.

**Important note Windows® 7 - optimum settings**

To best achieve the specified 200 MB/s data transfer rating please make sure the following settings are introduced to your network adaptor via the settings in Windows.

Windows® 7 10G network adapter settings:

- Interrupt moderation rate: **high**
- Receive side scaling ques: **8**
- Receive buffers: **2048**

For more information on how to do this please see appendix “Optimal Windows settings for 10Gbit Ethernet Card” on page 710.

**Note** *The above Windows settings were tested and chosen using a specific setup of equipment (Intel® Ethernet Server adaptor x520). These setting may not be the optimal settings for your specific system.*

### 11.6.4 Installation of 1 Gbit SFP/10 Gbit SFP+ Module

**Introduction**
This section covers the installation and removal of the Small Form Factor Pluggable (SFP or SFP+) transceiver device from any interface supporting SFP or SFP+ modules.

This device enables an Optical Network connection to be plugged directly into the front panel, Optical Network interface of the IM2. It is also a necessary option for the 10 Gbit Ethernet card.

**Warnings**
Before installing this device please make sure you read the following warning which are specific for this device.

**Description of Electro Static Discharge (ESD)**

**CAUTION**

**Electrostatic discharge (ESD) can cause damage to electronic devices if discharged into the device, so you should take steps to avoid such an occurrence**

**CAUTION**

**HBM uses state-of-the-art electronic components in its equipment. These electronic components can be damaged by discharge of static electricity (ESD). ESD damage is quite easy to induce, often hard to detect, and always costly. Therefore we must emphasize on the importance of ESD preventions when handling a GEN series system, its connections or a plug-in card.**

**WARNING**

**Laser Safety**
**The system is classified as a Class 1 laser product. The SFP uses optical light source for data and command communication. It does not emit hazardous light but it is recommended to avoid direct exposure to the beam.**

**Installation steps**

**1** First make sure the mainframe unit is switched off then locate the available SFP slot and remove the plastic plug (if inserted).

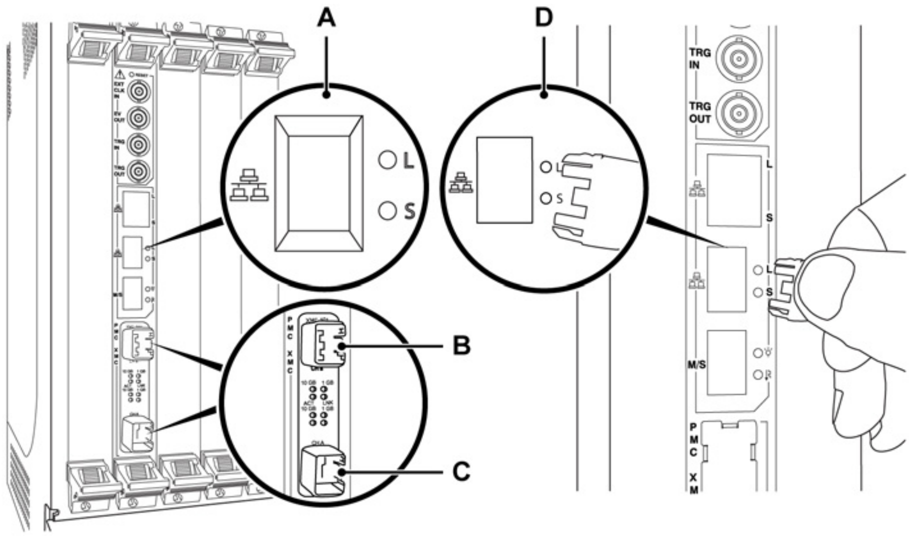



**Figure 11.40:** Interface/Controller Module SFP location

**A** Interface/Controller Module SFP/SFP+ locations

**B,C** Interface/Controller Module SFP+ location

**D** Remove cap*

**Note** *This installation is valid for any interface that supports the SFP or SFP+ options.*

Figure 11.40 shows the location of three Ethernet interfaces. For the rest of this procedure we will continue showing only the Standard 1 Gbit optical interface example graphically.

2 Grasp module between fingers and thumb at the end with the small black removal-bar and Insert back end into the available SFP slot, until you hear a click.

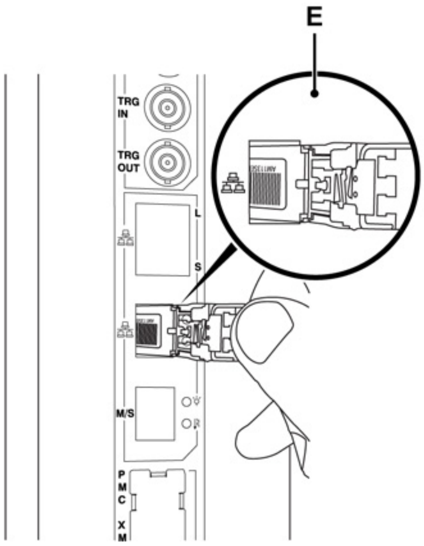



**Figure 11.41:** Insert device in IM2 Module

**E** Insert device

3 Embedded software will recognize the device and connect to it automatically when the mainframe is powered on.

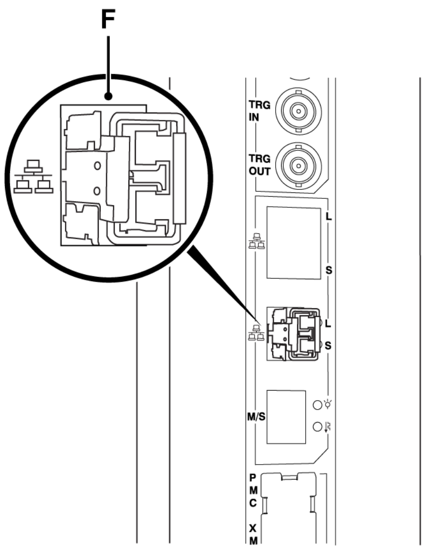



**Figure 11.42:** IM2 Module with device

**F** Device being inserted

4 To remove the module from the mainframe first make sure the mainframe is powered off and then grasp the small black removal-bar and pull away and out from the mainframe. The spring loaded removal-bar will release the SFP from the front panel.

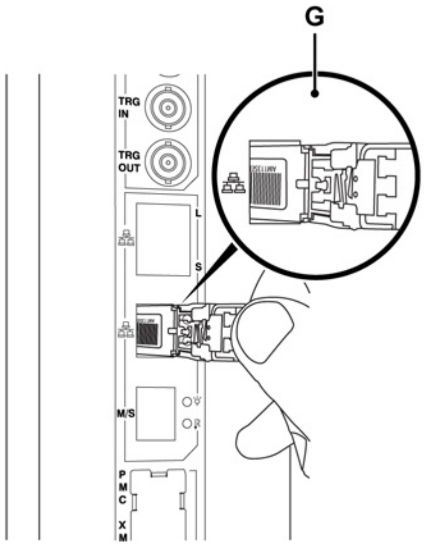



**Figure 11.43:** IM2 Module - Remove device

**G** Remove device

Then, if available replace the small plastic plug to protect the optical inlet.

### 11.6.5 Option - IRIG and IRIG/GPS time synchronization

The IRIG cards provide precise time and frequency reference to the GEN series data acquisition system. Time is acquired from either the GPS satellites using an antenna / receiver (IRIG/GPS model only) or from time code signals, typical IRIG B.

For specifications and ordering information see "B3705-1.0 en (GEN series GEN7t Transient Recorder and Data Acquisition System)" on page 378 and "B3720-1.0 en (GEN series GEN16t Transient Recorder and Data Acquisition System)" on page 392.

**Note** *Available for IM1 and IM2*

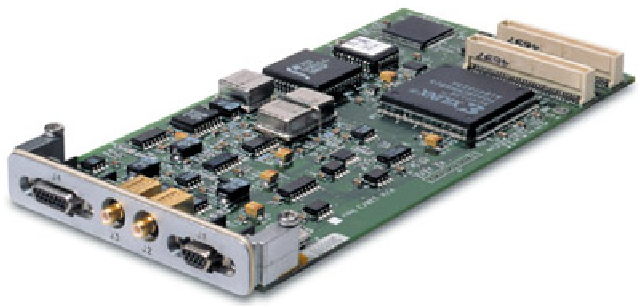
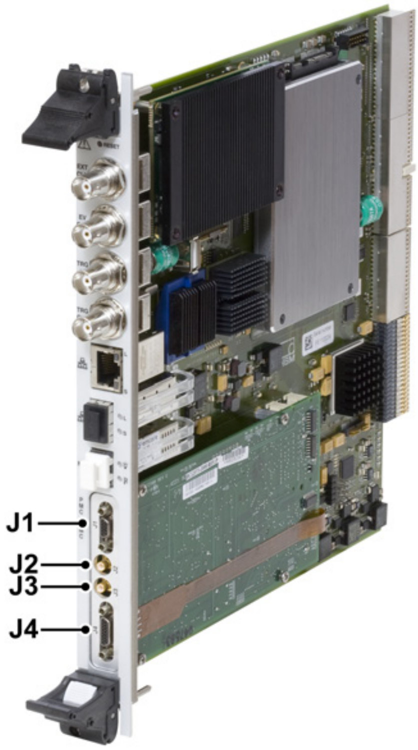


**Figure 11.44:** IRIG & IRIG/GPS card

### 11.6.6 GPS Antenna System Rules




**J1** GPS antenna connector (9-pin micro ‘DP’)

**J2** IRIG AM modulate Time Code In (SMB socket)

**J3** IRIG AM modulate Time Code Out (SMB socket)

**J4** IRIG DCLS time code In and Out (15-pin micro ‘DP’)

SMB to BNC cable adapters included to allow standard coaxial cable connections to IRIG In and or Out SMB socket.

Check www.symmetricom.com for option and detailed support on BC635PMC (IRIG) or BC637PMC (GPS)

**Rule 1. Antenna placement**

**A** *View of the sky*

Select an area where the GPS antenna will have an unobstructed view of the sky. An ideal position has no obstructions above 10 degrees above the horizon. The total blockage of the sky (due to buildings, mountains, etc.) should be less than 50 %. If less than 50 % of the sky is visible to the antenna, contact Symmetricom for further assistance.

**B** *Lightning considerations*
Locate the antenna at least 15 meters away from lightning rods, towers, or structures that attract lightning. GPS antenna damage is usually not the result of a direct lightning strike, but the effects of a lightning strike on a nearby structure. Locate the GPS antenna lower than any structures that may attract a strike.

**C** *Maintenance considerations*
If the GPS antenna fails or must be checked, having the antenna positioned in an accessible location will facilitate maintenance. Avoid installing the antenna on a tower, which requires a specialist to maintain.

**D** *Interference consideration*
Avoid the direct radiation from transmitting antennas (such as TV or Cellular).

**Rule 2. Is a GPS line amplifier needed?**

**A** *Cable length*
Add up the total length of all the cables for the installation. If the total cable length is 150 ft or less, no amplifier is needed. If the total length is between 150 ft and 300 ft, a line amplifier is required. For lengths greater than 300 ft, contact Symmetricom for further assistance.

**B** *Placement*
Mount line amplifiers as close to the antenna as possible. Connect the amplifier directly to the antenna. The line amplifiers fit nicely inside the antenna mast where they are protected from the weather.

**Rule 3: Lightning arrestors**

**A** *Is a lightning arrestor needed?*
Very probably, yes. Lightning does not have to strike the antenna to significantly damage the antenna and GPS receiver. Lightning strikes induce damaging voltages in the antenna system when striking nearby objects.

**B** *What do I need?*
A commonly used configuration is to place a lightning arrestor where the antenna cable enters the building (either inside or outside), because there is often a good earth ground nearby to connect to. If the cable between this lightning arrestor and the GPS receiver is longer than four meters, it is good practice to place a second lightning arrestor within four meters of the GPS receiver. The second arrestor reduces any lightning-induced voltages in the cable to the receiver.

**C** *Grounding*
The lightning arrestor does not need a grounding strap if it is directly bolted to a grounding plate. A grounding strap should be used if you cannot connect directly to a grounding plate.

**D** *Caution*
If you are not comfortable designing your own lightning protection system, seek professional assistance. This is only a guide.

**Rule 4: Interconnect cables**

**A** *Cable options*

Symmetricom's interconnect cables are available in various lengths. For ease of pulling antenna system cable through a conduit, or if you wish to cut the cable to an exact length, you may choose to have a connector on only one end.

**B** *Multiple antenna site installations*

Multiple site installations may be done more efficiently using bulk cable and a connector installation tool kit. For more information about multiple antenna site installations or general questions about GPS antenna system installation, please contact Symmetricom's Customer Technical Assistance Center.

## 11.7 IM1 - Interface/Controller Module Options

Your GEN series data acquisition system can be equipped with a variety of options. Most options are factory-installed, i.e. you must choose an option at the time of ordering or return the instrument to a qualified service point for the upgrade.

The IM1 Interface/Controller modules of the GEN series mainframe have one expansion slot that can be used for one of the following options:

| Option (for IM1) | Uses expansion slot |
|---|---|
| SCSI interface (1-G004-2)(2) | Yes(4) |
| External SCSI drive (1-G005-2)(3) | No |
| Rack mount SCSI drive (1-G006-2)(3) | No |
| Fiber optic Ethernet (1-G050-2)(1)(2) | No(4) |
| IRIG (1-G001-2) | Yes(4) |
| IRIG/GPS (1-G002-2) | Yes(4) |

(1) Replacement option of standard communication slot - does not use expansion slot.

(2) The fiber optic Ethernet and SCSI option cannot be combined.

(3) Needs SCSI Interface option.

(4) Factory installed option only.

### 11.7.1 Option - Fiber optic Ethernet Interface

The GEN series Optical 1 Gbit Ethernet interface is 'factory-installed-only' and replaces the standard single-channel copper wire Ethernet interface of a GEN Series interface/controller module.

**Figure 11.45:** Fiber Optic Ethernet card

The option provides an extra 1 Gigabit optical Ethernet link for the fastest possible communications. The use of fiber optic links in local area networks is now common place due to the inherent advantages of using fiber. High data rates can be maintained without electromagnetic or radio frequency interference (EMI/RFI). Longer distances can be achieved over that of copper wiring. For the industrial user, fiber offers high-voltage isolation, intrinsic safety and elimination of ground loops in (geographically) large installations.

With the fiber optic Ethernet Option you have:

- Speed: 1 Gbit per second
- Versatility: Ability to select copper or fiber
- Innovation: High speed, excellent reliability and latest technology

**Auto detection**

At the system start-up the option auto-detects which of the interfaces is used i.e. copper or fiber. When both interfaces are connected the fiber optic connection has priority and will be used.

The initial selected interface remains in control as long as the system is powered. To switch to another interface you must power-down the system and start-up again with the required interface connected.

| **High Speed Ethernet** | | | |
|---|---|---|---|
| **Component** | **Unit Description** | | **Value** |
| Transfer rate | Typical | Through a 1 GB Ethernet with dedicated PC and Perception software | 15 MS/s (30 MB/s) |
| | Maximum | Through a 1 GB Ethernet with dedicated PC and Perception software but without PC screen updates | 25 MS/s (50 MB/s) |

**Front-Panel layout**
With the option installed the front-panel of the interface/controller module has the following layout:

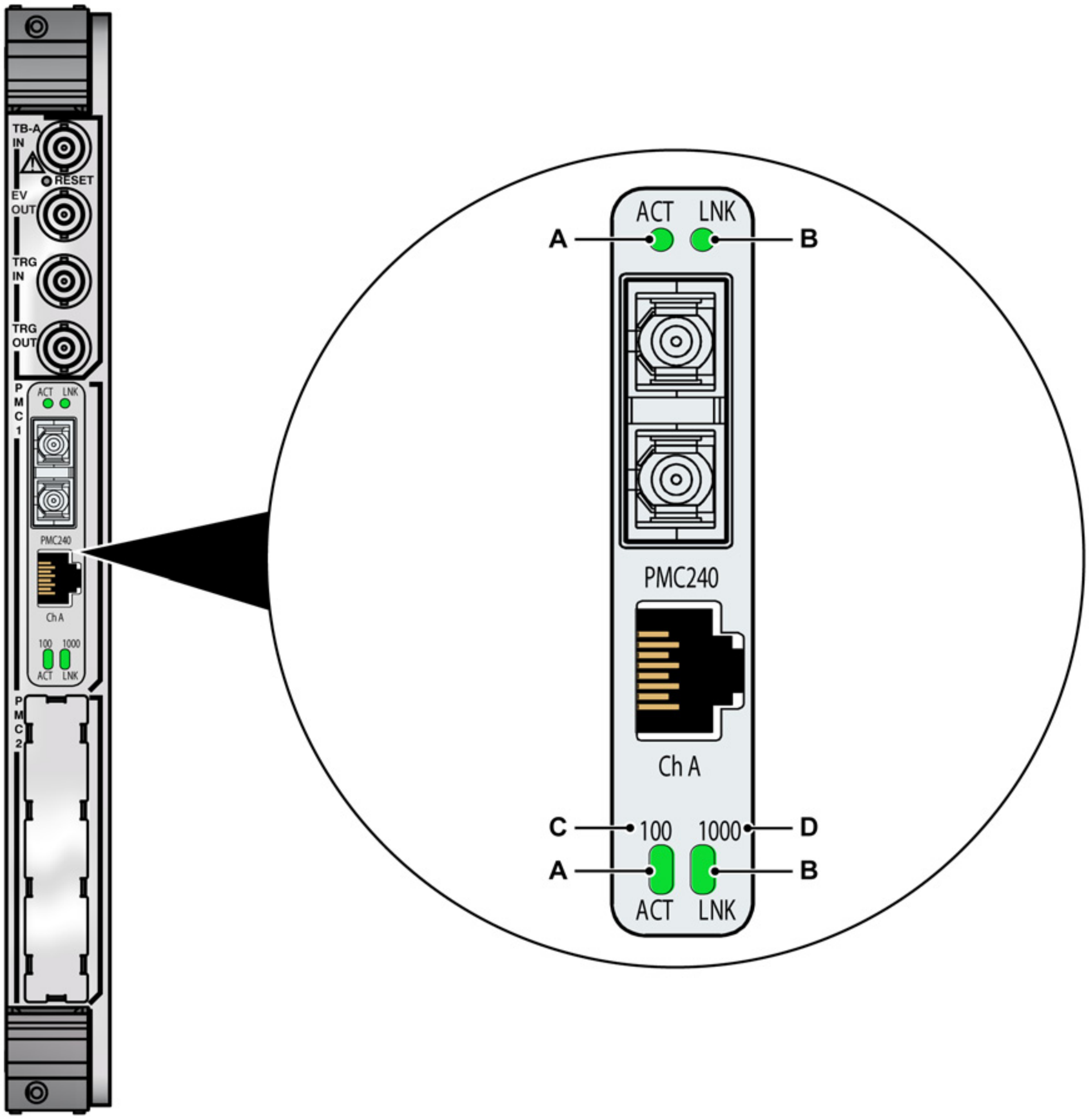



**Figure 11.46:** Front-Panel of the Interface/Controller Module

**A** ACT: Indicates channel activity
**B** LNK: Indicates Ethernet link status
**C** 100: Indicates link speed = 100 MB/s
**D** 1000: Indicates link speed = 1000 MB/s (1 GB/s)

The following Figure 11.47 indicates the positioning of the transmit and receive plugs and orientation of the connectors and keying of the plugs. The SC-type socket is designed to support self-locking duplex SC-type male connectors. This ensures that the fiber optic plugs are securely fastened to the sockets.

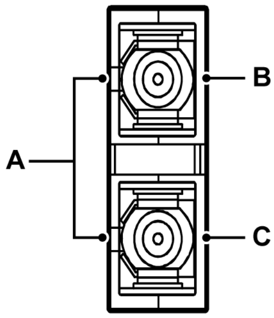



**Figure 11.47:** Receive (RX) - Transmit (TX) connector

**A** Keying

**B** Receive (RX)

**C** Transmit (TX)

**Connection**

Connect to the fiber optic interface using fiber optic cable with self-locking duplex SC-type male connectors.

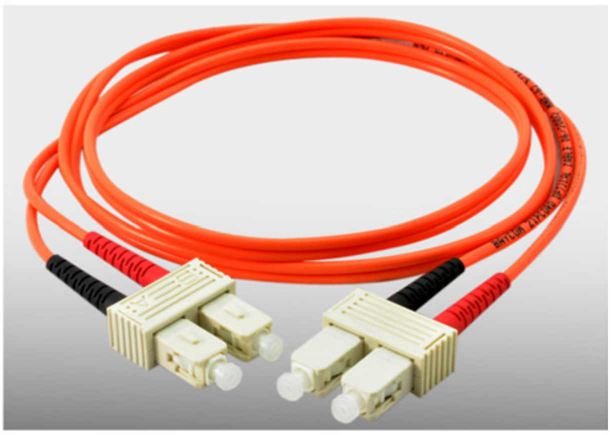


**Figure 11.48:** Fiber optic cable with duplex SC-type connectors

To connect the fiber optic interface to a network, insert the SC connector on one end of the fiber optic cable into the interface, as shown in Figure 11.49. Ensure that the connector is inserted completely into the jack. Then insert the connector on the other end of the fiber optic cable into the connector on an Ethernet switch, or another computer system (as appropriate).

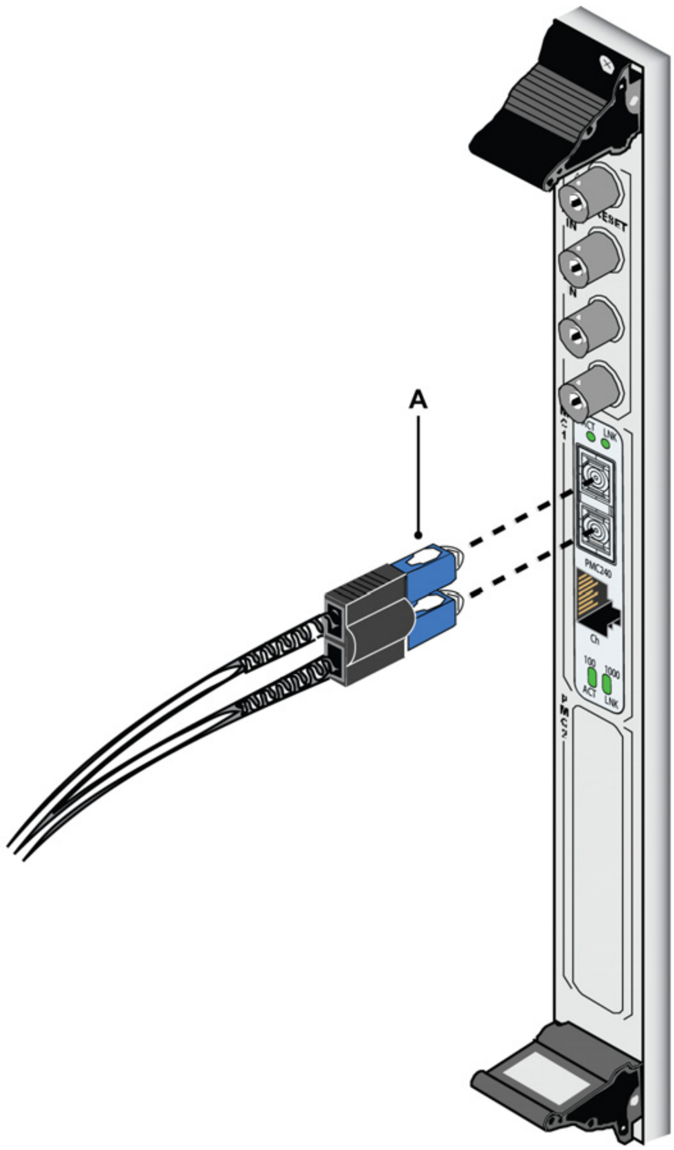



**Figure 11.49:** Connecting the fiber optic cable

**A** SC connector

| Fiber Optic Ethernet Specifications | |
|---|---|
| Fiber optic Ethernet | 1000 Base-SX full duplex, 1 GB/s |
| Connectors | |
| SC-Type | connectors for dual channel fiber optic data<br>1 Ch. in, 1 Ch. out |
| RJ45 | 8 contact, female for dual channel standard copper communication |
| Fiber optic | |
| Wavelength | 850 nm |
| Cable type | Multi Mode |
| Maximum cable length | 500 m |
| Auto-Detection (1) | Auto-detects at power-on if copper or fiber connection used, the fiber connection has priority if both connections are used. |
| Interface (2) | |
| Copper | Half and full duplex with auto detection up to 100 m cable length<br>10 Base-T<br>100 Base-TX<br>1000 Base-T |
| Fiber | Ethernet standards supported: Full duplex, up to 500 meters link length<br>1000 Base-SX |
| Indicators | Two sets of green LED’s for indicating Ethernet channel operational status:<br>• ACT: indicates channel activity<br>• LNK: Indicates Ethernet link status<br>• 100: Indicates link speed = 100 M-bits<br>• 1000: Indicates link speed = 1000 M-bits (Gigabit) |

(1) At boot time GEN series will check in order the optical network first. (Reboot and unplug the Fiber optic network to switch back to copper)

(2) It is possible to drive either the Copper or the Fiber optic network separately but not simultaneously.

| Ordering Information | | |
|---|---|---|
| **Component** | **Unit Description** | **Order number** |
| Fiber optic Ethernet  | A replacement for the standard Ethernet connection, a combined fiber optical or copper Ethernet interface to a GEN7t or GEN16t mainframe. Option can only be installed at the factory. | 1-G050-2 |

### 11.7.2 Option - SCSI interface card

The SCSI option provides expansion and flexibility, allowing GEN series users to add a wide range of external hard drives for local storage of recordings.

Typical applications include:

- Storage of data without the use of the Windows PC
- Improvement of aggregate acquisition speed in multi-mainframe configurations

The SCSI option requires the external connection of a SCSI disk that support Ultra320 SCSI. When using a lower graded disk a warning will be generated and specified through put can not be guaranteed.

When the external SCSI disk is used attach the external disk prior to booting the GEN series mainframe. Only during boot of the GEN series mainframe the attached SCSI disk will be recognized.

**WARNING**

**Never disconnect the SCSI disk while the GEN series mainframe is still powered ON. Serious danger exits of losing your valuable data. The GEN series SCSI disk is not a plug and play device.**

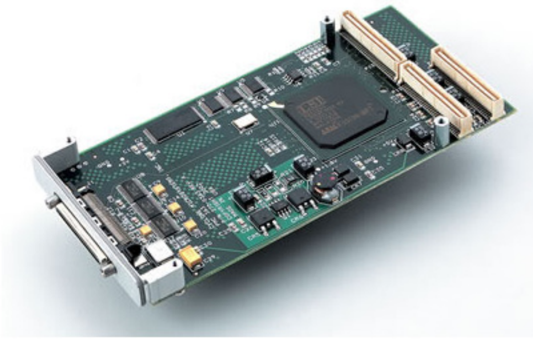
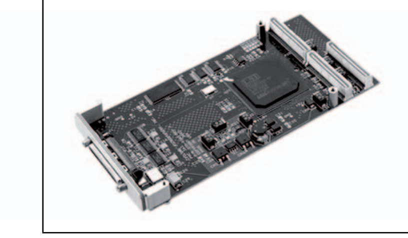


**Figure 11.50:** SCSI interface card

| **SCSI** | |
|---|---|
| Type | |
| Ultra320 SCSI | 16-bit |
| Connector | Very High Density Cable Interconnect (VHDCI), 68-pin |
| Speed | |
| To SCSI drive | 8-10 MS/s (16-20 MB/s) |
| To SCSI RAID drive | 25-30 MS/s (50-60 MB/s) |
| Max number of devices | |
| Cables | Up to 12 m in length; 16 devices |
| Cables | Over 12 m in length; 2 devices |
| Termination | Low Voltage Differential (LVD) termination |

| **Ordering Information** | | |
|---|---|---|
| **Article** | **Description** | **Order No.** |
| Interface  | Fits the PMC slot of a GEN series Interface Controller Module IM1 | 1-G004-2 |

| Ordering Information | | |
|---|---|---|
| **Article** | **Description** | **Order No.** |
| External Hard Disk Drive | Needs interface option, stand alone Hard Disk Drive housing with 300 GB Hard Disk Drive; including connection cable to SCSI interface | 1-G005-2 |
| Rack Hard Disk Drive | GEN series Rack mount 300 GB SCSI Hard Disk Drive with housing; including connection cable to SCSI interface, needs SCSI interface option | 1-G006-2 |
| Rack RAID | GEN series Rack mountable SCSI RAID type ICEBOX or similar; including connection cable to SCSI interface, needs SCSI interface option. *More details on request* | on request |

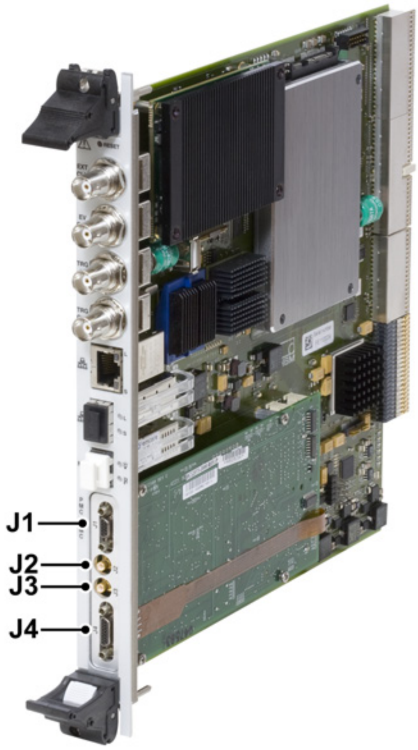
### 11.7.3 Option - IRIG and IRIG/GPS time synchronization

The IRIG cards provide precise time and frequency reference to the GEN series data acquisition system. Time is acquired from either the GPS satellites using an antenna / receiver (IRIG/GPS model only) or from time code signals, typical IRIG B.

For specifications and ordering information see "B3705-1.0 en (GEN series GEN7t Transient Recorder and Data Acquisition System)" on page 378 and "B3720-1.0 en (GEN series GEN16t Transient Recorder and Data Acquisition System)" on page 392.

**Note** *Available for IM1 and IM2*

### 11.7.4 GPS Antenna System Rules




**J1** GPS antenna connector (9-pin micro 'DP')

**J2** IRIG AM modulate Time Code In (SMB socket)

**J3** IRIG AM modulate Time Code Out (SMB socket)

**J4** IRIG DCLS time code In and Out (15-pin micro 'DP')

SMB to BNC cable adapters included to allow standard coaxial cable connections to IRIG In and or Out SMB socket.

Check www.symmetricom.com for option and detailed support on BC635PMC (IRIG) or BC637PMC (GPS)

**Rule 1. Antenna placement**

**A** *View of the sky*

Select an area where the GPS antenna will have an unobstructed view of the sky. An ideal position has no obstructions above 10 degrees above the horizon. The total blockage of the sky (due to buildings, mountains, etc.) should be less than 50 %. If less than 50 % of the sky is visible to the antenna, contact Symmetricom for further assistance.

**B** *Lightning considerations*
Locate the antenna at least 15 meters away from lightning rods, towers, or structures that attract lightning. GPS antenna damage is usually not the result of a direct lightning strike, but the effects of a lightning strike on a nearby structure. Locate the GPS antenna lower than any structures that may attract a strike.

**C** *Maintenance considerations*
If the GPS antenna fails or must be checked, having the antenna positioned in an accessible location will facilitate maintenance. Avoid installing the antenna on a tower, which requires a specialist to maintain.

**D** *Interference consideration*
Avoid the direct radiation from transmitting antennas (such as TV or Cellular).

**Rule 2. Is a GPS line amplifier needed?**

**A** *Cable length*
Add up the total length of all the cables for the installation. If the total cable length is 150 ft or less, no amplifier is needed. If the total length is between 150 ft and 300 ft, a line amplifier is required. For lengths greater than 300 ft, contact Symmetricom for further assistance.

**B** *Placement*
Mount line amplifiers as close to the antenna as possible. Connect the amplifier directly to the antenna. The line amplifiers fit nicely inside the antenna mast where they are protected from the weather.

**Rule 3: Lightning arrestors**

**A** *Is a lightning arrestor needed?*
Very probably, yes. Lightning does not have to strike the antenna to significantly damage the antenna and GPS receiver. Lightning strikes induce damaging voltages in the antenna system when striking nearby objects.

**B** *What do I need?*
A commonly used configuration is to place a lightning arrestor where the antenna cable enters the building (either inside or outside), because there is often a good earth ground nearby to connect to. If the cable between this lightning arrestor and the GPS receiver is longer than four meters, it is good practice to place a second lightning arrestor within four meters of the GPS receiver. The second arrestor reduces any lightning-induced voltages in the cable to the receiver.

**C** *Grounding*
The lightning arrestor does not need a grounding strap if it is directly bolted to a grounding plate. A grounding strap should be used if you cannot connect directly to a grounding plate.

**D** *Caution*
If you are not comfortable designing your own lightning protection system, seek professional assistance. This is only a guide.

**Rule 4: Interconnect cables**

**A** *Cable options*

Symmetricom’s interconnect cables are available in various lengths. For ease of pulling antenna system cable through a conduit, or if you wish to cut the cable to an exact length, you may choose to have a connector on only one end.

**B** *Multiple antenna site installations*

Multiple site installations may be done more efficiently using bulk cable and a connector installation tool kit. For more information about multiple antenna site installations or general questions about GPS antenna system installation, please contact Symmetricom’s Customer Technical Assistance Center.

## 11.8 Master/Slave Card

The GEN series can be operated as a fully synchronized Multi-Mainframe system with multiple mainframes using the Master/Slave card.

With the Master/Slave card you can:

- connect one GEN series “Master” to up to eight “Slaves”
- fully synchronize up to nine mainframes
- record up to 1080 channels with 1 MS/s sampling speed each by using all slots
- or record up to 540 channels with 100 MS/s per channel by using all slots
- use the fiber optic link with up to a 500 m cable between the master and each slave

And the Master/Slave option provides:

- the sampling clock, absolute time info, trigger and start/stop signals between the mainframes, creating a real high channel synchronized system out of the nine mainframes
- a timing accuracy between the mainframes better than 100 ns
- an automatic cable length detection and compensation

**Master/Slave card operating modes**

The Master/Slave card has three operating modes:

- Master
- Slave
- Stand-alone

In Master mode:

- all connectors function as master output
- the start of recording as well as synchronization signals are transmitted to all connected slaves
- all trigger signals are combined into a global master/slave trigger signal

In Slave mode:

- the top connector is configured as slave input, all other connectors are unused
- all received signals are transferred to a bus for internal distribution
- internal slave trigger signals are transferred to the outside

In Stand-alone mode:

- Stand-alone mode is OFF: the Master/Slave card does not communicate with other Master/Slave cards.

**Fiber optic cable**
The Master/Slave card has optical I/O (IN/OUT) that connects to other Master/Slave cards.

The fiber optic cable:

- allows up to a 500 m cable between the master and each slave (for more information, please refer to "Calculating maximum fiber cable length" on page 691)
- distributes the sampling clock, absolute time info, trigger and start/stop signals between mainframes, creating a real high channel synchronized system out of the nine mainframes
- enables a timing accuracy between the mainframes less than 100 ns

### 11.8.1 Master/Slave card operations

The Master/Slave card is easily inserted into the GEN series mainframe and is automatically recognized by the Perception software. A Master/Slave card can be used as a master or slave. One card is required in the master mainframe and one card is required per slave mainframe. Each card has eight LC® connectors for the fiber optic cable.

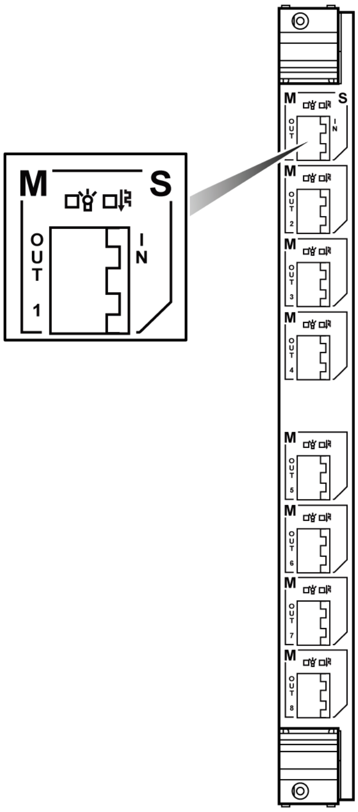



**Figure 11.51:** Master/Slave card

In Master mode, all connectors **M** function as master output (**OUT 1** to **OUT 8**).

In Slave mode, the top connector **S** functions as a slave input (**IN**), all other connectors are unused.

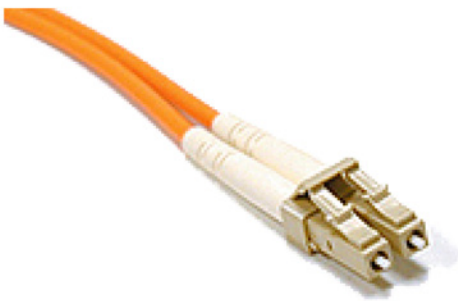


**Figure 11.52:** Example of a duplex LC® connector

**LED indicators**
On the front panel of the Master/Slave card two LEDs indicate the status of the link.
The icon is used to identify the signal detect function.
The icon is for data/synchronization identification.

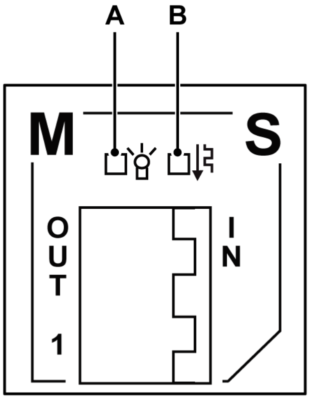



**Figure 11.53:** LED indicators

**A** icon

**B** icon

The following table shows the function and possible combinations of the two LEDs.

*Table 11.1: Master/Slave card front panel LED indicators*

| FRONT PANEL LED INDICATORS | | | |
|---|---|---|---|
| **Status** | | | **Description** |
| No Link | off | off | No valid characters detected/ no optical signal detected |
| Optical signal detection/ initialization | on | off | Alignment characters detected |
| Receiving data | on | on | Receiving valid data |

In the GEN series tower model the Master/Slave card is installed on the left-hand side of the Interface/Controller module.

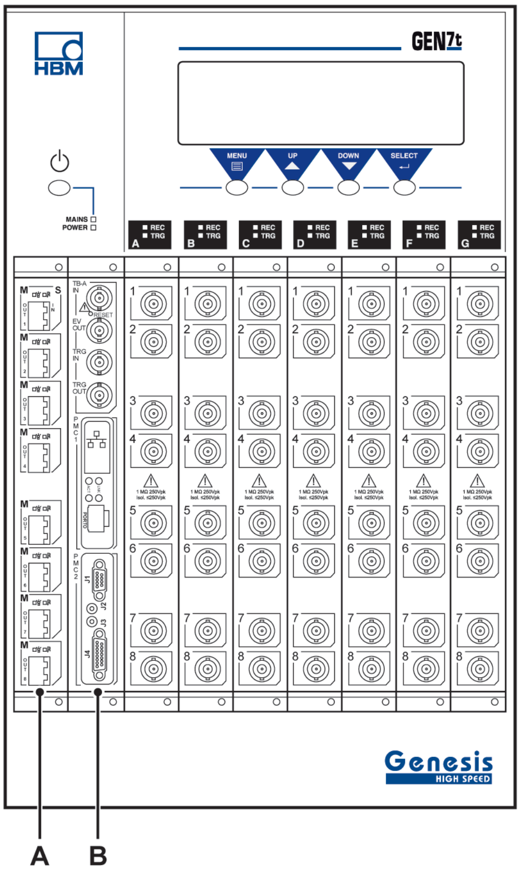



**Figure 11.54:** GEN series tower model with Master/Slave card installed

**A** Master/Slave card

**B** Interface/Controller module

In the GEN series 19” rack model the Master/Slave card is installed into Slot **A** on the right-hand side of the Interface/Controller module.

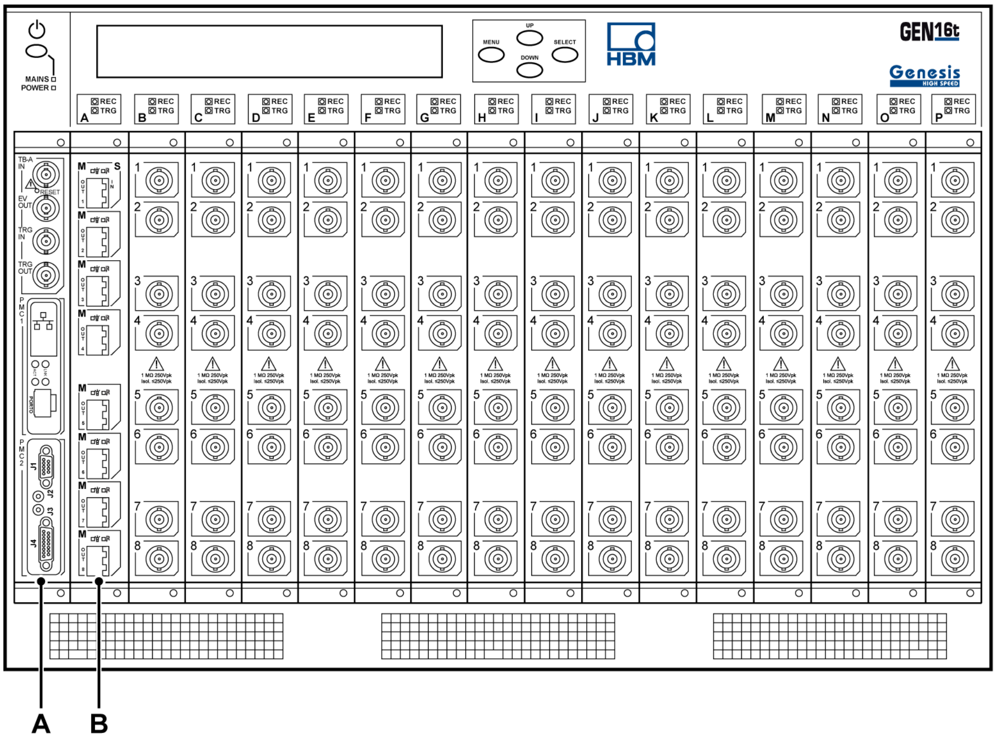


**Figure 11.55:** GEN series 19” rack model with Master/Slave card installed

**A** Interface/Controller module

**B** Master/Slave card (Slot A)

**Note** *With a Master/Slave card installed the GEN series 19” rack model can accommodate up to 15 cards (recorders).*

### 11.8.2 Installation

**Installing and removing the Master/Slave card**
The Master/Slave card is easily inserted into the GEN series mainframe and is automatically recognized by the Perception software.

The card is removed and installed in the same way as all the acquisition cards.

**Note** *On the GEN series 19” rack model remove the acquisition card from slot A.*

**CAUTION**

**HBM uses state-of-the-art electronic components in its equipment. These electronic components can be damaged by a discharge of static electricity (ESD). Therefore, we must emphasize the importance of ESD preventions when removing or installing cards/modules.**

**CAUTION**

**The GEN series Data Acquisition System is factory-calibrated as delivered to the customer. Swapping, replacing or removing of cards/ modules may result in minor deviations to the original calibration. The GEN series system should be tested and if necessary, calibrated, at one-year intervals or after any major event that may affect calibration. When in doubt, consult your local supplier.**

**LASER SAFETY**

**CLASS 1 LASER PRODUCT. Avoid exposure to laser radiation. Do not stare into an open aperture, because invisible laser radiation may be emitted from the aperture when a cable is not inserted in the connector port. The system is classified as a Class 1 laser product. The Master/Slave card uses an LC® Optical Tranceiver for communication. It does not emit hazardous light but it is recommended to avoid direct exposure to the beam.**


The built-in laser complies with laser product standards set by government agencies for Class 1 laser products:

- In the USA, the Master/Slave card is certified as a Class 1 laser product conforming to the requirements contained in the Department of Health and Human Services (DHHS) regulation CDRH 21 CFR, Chapter I Subchapter J Part 1040.10.
- Outside the USA, the Master/Slave card is certified as a Class 1 laser product conforming to the requirements contained in IEC/ EN 60825-1:1994+A1+A2 and IEC/EN 60825-2.

**Installing the Master/Slave card**

To install the Master/Slave card proceed as follows:

**1** Shut down the GEN series and remove the power input cable.
**2** Ensure that the ejector levers are in the outermost position, tilting away from the card.

**3** Slide the card into its guide rails until the ejectors contact the perforated metal strips at top and bottom.

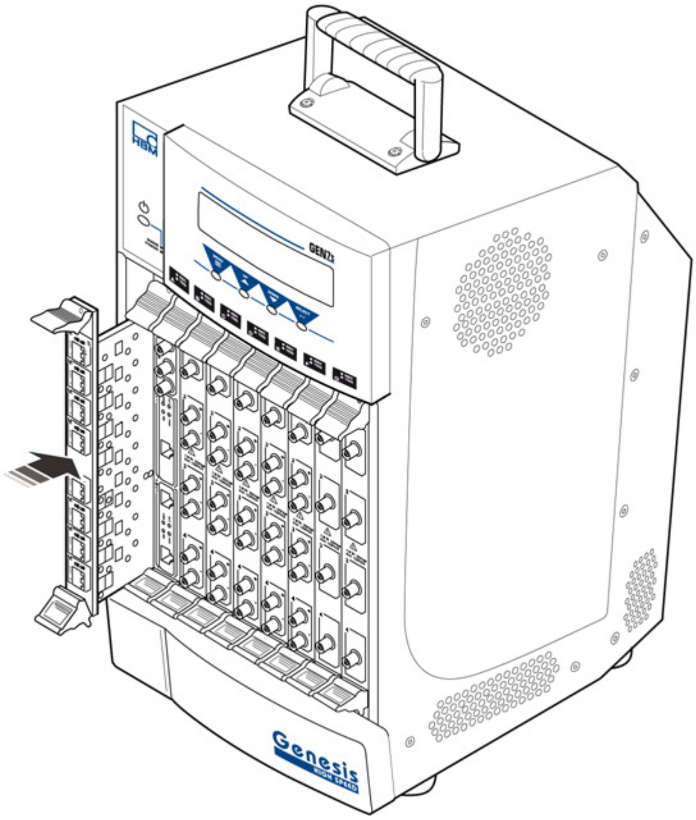


**Figure 11.56:** Slide in the card

4 Press both ejectors inwards to seat the card. They act as levers to gently push the card into its backplane sockets.

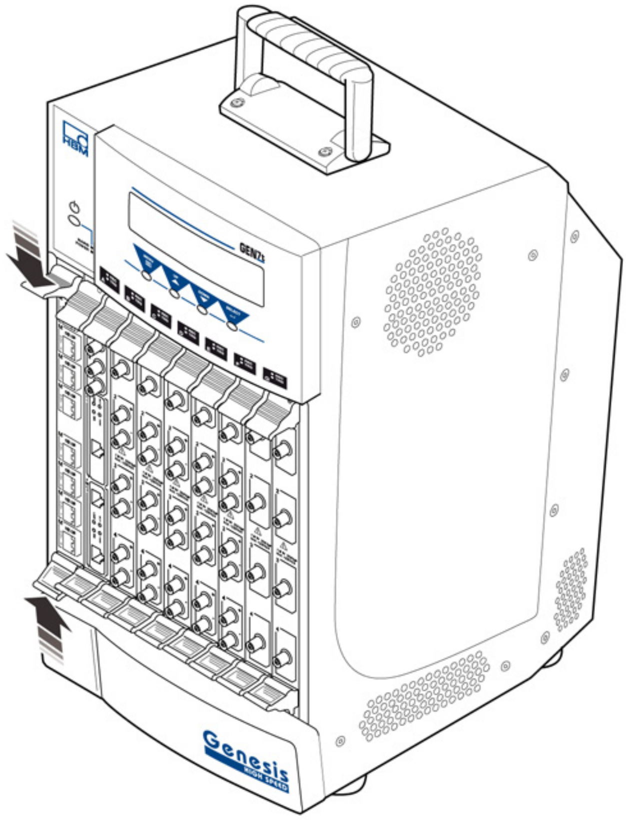



**Figure 11.57:** Press ejectors inwards

**5** Fasten the small set screw on both ejectors on the card.

**Figure 11.58:** Ejector set screw

The Master/Slave card is installed.

**Removing the Master/Slave card**

To remove the Master/Slave card:

**1** Shut down the GEN series and remove the power input cable.
**2** Loosen the small set screw on both ejectors on the card.

**Figure 11.59:** Ejector set screw

3 Press the inner grey button on each ejector to release the catch.

**Figure 11.60:** Inner gray button on ejector

**4** Press both ejectors outwards to release the card. They act as levers to gently pull the card from its backplane sockets.

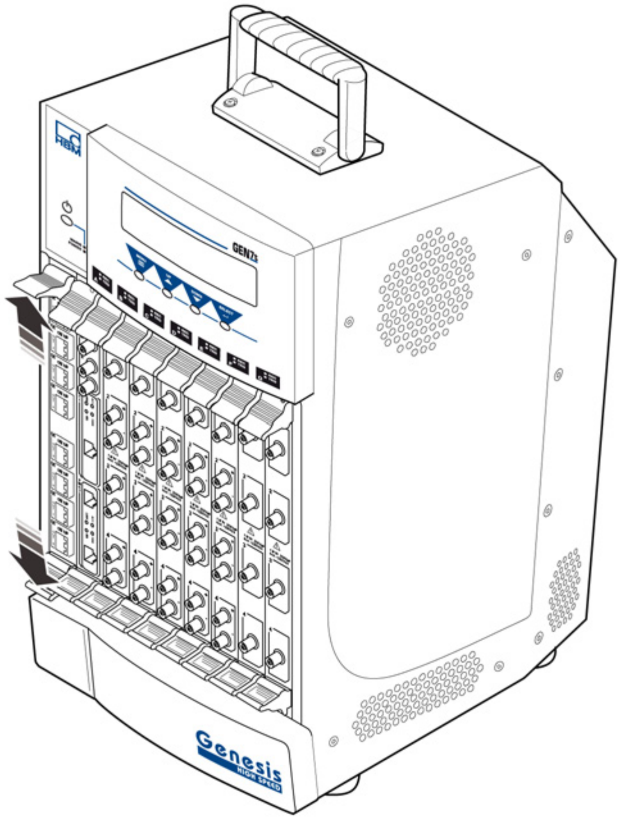


**Figure 11.61:** Press ejectors outwards

5 Slide the card out of the GEN series unit.

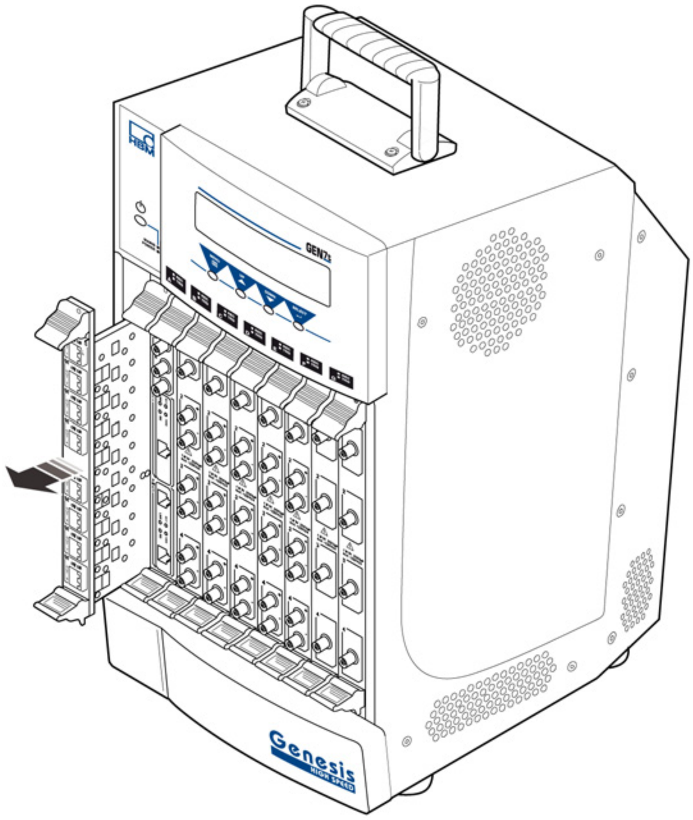


**Figure 11.62:** Remove the card

### 11.8.3 Connecting the Master/Slave card

With the fiber optic cable, connect the Master/Slave card labelled **M**, **OUT** of the master mainframe to the top connector labelled **M/S IN** of the Master/Slave card of the slave mainframes.

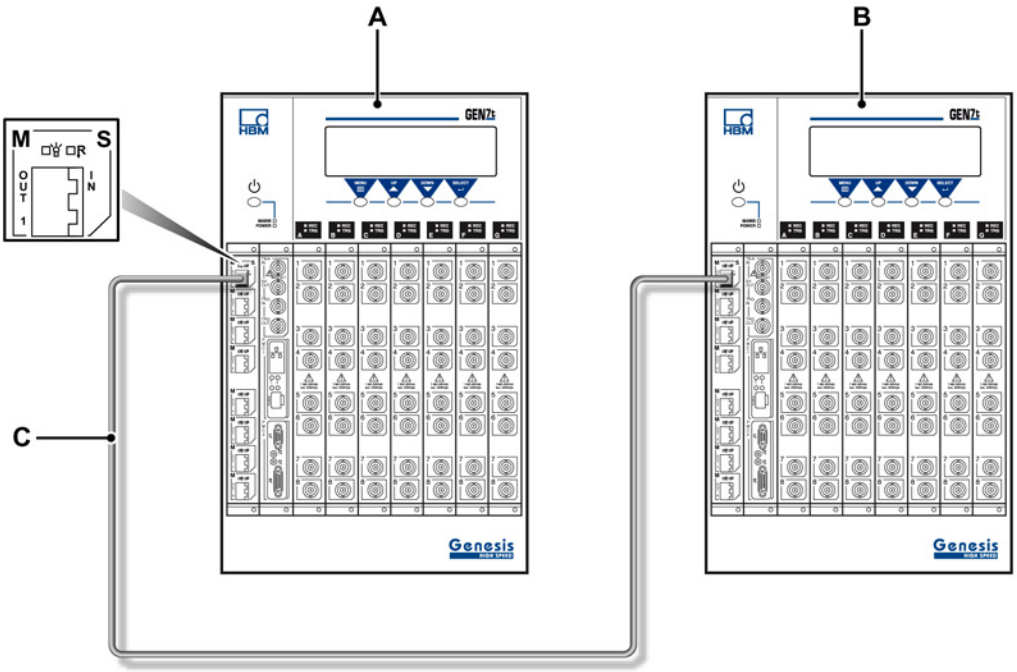



**Figure 11.63:** Connecting the Master/Slave

**A** Master mainframe (**M**, **OUT**)

**B** Slave mainframe (**M/S IN**)

**C** Fiber optic cable

**IMPORTANT**

**Connect the Fiber optic cable of the slave mainframes to the top connector labelled M/S IN of its Master/Slave card.**
**With a Master/Slave card operating in slave mode only the top connector labelled M/S IN is configured as a slave, all other connectors will not send or receive signals.**

### 11.8.4 Example of a Master/Slave configuration

The following diagram shows an example of a Master/Slave configuration with a master driving five slave mainframes.

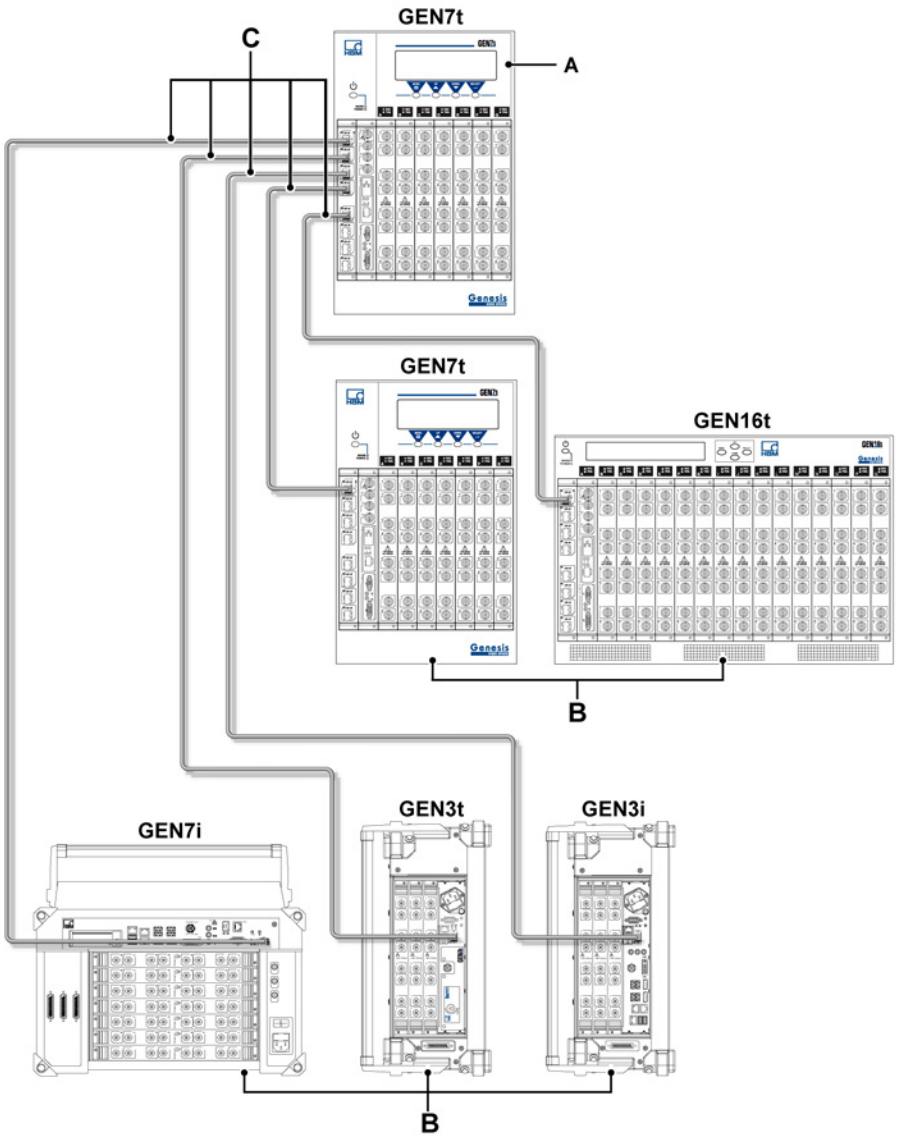



**Figure 11.64:** Master/Slave configuration with five slave mainframes

**A** Master mainframe

**B** Slave mainframes

**C** Fiber optic cable

1 Connect the connector labelled **M/S**, **OUT 1** of the master mainframe to the top connector labelled **M/S IN** of the first slave mainframe.

2 Connect the connector labelled **M**, **OUT 2** of the master mainframe to the top connector labelled **M/S IN** of the second slave mainframe.

3 Connect the connector labelled **M**, **OUT 3** of the master mainframe to the Master/Slave synchronization connector of the third slave mainframe.

4 Connect the connector labelled **M**, **OUT 4** of the master mainframe to the Master/Slave synchronization connector of the fourth slave mainframe.

5 Connect the connector labelled **M**, **OUT 5** of the master mainframe to the Master/Slave synchronization connector of the fifth slave mainframe.

### 11.8.5 Setting the Master/Slave operating modes

A Master/Slave card can be used as a master or slave. After installation of the Master/Slave card into the mainframe, set the operating modes in the Perception software.

In the *Perception work* area:

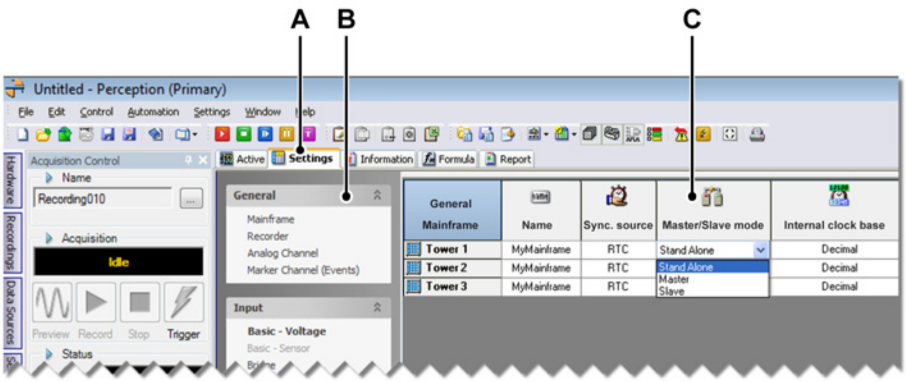


**Figure 11.65:** Perception work area with Master/Slave

**A** Settings tab

**B** General group

**C** Master/Slave mode column

To set the Master/Slave operation in the Perception software, proceed as follows:

1. If it is not already active, start Perception.
2. Make sure that you are connected to the required mainframes. Use the *Hardware Navigator* to do this.
3. Select the **Settings** sheet.
4. In the **Settings** sheet, go to the **General** group in the task pane and select **Mainframe**.
   A list of available mainframes is displayed in the settings area.
5. Set the master:
   a. Select the mainframe that you want to use as the Master.
   b. Double-click on the **Master/Slave mode** cell to open it for modification.
   c. In the drop-down list that comes up, select **Master**.
6. Set one or more slaves:
   a. Select the mainframe that you want to use as a Slave.
   b. Double-click on the **Master/Slave mode** cell to open it for modification.
   c. In the drop-down list that comes up, select **Slave**.

To disable the Master/Slave operation and set the mainframe to Stand-alone mode:

1 Select the mainframe that you want to use as a Stand-alone.
2 Double-click on the **Master/Slave mode** cell to open it for modification.
3 In the drop-down list that comes up, select **Stand-alone**.

The Master/Slave operating mode of the mainframe has been set.

If you have set the mainframe to Master mode, the letter **"M"** appears in the GEN series front panel.


**Figure 11.66:** Mainframe in Master mode

If you have set the mainframe to Slave mode, the letter **"S"** appears in the GEN series front panel.


**Figure 11.67:** Mainframe in Slave mode

The installation of the Master/Slave option is completed.

### 11.8.6 Setting the Master/Slave trigger

When the Master/Slave card is in use, a recorder can either put the recorder trigger on the Master/Slave trigger line and/or pick up the trigger from the Master/Slave trigger line.

There are four settings that can be selected in the Perception software:

- Disabled
  No trigger transmitted to or received from other mainframes
- Transmit
  Transmit trigger(s) from this recorder to other mainframes
- Receive
  Receive trigger(s) from other mainframes
- Transceive
  Transmit and receive trigger(s) from other mainframes

The settings are controlled in a block diagram or through the *Master/Slave trigger* setting in the sheet.

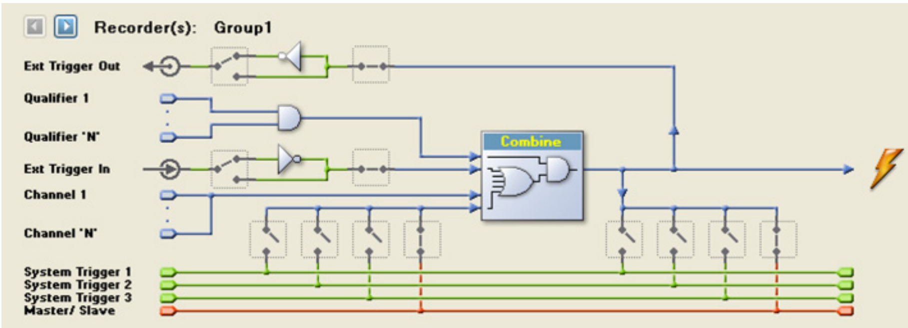



**Figure 11.68:** Block diagram

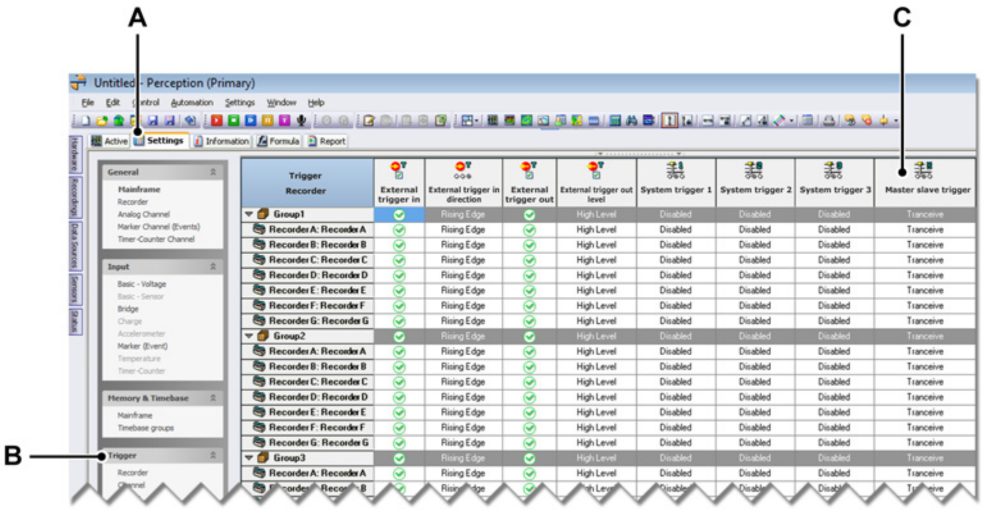



**Figure 11.69:** Perception work area with Master/Slave trigger

**A** Settings tab

**B** Trigger group

**C** Master/Slave trigger column

To set the Master/Slave trigger in the Perception software, proceed as follows:

1. If it is not already active, start Perception.
2. Make sure that you are connected to the required mainframes. Use the *Hardware Navigator* to do this.
3. Select the **Settings** sheet.
4. If it is not already done, switch the **Settings** sheet layout modes to **Advanced** mode.
5. In the **Settings** sheet, go to the **Trigger** group in the task pane and select **Recorder**.
   A list of available recorders is displayed in the settings area.
6. Select the recorder that you want to set.
7. Double-click on the **Master/Slave trigger** cell to open it for modification.

8 In the drop-down list that comes up, select the setting you want to use.

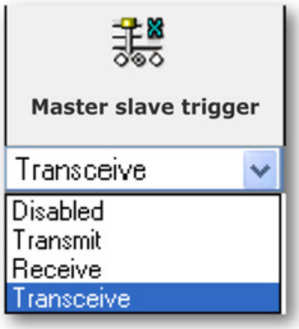



**Figure 11.70:** Master/Slave trigger list

### 11.8.7 Synchronizing a Master/Slave setup to external time sources

In a Master/Slave setup all time information is recorded by the Master mainframe only. Synchronization source selection on Slaves is disabled as Slave mainframe are dedicated to follow the Master mainframe.

For the Master mainframe, depending on the selected synchronization source the date and time are controlled by either the PC (RTC), or an installed IRIG (IRIG) or IRIG/GPS (GPS) card. The source is selected in the Perception software.

In the *Perception work* area:

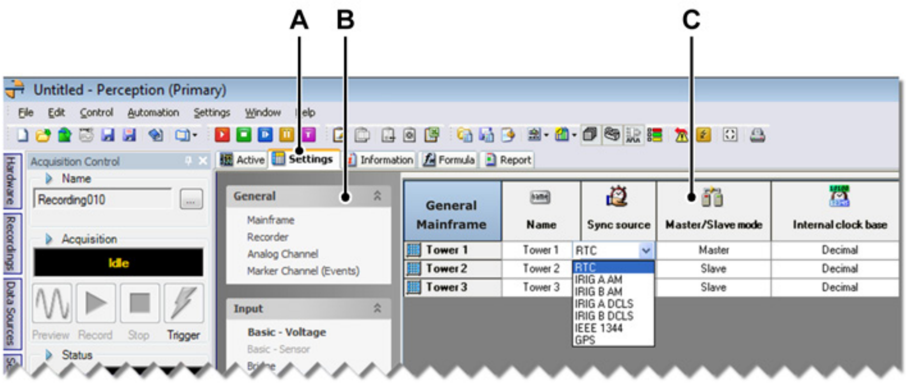



**Figure 11.71:** Perception work area synchronization source

**A** Settings tab

**B** General group

**C** Sync source column

To set the synchronization source in the Perception software, proceed as follows:

1. If it is not already active, start Perception.
2. Make sure that you are connected to the required mainframes. Use the *Hardware Navigator* to do this.
3. Select the **Settings** sheet.
4. In the **Settings** sheet, go to the **General** group in the task pane and select **Mainframe**.
   A list of available mainframes is displayed in the settings area.
5. Select the Master mainframe.

**Note** *In a Master/Slave configuration, the synchronization source cannot be set if the Master/Slave card of the selected mainframe is operating in Slave mode!*

6 Double-click on the **Sync source** cell to open it for modification.

7 In the drop-down list that comes up, select the synchronization source you want to use.

See appendix "Master/Slave synchronization verification procedure" on page 675 how to check synchronization.

# 12 Input Cards

## 12.1 Available input cards

- **Isolated 1kV** - on page 274
  For use with especially high voltage inputs, externally conditioned signals or isolated voltage probes and current clamps. The isolated balanced differential inputs allow direct connection to any voltage up to 600 VRMS CAT II on either input of each channel. The signal conditioner provides six channels of voltage inputs from ± 20 mV to ± 1000 V.
- **Isolated Basic** - on page 289
  Ideally suited for high definition transient recording. 8 channels with single-ended isolated inputs on one card. 200 kS/s or 2 MS/s digitizing rate. 16/18-bit resolution. The signal conditioner provides eight channels of voltage inputs from ± 10m V to ± 50 V. This card also supports IEPE transducers and TEDS class 1.
- **Basic** - on page 299
  Ideally suited for high definition transient recording. 8 channels with single-ended or isolated inputs on one card.
  200 kS/s or 1 MS/s digitizing rate. 16-bit resolution. The signal conditioner provides eight channels of voltage inputs from ± 1 V to ± 50 V.
- **Basic XT** - on page 302
  Has all the features of the basic input card with higher voltage input ranges up to ± 100 V. 8 channels with single-ended or isolated inputs on one card. 200 kS/s or 1 MS/s digitizing rate. 16-bit resolution. The signal conditioner provides eight channels of voltage inputs from ± 2 V to ± 100 V.
- **Bridge** - on page 310
  Bridge wizard for error-free setup and fast auto balance. 200 kS/s and 1 MS/s versions. Isolated and differential inputs. High gain, extremely good SNR even at the maximum 400 kHz bandwidth. Both versions come with on-board, software selectable shunt calibration and bridge completion resistors.
- **Universal** - on page 335
  Unique high-end card serves a variety of needs. Differential and/or isolated measurements to IEPE-based vibration or shunt-based current measurements.
  Supports any type of 'constant current' vibration and acceleration sensors. In “current mode” the built-in shunt can be used to measure up to 1 ampere in a safe, isolated and fused manner, without the need of external shunt resistors.
- **Binary Marker** - on page 342
  The binary marker card enables up to 64 "digital" recorded channels. This card can be used to record status signals from the process or test; like high/low, open/closed or left/right. In addition 3 counter/timer channels are available.

- **Binary Marker HV** - on page 343
  A general purpose card that is also specifically suited for the medium/high voltage market.
  Acquire 32 digital event signals (markers) as well as 8 digital event signals that are optically isolated. More details can be found in the BE3200 manual.
- **High Resolution IEPE and Charge input cards** - on page 337
  A versatile card for use in the following application areas:
  In basic mode as differential or non-isolated entry level electrical input amplifiers or preconditioned signals. In Accelerometer mode for use with IEPE based sensors. In Charge mode to support charge type sensors.
- **High speed digitizers** - on page 336
  For ultra fast signals 25 MS/s and 100 MS/s versions. Equipped with four channels sampling at incredibly high speed. Selectable anti-aliasing filtering and 14-bit (100 MS/s) or 15-bit resolution (25 MS/s). Enhanced resolution mode increases input resolution for both models to 16-bit. Inputs are single ended or differential. The 25 MS/s digitizer replaces the 20 MS/s high speed digitizer that was produced before 2007.
- **5B Integration card** - on page 351
  In situations where non-standard or specific card requirements are needed, for example LVDT or PT100 signals that need to be conditioned and acquired, the 5B Integration card is used.
- **High voltage isolated digitizers** - on page 341
  The Isolated GN401, GN110, GN111, GN112 and GN113 are a complete programmable single-channel digitizing subsystem for use in the GEN DAQ system. The transmitters are designed to provide for high voltage isolation while maintaining high dynamic accuracy. It is typically used for accurate isolated measurements in harsh environments.

  The Isolated transmitters come in two models to best fit your requirements. A high voltage / high power model that you can use in even the most demanding applications and harsh environments, and a medium voltage / medium power model. This last front-end can be directly powered from the mains. The built-in power supply provides isolation up to 1.8 kV.

  Up to 4 Isolated Digitizers (channels) can be connected to a single receiver module.

  *These digitizers are described in a separate document.*

*Table 12.1: Available acquisition cards with signal conditioning (Part 1)*

| **Acquisition Cards** | | | |
|---|---|---|---|
| **Model** | **Type** | **Isolation** | **Max. SR(1)** |
| GN810 | Single Ended | no | 200 kS/s |
| GN811 | Single Ended | no | 1 MS/s |
| GN812 | Unbalanced Differential | yes | 1 MS/s |
| GN813 | Unbalanced Differential | yes | 1 MS/s |
| GN814 | Unbalanced Differential | yes | 200 kS/s |
| GN410 | Bridge/Differential | yes | 200 kS/s |
| GN411 | Bridge/Differential | yes | 1 MS/s |
| GN440 | Differential/IEPE/Shunt | yes | 200 kS/s |
| GN441 | Differential/IEPE/Shunt | yes | 1 MS/s |
| GN1611 | Differential | no | 20 kS/s |
| GN3211 | Differential | no | 20 kS/s |
| GN1610 | Differential/IEPE/Charge | no | 250 kS/s |
| GN3210 | Differential/IEPE/Charge | no | 250 kS/s |
| GN413 | Differential/Single Ended | no | 25 MS/s |
| GN412 | Differential/Single Ended | no | 100 MS/s |
| GN401 | Multi Mode Optical Fiber | yes | 100 MS/s |
| GN402 | Single Mode Optical Fiber | yes | 100 MS/s |
| GN611 | Balanced Differential | yes | 200 kS/s |
| GN610 | Balanced Differential | yes | 2 MS/s |
| GN816 | Unbalanced Differential | yes | 200 kS/s |
| GN815 | Unbalanced Differential | yes | 2 MS/s |
| GN6470 | Binary | no | 1 MS/s |
| GN4070 | Optical & Binary | yes & no | 1 MS/s |

(1) Maximum Sample Rate/channel (not multiplexed).

*Table 12.2: Available acquisition cards with signal conditioning (Part 2)*

| **Acquisition Cards** | | | | | |
|---|---|---|---|---|---|
| **Model** | **Resolution** | **Memory/ card** | **Channels** | **Event, T/C(2)** | **Fast Streaming** |
| GN810 | 16 bit | 128 MB | 8 | 0, 0 | no |
| GN811 | 16 bit | 256 MB | 8 | 0, 0 | no |
| GN812 | 16 bit | 512 MB | 8 | 0, 0 | no |
| GN813 | 16 bit | 512 MB | 8 | 0, 0 | no |
| GN814 | 16 bit | 128 MB | 8 | 0, 0 | no |
| GN410 | 16 bit | 128 MB | 4 | 0, 0 | no |
| GN411 | 16 bit | 512 MB | 4 | 0, 0 | no |
| GN440 | 16 bit | 128 MB | 4 | 0, 0 | no |
| GN441 | 16 bit | 512 MB | 4 | 0, 0 | no |
| GN1611 | 16 bit | 200 MB | 16 | 16, 0 | no |
| GN3211 | 16 bit | 200 MB | 32 | 16, 0 | no |
| GN1610 | 16/24 bit | 2 GB | 16 | 16, 2 | no |
| GN3210 | 16/24 bit | 2 GB | 32 | 16, 2 | no |
| GN413 | 15 bit | 128 MB | 4 | 0, 0 | no |
| GN412 | 14 bit | 2 GB | 4 | 0, 0 | no |
| GN401 | --(3) | 2 GB | 4(3) | 0, 0 | no |
| GN402 | --(3) | 2 GB | 4(3) | 0, 0 | no |
| GN611 | 16/18 bit | 200 MB | 6 | 16, 2 | no |
| GN610 | 16/18 bit | 2 GB | 6 | 16, 2 | no |
| GN816 | 16/18 bit | 200 MB | 8 | 16, 2 | yes |
| GN815 | 16/18 bit | 2 GB | 8 | 16, 2 | yes |
| GN6470 | 1 bit | 512 MB | 64 | 0, 0 | no |
| GN4070 | 1 bit | 512 MB | 8 & 32 | 0, 0 | no |

(1) Maximum Sample Rate/channel (not multiplexed).

(2) Digital Events, Timer/Counter channels (Supported by GEN7i, GEN3i, GEN3t and GEN2i Digital Event/Timer/Counter connector only).

(3) This card supports a maximum of four optical fiber transmitter channels.

| Optical Fiber Transmitter Channels | | | | | |
|---|---|---|---|---|---|
| **Transmitter**<br>Every transmitter is a single channel unit. Every unit has an unbalanced differential input, amplifier, analog anti alias filter and ADC with an optical data and control link to the receiver card. The receiver card has the recording logic, sample rate selection and memory. | | | | | |
| **Model** | **Receiver Card** | **Power** | **Sample rate** | **Resolution** | **Isolation** |
| GN110 | Fiber100M 6600 | Battery | 100 MS/s | 14 bit | User application defined |
| GN111 | Fiber100M 6600 | Battery | 25 MS/s | 15 bit | User application defined |
| GN112 | Fiber100M 6600 | 120/ 240 V AC | 100 MS/s | 14 bit | 1800 V RMS |
| GN113 | Fiber100M 6600 | 120/ 240 V AC | 25 MS/s | 15 bit | 1800 V RMS |
| GN114 | Fiber100M 7600 | External 12 V DC | 100 MS/s | 14 bit | User application defined |

## 12.2 Isolated 1kV input cards

### 12.2.1 GN610, Isolated 1kV 2MS/s input card

- 6 analog channels
- Isolated, balanced differential inputs
- ± 20 mV to ± 1000 V input range
- 600 V RMS CAT II reinforced isolation
- User selectable digital Bessel, Butterworth and Elliptic filters
- 2 MS/s sample rate
- 18 bit resolution
- 2 GB memory
- Two 4 mm banana plugs for each channel
- Real-time cycle based calculation; Triggering on calculated result
- Digital Event/Timer/Counter support

The isolated balanced differential inputs allow direct connection to any voltage up to 600 V RMS on both inputs of each channel.
The signal conditioner provides voltage inputs from ± 20 mV to ± 1000 V combining low and high voltage input ranges all-in-one card.
The model uses two 4 mm safety banana plugs for each channel. A standard safety rated BNC-to-banana adapter can be used to easily connect coax cables using BNCs.
This card meets the international IEC61010-1:2010 safety standard. The card offers 600 V RMS CAT II and 300 V RMS CAT III (reinforced) isolation to allow safe measurements within the most demanding electrical environments.
Every channel is equipped with an independent full range input amplifier, 7-pole Bessel or Butterworth analog anti-aliasing filter, user selectable digital Bessel, Butterworth and Elliptic IIR filters and an 18 bit Analog-to-Digital converter.
For true real-time analysis the card offers real-time cycle based calculations. Automatic zero crossing detection allows for asynchronous true RMS, mean and other calculations that can be used to trigger the recording.
If supported by the selected mainframe, the GEN DAQ series input card offers 16 digital input events, two digital output events and two timer/counter channels.

For specification and ordering information, please refer to "B3618-4.0 en (GEN series GN610)" on page 432.

### 12.2.2 GN611, Isolated 1 kV 200kS/s input card


- 6 analog channels
- Isolated, balanced differential inputs
- ± 20 mV to ± 1000 V input range
- 600 V RMS CAT II reinforced isolation
- User selectable digital Bessel, Butterworth and Elliptic filters
- 200 kS/s sample rate
- 18 bit resolution
- 200 MB memory
- Two 4 mm banana plugs for each channel
- Real-time cycle based calculation; Triggering on calculated result
- Digital Event/Timer/Counter support

The isolated balanced differential inputs allow direct connection to any voltage up to 600 V RMS on both inputs of each channel.
The signal conditioner provides voltage inputs from ± 20 mV to ± 1000 V combining low and high voltage input ranges all-in-one card.
The model uses two 4 mm safety banana plugs for each channel. A standard safety rated BNC-to-banana adapter can be used to easily connect coax cables using BNCs.
This card meets the international IEC61010-1:2010 safety standard. The card offers 600 V RMS CAT II and 300 V RMS CAT III isolation to allow safe measurements within the most demanding electrical environments.
Every channel is equipped with an independent full range input amplifier, 7-pole Bessel or Butterworth analog anti-aliasing filter, user selectable digital Bessel, Butterworth and Elliptic IIR filters and an 18-bit Analog-to-Digital converter.
For true real-time analysis the card offers real-time cycle based calculations. Automatic zero crossing detection allows for asynchronous true RMS, mean and other calculations that can be used to trigger the recording.
If supported by the selected mainframe, the GEN DAQ series input card offers 16 digital input events, two digital output events and two timer/counter channels.

For specification and ordering information, please refer to "B3716-4.0 en (GEN series GN611)" on page 456.

### 12.2.3 Using the GN610 and GN611

**WARNING**

**High bandwidth and measurement cabling**

Due to the high bandwidth measurement capabilities of the acquisition card in combination with the high measurement sensitivity of the card it is important to pay close attention to the measurement cabling.

Some advice to prevent measuring unwanted disturbances:

- Keep measurement cables as short as possible in order to reduce the reception of environmental disturbances.
- Use shielded cables. The cable should have the measurement cables paired inside a shield. Preferable the shield is connected to the chassis of the measurement Genesis High Speed equipment or alternatively the chassis of the object under test.

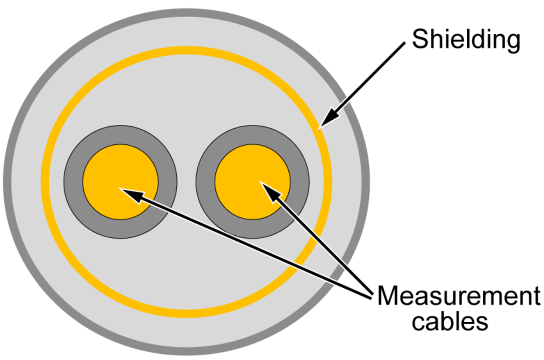



**Figure 12.1:** Shielded cable[1]

(1) Use HBM 1-KAB290-xxx. These cables are designed to meet this setup.

- In case of high frequency disturbance where high bandwidth measurement is not required one can reduce the measurement bandwidth by using the lowpass filter of the acquisition card.
- In case unshielded cables are used keep them as close together as possible, i.e. position them next to each other (to keep the loop small).

- Make sure that measurement cables that are used for measuring high dynamic or distorting signals are not closely positioned to measurement cables used for measuring small sensitive signals.
- Keep all measurement cables well separated from cables connected to high switching loads or motor cables.
- Separate measurement equipment and cables from potentially interfering equipment like frequency inverters or wireless equipment.

General cabling remark: Only use properly rated cables for the signal to measure, both voltage and current rating should be matched to the signal to measure.

**WARNING**

**This instrument must be properly earthed.**

When using this card we advise to use the standard GEN series protective earth connections to ensure the entire unit is earthed.
Please see section "Connecting power" on page 62 for further details.

**If connection to a protective earth is not possible for any reason then please refer to the international safety standard EN 50191:2000**

**WARNING**

**Overvoltage and current protection**

All signal inputs are protected against voltage overload. This is specified at ± 1000 V for all ranges except for the ± 1000 V range that is limited to ± 1250 V. Exceeding these limits, particularly when connected to potentially high-current sources, can cause severe damage that is not covered by the manufacturer's warranty.

**WARNING**

**Disconnect voltages before removing the card from the system.**

The measuring circuit can carry hazardous voltages and should be disconnected before the card is removed from the card slot of the measurement system.

**WARNING**

**High Voltage and qualified personnel**

For measurements falling within the scope of the EN 50110-1 and EN 50110-2, please note that all cards with working voltages above 50 V AC RMS or 120 V DC may only be connected by a qualified technician or a person trained in electrical engineering and supervised by a qualified technician. (Qualified technicians are persons who, due to their specialist training, knowledge and experience as well as their knowledge of the relevant provisions are able to assess the work with which they are entrusted and detect possible risks and who have been nominated as qualified technicians by their employer).

**WARNING**

**Connectors and cables**

Only use approved shielded/shrouded banana connectors with this card. Do not use any other type of connector.

Don't use non-protected or non-shrouded connectors.
The following connectors are unsafe to use with this card and should not be used.

**Figure 12.2:** Unsafe connectors

The inputs on the 1kV card are only compatible with the following connectors and cables. All cables used with the 1kV card should support 1000 V DC (or 1000 V AC peak) and 600 V CAT II.

**Figure 12.3:** Safe connectors

### 12.2.4 Understanding the GN610 and GN611 category rating

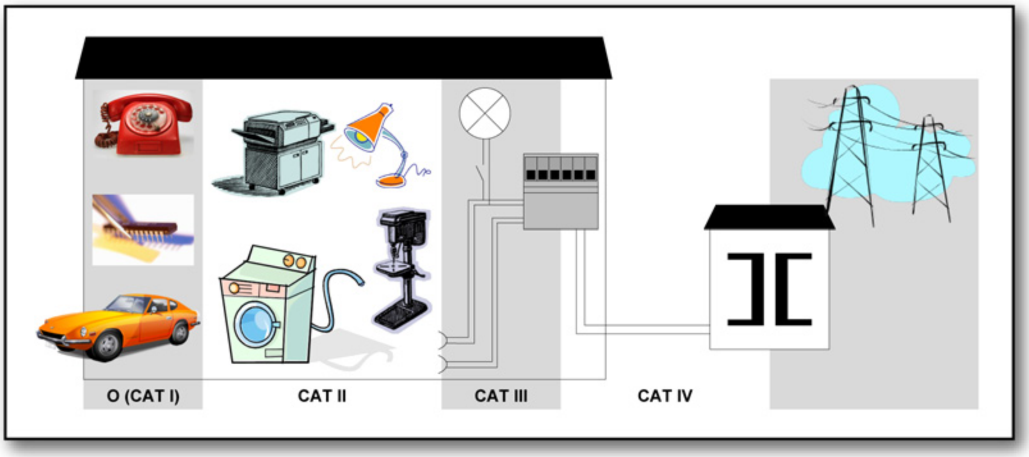



**Figure 12.4:** Category indication according to IEC 61010-2-030:2010

**Example:** A measurement device is specified as 600 V CAT II, maximum input voltage 1000 V DC.

*Table 12.3: Insulation test voltages according to IEC 61010-2-030:2010*

| Nominal Voltage (V RMS or V DC) | IEC 61010-2-030:2010 | | | | | |
|---|---|---|---|---|---|---|
| | 5 sec. AC test (V RMS) | | | Impulse test (V) | | |
| | CAT II | CAT III | CAT IV | CAT II | CAT III | CAT IV |
| ≤ 150 | 840 | 1.390 | 2.210 | 1.550 | 2.500 | 4.000 |
| > 150 ≤ 300 | 1.390 | 2.210 | 3.310 | 2.500 | 4.000 | 6.000 |
| > 300 ≤ 600 | 2.210 | 3.310 | 4.260 | 4.000 | 6.000 | 8.000 |
| > 600 ≤ 1 000 | 3.310 | 4.260 | 6.600 | 6.000 | 8.000 | 12.000 |

Using the above table one can deduct that this specification informs the user the device passed the insulation tests; 5 sec at 2.210 V RMS and impulse 4.000 V. The maximum operating input voltage is 1000 V DC. This device is to be used to measure CAT II circuitry up to 600 V.

### 12.2.5 Understanding the GN610 and GN611 input

The signal input channels of the GN610 are of the balanced type. This means that both inputs within one channel pair are exactly the same with the only difference being an opposite polarity or sign. Below you can find a (simplified) schematic representation of the input channel.
The input channels are of the isolated type. This means that the input channel and amplifier are fully isolated from (earth) ground. Fully isolated in this context means a very high resistance and very small capacitive coupling to ground.

**Characteristics per channel:**

- The Resistance/Capacitance from each terminal to ground is identical.
- Both terminals have isolated connectors (i.e. isolated from system ground).
- The isolated ground is not externally accessible as shown in Figure 12.5.

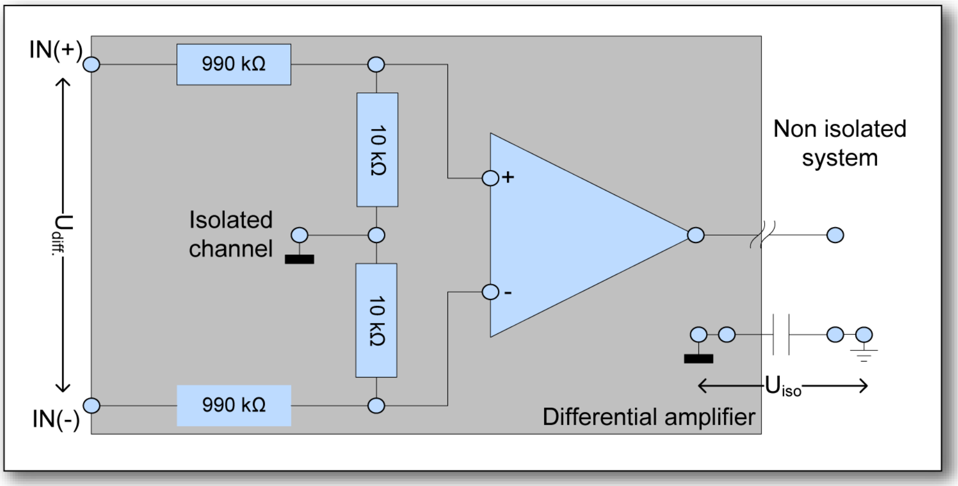



**Figure 12.5:** Isolated balanced input channel

**(not) using probes:**
Using passive voltage probes together with balanced isolated inputs is very difficult and <u>not recommended</u>. The main reason for this is that there is no ground reference for the probe to divide the input voltage down.

Looking at Figure 12.5 the GN610 specifies U IN(+), U IN(-) and |Uiso| ≤ 1 kV. Using a standard passive 10:1 probe in combination with the GN610 gives the situation as shown in Figure 12.6.

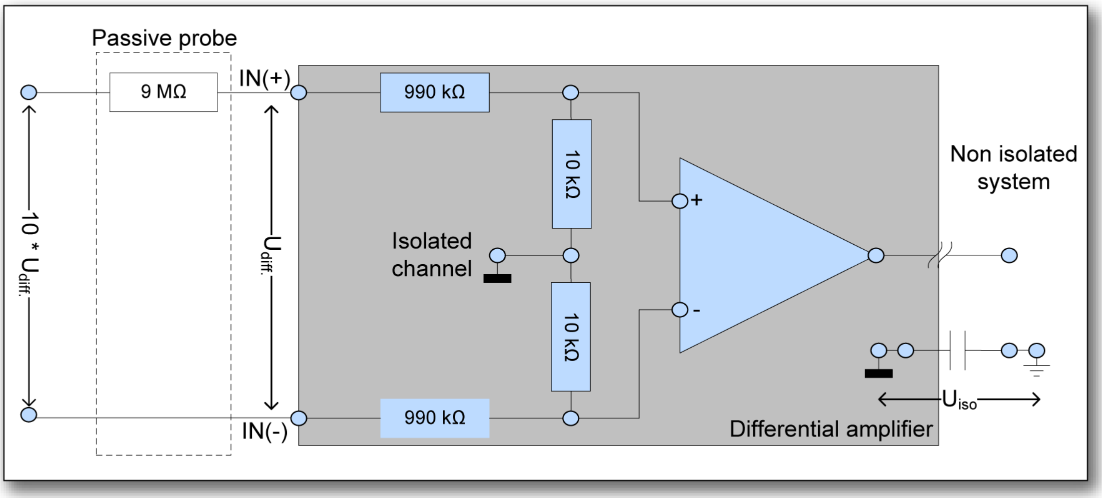



**Figure 12.6:** Isolated balanced input channel with passive probe

**Example1:**

In this setup U IN(-) is not divided, so it is required that |U IN(-)| ≤ 1 kV. Assuming U IN(-) is connected to 0 V we can calculate the voltages at $U_{iso}$ and U IN(+)

| | |
|---|---|
| Assuming: | U IN(-) = 0V<br>10:1 probe used, probe input Voltage applied is 10* $U_{diff}$ |
| Results in: | U IN(+) = 10 * $U_{diff}$ / 11M * 2M = 1.82 * $U_{diff}$<br>$U_{iso}$ = 10 * $U_{diff}$/ 11M * 1M = 0.91 * $U_{diff}$ |

Due to the 2 MΩ impedance between U IN(+) and U IN(-) the probe doesn't divide by 10, but by 5.5 (10 / 1.82). So in case the maximum specified $U_{diff}$ of 1 kV is considered this smaller division factor results the U IN(+) level to be way above the channels specification.

**Example2:**

Since U IN(-) is not divided, there are very strict consideration on how signals can be attached. Assume the U IN(+) and U IN(-) are reversed by accident. We can calculate $U_{iso}$ and U IN(-).

| | |
|---|---|
| Assuming: | U IN(-) = 10 * $U_{diff}$<br>U IN(+) = 0 V |
| Results in: | $U_{iso}$ = 10 * $U_{diff}$ / 11M * 10M = 9.1 * $U_{diff}$ |

In case the maximum specified $U_{diff}$ of 1 kV is considered both U IN(-) and $U_{iso}$ are way above the channels specification.

### 12.2.6 GN610 and GN611 Input Overload protection

The input section has several methods to protect against Voltage overload on the input.

Every selected input range allows a 200 % overload without any change of input resistance or auto ranging. This 200 % overrange is designed to allow for smaller voltage overloads without effecting your measurement. Within this 200 % overload the amplifier is also able to respond with normal rise/fall times to signal being restored within the standard selected range.

When exceeding the 200 % overload condition, the input impedance might start to increase. The impedance increase will lower the input current with the positive effect of lowering the dissipated heat. It is the excessive heat dissipation that typically damages the input channel.

The first action of the system will be to add an additional current load on your input signal to create an extra voltage drop on the input series resistance. The actual additional current depends on several factors and is therefore not predictable. A negative side effect of this additional current is the extra power dissipated in the input section which in turn results in additional heat dissipation.

Within the lower ranges of the amplifier (≤ ±5 V ranges) the input section will start switching to disconnect from the input signal to reduce the power dissipated.

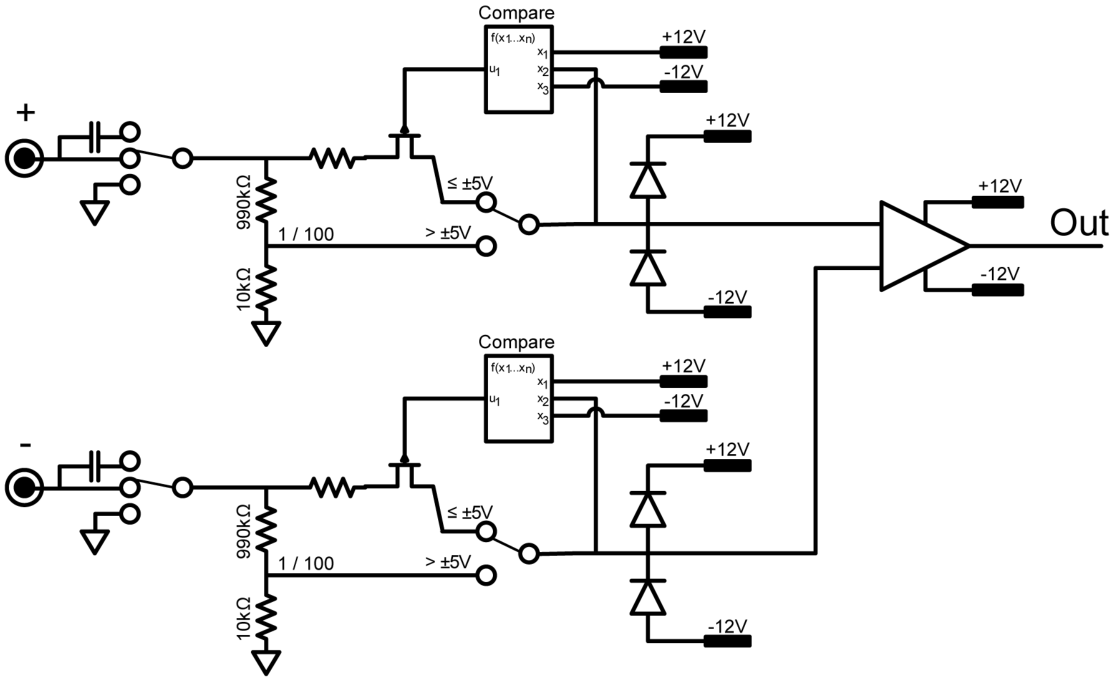



**Figure 12.7:** Input Overload protection - Schematic diagram

**Thermal monitor of the input channels**

Any overload condition has the same end result: extra heat generated within the channel. Not only because of the extra current through the input resistance, but also because internal amplifier sections will be driving their local output to maximum levels creating excessive heating within the amplifier.

As a third protective mechanism every input is equipped with a thermal sensor to monitor the local temperature. When the local temperature reaches maximum levels the system will automatically start changing the user selected input range to reduce the dissipated heat. As the heat dissipation will not immediately start the auto ranging, short overloads will not results in auto ranging. Longer overload conditions will lead to higher local temperature and this will start the auto ranging process.

Whenever an overload condition pushes local temperature to above the maximum level, the input range will be adapted to a factor 10 less sensitive range. E.g. User selected ±40 mV range, when required the system will change the range to ±400 mV. As this might not be enough due to an even higher overvoltage, the system keeps on monitoring the local temperature. If the local temperature doesn't reduce within the expected response time, the system will automatically increase the input range with a factor of 10 for a second, third or how many times required to reach a safe condition not to increase local temperature anymore.

Every one of the automatic range changes will be identified within your measurement data. Not only will your measured input be scaled correctly with the adapted input range, but also the exact moment the automatic range change happens is identified within Perception software.

As the highest selectable range is ±1 kV the ultimate protection for the system will be to disconnect the input from the external signal source. This step will only be executed if the system is in the ±1 kV range and local temperature is still outside maximum operating limits. Disconnecting from the external signal source is done by grounding the input. When inputs are grounded, the only connections to the external signal are the input connectors and the input pin of the ground relay.

**Thermal shutdown in critical conditions**
This protective scheme allows for any overload condition the input would be confronted with during normal operation. For any other failure condition that would result in excessive heat dissipation, the system has a last protective stage built in. When local temperatures reach a critical condition the system will turn-off the mains power automatically to prevent damage to the system or other systems near the GEN series system. Maximum and critical temperature conditions are defined as such that it is very unlikely the system will ever reach this critical condition when operating within its specified conditions.

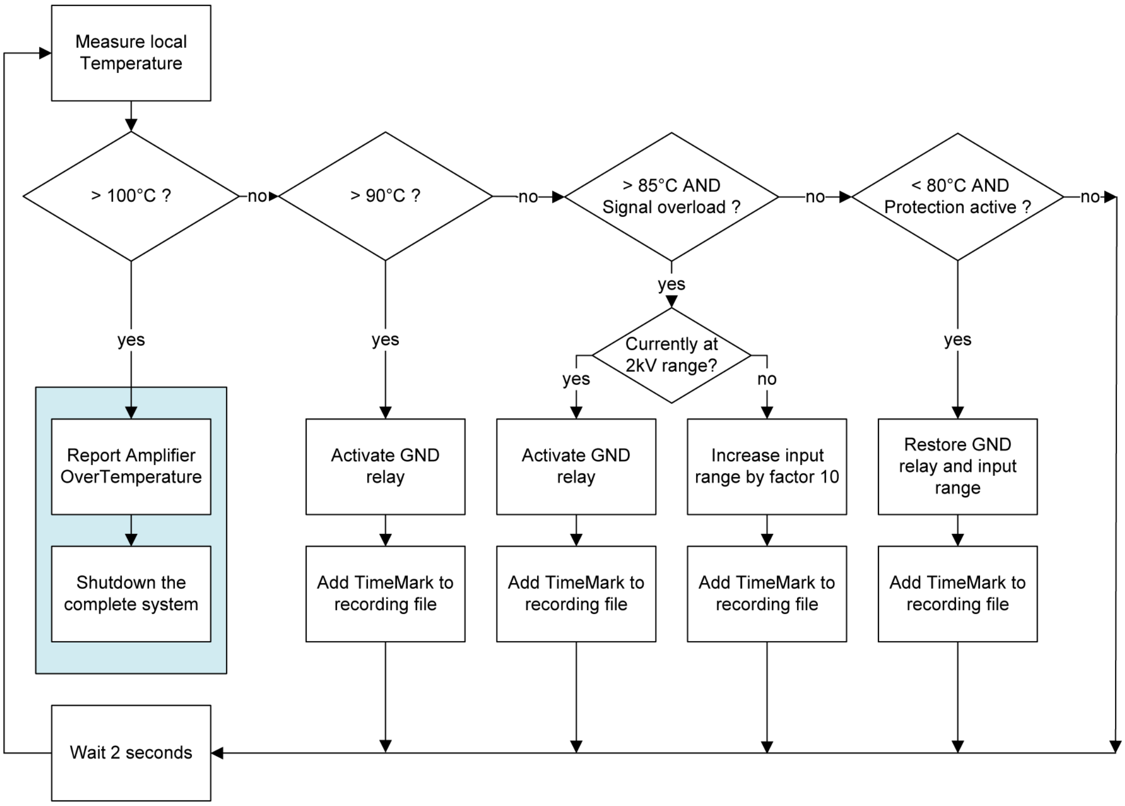



**Figure 12.8:** Automatic thermal overload response

**Automatic restore of user selected range**
As the GEN series system is designed to measure 24 hours a day 7 days a week, the automatic ranges switching has the negative side effect of reduced sensitivity of the amplifier. During the actual overload condition the channel will not be able to measure the input signal anyhow, so no extra negative side effects are introduced. If the overload condition disappears and the system is running unattended, the automatic selected input range will not be the best measurement range. Therefore the amplifier will remember the original selected user range and restore this user selection as soon as regular thermal conditions are restored. Temporary large overload conditions will then only result in temporary adjusted input sensitivity.

It is expected that the thermal conditions might only be restored because of the automatic range adaption of the input channel. So the actual overload condition might not have disappeared yet. If this would be the case, the thermal increase would re-trigger the automatic range adaption process and the overload is handled exactly the same way as before.

In case the overload condition is permanent, the system keeps on automatic ranging to reduce the dissipated heat, then restores the user selected range with the effect of overheating again therefore restarting the automatic ranging process again. This cycle will repeat forever until the overload condition disappears.

## 12.3 Isolated Basic/IEPE cards

### 12.3.1 GN815, Isolated Basic/IEPE 2MS/s input card


- IEPE transducer support
- TEDS class 1 support for IEPE
- 8 analog channels
- Isolated, unbalanced differential inputs
- ± 10 mV to ± 50 V input range
- User selectable digital Bessel, Butterworth and Elliptic filters
- 2 MS/s sample rate
- 18 bit resolution
- 2 GB memory
- One isolated metal BNC for each channel
- Real-time calculation; Triggering on calculated result
- Digital Event/Timer/Counter support

The GEN DAQ Basic/IEPE ISO 2 MS/s Input Card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or probes and current clamps. This card also supports IEPE transducers and TEDS class 1 for easy setup of the acquisition channels.
Every channel is equipped with an independent full range input amplifier, a 7-pole Bessel or Butterworth analog anti-aliasing filter, user selectable digital Bessel, Butterworth and Elliptic IIR filters and an 18 bit Analog-to-Digital converter operating at up to 2 MS/s.
The amplifier provides voltage inputs from ± 10 mV to ± 50 V. The model uses an isolated metal BNC for each channel.
For true real-time analysis the card offers real-time cycle or timer based calculations. Automatic zero crossing detection allows for asynchronous true RMS, mean and other calculations that can be used to trigger the recording.
If supported by the selected mainframe, the GEN DAQ series input card offers 16 digital input events, two digital output events and two timer/counter channels.

For specification and ordering information, please refer to "B3997-1.0 en (GEN series GN815)" on page 548.

### 12.3.2 GN816, Isolated Basic/IEPE 200kS/s input card


- IEPE transducer support
- TEDS class 1 support for IEPE
- 8 analog channels
- Isolated, unbalanced differential inputs
- ± 10 mV to ± 50 V input range
- User selectable digital Bessel, Butterworth and Elliptic filters
- 200 kS/s sample rate
- 18 bit resolution
- 200 MB memory
- One isolated metal BNC for each channel
- Real-time calculation; Triggering on calculated result
- Digital Event/Timer/Counter support

The GEN DAQ Basic/IEPE ISO 200 kS/s Input Card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or probes and current clamps. This card also supports IEPE transducers and TEDS class 1 for easy setup of the acquisition channels.
Every channel is equipped with an independent full range input amplifier, a 7-pole Bessel or Butterworth analog anti-aliasing filter, user selectable digital Bessel, Butterworth and Elliptic IIR filters and an 18 bit Analog-to-Digital converter.
The amplifier provides voltage inputs from ± 10 mV to ± 50 V. The model uses an isolated metal BNC for each channel.
For true real-time analysis the card offers real-time cycle or timer based calculations. Automatic zero crossing detection allows for asynchronous true RMS, mean and other calculations that can be used to trigger the recording.
If supported by the selected mainframe, the GEN DAQ series input card offers 16 digital input events, two digital output events and two timer/counter channels.

For specification and ordering information, please refer to "B3998-1.0 en (GEN series GN816)" on page 570.

### 12.3.3 Using the GN815 and GN816

**WARNING**

**High bandwidth and measurement cabling**

Due to the high bandwidth measurement capabilities of the acquisition card in combination with the high measurement sensitivity of the card it is important to pay close attention to the measurement cabling.

Some advice to prevent measuring unwanted disturbances:

- Keep measurement cables as short as possible in order to reduce the reception of environmental disturbances.
- Use shielded cables. The cable should have the measurement cables paired inside a shield. Preferable the shield is connected to the chassis of the measurement Genesis High Speed equipment or alternatively the chassis of the object under test.

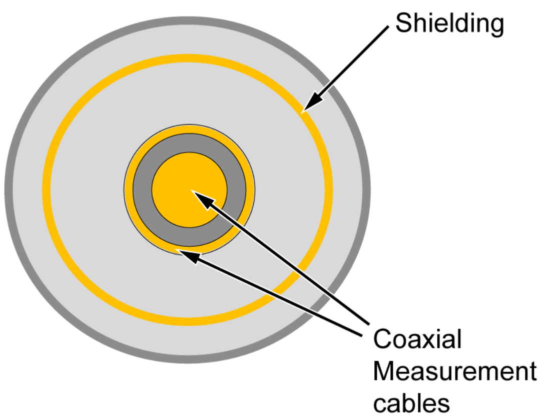



**Figure 12.9:** Shielded cable

- In case of high frequency disturbance where high bandwidth measurement is not required one can reduce the measurement bandwidth by using the lowpass filter of the acquisition card.
- In case unshielded cables are used keep them as close together as possible, i.e. position them next to each other (to keep the loop small).
- Make sure that measurement cables that are used for measuring high dynamic or distorting signals are not closely positioned to measurement cables used for measuring small sensitive signals.

- Keep all measurement cables well separated from cables connected to high switching loads or motor cables.
- Separate measurement equipment and cables from potentially interfering equipment like frequency inverters or wireless equipment.

General cabling remark: Only use properly rated cables for the signal to measure, both voltage and current rating should be matched to the signal to measure.

**WARNING**

**This instrument must be properly earthed.**

When using this card we advise to use the standard GEN series protective earth connections to ensure the entire unit is earthed.
Please see section "Connecting power" on page 62 for further details.

**If connection to a protective earth is not possible for any reason then please refer to the international safety standard EN 50191:2000**

**WARNING**

**Overvoltage and current protection**

The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200 % of the selected input range.

**WARNING**

**Disconnect voltages before removing the card from the system.**

The measuring circuit can carry hazardous voltages and should be disconnected before the card is removed from the card slot of the measurement system.

**WARNING**

**Connectors and cables**

The specified ± 50 V DC voltage range of the Isolated Basic acquisition card is such that it falls below the low voltage limit as specified in IEC61010.

The limit for safe voltage and currents is set in the IEC61010-1 standard in Section 6.3 – limit values for accessible parts. The limits are:

*Table 12.4: Limit for safe voltage and currents is set in the IEC61010-1*

| | Normal operation | Single fault condition |
|---|---|---|
| Voltage | 70 V DC | 140 V DC |
| | 33 V rms | 55 V rms |
| | 46.7 V peak | 78 V peak |
| Current | 2 mA DC | 15m A DC |
| | 0.5 mA rms | 3.5m A rms |
| | 0.7 mA peak | 5 mA peak |

It’s good practice to use isolated measurement cables. However since the Isolated Basic card falls below the low voltage limit for accessible parts also non-protected or non-shrouded connectors can be used in combination with this card.

**Figure 12.10:** Safe connectors for use with Isolated Basic acquisition cards

### 12.3.4 Understanding the GN815 and GN816 isolation

The specified ± 50 V DC voltage range of the Isolated Basic acquisition card is such that it falls below the low voltage limit as specified in IEC61010.

The isolation of the isolated basic card (GN815 and GN816) is in line with the limit for safe voltage and currents as mentioned above.

*Table 12.5: Limit for safe voltage and currents (GN815 and GN816)*

| | |
|---|---|
| Input signal to input signal | ± 140 V DC, 55 V rms AC (low voltage limit) |
| Input signal-to-chassis | ± 70 V DC, 33 V rms AC (low voltage limit) |
| Channel to chassis | ± 70 V DC, 33 V rms AC (low voltage limit) |
| Channel to channel | ± 70 V DC, 33 V rms AC (low voltage limit) |
| Nondestructive, to chassis (earth) | ± 70 V DC, 33 V rms AC (low voltage limit) |

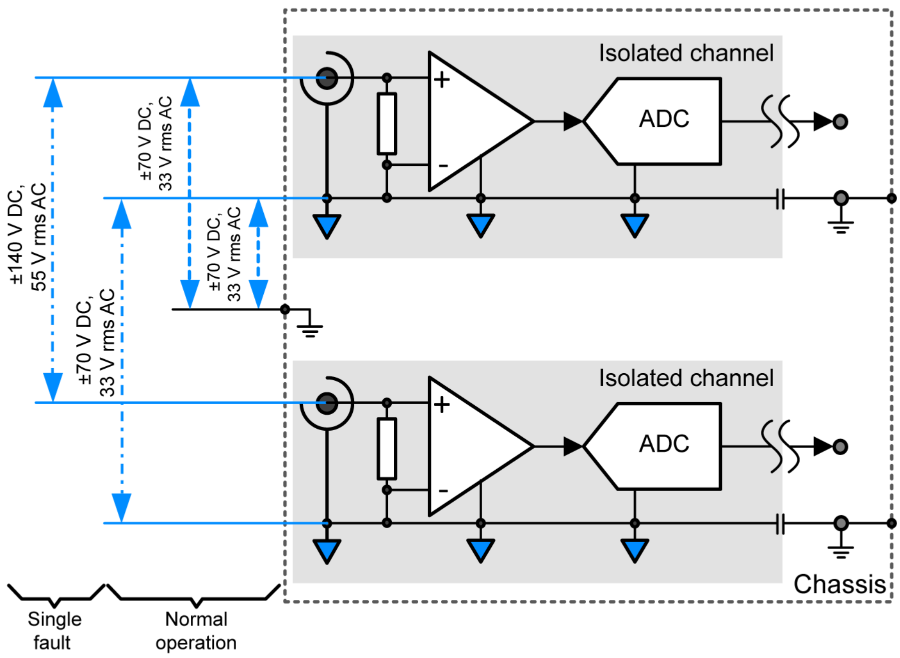



**Figure 12.11:** Isolation of the isolated basic card (GN815/GN816)

### 12.3.5 Understanding the GN815 and GN816 input

The signal input channels of the GN815 and GN816 are of the single ended isolated type (also termed unbalanced isolated or unbalanced differential isolated).

This means that of both inputs within one channel pair one signal is directly connected to the isolated channel ground (this is the outer signal of the BNC plug). The other signal is connected to the conditioning amplifier.

Below you can find a (simplified) schematic representation of the input channel of the GN815 and GN816.

The input channels of the GN816 and GN816 are of the isolated type. This means that the input channel and amplifier are fully isolated from (earth) ground. Fully isolated in this context means a very high resistance and very small capacitive coupling to ground. This for safety and to avoid ground loops.

**Characteristics per channel:**
- The input BNC connector is isolated from the system ground.
- The isolated ground is externally accessible as shown in Figure 12.12.

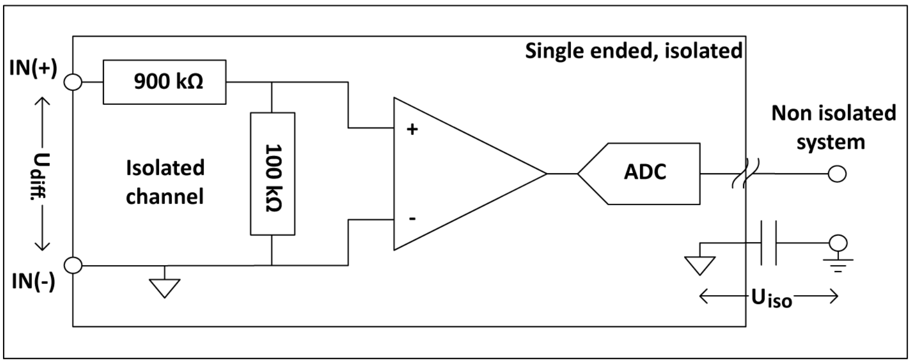



**Figure 12.12:** Single ended Isolated input channel

**Using probes:**
Using passive voltage probes together with single ended isolated inputs is very well possible.

Using a standard passive 10:1 probe in combination with the GN815 and GN816 gives the situation as shown in Figure 12.13.

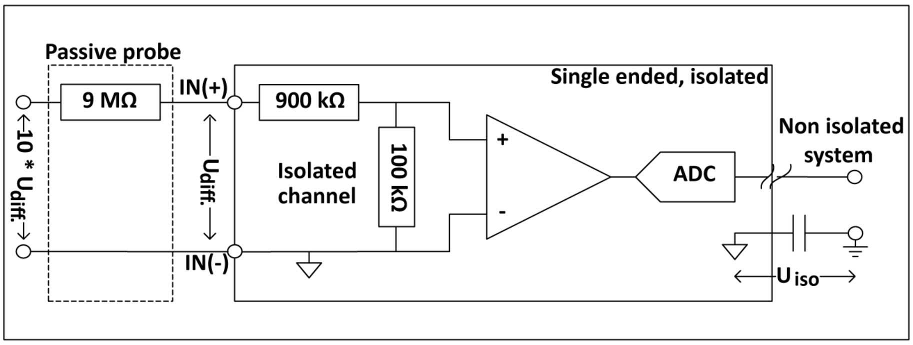



**Figure 12.13:** Input channel with a standard 10:1 passive probe

Using a High Voltage passive 10:1 probe in combination with the GN815 and GN816 gives the situation as shown in Figure 12.14. The voltage division is done externally in the probe to maintain accuracy.

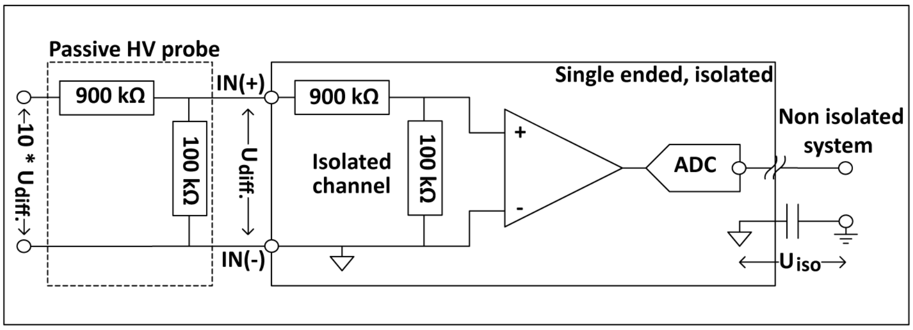



**Figure 12.14:** Input channel with a High Voltage 10:1 passive probe

### 12.3.6 GN815 and GN816 Input Overload protection

The input section has several methods to protect against Voltage overload on the input.

Every selected input range allows a 200 % overload without any change of input resistance or auto ranging. This 200 % overrange is designed to allow for smaller voltage overloads without effecting your measurement. Within this 200 % overload the amplifier is also able to respond with normal rise/fall times to signal being restored within the standard selected range.

When exceeding the 200 % overload condition, the input channel might start to take protective actions.

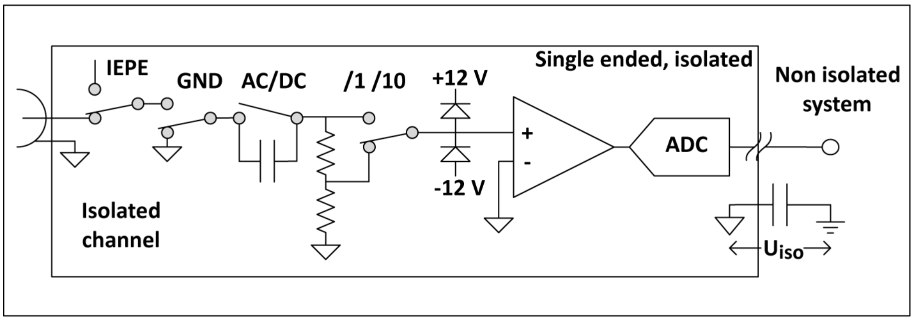



**Figure 12.15:** Input Overload protection - Schematic diagram

The **first** action of the system will be to add an additional current load on your input signal to create an extra voltage drop on the input series resistance. The actual additional current depends on several factors and is therefore not predictable. A negative side effect of this additional current is the extra power dissipated in the input section which in turn results in additional heat dissipation.

**Thermal monitor of the input channels**

Any overload condition has the same end result: extra heat generated within the channel. Not only because of the extra current through the input resistance, but also because internal amplifier sections will be driving their local output to maximum levels creating excessive heating within the amplifier.

The **second** action of the system will be to react to the increased temperature in the channel as a result of the over voltage. Every input is equipped with a thermal sensor to monitor the local temperature. When the local temperature reaches maximum levels the system will automatically start changing the user selected input range to reduce the dissipated heat. As the heat dissipation will not immediately start the auto ranging, short overloads will not results in auto ranging. Longer overload conditions will lead to higher local temperature and this will start the auto ranging process. The system will automatically increase the input range as many times required to reach a safe condition not to increase local temperature anymore.
Every one of the automatic range changes will be identified within your measurement data. Not only will your measured input be scaled correctly with the adapted input range, but also the exact moment the automatic range change happens is identified within Perception software.

**Automatic restore of user selected range**
As the GEN series system is designed to measure 24 hours a day 7 days a week, the automatic ranges switching has the negative side effect of reduced sensitivity of the amplifier. During the actual overload condition the channel will not be able to measure the input signal anyhow, so no extra negative side effects are introduced. If the overload condition disappears and the system is running unattended, the automatic selected input range will not be the best measurement range. Therefore the amplifier will remember the original selected user range and restore this user selection as soon as regular thermal conditions are restored. Temporary large overload conditions will then only result in temporary adjusted input sensitivity.

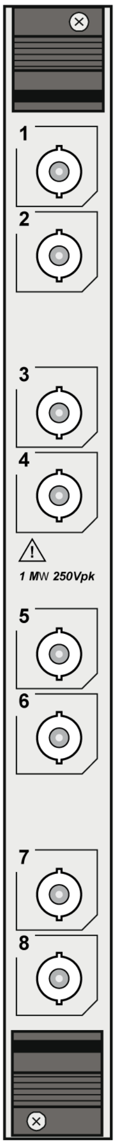
It is expected that the thermal conditions might only be restored because of the automatic range adaption of the input channel. So the actual overload condition might not have disappeared yet. If this would be the case, the thermal increase would re-trigger the automatic range adaption process and the overload is handled exactly the same way as before.

The **third** action of the system will take effect if the second action proves to be unsuccessful and the local temperature is still outside maximum operating limits. The input signal will be disconnected from the channel. Disconnecting from the external signal source is done by grounding the input. When inputs are grounded, the only connections to the external signal are the input connectors and the input pin of the ground relay.

**Thermal shutdown in critical conditions**
This protective scheme allows for any overload condition the input would be confronted with during normal operation. For any other failure condition that would result in excessive heat dissipation, the system has a last protective stage built in. When local temperatures reach a critical condition the system will turn-off the mains power automatically to prevent damage to the system or other systems near the GEN series system. Maximum and critical temperature conditions are defined as such that it is very unlikely the system will ever reach this critical condition when operating within its specified conditions.

## 12.4 Basic amplifier non-isolated input cards

### 12.4.1 GN810 Basic 200kS/s input card

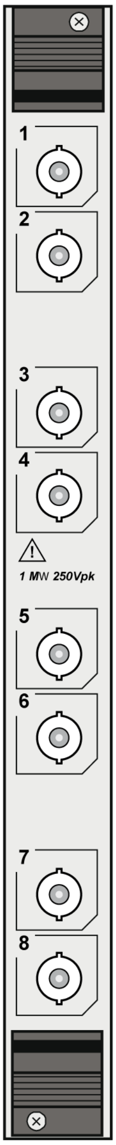



- 8 analog channels
- Single ended inputs
- ± 1 V to ± 50 V input range
- User selectable digital Bessel and FIR filters
- 200 kS/s sample rate
- 16 bit resolution
- 128 MB memory
- Single metal BNC for each channel

The GEN DAQ Basic 200 kS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or probes and current clamps.
The basic signal conditioner provides eight channels of single ended voltage inputs from ± 1 V to ± 50 V full scale with full offset and auto-zero capability. Every channel is equipped with an independent full range input amplifier, 7-pole Bessel and Butterworth anti-alias filter, 16-bit Analog-to-Digital converter and several selections of digital filtering. The on-board transient memory size is 64 Mega-Samples (128 Mega-Bytes). The memory is shared among enabled channels.
Each channel also features two set-points for trigger or alarm purposes. Extensive acquisition and trigger modes allow many different ways to capture valuable data even at the highest sample rates. All channels are synchronously sampled at full speed without multiplexing and almost immeasurable crosstalk. The model uses standard metal BNC connectors, whose shells are connected to ground. The inputs are 1 MΩ impedance and are compatible with probes and current clamps.

For more information about the GN810 Basic 200K input card, please refer to "B2632-3.0 en (GEN series GN810)" on page 478.

### 12.4.2 GN811 Basic 1MS/s input card

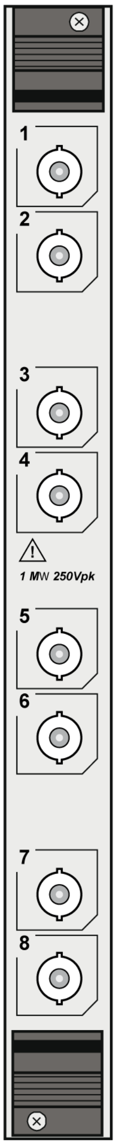



- 8 analog channels
- Single ended inputs
- ± 1 V to ± 50 V input range
- User selectable digital Bessel and FIR filters
- 1 MS/s sample rate
- 16 bit resolution
- 256 MB memory
- Single metal BNC for each channel

The GEN DAQ Basic 1 MS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or probes and current clamps.
The basic signal conditioner provides eight channels of single ended voltage inputs from ± 1 V to ± 50 V full scale with full offset and auto-zero capability. Every channel is equipped with an independent full range input amplifier, 7-pole Bessel and Butterworth anti-alias filter, 16-bit Analog-to-Digital converter operating at 1 MS/s and several selections of digital filtering.
The on-board transient memory size is 128 Mega-Samples (256 Mega-Bytes). The memory is shared among enabled channels.
Each channel also features two set-points for trigger or alarm purposes. Extensive acquisition and trigger modes allow many different ways to capture valuable data even at the highest sample rates. All channels are synchronously sampled at full speed without multiplexing and almost immeasurable crosstalk. The model uses standard metal BNC connectors. The inputs are 1 MΩ impedance and are compatible with probes and current clamps.

For more information about the GN811 Basic 1M input card, please refer to "B2640-3.0 en (GEN series GN811)" on page 492.

## 12.5 GN812 Basic 1MS/s Isolated input card



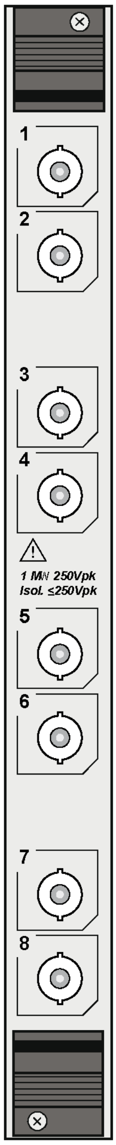

- 8 analog channels
- Unbalanced differential inputs
- ± 1 V to ± 50 V input range
- 250 V DC Isolation
- User selectable digital Bessel and FIR filters
- 1 MS/s sample rate
- 16 bit resolution
- 512 MB memory
- Single isolated BNC for each channel

The GEN DAQ Basic ISO 1 MS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or isolated probes and current clamps.
The basic signal conditioner provides eight channels of isolated single ended voltage inputs from ± 1 V to ± 50 V full scale with full offset and auto-zero capability.
Every channel is equipped with an independent full range input amplifier, 7-pole Bessel and Butterworth anti-alias filter, 16-bit Analog-to-Digital converter operating at 1 MS/s and several selections of digital filtering.
The on-board transient memory size is 256 Mega-Samples (512 Mega-Bytes). The memory is shared among enabled channels.
Each channel also features two set-points for trigger or alarm purposes.
Extensive acquisition and trigger modes allow many different ways to capture valuable data even at the highest sample rates. All channels are synchronously sampled at full speed without multiplexing and almost immeasurable crosstalk.
The model uses standard isolated BNC connectors, whose shells are connected to isolated ground. The inputs are 1 MΩ impedance and are compatible with isolated probes and current clamps.

For more information about the GN812 Basic 1M Isolated input card, please refer to "B2634-3.0 en (GEN series GN812)" on page 506.

## 12.6 Basic Extended Isolated amplifier card

### 12.6.1 GN813 Basic XT ISO 1 MS/s input card

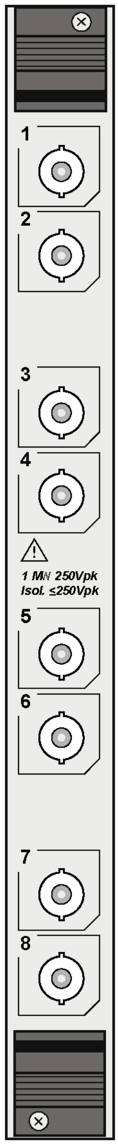



- 8 analog channels
- Unbalanced differential inputs
- ± 2 V to ± 100 V input range
- 250 V DC channel to channel Isolation
- User selectable digital Bessel and FIR filters
- 1 MS/s sample rate
- 16 bit resolution
- 512 MB memory
- Single isolated BNC for each channel

The GEN DAQ Basic XT ISO 1 MS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or isolated probes and current clamps.
The basic signal conditioner provides eight channels of isolated single ended voltage inputs from ± 2 V to ± 100 V full scale with full offset and auto-zero capability.
Every channel is equipped with an independent full range input amplifier, 7-pole Bessel and Butterworth anti-alias filter, 16-bit Analog-to-Digital converter operating at 1 MS/s and several selections of digital filtering.
The on-board transient memory size is 256 Mega-Samples (512 Mega-Bytes). The memory is shared by enabled channels.
Each channel also features two set-points for trigger or alarm purposes.
Extensive acquisition and trigger modes allow many different ways to capture valuable data even at the highest sample rates. All channels are synchronously sampled at full speed without multiplexing and almost immeasurable crosstalk.
The model uses standard isolated BNC connectors, whose shells are connected to isolated ground. The inputs are 1 MΩ impedance and are compatible with isolated probes and current clamps.

For more information about the GN813 Basic XT ISO 1 MS/s input card, please refer to "B2635-4.0 en (GEN series GN813)" on page 520.

### 12.6.2 GN814 Basic XT ISO 200kS/s input card




- 8 analog channels
- Unbalanced differential inputs
- ± 2 V to ± 100 V input range
- 250 V DC Isolation
- User selectable digital Bessel and FIR filters
- 200 kS/s sample rate
- 16 bit resolution
- 128 MB memory
- Single isolated BNC for each channel

The GEN DAQ Basic XT ISO 200 kS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or isolated probes and current clamps.
The basic signal conditioner provides eight channels of isolated single ended voltage inputs from ± 2 V to ± 100 V full scale with full offset and auto-zero capability.
Every channel is equipped with an independent full range input amplifier, 7-pole Bessel and Butterworth anti-alias filter, 16-bit Analog-to-Digital converter and several selections of digital filtering.
The on-board transient memory size is 64 Mega-Samples (128 Mega-Bytes). The memory is shared among enabled channels.
Each channel also features two set-points for trigger or alarm purposes. Extensive acquisition and trigger modes allow many different ways to capture valuable data even at the highest sample rates. All channels are synchronously sampled at full speed without multiplexing and almost immeasurable crosstalk.
The model uses standard isolated BNC connectors, whose shells are connected to isolated ground. The inputs are 1 MΩ impedance and are compatible with isolated probes and current clamps.

For more information about the GN814 Basic XT ISO 200K input card, please refer to "B2889-5.0 en (GEN series GN814)" on page 534.

### 12.6.3 Optional G041 1kV DC probe

The 1kV DC probe is a special front end extension for the basic extended isolated amplifier cards (1-GN813-2 and 1-GN814-2). It increases the maximum input range by a factor of ten with a maximum input voltage of +/- 1000 V.
The HV probe offers an accuracy of 0.1 % (0.05% typical) and can be freely moved in front of any channel within these specification. Using the probe together with the basic extended isolated amplifier card operating in wideband, the bandwidth is designed to meet 250 kHz ± 10% (-3 dB)

To accommodate the probes, there is a 1kV DC probe rack mount housing available. This uses up a single height unit and holds up to sixteen 1kV DC probes. Each probe comes with a fixed output connection cable with double isolated coax cable. This connects directly into the Genesis isolated Basic amplifier.

**CAUTION**

**As the probe rack specifies the maximum voltages per input pin, the 1kV DC and AC probes are not to be mixed in one probe rack.**

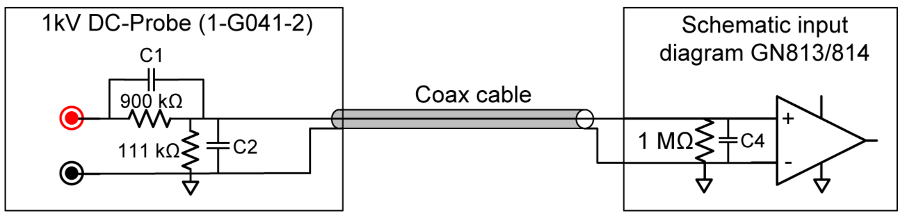



**Figure 12.16:** 1kV DC probe 1-G041-2

The probes have no calibration points. The DC inaccuracy is designed to meet it's specifications based in the input resistance of the basic extended isolated amplifiers. The AC bandwidth inaccuracy is designed to meet it's specification based on the variance of the capacitive load of the basic extended isolated amplifiers. Calibration of the 1kV DC probes will only check if tolerances are still met. When deviations occur a repair must be done as no adjustments can be carried out.

**CAUTION**

**The 1kv DC probe attached coaxial cable adds capacitive load to the output of the probe. Every cm length added or removed changes the capacitive load. By design the cable length of the 1kV DC probe is fixed and can't be changed.**

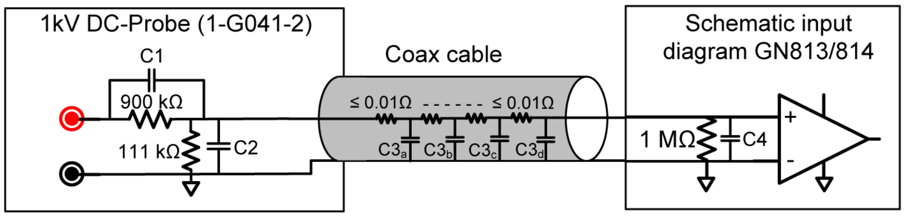



**Figure 12.17:** 1kV DC probe cable capacitance

| **Specifications** | |
|---|---|
| Number of channels | 1 per probe, 16 per probe rack |
| Input type | Isolated unbalanced differential (isolated single ended) |
| Input connectors | 2; 4 mm safety banana plugs (red and black) |
| Input impedance | 1 MΩ ± 1%; when using a 1 MΩ output load |
| Divider ratio | 1 on 10 |
| Inaccuracy | 0.1 % |
| Maximum input voltage | |
| Positive input (Red) | 1000 V DC |
| Negative input (Black) | 250 V DC; As specified by GN813 and GN814 cards |
| Bandwidth | 250 kHz ± 10% (-3 dB) |
| Coax cable length | Fixed; Several variances as delivered |

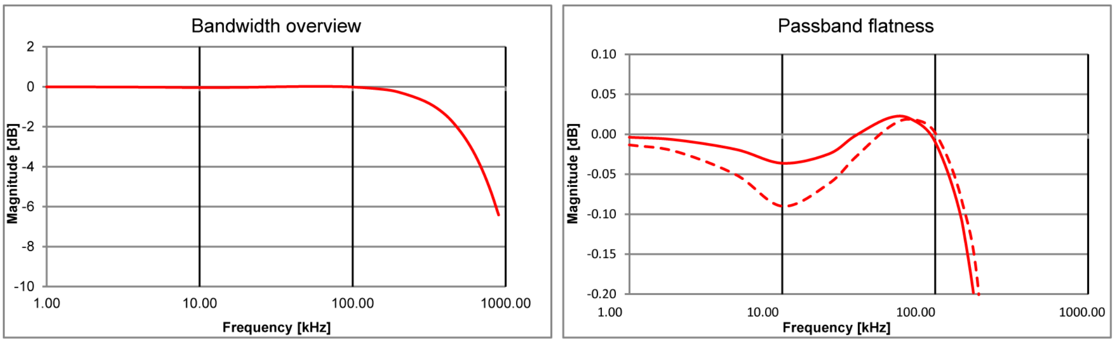



**Figure 12.18:** Figure Typical 1kV DC probe bandwith

### 12.6.4 Optional G042 1kV AC probe

The 1kV AC probe is a special front end extension for the basic extended isolated amplifier cards (1-GN813-2 and 1-GN814-2). It decouples any DC voltage component up to ± 1000 V DC from the amplifiers input and allows high resolution acquisition of the AC portion only of the incoming signal. The AC portion can be as high as 100 V using the input ranges of the attached acquisition card. Higher resolution can be achieved by selecting the proper measurement range. The high pass AC coupled bandwidth is at 0.8 Hz ± 20%.

To accommodate the probes, there is a 1kV AC probe rack mount housing available. This uses up a single height unit and holds up to sixteen 1kV AC probes. Each probe comes with a fixed output connection cable with double isolated coax cable. This connects directly into the Genesis isolated Basic amplifier.

**CAUTION**

**As the probe rack specifies the maximum voltages per input pin, the 1kV DC and AC probes are not to be mixed in one probe rack.**

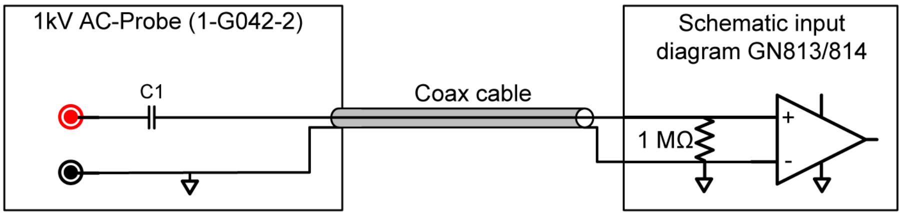



**Figure 12.19:** Figure 1kV DC probe 1-G042-2

The probes have no calibration points. As the probe is fixed AC coupled, no DC inaccuracy is specified. The AC high pass bandwidth inaccuracy is designed to meet it's specification based on the input impedance of the basic extended isolated amplifiers. Calibration of the 1kV AC probes will only check if tolerances are still met. When deviations occur a repair must be done as no adjustments can be carried out.

**CAUTION**

**Cable length of the 1kV AC probes is not critical for correct operation. However it is advised not to change the length to prevent possible side effects like ringing of step responses due to large impedance mismatches.**

| **Specifications** | |
|---|---|
| Number of channels | 1 per probe, 16 per probe rack |
| Input type | Isolated unbalanced differential (isolated single ended) |
| Input connectors | 2; 4 mm safety banana plugs (red and black) |
| Input impedance | 1 MΩ ± 1% for AC signal > 1 Hz; when using a 1 MΩ output load |
| Divider ratio | 1 on 1 for AC signal > 20 Hz |
| Inaccuracy | AC signal > 100 Hz; As specified by GN813 and GN814 cards |
| Maximum input voltage | |
| Positive input (Red) | 1000 V DC |
| Negative input (Black) | 250 V DC; As specified by GN813 and GN814 cards. |
| AC coupling Bandwidth | 0.8 Hz ± 20% (-3 dB) |
| Bandwidth | As specified by GN813 and GN814 cards |
| Coax cable length | Fixed; Several variances as delivered |

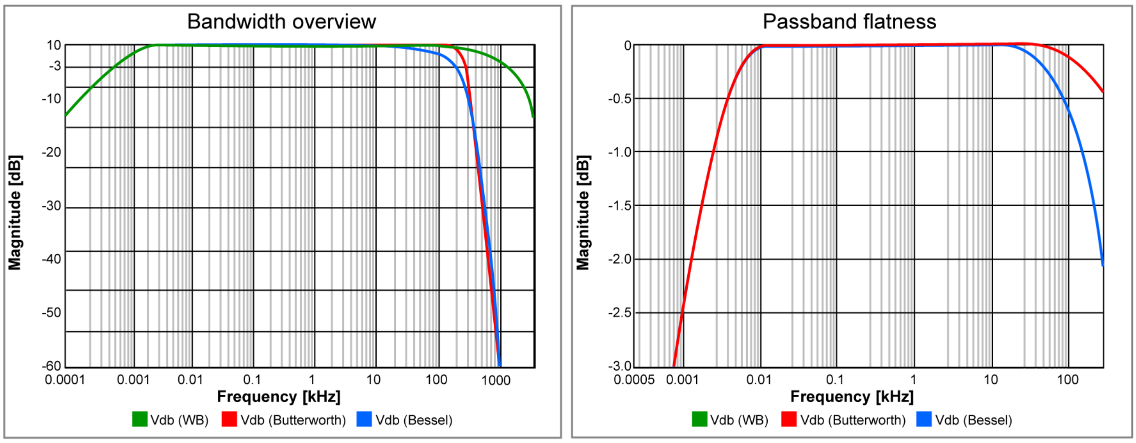


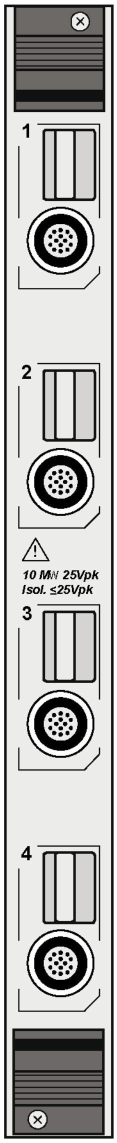

**Figure 12.20:** Typical 1kV AC probe bandwith

**Green:** GN813/GN814 in wideband

**Red:** GN813/GN814 using Butterworth anti-alias filter

**Blue:** GN813/GN814 using Bessel anti-alias filter

## 12.7 GN410 and GN411 Bridge input cards




The GN410 and GN411 bridge input cards are suitable for strain gauges, strain-gauge based force, pressure or torque transducers and piezo-resistive accelerometers. The inputs can also be used as a general purpose low voltage differential amplifier with AC and DC coupling. It provides bipolar DC excitation voltage or current, flexible software-switched completion options and a variety of calibration methods for any type of bridge configuration.

Front panel connectors are LEMO 2B type. Every channel is equipped with an independent high-gain amplifier, 7-pole Bessel and Butterworth anti-alias filters, 16-bit Analog-to-Digital converter operating at up to 1 MS/s, and digital filtering. All channels are sampled at full speed with no multiplexing and almost immeasurable crosstalk. A 200 kS/s model is available for medium speed acquisition requirements.

The bridge amplifiers support quarter, half and full bridge configurations from three to eleven wires. Each channel includes software-switched half-bridge completion resistors, two fixed shunt calibration resistor and one socket for an additional user-provided shunt resistor. A 350 Ω quarter-bridge completion resistor is supplied for each channel, plus one socket for an additional user supplied value. A unique and powerful ability allows the amplifier to individually measure each input and each excitation lead to quickly diagnose wiring problems. Each channel also features two set-points for trigger or alarm purposes plus hardware detection of open/shorted excitation leads and amplifier over-range.

For more information about the Bridge input card, please refer to "B3244-1.0 en (GEN series GN410 and GN411)" on page 589.

### 12.7.1 Bridge amplifier configuration

Input diagrams and typical connection diagrams for the GN410 and GN411 bridge amplifiers are shown on this and the following pages. For the maximum versatility, the amplifiers allow a wide range of configurations. At minimum three wires are necessary for a quarter- or half-bridge sensor and four wires for a full bridge. Optional remote sensing of excitation voltage is supported for precision transducer applications, which adds two wires. Remote shunt calibration is possible with the addition of two or three more wires. Finally, both an isolated common and a driven guard are provided for optional shielding.

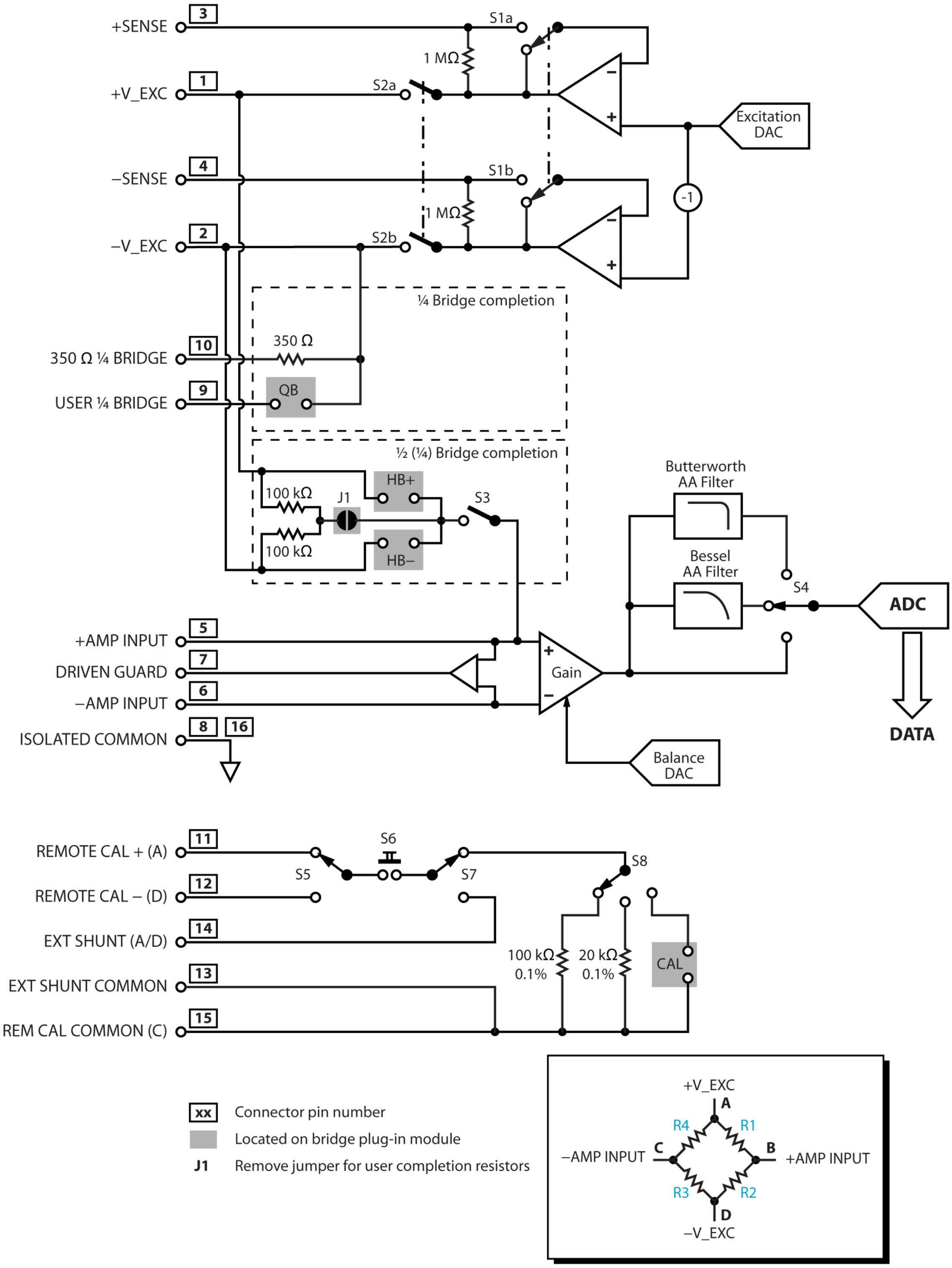



**Figure 12.21:** Bridge amplifier block diagram with pinning

### 12.7.2 Input connectors

The LEMO 2B316 connector pin-out is compatible with the Liberty data acquisition system. The mating male connector is LEMO P/N FGG2B316CLADxx, where xx is the desired cable collet size, or similar.

### 12.7.3 Bridge completion

Each bridge amplifier channel contains a pair of fixed 10 kΩ resistors for half-bridge completion that can be switched in under software control. The user can install two resistors on the removable bridge completion card for another value and/or precision half-bridge completion. If so, a soldered jumper must be removed for correct operation.

Additional pins on the LEMO connector provide a precision 350 Ω resistor plus an additional user-provided value for quarter-bridge completion. The user-provided value is located on removable bridge completion card. The completion sockets are designed for Vishay Micro Measurements S-Type resistors but can be used with other similar types. A diagram of the card layout on one of the following page shows the location of each resistor.

### 12.7.4 Shunt calibration

Each bridge amplifier channel contains 100 KΩ and 20 KΩ, 0.1% fixed precision resistors that can be switched in under software control. With a Gage Factor of 2.00, this resistor simulates the following values of deflection for various bridge configurations.

*Table 12.6: Deflection for various bridge configurations*

| | **100 KΩ** | | | **20 KΩ** | | |
|---|---|---|---|---|---|---|
| **BRIDGE** | **1000 Ω** | **350 Ω** | **120 Ω** | **1000 Ω** | **350 Ω** | **120 Ω** |
| mV/V | 2.4888 | 0.873 | 0.299 | 12.20 | 4.337 | 1.495 |
| µstr full bridge | 1244 | 437 | 150 | 6098 | 2169 | 748 |
| µstr $^1/_2$ bridge | 2488 | 873 | 300 | 12195 | 4337 | 1496 |
| µstr $^1/_4$ bridge | 4975 | 1747 | 600 | 24390 | 8674 | 2991 |

A convenient plug-in module is provided for installation of one additional user-supplied shunt resistor on each channel. The diagram below shows the location of the user completion resistors. A fourth calibration resistor can be connected externally at the connector pins. Any of the four available shunt cal resistors can be switched in under software control to provide multi-point calibration and linearity verification.

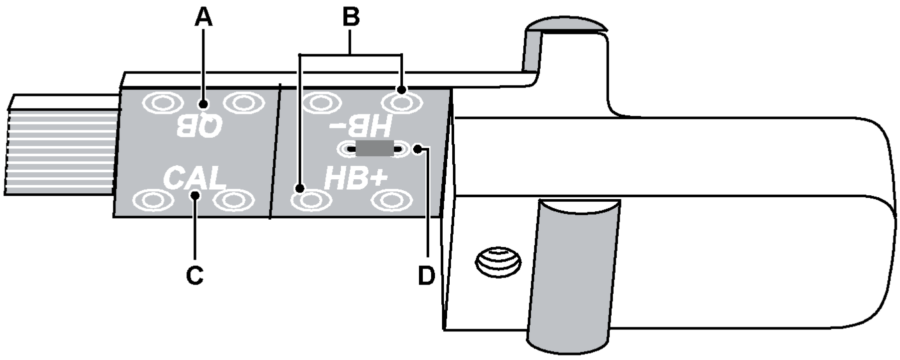



**Figure 12.22:** Shunt calibration completion plug-in module

**A** User Quarter-Bridge Completion

**B** User Half-Bridge Completion

**C** User Shunt Cal

**D** JUMPER! *Remove when installing Half-Bridge completion*

### 12.7.5 Shielding and driven guard

When long cable runs are required, the excitation leads and signal leads are generally separately twisted and shielded within the cable to minimize the cross-coupling that would otherwise occur.

The high-performance signal conditioners offers the “driven guard” system where the cable shield is connected only to the drive pin of the conditioner. When connected like this the shield is driven to a potential equal to the common-mode voltage of the bridge. The driven shield or guard therefore minimizes the potential difference between the internal conductors and the shield, thereby reducing the amount and levels of partial discharges between them. In all cases, the driven shield is terminated only at the driven guard conditioner terminal. It is strongly advised to have the driven shield surrounded by an outer shield that is terminated to ground preferably at the strain gauge installation site as shown in Figure 12.23.

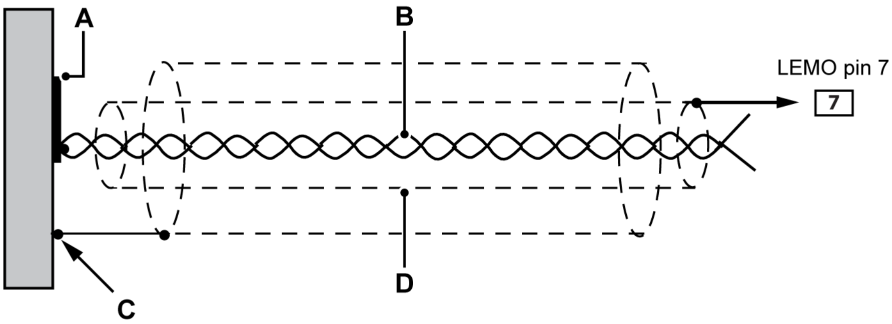



**Figure 12.23:** The driven guard approach to minimize induced noise

**A** Strain gauges
**B** Signal conductors
**C** Outer shield
Terminated near strain gauges - signal source
**D** Inner shield
Driven guard at +Vcm

### 12.7.6 Various bridge configurations

The diagrams below shows possible bridge configurations.

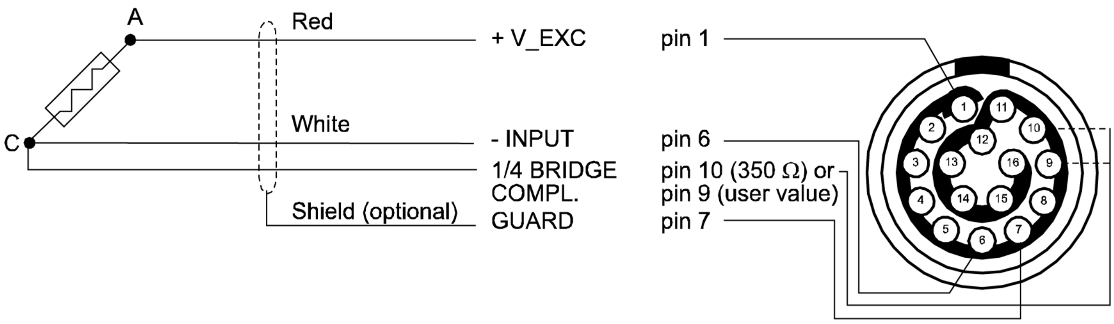



**Figure 12.24:** Three-wire quarter bridge

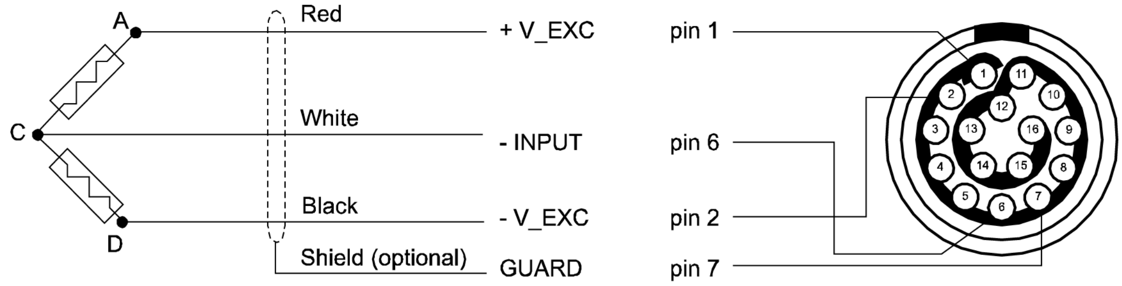



**Figure 12.25:** Half bridge standard wiring

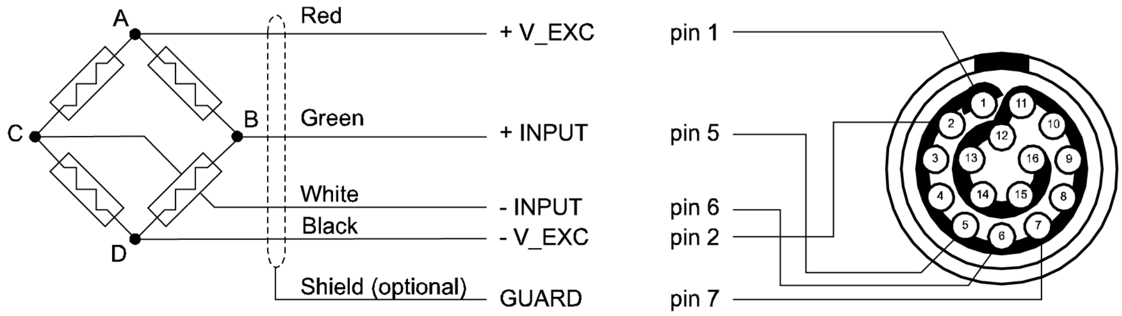
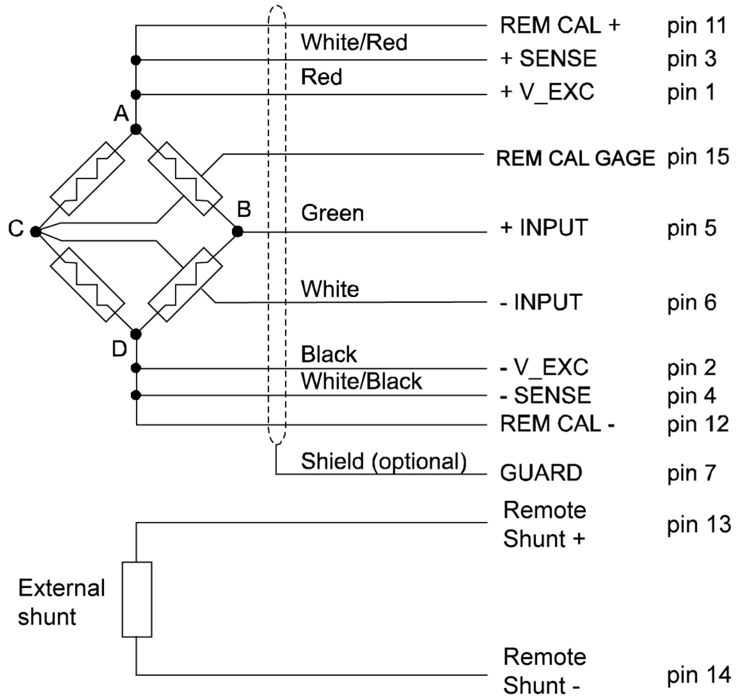



**Figure 12.26:** Full bridge standard wiring




Any shunt calibration resistor can be switched into either the positive (A-C) or negative (C-D) arm of the bridge under software control.
You may find that the bridge has only 4 wires that will connect to 4 pins in the connector. You must therefore pay attention to the short circuits across the following combination of pins:
1, 3 and11
2, 4 and12
6 and 15

**Figure 12.27:** Full bridge with remote sensing and remote calibration

### 12.7.7 Bridge connector reference card

Make copies of this page to record and document your test setups.

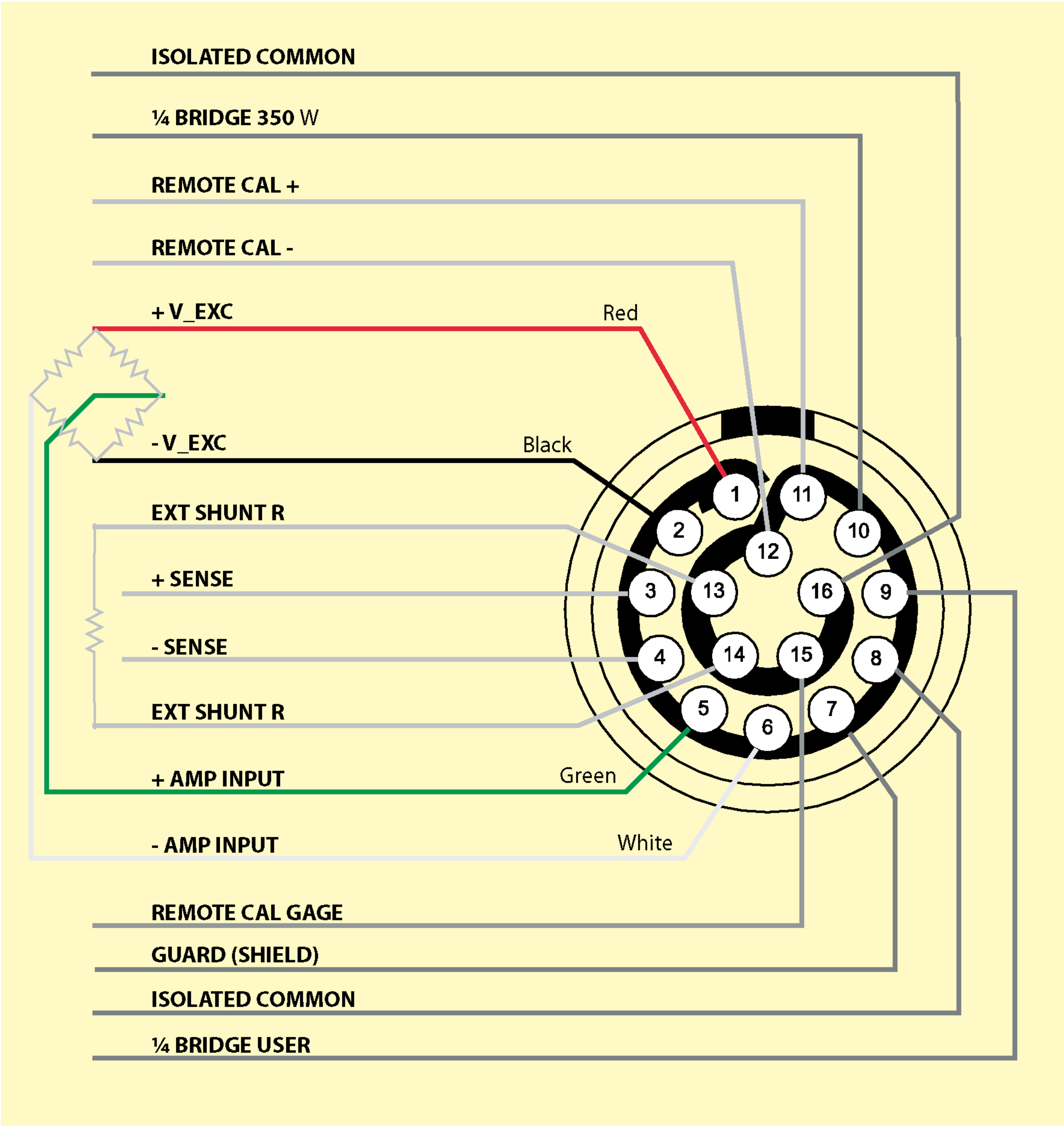



**Figure 12.28:** Reference card: LEMO FGG.2B.316 Connector, solder cup view of male connector

### 12.7.8 Configuring and using the bridge amplifier

This section describes the procedures required when configuring and using the bridge amplifier for both the hardware as well as the software (Perception).

In the Perception software a simplified block diagram is used as reference and complementary control.

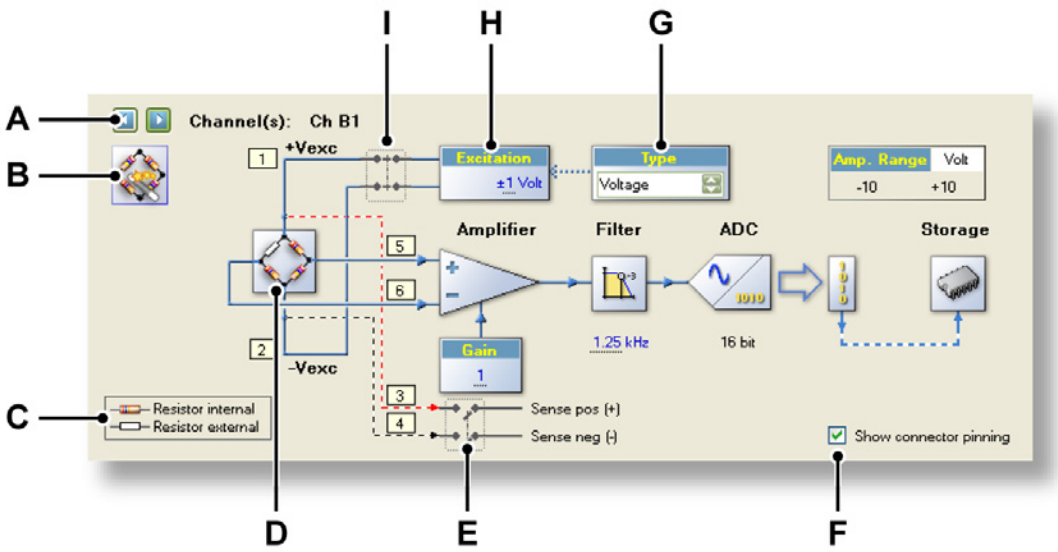



**Figure 12.29:** Perception Bridge Amplifier simplified block diagram

**A** Channel select

**B** Start Bridge Wizard

**C** Legend

**D** Bridge representation (click to toggle bridge completion)

**E** Sense on/off (S1a and S1b in Figure 12.21 on page 312)

**F** Show connector pinning on/off

**G** Excitation type

**H** Excitation value

**I** Excitation on/off (S2a and S2b in Figure 12.21 on page 312)

**Bridge completion**

The Wheatstone bridge used in most strain gauge measurement circuits usually consists of (a) the gages for actively measuring the strains and (b) precision resistors for completing the circuit. In the GN410 and GN411 bridge completion can be for full, half and quarter bridge configurations. Completion resistors can be internal (incorporated in the GN410 and GN411) or external (when required).

**Bridge completion - full (4/4) bridge**

A full bridge type sensor is a sensor that has all four bridge resistors on-board, no completion is required.

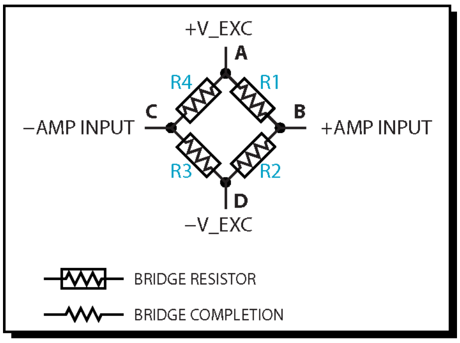



**Figure 12.30:** Full bridge layout

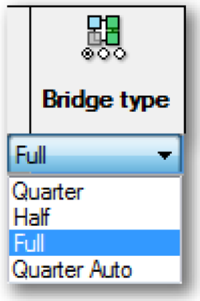
To connect such a bridge you need a minimum of four wires. Refer to Figure 12.27 for connection details. When using a full bridge you need to inform the Perception software about this.

**To select full bridge completion in Perception**
To select full bridge completion proceed as follows:

**1** In Perception go to the **Settings** sheet.
**2** In the task pane select the **Bridge** in the **Input** section.
**3** Select one or more channels.

**4** Do one of the following:

- In the spreadsheet style matrix in the **Bridge type** column select the bridge type **Full**.




- In the simplified graphical diagram click on the bridge icon (**D** in Figure 12.29 on page 319) until you see the full bridge representation.

**Bridge completion - half (1/2 or 2/4) bridge**
A half bridge type sensor is a sensor that has two bridge resistors on-board, completion is required.

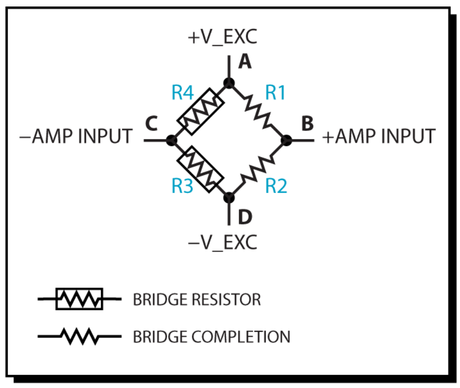



**Figure 12.31:** Half bridge layout

In this situation a sensor is used with two (out of four) resistors R4 and R3. These resistors are placed between A-C and C-D.

You now have to provide the two additional resistors R1 and R2. To do this there are two options:

**1** Use the standard 100 kΩ resistors inside the acquisition card.
**2** Provide two resistors.

In situation (1) you do not need to do anything from a hardware point of view.

In situation (2) you will need to add the two resistors to the plug-in module on the locations marked HB+ and HB-. You will also need to remove the jumper J1. Refer to Figure 12.21 on page 312 for electrical/schematic details and to for mechanical/location details.

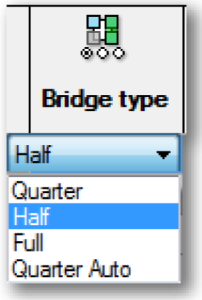
To connect such a bridge you need a minimum of three wires. Refer to Figure 12.26 for connection details. When using a half bridge you need to inform the Perception software about this.

**To select half bridge completion in Perception**
To select half bridge completion in Perception proceed as follows:

**1** In Perception go to the **Settings** sheet.
**2** In the task pane select the **Bridge** in the **Input** section.
**3** Select one or more channels.

**4** Do one of the following:

- In the spreadsheet style matrix in the **Bridge type** column select the bridge type **Half**.




- In the simplified graphical diagram click on the bridge icon (**D** in Figure 12.29 on page 319) until you see the half bridge representation.

**5** When you select half bridge completion, switch S3 in Figure 12.21 will be closed.

**Bridge completion - quarter (1/4) bridge**

A quarter bridge type sensor is a sensor that has a single bridge resistor on-board, completion is required.

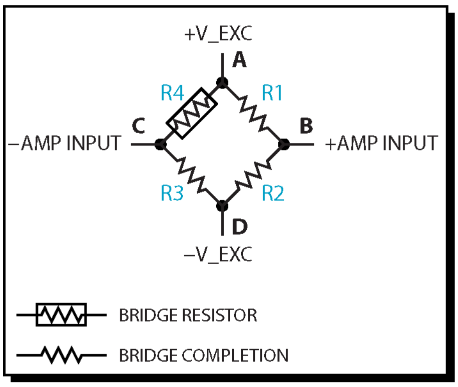



**Figure 12.32:** Quarter bridge layout

In this situation a sensor is used with only one resistor R4. This resistor is placed between A and C.

You now have to provide the three additional resistors R1, R2, and R3 for completion of the bridge. You do this by using the half-bridge completion as described in the previous section and adding an additional resistor R3 between C and D. To do this there are two options:

**1** Use the standard 350 Ω resistor inside the acquisition card.
**2** Provide a resistor.

In situation (1) you do not need to do anything from a hardware point of view.

In situation (2) you will need to add the resistor on the plug-in module on the location marked QB. Refer to Figure 12.21 on page 312 for electrical/schematic details and to for mechanical/location details.

Additional wiring: you need to add wiring for the quarter bridge completion resistor. Depending on the selection you made, connect either pin 10 (350 Ohm) or pin 9 (user) to the bridge connection marked C in the diagram, or directly to pin 6 (-amp in) of the connector. Refer to Figure 12.24 for connection details.

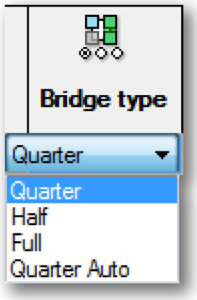
When using a quarter bridge you need to inform the Perception software about this.

**To select quarter bridge completion in Perception**
To select half bridge completion in Perception proceed as follows:

**1** In Perception go to the **Settings** sheet.
**2** In the task pane select the **Bridge** in the Input section.
**3** Select one or more channels.

**4** Do one of the following:

- In the spreadsheet style matrix in the **Bridge type** column select the bridge type **Quarter**.




- In the simplified graphical diagram click on the bridge icon (**D** in Figure 12.29 on page 319) until you see the quarter bridge representation.

**5** When you select quarter bridge completion, switch S3 in Figure 12.21 on page 312 will be closed.

**Excitation**

The following options are provided for bridge excitation:

- You can switch excitation on and off.
- You can select between voltage and current excitation.
- You can use sense lines to make sure that the correct voltage is applied to the bridge even with longer lead wiring.

You make all these selections in the Perception application. However, when using sense lines you will need to do additional wiring:

- Add a connection from pin 3 (+sense) to the bridge connection marked A in Figure 12.21 on page 312.
- Add a connection from pin 4 (-sense) to the bridge connection marked D in Figure 12.21 on page 312.

**Excitation on/off:** Provision for separately switching off the bridge voltage while the remainder of the measuring circuit remains operational is an important and useful feature, particularly when measuring dynamic strains. Any output observed when the bridge voltage is switched off must be due to electrical noise, as the output cannot possibly be the result of resistance changes in the measuring circuit when a bridge voltage is not present. The ability to turn off the bridge power is therefore a useful diagnostic tool for establishing whether electrical noise is a problem.

**Voltage and current excitation:** For the balanced bridge it doesn’t matter if the power supply is of the constant-voltage or constant-current variety. In both cases the output will be zero for the resistively balanced state. However, resistive balance circuits may be used with constant current excitation to obtain an initial zero balance of the instrument output when the bridge itself is unbalanced.

**Sense lines:** Remote sense or, more correctly, remote sensing of excitation voltage, is commonly recommended for use with precision, commercial transducers to prevent leadwire resistance changes (due to changes in either temperature or length) from affecting transducer span, or sensitivity.

Leadwire attenuation presents a potentially significant error source in transducers utilizing a Wheatstone bridge circuit. The leadwires represent a parasitic resistance, and a portion of the excitation voltage intended for the bridge circuit is dropped in the leadwire system, reducing the voltage actually present at the transducer, and effectively reducing the transducer sensitivity.

**In Perception**

To make the required settings in the Perception software do the following:

1 In Perception go to the **Settings** sheet.
2 In the task pane select the **Bridge** in the **Input** section.
3 Select one or more channels.

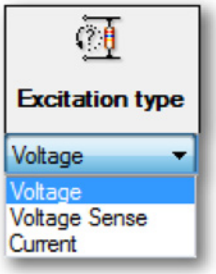
4 To switch the excitation on or off do one of the following (this will open/close the switch marked S2a and S2b in Figure 12.21):

- In the spreadsheet style matrix double-click in the correct row(s) on the **Excitation** column.


- In the simplified graphical diagram click on the excitation switch (**I** in Figure 12.29 on page 319).

5 To select an excitation type do one of the following:

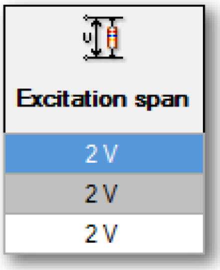
- In the spreadsheet style matrix in the **Excitation type** column make your selection




- In the simplified graphical diagram click the **Type** spinner (**G** in Figure 12.29 on page 319) until you see your selection.

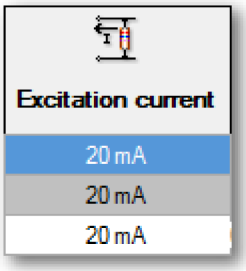
You can select between one of the following excitation type options:

- **Voltage:** Voltage excitation. When you select voltage excitation a voltage is applied between the bridge connection marked A (plus) and the bridge connection marked D (minus). To set the voltage level do one of the following:
  - In the spreadsheet style matrix in the **Excitation span** column enter the required voltage.




  - In the simplified graphical diagram use the **Excitation** box (**H** in Figure 12.29 on page 319) to enter a value.

- **Voltage Sense:** Voltage excitation with sense. When you select this option the sense lines are used: this will put the switch marked S1a and S1b in Figure 12.29 on page 319 into the sense position. Use the **Voltage** procedure to set the required voltage. You can also use the sense check boxes (marked **E** in Figure 12.29 on page 319) to toggle the sense lines.
- **Current:** Current excitation. Now a constant current is fed into the bridge. To set the current level do one of the following:
  - In the spreadsheet style matrix in the **Excitation current** column enter the required current.




  - In the simplified graphical diagram use the **Excitation** box (**H** in Figure 12.29 on page 319) to enter a value.

**Shunt verification - setup**
You can use a shunt resistor to verify a bridge: when you connect a shunt resistor in parallel with resistor R4 (A-C) or R3 (C-D) of the bridge this will produce an output signal simulating strain: a deflection. With known resistor and excitation values you can calculate the theoretical deflection. You can compare this with the measured deflection.

The following options are provided:

- Select the active bridge arm: A-C or C-D.
- Select between an internal or external shunt resistor.
- When **internal** select between:
  - **Factory installed:** 20 kΩ or 100 kΩ precision resistors.
  - **User installed:** you will need to add the resistor on the plug-in module on the location marked **CAL**. Refer to Figure 12.21 on page 312 for electrical/schematic details and to for mechanical/location details.

**Additional wiring**
When using remote calibration / shunt verification you will need to add the following wiring:

- Connect point A of bridge with pin 11 (Remote Cal +) of connector.
- Connect point D of bridge with pin 12 (Remote Cal -) of connector.
- Connect point D of bridge with pin 12 (Remote Cal -) of connector.
- In addition: when using an external shunt resistor connect this resistor between pin 14 (External Shunt A/D) and pin 13 (External Shunt Common) of connector.

For an example refer to Figure 12.27 "Full bridge with remote sensing and remote calibration " on page 317.

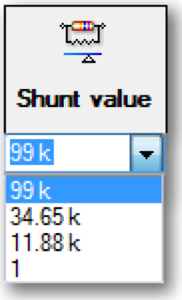
**In Perception**
To make the required settings in the Perception software do the following:

**1** In Perception go to the **Settings** sheet.
**2** In the task pane select the **Bridge** in the **Input** section.
**3** Select one or more channels.

**4** Select between internal or external shunt usage: in the **Internal shunt** column enable internal to use an **internal** shunt or clear the option to select an **external** resistor. This selection operates switch S7 in Figure 12.21.

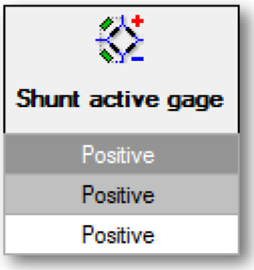

Depending on the selection:

- When **internal** is chosen select the correct value in the **Shunt value** column:




  or type the value of the CAL resistor. This selection operates switch S8 in Figure 12.21 on page 312.
- When **external** is chosen type the correct value of the external resistor in the **Shunt value** column.

5 Select the bridge arm to operate switch S5 in Figure 12.21 on page 312:
- In the sheet use the **Active gage** column to select between **Positive** (A-C) or **Negative** (C-D).




- In the simplified block diagram click on the **Remote calibration select** switch (**B** in Figure 12.29 on page 319) to switch between the two gages.

**Shunt verification - procedure**
Once you have correctly set up all wiring and resistors you can do an actual shunt verification.

**Shunt verification preparation**
To do a shunt verification in Perception make the following preparations:

1 In Perception go to the **Settings** sheet.
2 In the task pane select the **Bridge** in the **Input** section.
3 Select one or more channels.
4 Switch **Excitation ON**.
5 Select an **Excitation voltage.**
6 In the task pane select **Shunt Verification** in the **Sensors** section.
7 Select one or more channels.
8 Select between internal or external shunt usage: in the **Internal shunt** column enable internal to use an **internal** shunt or clear the option to select an **external** resistor. Make the appropriate value setting as described earlier. You can also click on the switch in the diagram (**G** in Figure 12.33).
9 Select the bridge arm: use the **Active gage** column to select between **Positive** (A-C) or **Negative** (C-D). You can also click on the switch in the diagram (**I** in Figure 12.33).

The actual shunt verification is done using the shunt verification dialog.

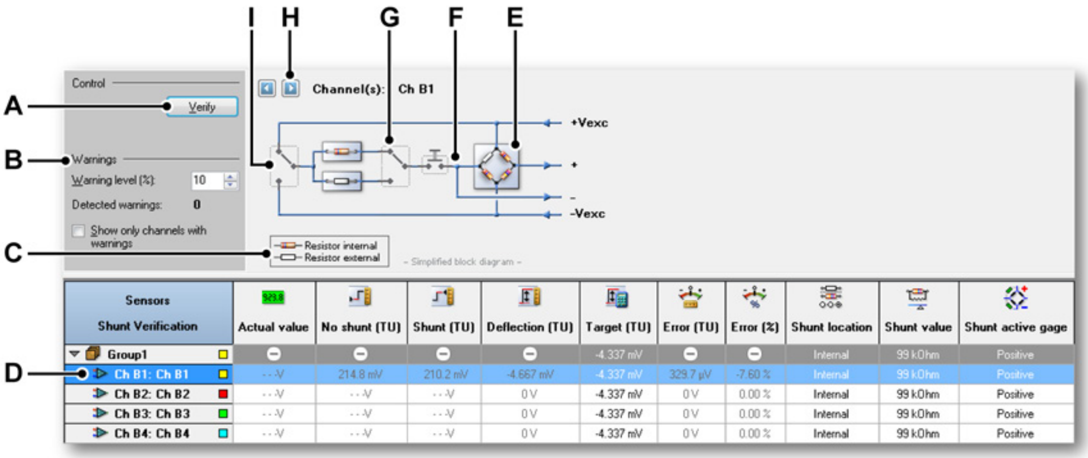



**Figure 12.33:** Shunt Verification dialog

**A** Verify command

**B** Warning settings

**C** Legend

**D** Channel select

**E** Bridge representation

**F** Verify command

**G** Shunt location select

**H** Channel select

**I** Shunt active gage select (S5 in Figure 12.21 on page 312)

**Shunt verification**

To do the actual shunt verification:

1. In Perception go to the **Settings** sheet.
2. In the task pane select the **Sensors** in the **Shunt Verification** section.
3. Select one or more channels.
4. Enter a value for the **Warning level** as a percentage.
5. Enter a value as **Target** : the target value is the result of the bridge value, excitation value and shunt value. Tables exist for commonly used values. As an example refer to Figure 12.28. In Figure 12.33 on page 332 the value is used that corresponds to a 350 Ω bridge, 20 kΩ shunt - therefore a 4.337 mV deflection per volt excitation - and 1 volt excitation.
6. Click **Verify**. This will actually close S6 in Figure 12.21 on page 312 for a short period of time to measure the deflection.

### Bridge balance

The bridge circuit is only in balance (has no output when the bridge voltage is applied) provided that R1 / R2 = R4 / R3. Taking into account the various resistance tolerances on the strain gauge(s), resistors and leadwires, an initial unbalance is invariably present. Adjustment of initial balance so that at zero strain there is zero output is achieved by bridge balancing.

While resistive-balance circuits are widely used in strain gauge instrumentation, the GN410 and GN411 uses an alternative electronic method of balancing the output to zero involving measuring the output of the bridge and injecting an equal and opposite voltage. This method permits rapid automatic balancing in multi-channel systems and eliminates the bridge loading errors that are possible in the resistive system when making measurements with precision strain gauge transducers.

**HINT/TIP**

When doing a bridge balance, the GN410 and GN411 acquisition card measures the input value at the connector of the acquisition card. This means it cannot “see” if a bridge is actually connected or not. When no voltage is present this can be since the bridge is balanced or that no bridge is connected.

Bridge balancing in Perception is done through the Bridge Balance dialog.

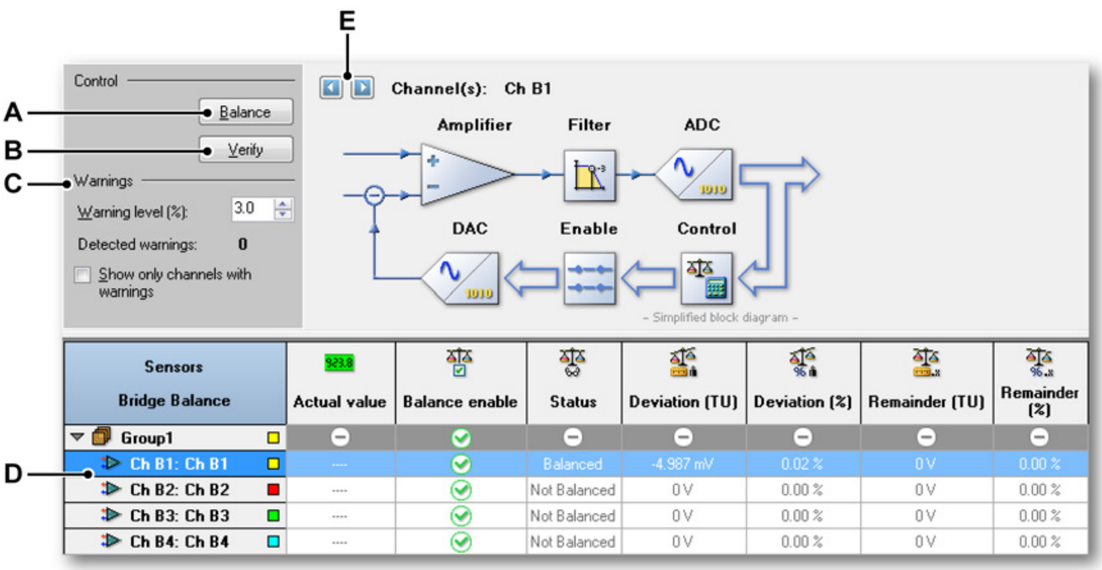



**Figure 12.34:** Bridge Balance dialog

**A** Balance command

**B** Verify command

**C** Warning settings

**D** Channel select

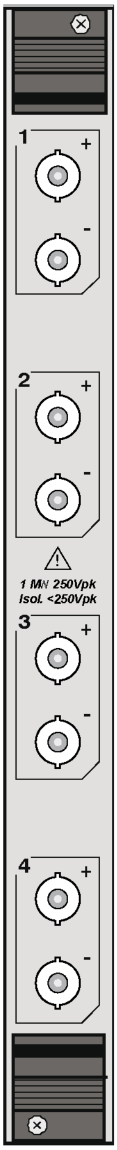
**E** Schematic block diagram of balance circuit

**To balance a bridge**

To balance a bridge in Perception do the following:

1. In Perception go to the **Settings** sheet.
2. In the task pane select **Bridge Balance** in the **Sensors** section.
3. Use the **Balance Enable** column to enable/disable the balancing of channels.
4. Enter a value for the **Warning level** as a percentage.
5. Select one or more channels.
6. Click the **Balance** command and wait for the results.

## 12.8 GN440 and GN441 Universal amplifier input cards




This unique, high-end, input card with ultra-fast amplifier serves a variety of needs; from differential and/or isolated measurements to IEPE-based vibration or shunt-based current measurements.

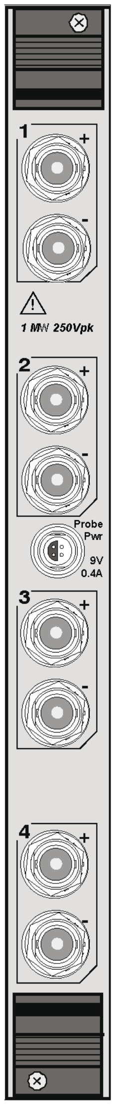
The universal amplifier input card has four input channels, each sampling at 200 kS/s or 1 MS/s maximum with 16 bit resolution. The bandwidth is 500 kHz and a selection of time or frequency domain optimized filters is available to eliminate noise if needed. The voltage range for a channel can be set from ±10 mV to ±100 V, making the card adaptable to nearly every application. True optical isolation allows for measurements with up to 250 V RMS common mode voltage.

The on-board differential input amplifiers eliminate noise picked up in the device under test or the measurement leads. Each amplifier typically offers a high CMRR of 80dB. By switching to "IEPE mode", the amplifiers supports any type of constant current supplied vibration and acceleration sensors. In "Current mode", the built-in shunt can be used to measure up to 1 ampere in a safe, isolated and fused manner, without the need of external shunt resistors.

For more information about the Universal amplifier input card, please refer to "B3250-1.0 en (GEN series GN440 and GN441)" on page 593.

## 12.9 GN412 and GN413 High Speed - differential input cards

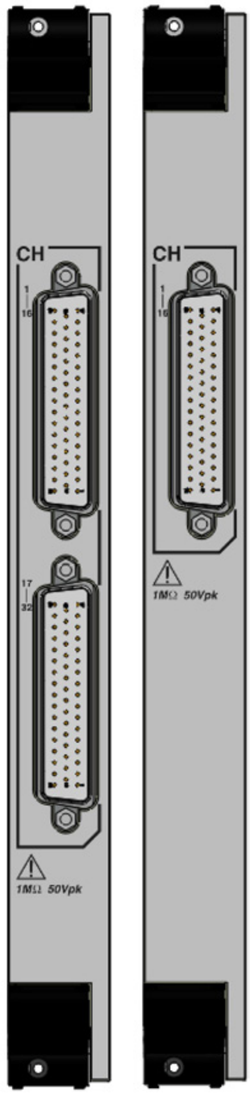
For ultra fast signals, the **25 MS/s** and **100 MS/s** high speed differential input cards are equipped with four channels sampling at incredible high speed. With selectable anti-aliasing filtering and 14-bit (100 MS/s) or 15-bit resolution (25 MS/s), these inputs turn the GEN DAQ systems into an extremely fast transient recorder. Enhanced resolution mode increases input resolution for both models to 16-bit at lower speeds. The inputs feature a fully differential amplifier offering good common mode rejection and enabling of ground measurements.




For more information about the High Speed Digitizers - differential inputs input card, please refer to "B3248-1.0 en (GEN series GN412 and GN413)" on page 429.

## 12.10 High Resolution IEPE and Charge input cards

### 12.10.1 GN1610 and GN3210 IEPE and charge 250 kS/s input cards




The **GN1610 and GN3210 IEPE and charge 250 kS/s** input cards are a no-compromise solution for high channel count data acquisition systems.

This card brings:

- A cost-effective solution with 16 or 32 channels per card
- High precision with a 24-bit A-to-D convertor for each channel
- Sample rates up 250 kS/s (both decimal and binary)
- Flexibility; each channel can be individually assigned one of the following signal conditioners:
  - IEPE for accelerometers, microphones, etc.
  - Charge for pressure transducers, piezoelectric accelerometers, etc.
  - Voltage (full differential and single-ended)
- TEDS readout support for IEPE transducers
- Digital event and timer-counter support (on compatible mainframes only)
- 1.8 GB on-board memory

The large amount of channels on this single card require special attention and are therefore equipped with 50-pin D connectors. To provide easy access to all channels breakout cables are available as an option with 19 inch panels for BNC connectors.

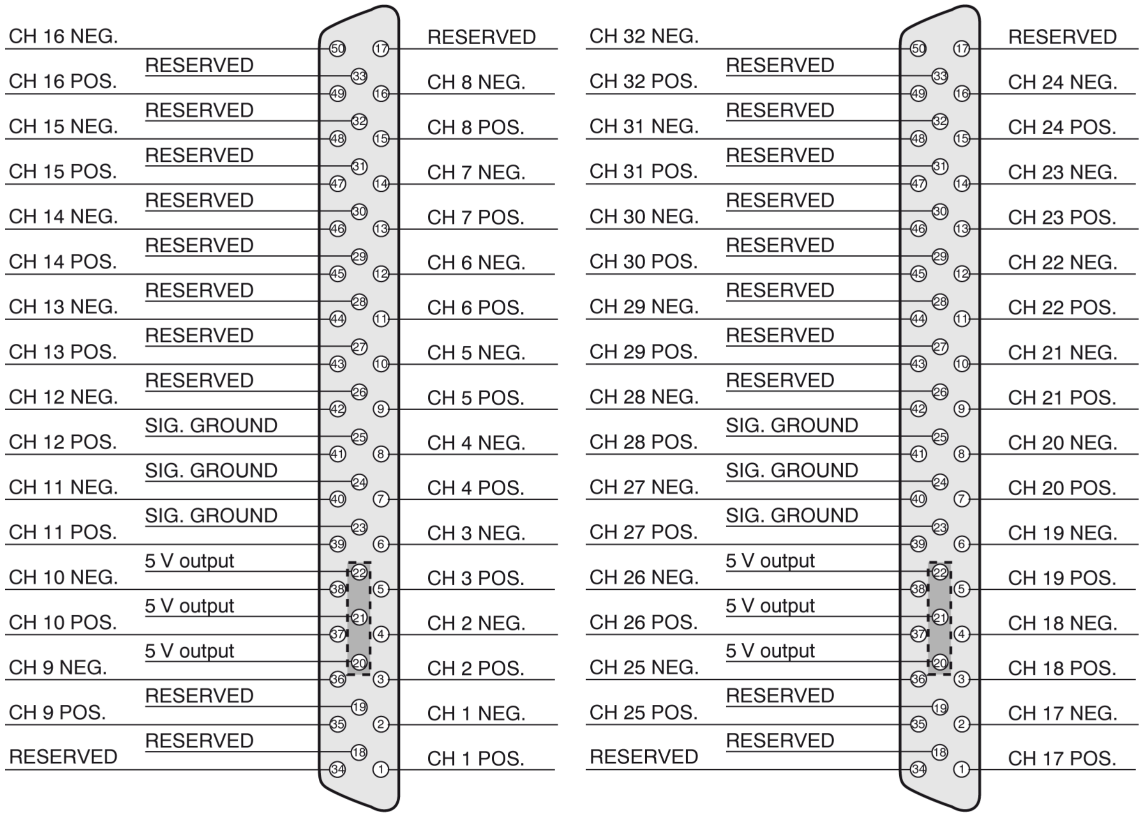


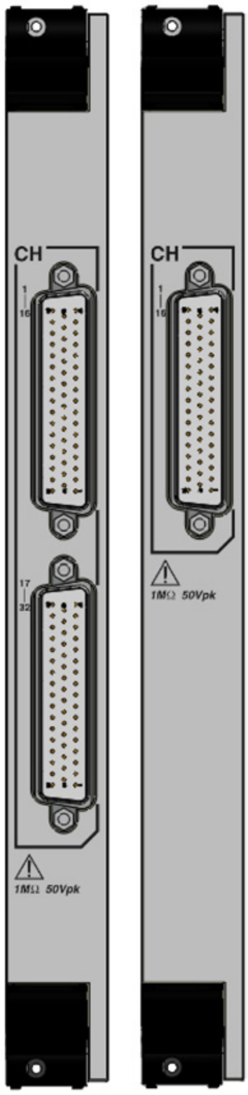

**Figure 12.35:** Pin diagram for top 16 Ch Connector (left), Bottom 16 Ch connector (right, 32 Ch Card only)

**Note** *Both positive and negative pins must be connected to avoid erroneous measurement results with noise.*

**Note** *There are 3 output pins available on each connector giving 5 V at 0.3 A in total from an automatic resettable fuse.*

For more information about the 16/32 Channel Accel Card 250 kS/s input card, refer to "B3240-2.0 en (GEN series GN1610 and GN3210)" on page 596.

### 12.10.2 GN1611 and GN3211 basic 20 kS/s input cards




The **GN1611 and GN3211 basic 20 kS/s** input cards are a no-compromise solution for high-channel-count data acquisition systems.

This card brings:

- A cost-effective solution with 16 or 32 channels per card
- High precision with a 16-bit A-to-D convertor for each channel
- Sample rates up to 20 kS/s (both decimal and binary)
- Digital event support (on compatible mainframes only)
- 200 MB on-board memory

The large amount of channels on this single card require special attention and are therefore equipped with 50-pin D connectors. To provide easy access to all channels, breakout cables are available as an option with 19 inch panels for BNC connectors.

## Front View

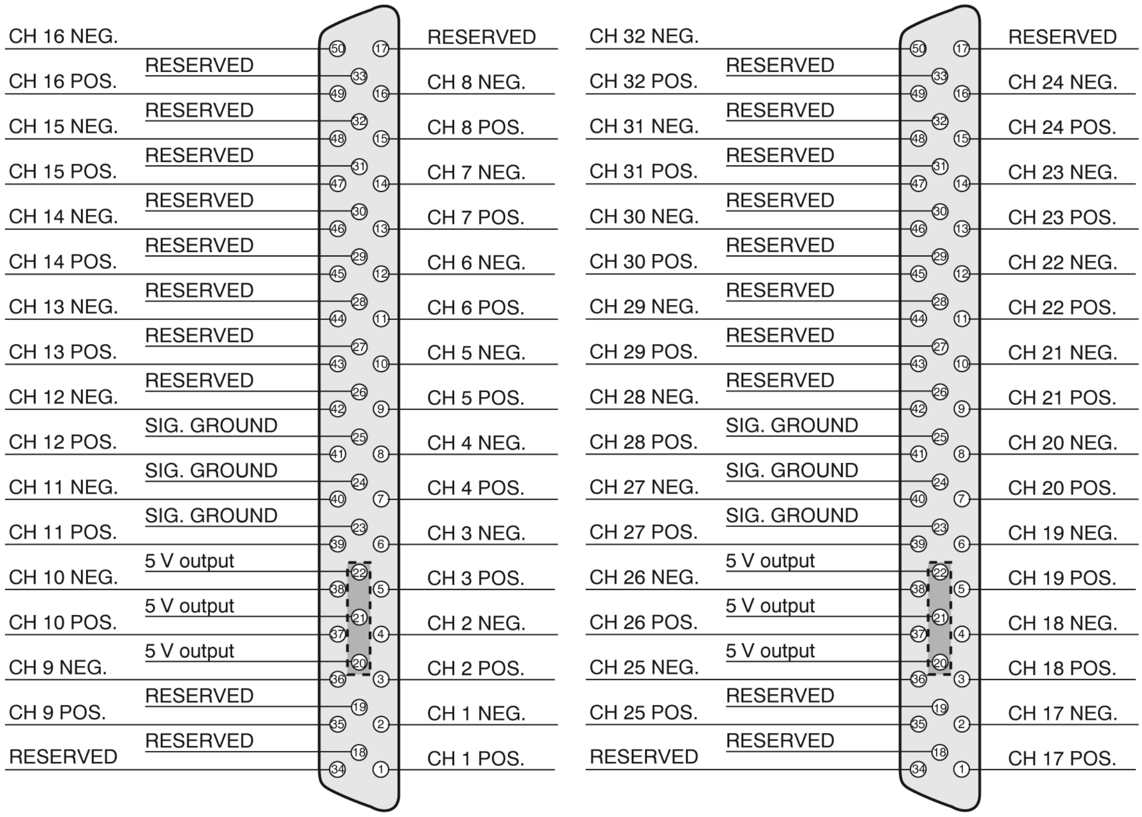



**Figure 12.36:** Pin diagram for top 16 Ch Connector (left), Bottom 16 Ch connector (right, 32 Ch Card only)

**Note** *Both positive and negative pins must be connected to avoid erroneous measurement results with noise.*

**Note** *There are 3 output pins available on each connector giving 5 V at 0.3 A in total from an automatic resettable fuse.*

For more information about the 16/32 Channel Basic Card 20 kS/s input card, please refer to "B3264-2.0 en (GEN series GN1611 and GN3211)" on page 604.

### 12.11 GN401 Optical Fiber Isolated 100 MS/s input card

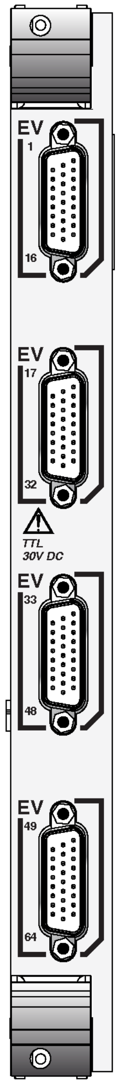
- 4 analog channels per receiver
- Digital fiber optic link
- Calibrated isolated analog output
- 2 GByte memory
- Isolated, unbalanced differential inputs
- GN110 and GN111 battery powered transmitter (HV6600)
- GN112 and GN113 continuous power; 1.8 kV RMS isolation transmitter (MV6600)
- ± 20 mV to ± 100 V input ranges
- 25 or 100 MS/s sample rate transmitter
- 15 or 14 bit resolution
- Metal BNC inputs

Offers fiber optic isolation for high speed transient recorder applications. The isolated system consists of a transmitter unit (GN110, GN111, GN112 or GN113) connected via fiber optic cable to the GN401 receiver built into any GEN Series mainframe.
By converting the analog signal into a digital signal and transmit it via fiber optic cable to the receiver, the transmission does not add any drift or error to the measured signal. The GN401 receiver records the digital signal from the GN110, GN111, GN112 and GN113.
The combination of transmitter and receiver form an integrated system of isolation and data acquisition. The full transient and data recorder feature set of the GN401 together with the powerful Perception software eliminate the need to use separate data acquisition hardware or software.
The GN112 and GN113 offer continuous powered isolation at 1.8 kV RMS while the GN110 and GN111 offer higher isolation options using battery power, with 24 hours battery operation time.

For more information about the GN401 Optical Fiber Isolated 100 MS/s input card, refer to "B2629–2.0 en (GEN series GN401)" on page 406.

## 12.12 Binary marker cards

### 12.12.1 GN6470 Binary marker card




The GN6470 binary marker input card is a dedicated binary input option for the GEN series instruments. It enables to record up to 64 binary input channels (marker channels) with up to 1 MS/s per channel. In addition 9 binary input channels can be assigned under software control to provide 3 channels of counter/timer functionality.

The binary channels can be recorded and reviewed in Perception like analog channels and enable a large number of binary status signals to be recorded together with the analog input channels.

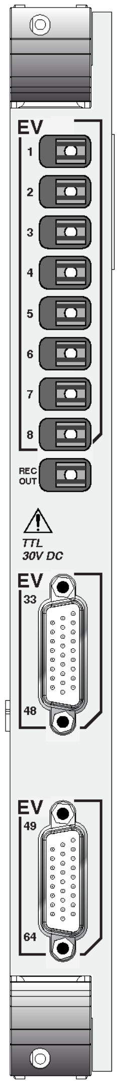
The counter/timer functionality includes:

- 64-bit general purpose up/down counter
- Frequency/RPM counter
- Quadrature/position measurements

The counter/timer functionality uses up to 3 event bits per channel. These event bits also keep their original functionality. You can, for example, use a quadrature encoder and at the same time look at the quadrature signals separately.

For more information about the Binary marker input card, please refer to "B3245-1.0 en (GEN series GN6470)" on page 613.

### 12.12.2 GN4070 Binary marker HV card




The binary marker HV input card allows you to acquire 32 digital event signals (markers) as well as 8 digital event signals that are optically isolated. Although general purpose, this card is specifically suited for the medium/high voltage market. A fiber optic isolated output is provided to present an REC-signal that can be used to drive an external instrument. The fiber optic inputs and the fiber-optic REC output allow for a tight integration with the BE3200 high-definition test sequencer.

In addition 9 binary input channels can be assigned under software control to provide 3 channels of counter/timer functionality.

The counter/timer functionality includes:

- 64-bit general purpose up/down counter
- Frequency/RPM counter
- Quadrature/position measurements

The counter/timer functionality uses up to 3 event bits per channel. These event bits also keep their original functionality. You can, for example, use a quadrature encoder and at the same time look at the quadrature signals separately.

For more information about the Binary Marker HV input card, please refer to "B3246-1.0 en (GEN series GN4070)" on page 609.

### 12.12.3 Connector pinning GN6470 and GN4070

The GN6470 binary marker cards come with four 26-pin connectors. The GN4070 has the top two connectors replaced with eight optical receivers and one optical transmitter. The following diagram and table provide the pinning information of each 26 pin connector.

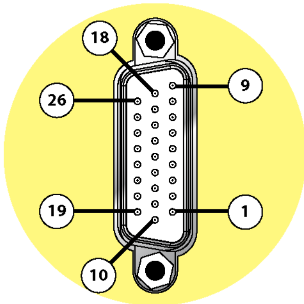



**Figure 12.37:** Binary marker card connector pinning

*Table 12.7: Event bit (marker) connector pinning*

| PIN # | EV1-16 | EV17-32 | EV33-48 | EV49-64 |
|---|---|---|---|---|
| **1** | Event Bit 16 | Event Bit 32 | Event Bit 48 | Event Bit 64 |
| **2** | Event Bit 15 | Event Bit 31 | Event Bit 47 | Event Bit 63 * |
| **3** | Event Bit 14 | Event Bit 30 | Event Bit 46 | Event Bit 62 * |
| **4** | Event Bit 13 | Event Bit 29 | Event Bit 45 | Event Bit 61 * |
| **5** | Event Bit 12 | Event Bit 28 | Event Bit 44 | Event Bit 60 |
| **6** | Event Bit 11 | Event Bit 27 | Event Bit 43 | Event Bit 59 * |
| **7** | Event Bit 10 | Event Bit 26 | Event Bit 42 | Event Bit 58 * |
| **8** | Event Bit 9 | Event Bit 25 | Event Bit 41 | Event Bit 57 * |
| **9** | Event Bit 8 | Event Bit 24 | Event Bit 40 | Event Bit 56 |
| **10** | Event Bit 7 | Event Bit 23 | Event Bit 39 | Event Bit 55 * |
| **11** | Event Bit 6 | Event Bit 22 | Event Bit 38 | Event Bit 54 * |
| **12** | Event Bit 5 | Event Bit 21 | Event Bit 37 | Event Bit 53 * |
| **13** | Event Bit 4 | Event Bit 20 | Event Bit 36 | Event Bit 52 |
| **14** | Event Bit 3 | Event Bit 19 | Event Bit 35 | Event Bit 51 |
| **15** | Event Bit 2 | Event Bit 18 | Event Bit 34 | Event Bit 50 |
| **16** | Event Bit 1 | Event Bit 17 | Event Bit 33 | Event Bit 49 |
| **17** | Ground | Ground | Ground | Ground |
| **18** | Ground | Ground | Ground | Ground |
| **19** | Ground | Ground | Ground | Ground |
| **20** | Ground | Ground | Ground | Ground |

| PIN # | EV1-16 | EV17-32 | EV33-48 | EV49-64 |
|---|---|---|---|---|
| 21 | Ground | Ground | Ground | Ground |
| 22 | Ground | Ground | Ground | Ground |
| 23 | Ground | Ground | Ground | Ground |
| 24 | Ground | Ground | Ground | Ground |
| 25 | + 5 V | + 5 V | + 5 V | + 5 V |
| 26 | + 5 V | + 5 V | + 5 V | + 5 V |

(*) = Event input combined with counter/timer channel function

### 12.12.4 GN6470 and GN4070 Counter mode pinning

When in counter mode Event Bit 53 through 63 are used to provide the counter functionality. These bits are located on the bottom connector as follows:

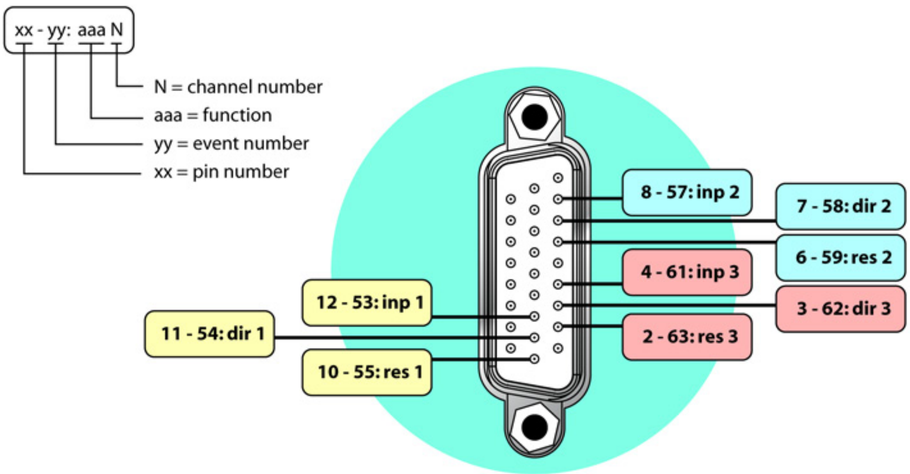



**Figure 12.38:** Counter pinning layout

*Table 12.8: Counter bit connector pinning*

| PIN # | EVENT | COUNTER | FUNCTION |
|---|---|---|---|
| 12 | Event Bit 53 | 1 | Counter input |
| 11 | Event Bit 54 | 1 | Direction: increment / decrement |
| 10 | Event Bit 55 | 1 | Reset |
| 8 | Event Bit 57 | 2 | Counter input |
| 7 | Event Bit 58 | 2 | Direction: increment / decrement |
| 6 | Event Bit 59 | 2 | Reset |
| 4 | Event Bit 61 | 3 | Counter input |
| 3 | Event Bit 62 | 3 | Direction: increment / decrement |
| 2 | Event Bit 63 | 3 | Reset |

In the Perception software the event bits are combined within one channel and labeled as CH1_1 through CH1_64. The counter/timer channels are referred to as CH2 through CH4.

**Counter input** The counter input is the actual signal input. The counter value will be modified on each rising edge of this signal. The maximum input rate is 10 Mhz.

**Direction** The direction signal determines if the counter will be incremented (direction = “0”), or decremented (direction = “1”) on each rising edge of the counter input.

**Reset** The reset signal will reset the counter to zero. The reset enabling as well as the active level is determined under software control.

The actual mode of the counter/timer channel is selected in the Perception software.

### 12.12.5 GN6470 and GN4070 Frequency (RPM) mode pinning

When in frequency mode Event Bit 53 through 63 are used to provide the frequency measurement functionality. These bits are located on the bottom connector as follows:

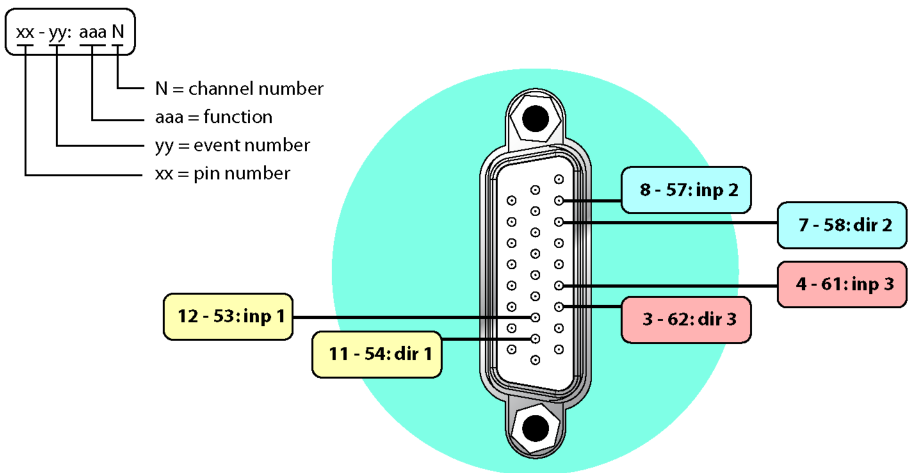



**Figure 12.39:** Frequency measurement pinning layout

*Table 12.9: Counter bit connector pinning*

| PIN # | EVENT | FREQ. CH. | FUNCTION |
|---|---|---|---|
| **12** | Event Bit 53 | 1 | Counter input |
| **11** | Event Bit 54 | 1 | Direction: increment / decrement |
| **10** | Event Bit 55 | – | Not used |
| **8** | Event Bit 57 | 2 | Counter input |
| **7** | Event Bit 58 | 2 | Direction: increment / decrement |
| **6** | Event Bit 59 | – | Not used |
| **4** | Event Bit 61 | 3 | Counter input |
| **3** | Event Bit 62 | 3 | Direction: increment / decrement |
| **2** | Event Bit 63 | – | Not used |

In the Perception software the event bits are combined within one channel and labeled as CH1_1 through CH1_64. The counter/timer channels are referred to as CH2 through CH4.

For frequency measurements, the counter/timer channels use an additional gate-clock to create a time-interval (gate-time) in which pulses are counted. The gate-time determines the possible resolution of the measurement. The minimum gate-time is 1 µs, the maximum gate-time is 10 s.

**Counter input** The counter input is the actual signal input. The counter will be incremented on each rising edge of this signal. The maximum input frequency is 10 MHz.

**Direction** The direction signal determines if the counter will be incremented (direction = “0”), or decremented (direction = “1”) on each rising edge of the counter input.

The actual mode of the counter/timer channel is selected in the Perception software. In Perception the RPM is derived from the measured frequency.

### 12.12.6 GN6470 and GN4070 Quadrature (position) mode pinning

When in quadrature mode Event Bit 53 through 63 are used to provide the position measurement capability by measuring the signals as provided by quadrature encoders. These bits are located on the bottom connector as follows:

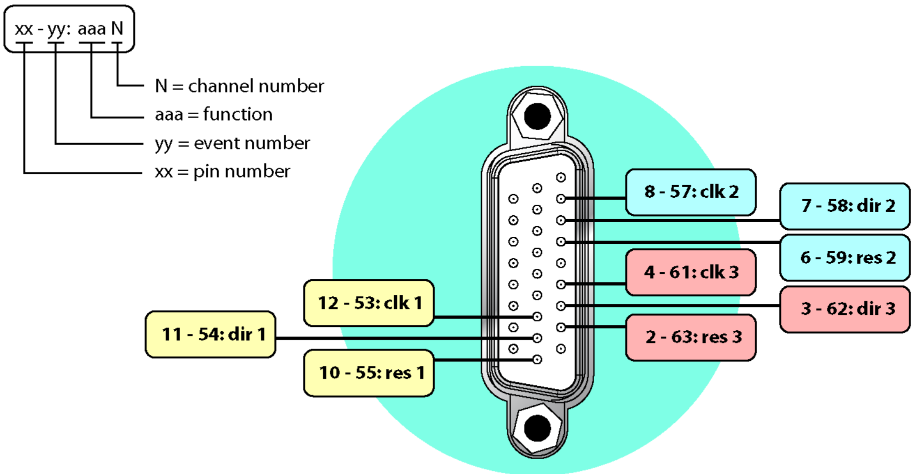



**Figure 12.40:** Quadrature measurement pinning layout

*Table 12.10: Quadrature measurement bit connector pinning*

| PIN # | EVENT | QUAD. CH. | FUNCTION |
|---|---|---|---|
| **12** | Event Bit 53 | 1 | Clock input (A) |
| **11** | Event Bit 54 | 1 | Direction input (B) |
| **10** | Event Bit 55 | 1 | Reset |
| **8** | Event Bit 57 | 2 | Clock input (A) |
| **7** | Event Bit 58 | 2 | Direction input (B) |
| **6** | Event Bit 59 | 2 | Reset |
| **4** | Event Bit 61 | 3 | Clock input (A) |
| **3** | Event Bit 62 | 3 | Direction input (B) |
| **2** | Event Bit 63 | 3 | Reset |

In the Perception software the event bits are combined within one channel and labeled as CH1_1 through CH1_64. The counter/timer channels are referred to as CH2 through CH4.

**Clock input (A)** The clock input is the actual signal input. The counter will be incremented on each rising edge of this signal if the direction input is low (“0”). The counter will be decremented on each rising edge of this signal if the direction input is high (“1”).

**Direction input (B)** The direction signal determines if the counter will be incremented (direction = “0”), or decremented (direction = “1”) on each rising edge of the counter input.

**Reset** The reset signal will reset the counter to zero. The reset enabling as well as the active level is determined under software control.

The actual mode of the counter/timer channel is selected in the Perception software.

The most common type of incremental encoder uses two output channels (A and B) to sense position. Using two code tracks with sectors positioned 90 degrees out of phase, the two output channels of the quadrature encoder indicate both position and direction of rotation. If A leads B, for example, the disk is rotating in a clockwise direction. If B leads A, then the disk is rotating in a counter-clockwise direction.

By monitoring both the number of pulses and the relative phase of signals A and B, you can track both the position and direction of rotation.

Some quadrature encoders also include a third output channel, called a zero or index or reference signal, which supplies a single pulse per revolution. This single pulse is used for precise determination of a reference position.

### 12.12.7 GN4070 Connectors and pinning

The binary marker HV modules come with nine (9) fiber optic connectors (see Figure 12.41) and two (2) 26-pin connectors. The lowest fiber optic connector provides the recording status output. The fiber optic input connectors provide the marker (event) channels 1 through 8. The non-isolated marker inputs provide the marker (event) channels labeled 33 through 64.

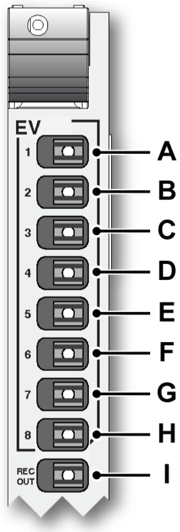



**Figure 12.41:** GN4070 Binary marker HV card (detail)

**A** Event bit 1

**B** Event bit 2

**C** Event bit 3

**D** Event bit 4

**E** Event bit 5

**F** Event bit 6

**G** Event bit 7

**H** Event bit 8

**I** Recording Active output

## 12.13 5B Integration card

**What is a 5B Integration card?**

The Genesis data acquisition system offers a variety of standard input cards to cover the most important physical application requirements. In situations where non-standard or specific requirements are needed, for example LVDT or PT100 signals that need to be conditioned and acquired, the 5B Integration card is used.

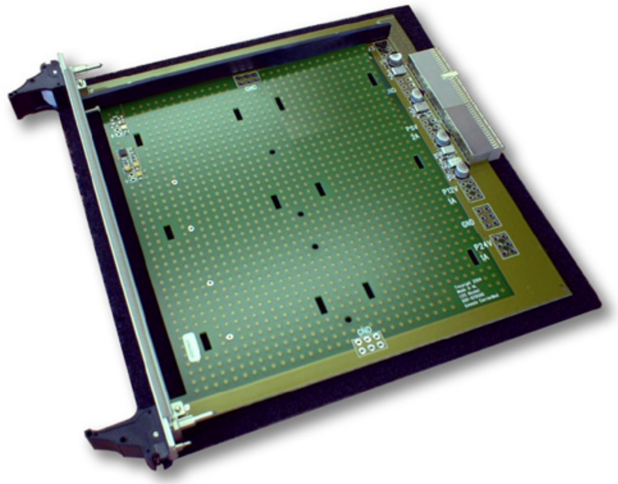


**Figure 12.42:** 5B Integration card

The 5B Integration card can be customized for these kinds of specific requirements using 5B modules that are available from separate vendors and can be directly fixed to the 5B Integration card.

**What is a 5B module?**
A 5B module is a single-channel fixed-range amplifier, these modules are the standard for fixed application signal conditioning in the lab and the factory floor. They offer small footprint, defined input and output connections, isolation, and good price/performance.

**Figure 12.43:** 5B module

There are several hundred different types of modules available for nearly each and every physical signal.

5B modules are available for signals like:

- Isolated AC and DC
- True RMS
- Current
- Strain gauge
- Carrier
- all kinds of TCs
- 2-, 3- and 4-wire RTDs
- LVDTs
- f to V converters
- RPM to V converters
- Potentiometers
- 4-20 mA transmitters

**Using the 5B Integration card with Genesis series**
The 5B Integration card is designed to work seamlessly with the GEN series mainframes, up to six 5B preamplifier modules can be attached to a card that supplies a range of fused supply voltages to the modules and has enough front panel space to mount the required input and output connectors.

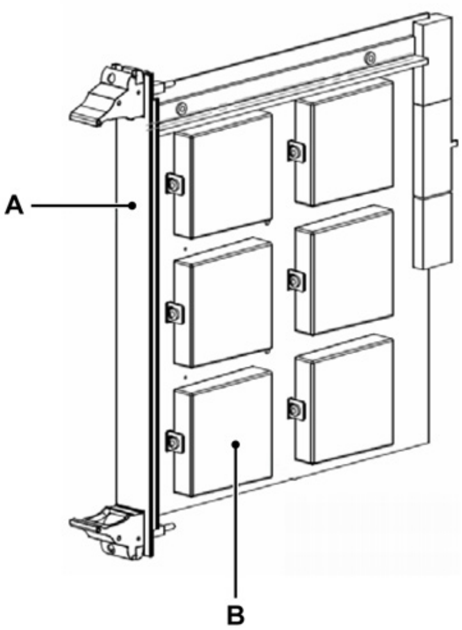



**Figure 12.44:** 5B Integration card design

**A** The front panel input and output connections as well as the internal wiring have to be made according to the customer's requirements.

**B** Up to six 5B modules can be mounted on the 5B Integration card.

After signal conditioning, using the 5B module, the signal is then fed into a standard input channel of any Genesis input card.

**Customization and ordering**
First check whether there are 5B modules available that do the job with respect to their fixed input range and the other limitations. Very often the input range is ok, because the Genesis input cards used behind the 5Bs are offering a 16 bit resolution and therefore most likely high enough resolution for any range required. Then select the proper module and define the input connectors needed for the sensor used.
From there the special card can be “customized” on site in local service department or through an outside vendor.
The 5B Integration card can be ordered from HBM and the 5B modules from any of the 5B vendors. The cabling, connectors and the specific documentation have to be done by the designer.

**What is included?**
When ordering the 5B Integration card, the following components are included:

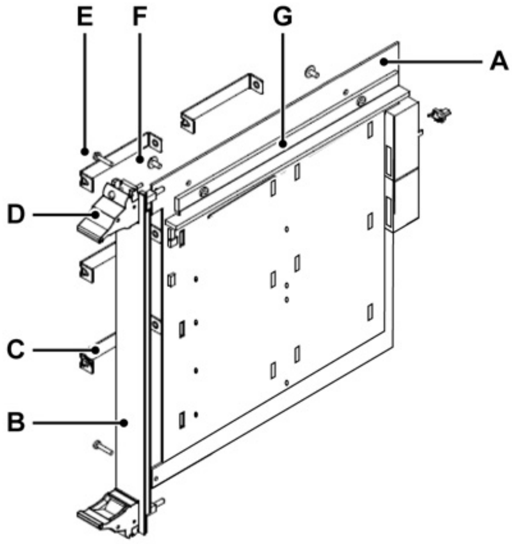



**Figure 12.45:** 5B Integration card components

**A** Genesis 5B Integration card 1x

**B** Execution/Genesis blind single with handle 1x

**C** Bracket/Genesis 5B Carrier Clamp 6x

**D** PAN/Genesis blind single with handle 1x

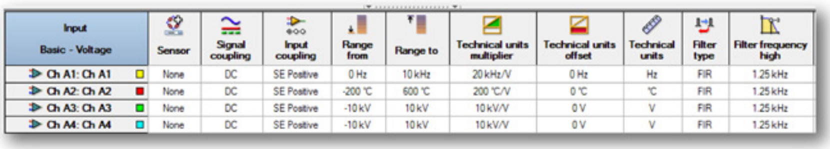
**E** Screw M2.5x0.45 12Torx 2x

**F** Screw M3x0.5 6ST 2x

**G** BRKT/Genesis Carrier Airflow 1x

**How to use the 5B based amplifier with Genesis and Perception**
As an example of a working 5B Integration card we will consider a card with two 5B modules mounted, one being an f to V converter and one being a TC module. These two have fixed ranges like 0-10.000 Hz and -200 °C to +600 °C, each being 0-5 Volt at the output.

Connect the output (preferable BNCs mounted on the 5B Integration card front panel) to two selected Genesis input channels now acting as “Frequency” and “TC” channel. Set sensitivity in these channels to 0-5 Volt (or whatever the 5B modules used are delivering as full scale value).
Scale the inputs to 0-10,000 Hz and -200 °C to +600 °C using the TU (technical units) input fields for those channels in Perception.
In order to do this either calculate the TU Multiplier value, or just do a two-point calibration and enter the upper and lower values there.
Save this setup as hardware setting and start any future measurements from there.



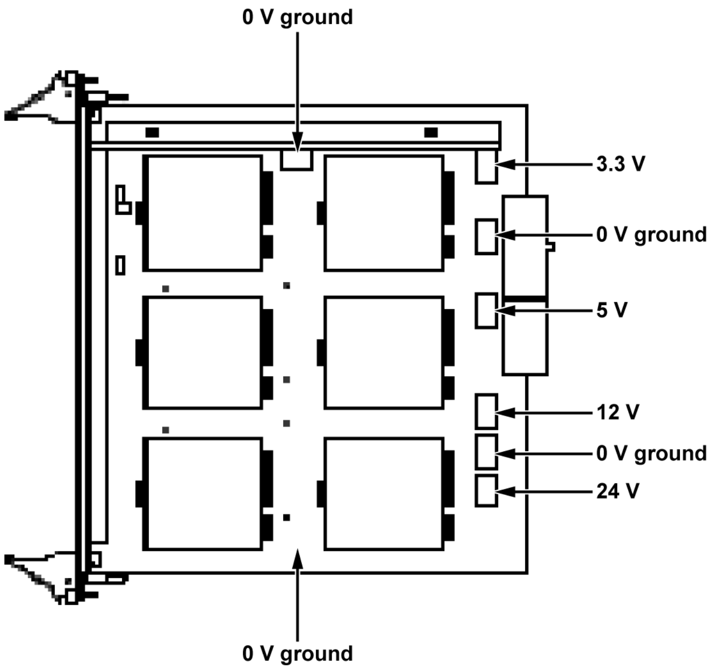
| Input Basic - Voltage | Sensor | Signal coupling | Input coupling | Range from | Range to | Technical units multiplier | Technical units offset | Technical units | Filter type | Filter frequency high |
|---|---|---|---|---|---|---|---|---|---|---|
| Ch A1: Ch A1 | None | DC | SE Positive | 0 Hz | 10 kHz | 20 kHz/V | 0 Hz | Hz | FIR | 1.25 kHz |
| Ch A2: Ch A2 | None | DC | SE Positive | -200 °C | 600 °C | 200 °C/V | 0 °C | °C | FIR | 1.25 kHz |
| Ch A3: Ch A3 | None | DC | SE Positive | -10 kV | 10 kV | 10 kV/V | 0 V | V | FIR | 1.25 kHz |
| Ch A4: Ch A4 | None | DC | SE Positive | -10 kV | 10 kV | 10 kV/V | 0 V | V | FIR | 1.25 kHz |

**Figure 12.46:** 5B Integration card setup

CH 1A and CH 2A are scaled to measure frequency and temperature using 5B modules in front of standard input channels.

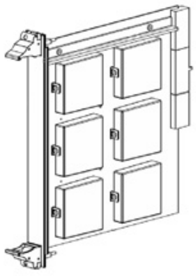
### 5B Integration card Specifications

| General Specifications | |
|---|---|




| | |
|---|---|
| 5B mounting positions | 6 (mounting materials included) |
| Voltage rails | |
| 3.3 V | Fused @ 2 A with soldering tabs |
| 5 V | Fused @ 2 A with soldering tabs |
| 12 V | Fused @ 1 A with soldering tabs |
| 24 V | Fused @ 1 A with soldering tabs |

**Note** *The card alone does not serve any function and must be combined with 5B series signal conditioners, proper connectors have to be mounted, internal card wiring (input/ output/power) has to be implemented and additional Genesis input channels have to be used to receive the 5B series output signal, HBM's Basic input cards series (GN810, GN811, GN815 or GN816) are most suited for this task.*
*For further help or information on the construction of this card please contact HBM's project group.*

| Ordering information | | |
|---|---|---|
| **Article** | **Description** | **Order No.** |
| 5B Integration card  | GEN DAQ 5B Integration card - uses one GEN DAQ slot, holds up to six 5B modules.<br>**Note**<br>*5B modules, I/O Connectors and cabling not included. Basic card required for acquisition.* | 1-G028-2 |

# 13 GEN series Synchronization Methods

## 13.1 PTP

### 13.1.1 PTP technology background[1]

**(1)** Source: Wikipedia® the free encyclopedia

The **Precision Time Protocol (PTP)** is a protocol used to synchronize clocks throughout a computer network. On a local area network, it achieves clock accuracy in the sub-microsecond range, making it suitable for measurement and control systems.

PTP was originally defined in the **IEEE 1588-2002** standard, officially entitled *"Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems"* and published in 2002. In 2008 a revised standard, **IEEE 1588-2008** was released. This new version, also known as PTP Version 2, improves accuracy, precision and robustness but is not backwards compatible with the original 2002 version.

**Architecture**

The IEEE 1588 standards describe a hierarchical master-slave architecture for clock distribution. Under this architecture, a time distribution system consists of one or more communication media (network segments), and one or more clocks. An ordinary clock is a device with a single network connection and is either the source of (master) or destination for (slave) a synchronization reference. A boundary clock has multiple network connections and can accurately bridge synchronization from one network segment to another. A synchronization master is selected for each of the network segments in the system. The root timing reference is called the grandmaster. The grandmaster transmits synchronization information to the clocks residing on its network segment.

The boundary clocks with a presence on that segment then relay accurate time to the other segments to which they are also connected.

A simplified PTP system frequently consists of ordinary clocks connected to a single network. No boundary clocks are used. A grandmaster is elected and all other clocks synchronize directly to it. IEEE 1588-2008 introduces a clock associated with network equipment used to convey PTP messages. The transparent clock modifies PTP messages as they pass through the device. Timestamps in the messages are corrected for time spent traversing the network equipment. This scheme improves distribution accuracy by compensating for delivery variability across the network.

### 13.1.2 PTP Protocol details

Synchronization and management of a PTP system is achieved through the exchange of messages across the communications medium. To this end, PTP uses the following message types.

- **Sync, Delay_Req, Follow_Up** and **Delay_Resp** messages are used by ordinary and boundary clocks and communicate time-related information used to synchronize clocks across the network.
- **Pdelay_Req, Pdelay_Resp** and **Pdelay_Resp_Follow_Up** are used by transparent clocks to measure delays across the communications medium so that they can be compensated for by the system. Transparent clocks and these messages associated with them are not available in IEEE 1588-2002.
- **Announce** messages are used by the best master clock algorithm in IEEE 1588-2008 to build a clock hierarchy and select the grandmaster.
- **Management** messages are used by network management to monitor, configure and maintain a PTP system.
- **Signaling** messages are used for non-time-critical communications between clocks. Signaling messages were introduced in IEEE 1588-2008.

Messages are categorized as **Event** and **General** messages. Event messages are time-critical in that accuracy in transmission and receipt timestamp accuracy directly affects clock distribution accuracy.

**Event messages:**

- Sync
- Delay_Req
- Pdelay_Req
- Pdelay_resp

**General messages :**

- Announce
- Follow_Up
- Delay_Resp
- Pdelay_Resp_Follow_Up

General messages are more conventional protocol data units in that the data in these messages is of importance to PTP, but their transmission and receipt timestamps are not.

**Management** and **Signaling** messages are members of the **General** message class.

### 13.1.3 Best master clock algorithm (BMC)

The **best master clock** (BMC) algorithm performs a distributed selection of the best candidate clock based on the following clock properties:

- **Identifier**
  A universally unique numeric identifier for the clock. This is typically constructed based on a device's MAC address.
- **Quality**
  Both versions of IEEE 1588 attempt to quantify clock quality based on expected timing deviation, technology used to implement the clock or location in a stratum schema, although only V1 knows a data field stratum. PTP V2 defines the overall quality of a clock by using the data fields clockAccuracy and clockClass.
- **Priority**
  An administratively assigned precedence hint used by the BMC to help select a grandmaster for the PTP domain. IEEE 1588-2002 used a single boolean variable to indicate precedence. IEEE 1588-2008 features two 8-bit priority fields.
- **Variance**
  A clock's estimate of its stability based on observation of its performance against the PTP reference.

IEEE 1588-2008 uses a hierarchical selection algorithm based on the following properties, in the indicated order:

1 Priority 1
2 Class
3 Accuracy
4 Variance
5 Priority 2
6 Unique identifier (tie breaker)

(1) “PTP technology background”, “PTP Protocol details” and “Best master clock algorithm”: Source: Wikipedia® the free encyclopedia

HBM systems use the following details for BMC:

| | GEN3i/GEN7i GEN3t/GEN7tA | GEN2i/GEN7t/ GEN16t (When using IM2) | QuantumX (B hardware) |
|---|---|---|---|
| **Priority 1** | 128 | 128 | 128 |
| **Class** | 248 | 248 | 248 |
| **Accuracy** | FE | FE | FE |
| **Variance** | FFFF | FFFF | FFFF |
| **Priority 2** | 122 | 125 | 128 |

When using any of the HBM systems listed in this table the systems in the left most column will be granted Master rights based on the BMC algorithm.

Adjustments to synchronize to external clock result in small deviations of the sample period. Technically speaking this could be seen as jitter on the ADC clock, depending on the jitter value this results in noise especially during frequency domain evaluations (FFT).

If sample rates are higher the small corrections are relatively bigger compared to the same adjustment on 100 times lower sample rates. Therefore the choice is made to prioritize the faster sampling systems within the HBM range to become clock master.

**HINT/TIP**

For each field the smallest value will win. Keeping in mind that if e.g. Priority 1 is smaller for System A compared to System B, all other fields are not looked at anymore as the weight of the first field outweighs all other fields.

## 13.2 PTP switch types

Within the PTP specification two types of switches are defined:

- Boundary clock switches
- Transparent clock switches

**Boundary Clock**

Boundary clocks are defined within a PTP system to sit in place of standard network switches or routers. Boundary clocks are defined as PTP clocks with more than a single PTP port, with each port providing access to a separate PTP communication path. The boundary clock acts as an interface between separate PTP domains intercepting and processing all PTP messages and passing all other network traffic. The BMC algorithm is used by the boundary clock to select the best clock any port can see. The chosen port (the one that receives the best clock) is set as a slave and all other ports of the boundary clock are asserted as masters to their domain (to forward the clock).

**Transparent Clock**

Transparent clocks have been added to version 2 of the standard as an improved method of forming cascaded topologies. Rather than acting as a multi-port ordinary clock as boundary clocks do, transparent clocks update a newly introduced time-interval field within PTP event messages. This 64-bit time-interval correction field allows for switch delay compensation to a potential accuracy of less than a picosecond. There are two types of transparent clocks, end-to-end and peer-to-peer. End-to-end transparent clocks update the time interval field for the delay associated with individual packet transfers, whereas peer-to-peer transparent clocks measure the line delay associated with the ingress transmission path and include this delay in the correction field also. Peer-to-peer transparent clocks can allow for faster reconfiguration after network topology changes.

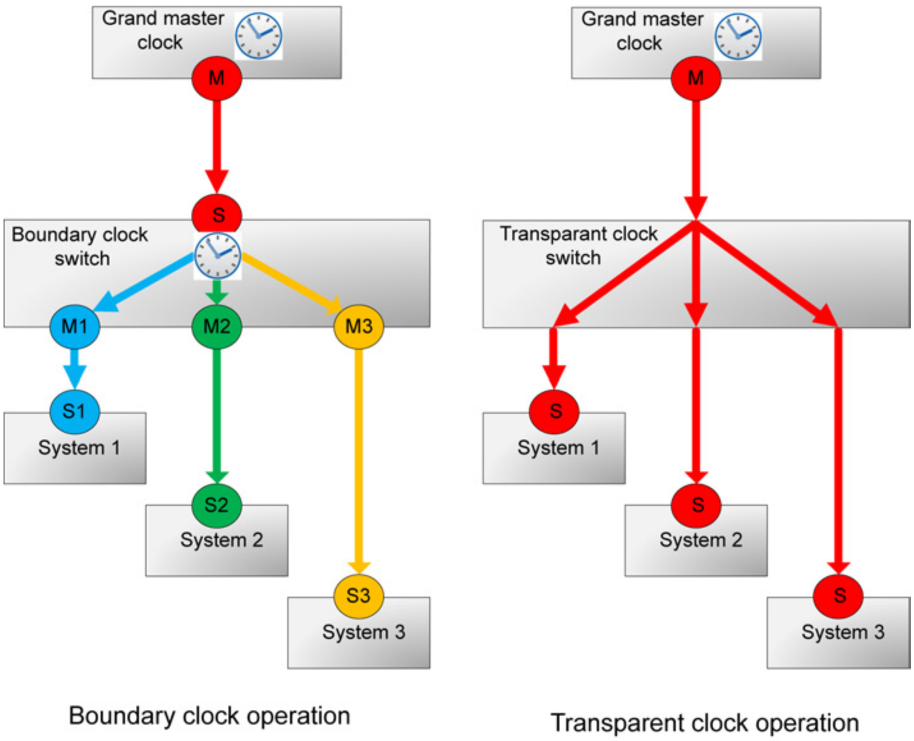



**Figure 13.1:** Boundary clock versus Transparent clock switch synchronization mode

### 13.2.1 Switches using Boundary Clocks

Switches using Boundary clocks have a built in clock and they create separate synchronization domains by segmenting the synchronization path from master clock to several slave clocks. As a result systems down stream of a boundary clock do not directly communicate PTP messages with the selected (grand) master. Standard Ethernet messages are passed through the switch while synchronization messages are used to synchronize the boundary slave clock.

**HINT/TIP**

As boundary clock switches create their own internal clock the overall stability and/or accuracy of your grandmaster clock is no longer available for any of the attached systems.

### 13.2.2 Switches using Transparent Clocks

Switches using Transparent clocks forward the master clock synchronization message to every port of the switch. The time required to transfer the message from the incoming port to the outgoing port must be measured and transferred together with the original synchronization message. There are two methods used to inform the internal delay information to the original synchronization messages:

- End to End
- Peer to Peer

Each of these two methods has its advantages and disadvantages.

**End-to-end transparent clocks**

End-to-end transparent clocks create a higher load on the master clock as the master “sees” all the slaves. End-to-end transparent clocks support a 1:N topology where there is one master communicating with a large number of slaves. They are however, good for linear systems where there are lots of daisy chained clocks.

**Peer-to-peer transparent clocks**

Peer-to-peer clocks avoids the higher master load, but introduce the need to be aware how the synchronization messages are routed through the network topology. They cannot resolve 1:N topologies as they cannot tell which line delay is being calculated and they must also maintain path delay measurements.

**One-step and Two-step clock synchronization**

PTP allows for two different types of time stamping methods:

- **One-step** clock synchronization
  One-step clocks update time information by adjusting the time information within the original synchronization messages (sync and delay-request) on-the-fly.
- **Two-step** clock synchronization
  Two-step clocks transmit the precise timestamps of packets using additional general messages (follow-up and delay-response).

A one-step end-to-end transparent clock updates for switch delay in sync and delay-request messages as they pass through the switch while a two-step transparent clock updates a field in the non-time-critical general message.

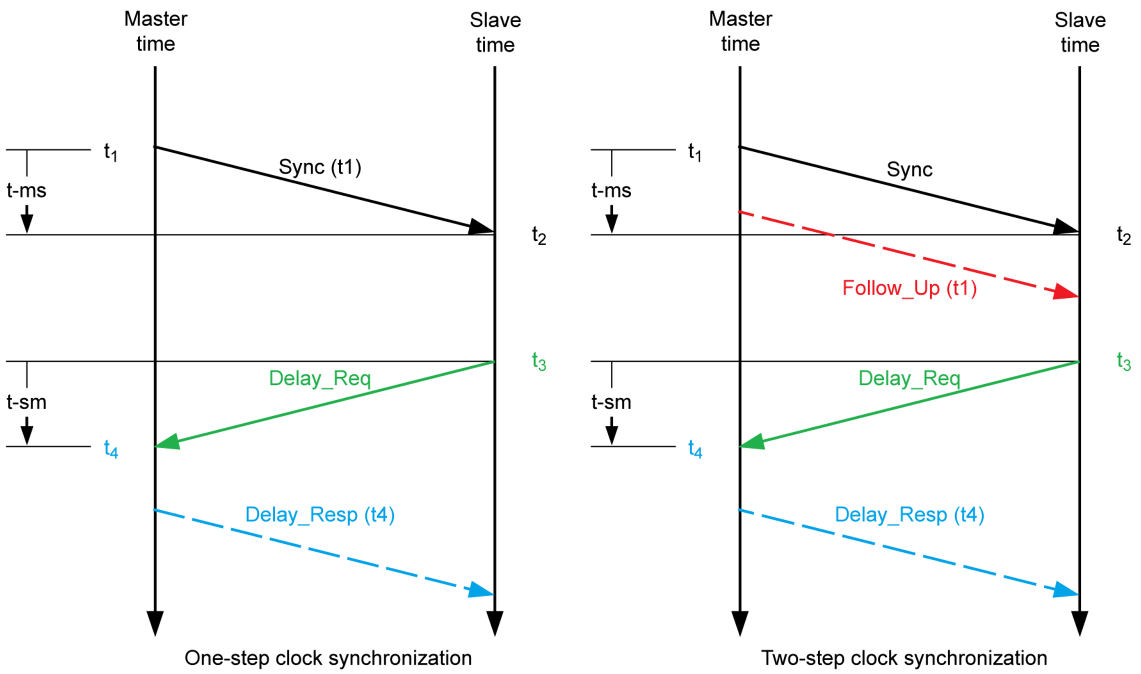



**Figure 13.2:** One-step versus Two-step clock synchronization

HBM systems are designed to work with End-to-End Two-step PTP protocol only. Switches that do not support the End-to-End Two-step PTP protocol are not tested and/or supported by HBM.

## 13.3 Transparent clock switch synchronization

The operation of PTP relies on a measurement of the communication path delay between the time source, referred to as a master, and the receiver, referred to as a slave. This process involves a message transaction between the master and slave where the precise moments of transmit and receive are measured - preferably at the hardware level. Messages containing current time information are adjusted to account for their path delay, therefore providing a more accurate representation of the time information conveyed. The path delay measurement process of PTP involves the precision timing of two messages - a sync message and a delay request. The average path delay of the two messages gives the one-way delay. This however, assumes that the communication path is completely symmetric. This assumption does not hold in a switched network however, largely due to the buffering process within Ethernet switches. PTP provides for transparent clocks to measure and account for this delay in a time-interval field within timing packets, thus making the switches temporary transparent to master and slave nodes. Transparent clocks must perform this operation very accurately and at the communication speed without introducing more delays. The end-to-end transparent clock forwards all messages just as a normal switch.

### 13.3.1 Message-based synchronization

PTP is based upon the transfer of network datagrams to determine system properties and to convey time information. A delay measurement principle is used to determine path delay, which is then accounted for in the adjustment of local clocks. At start up, a master/slave hierarchy is created using what is called the Best Master Clock (BMC) algorithm to determine which clock has the best source of time. The BMC algorithm is then run continuously to quickly adjust for changes in network configuration. Synchronization is achieved using a series of message transactions between master and slaves. There are five message types - Sync, Delay Request, Follow Up, Delay Response and Management - which are used for all aspects of the protocol. A sequence of message transactions takes place to synchronize a pair of clocks as shown in Figure 13.3.

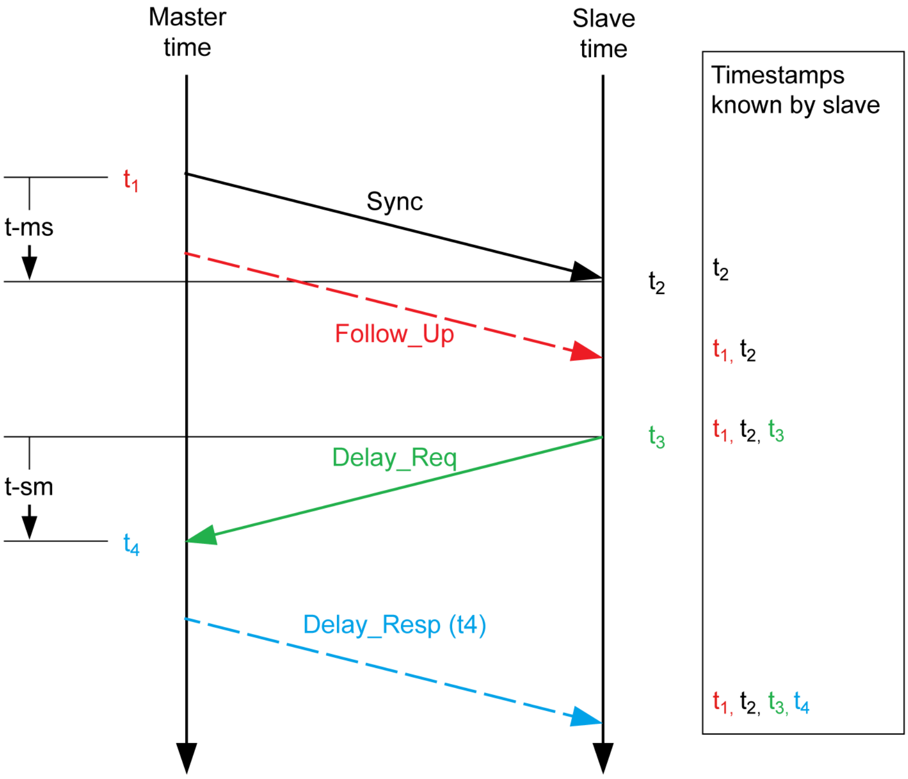



**Figure 13.3:** Master/Slave offset measurement

The message exchange process is as follows:

**1** The master sends a **Sync** message to the slave and notes the time, $\mathbf{t_1}$, at which it was sent.

**2** The slave receives the **Sync** message and notes the time of reception, $\mathbf{t_2}$.

**3** The master conveys to the slave the **timestamp $\mathbf{t_1}$** by either

  **a** Embedding the **timestamp $\mathbf{t_1}$** in the **Sync** message (one-step). This requires some sort of hardware processing for highest accuracy and precision

  **or**

  **b** Embedding the **timestamp $\mathbf{t_1}$** in a **Follow_Up** message (two-step).

**4** The slave sends a **Delay_Req** message to the master and notes the time, $\mathbf{t_3}$, at which it was sent.

**5** The master receives the **Delay_Req** message and notes the time of reception, $\mathbf{t_4}$.

**6** The master conveys to the slave the **timestamp $\mathbf{t_4}$** by embedding it in a **Delay_Resp** message.

After this message exchange the slave will have four timestamps from which can be determined both the slave offset (time offset by which the slave clock leads or lags the master) and the network delay (the time taken for packets to traverse the network link between the two nodes).

The link delay can be calculated as follows:

$$\mathrm{MasterSlave}_{\mathrm{delay}} = t_{ms} = t_2 - t_1$$

$$\mathrm{SlaveMaster}_{\mathrm{delay}} = t_{sm} = t_4 - t_3$$

In each case, the time differences refer to times taken from different clocks which may be offset from each other. However, if the assumption is made that the delay in one direction is the same as the delay in the opposite direction, then the two equations can be combined as follows:

$$\mathrm{Delay} = \frac{(t_2 - t_1) + (t_4 - t_3)}{2}$$

From Figure 13.3, it can be seen that the slave clock offset (the time interval by which the slave leads the master) is given by:

$$\mathrm{Offset} = t_2 - (t_1 + \mathit{Delay})$$

Substituting from Figure 13.3 above:

$$\mathrm{Offset} = t_2 - (t_1 + ½\ [(t_2 - t_1) + (t_4 - t_3)])$$

rearranging gives,

$$\begin{aligned}\mathrm{Offset} &= t_2 - t_1 - ½t_2 + ½t_1 - ½t_4 + ½t_3 \\ &= ½(2 \times t_2 - 2 \times t_1 - t_2 + t_1 - t_4 + t_3) \\ &= \frac{(t_2 - t_1) - (t_4 - t_3)}{2}\end{aligned}$$

If two sets of Sync and Follow up messages are sent, then the drift between the two clocks (the phase change rate) can be found by comparing the Δtime between the successive sync messages.

$$\text{Drift} = \frac{\Delta time_{slave} - \Delta time_{master}}{\Delta time_{master}}$$

### 13.3.2 Switch Delays

The majority of Ethernet switches on the market use a store-and-forward method to decide where to send individual packets. Incoming packets are stored in local memory, the packet is checked for errors before the packet is sent out on the appropriate port/ports. This process introduces variations in the forward and return latency time of the packet. The variations in these delays means that the assumption that packet delay is the same in each direction is invalid, thus rendering the path delay calculations of PTP inoperable. This issue has been compensated for with the use of two special switches, **boundary clocks** and **transparent clocks**, see "PTP switch types" on page 362 for details.

## 13.4 GEN series synchronization methods compared

GEN series systems support four different synchronization methods. Each method has its own pros and cons. It is mostly the customer's application use that determines the correct choice.

| Synchronization overview | | | | |
|---|---|---|---|---|
| | **Master/Slave** | **PTP** | **GPS** | **IRIG** |
| **Signal Phase** | Very good | Very good | Good | Average/Good |
| **Trigger(s) / Sweep(s)** | Very good | Average and extra cabling required | Average and extra cabling required | Average and extra cabling required |
| **Absolute Time of day** | When combined with PTP or GPS | When using a synchronized Grandmaster | Always | When using a synchronized IRIG source |
| **Start of recording** | Very good | Average | Average | Average |
| **Stop of recording** | Average | Average | Average | Average |

As the GEN series systems support several recording modes, the impact of each of these choices needs to be considered with respect to the recording mode.

### 13.4.1 Signal phase shift synchronization

Since typical GEN series applications use sample rates ranging from 10 kS/s to 100 MS/s, channel to channel phase match is the vital system characteristic.

Channel to Channel phase shift is defined as the phase/time differences measured between two channels recording the exact same signal. Phase shifts should therefor not be measured by comparing the first or last samples of a recording or sweep. Measuring phase shift should compare a single signal recorded by mulitple mainframes and then establish the exact time difference of the different signals when shown within Perception.

A quick and easy verification method uses a square wave and compares the rising edge of the square wave. Make sure to use a square wave signal with a period times longer than the expected phase match. This avoids larger phase errors being missed as the different subsequent rising edges can’t be separated from each other. E.g. A square wave of 100 kHz (10 µs period time) and a phase shift of 10 µs would show a 100 % synchronized trace. Lowering the square wave frequency to 10 kHz would suddenly show the 10 µs phase error. When in doubt lower the frequency and measure again.

**HINT/TIP**

As a square wave by definition has an instantaneous transition, it is not possible to establish phase shifts smaller than a single sample period. A complex but more accurate phase shift measurement uses a sine wave of ten times lower speed than the specified phase shift. Using a computed best fit sine wave on both signals allows the extraction of the sine waves phase at point X of each trace. The difference between each calculated sine wave's phase is your phase shift between channels.

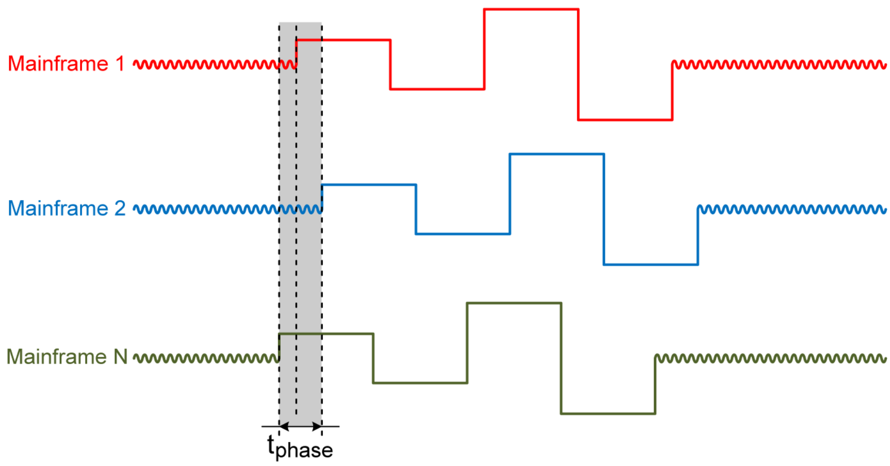



**Figure 13.4:** Determining Phase shift

**HINT/TIP**

Master/Slave and PTP are typically the best choices for phase synchronizing multiple GEN series systems. PTP does not support trigger exchange and should therefore typically be used when using the continuous recording user mode within Perception.

### 13.4.2 Trigger synchronization

When in Single sweep, Multiple sweep, Slow/Fast sweep or dual rate mode, the second most important synchronization after the channel to channel phase match, is the trigger exchange. As sweeps are always initiated by a trigger, the trigger point within each mainframe defines the start and end of the sweep period.

It is important to know that sweeps are shown with the trigger aligned at $t_0$. The net effect will be that triggers received with a time delay will in fact be time shifted in the software as if these triggers happened 100 % synchronous in time. If triggers are not 100 % synchronous on all systems, signal phase shifts are introduced by this effect.

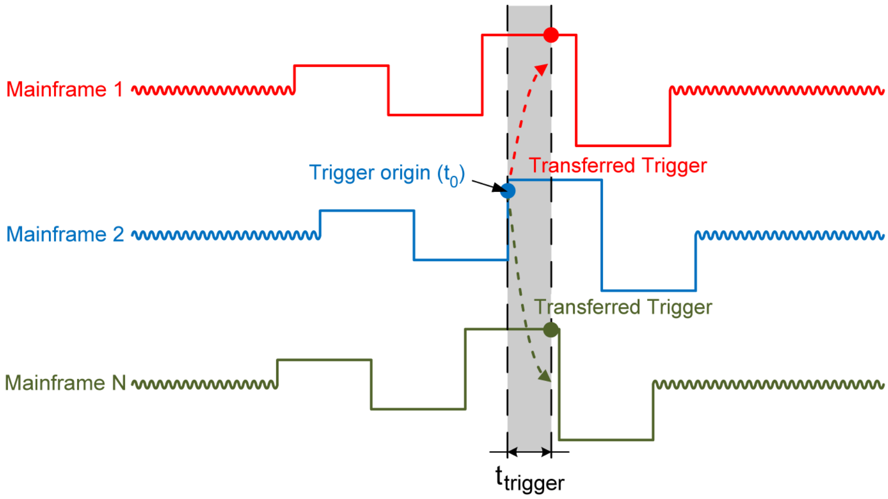



**Figure 13.5:** Triggering due to trigger transfer delays

The above measured signals will appear within Perception as follows:

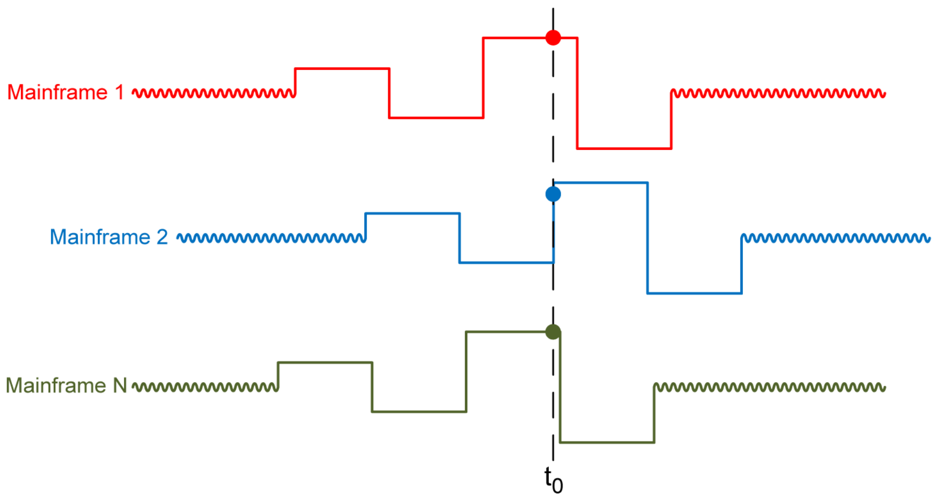



**Figure 13.6:** Signal phase shift introduced by $t_0$ alignment caused by Trigger transfer delays

### 13.4.3 Absolute time of day synchronization

The relevancy of this synchronization is a pure user application requirement. GEN series systems are synchronized to the controlling PC when Perception makes the first connection to the mainframe. If your PC is connected to the internet or an intranet the NTP process running within the operating system will allow the GEN series mainframe to synchronize to approximately 1 sec to absolute time of day.

In most cases this time indication meets the generic requirements to trace the time of day the recording was made.

**HINT/TIP**

GEN series systems store this time inside the PNRF file and set the file date/ time to this same time as well. However copying files from one storage medium to the next e.g. during archiving might change the listed file date and time. Perception software will only use the date/time stored inside the PNRF recording file and this is never affected by the adjustment that might occur while transferring the datafile.

If GEN series recorded data needs to be correlated to other (GEN series) systems that are not directly synchronized to the same time source, a more accurate absolute time of day is required to enable data correlation at a later point in time.

**HINT/TIP**

Whenever a GEN series recording is made using any of the available synchronization methods the need for absolute time of day synchronization is not required to get a correct signal phase match.

A typical use of absolute time of day synchronization would be two GEN series systems each at different locations that can't be connected by wires anymore. Using GPS absolute time synchronization would allow recorded data to be compared even if these two systems were not connected.

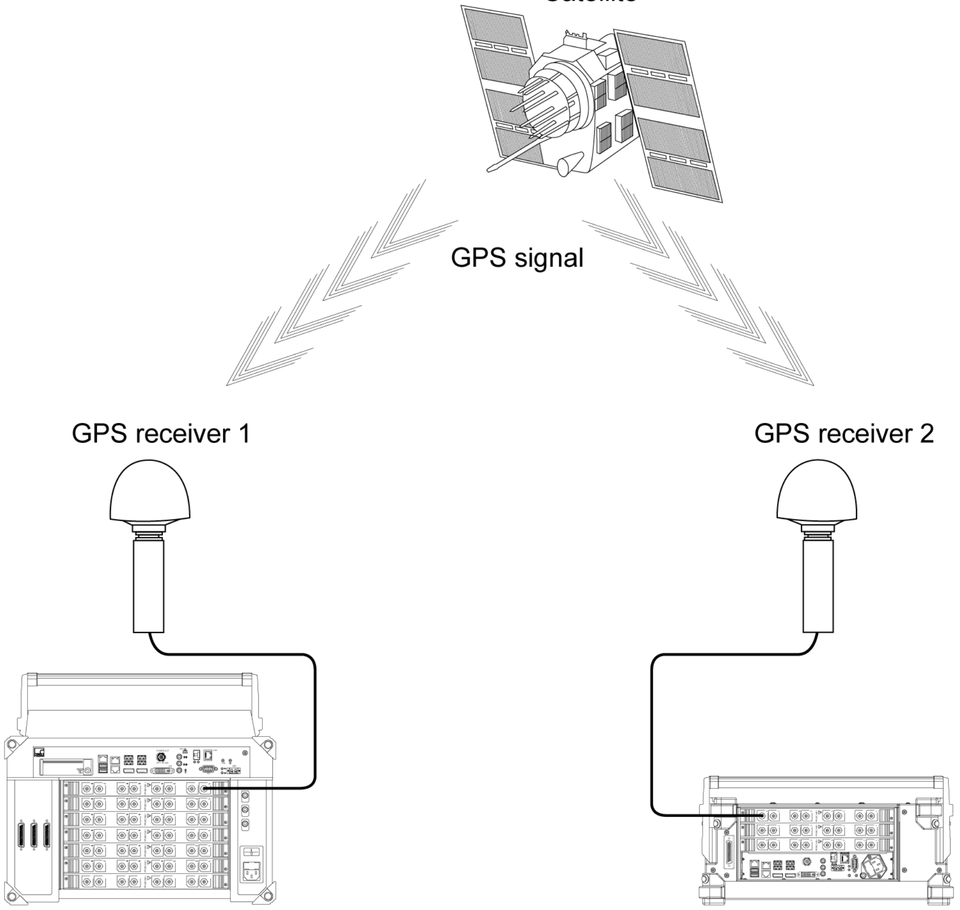



**Figure 13.7:** Typical GPS absolute time of day setup

### 13.4.4 Start/Stop synchronization

When using multiple mainframes in continuous mode expectations typically are that the first sample of each channel aligns. However depending on how the start and stop actions are synchronized this might not be the reality. Within GEN series systems, the response time from e.g. pressing a start button to a mainframe actually capturing the first sample is not specified and varies depending on many parameters like number of acquisition cards within the mainframe, but also the speed of your Windows PC. Given this variation in response a system start should be executed well in time to guarantee the recording of all important data.

When in Single sweep, Multiple sweep or Slow/Fast sweep mode, the start and stop synchronization of the recording is irrelevant. The entire recorded sweep data is determined by the trigger origin with a fixed pre- and post-trigger time frame. Typically in sweep based recordings the acquisition system is started first, checks on all system parts are performed and only when all systems are ready the first trigger is inserted.

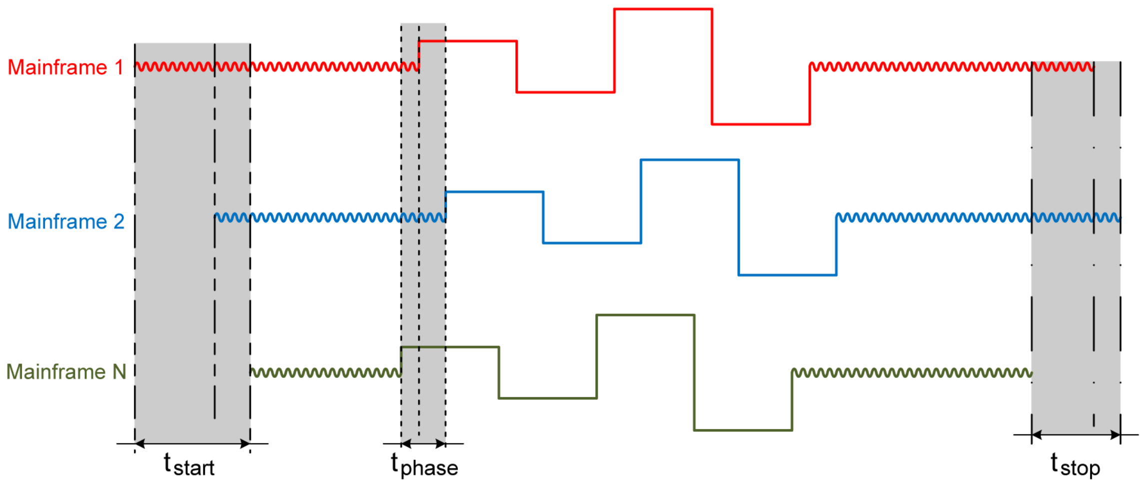



**Figure 13.8:** Measuring start/stop synchronization accuracy

### 13.4.5 Synchronization specification overview

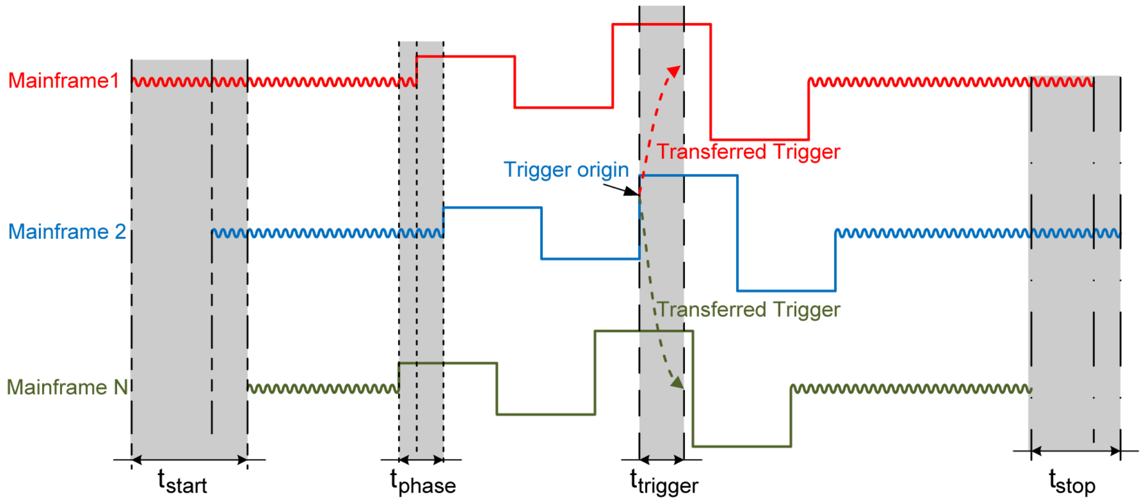



**Figure 13.9:** Synchronization specification overview

| **Delays** | $t_{phase}$ (1) | $t_{start}$ (2) | $t_{stop}$ (3) | $t_{trigger}$ (4) (5) | **QuantumX Support** |
|---|---|---|---|---|---|
| **Master/ Slave** | ≤ 150 ns | ≤ ± cable delay | ≤ ±1 s | ≤ ± 150 ns | Combined using PTP |
| **PTP** | ≤ 150 ns | ≤ ±1 s | ≤ ±1 s | ≤ ± 516 µs + cable delays | Yes |
| **GPS** | ≤ 1 µs | ≤ ±1 s | ≤ ±1 s | ≤ ± 516 µs + cable delays | No |
| **IRIG** | ≤ 10 µs + cable delays | ≤ ±1 s | ≤ ±1 s | ≤ ± 516 µs + cable delays | Technically possible |
| **Un-synchron-ized** | ≤ ±(1 + 0.5 s per hour since connection) | ≤ ±(1 + 0.5 s per hour since connection) | ≤ ±(1 + 0.5 s per hour since connection) | ≤ ±(1 + 0.5 s per hour since connection) | -- |

**(1)** $t_{phase}$ Maximum phase difference between signals. *This specification is not affected by any of the other specifications.*

**(2)** $t_{start}$ Maximum delay between start of recording of each mainframe.

**(3)** $t_{stop}$ Maximum delay between stop of recording of each mainframe.

**(4)** $t_{trigger}$ Maximum delay to transfer a trigger from a mainframe to all other mainframes.

**(5) Note on trigger exchange**
Trigger exchange is included in Master/Slave synchronization cable. All other synchronization modes require mainframes to be connected from each External Trigger Out to each External Trigger In on all mainframes in order to exchange triggers.

# A Specifications

## A.1 B3705-1.0 en (GEN series GEN7t Transient Recorder and Data Acquisition System)

- **Standalone desktop mainframe**
- **Seven slots for acquisition cards**
- **Accepts any mix of GEN DAQ acquisition cards**
- **Up to 224 analog channels**
- **100 MB/s continuous streaming rate**
- **1 Gbit optical Ethernet**
- **10 Gbit optical Ethernet with 200 MB/s continuous streaming rate**
- **IRIG/GPS time synchronization**
- **Master/Slave synchronization**

GEN7t is a robust portable transient recorder and data acquisition system and part of the proven GEN DAQ series data acquisition systems. GEN7t comes with a high-speed standard 1 Gbit Ethernet interface capable of streaming recorded data directly to the PC at data rates up to 100 MB/s. Optional 1 Gbit Optical Ethernet allows isolated control of the mainframe as well as cable lengths up to 10 km while maintaining the full streaming performance. The optional 10 Gbit optical Ethernet interface raises the streaming rate to 200 MB/s to allow higher streaming speed.
When more reliable or distributed storage of recorded data is required the GEN7t mainframe supports a built-in Solid State Disk or can directly store recorded data on a Network Attached Storage (NAS) device.
To synchronize the absolute time to other systems the GEN7t supports the optional IRIG and IRIG/GPS card while synchronizing multiple GEN DAQ systems can be done using the optional Master/Slave card.
GEN7t is configured and controlled using Perception software. This combination results in a sophisticated instrument for ultra-fast recording, analysis and reporting.

**GEN7t Block Diagram**

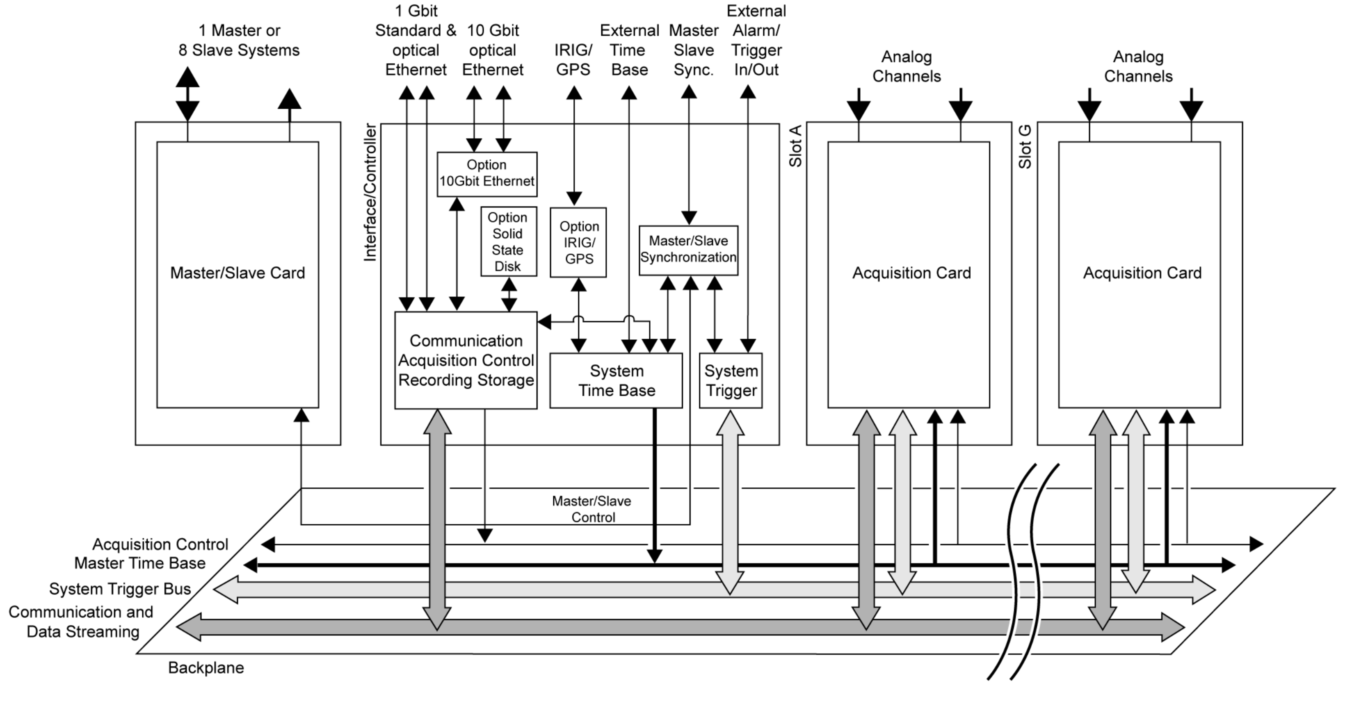


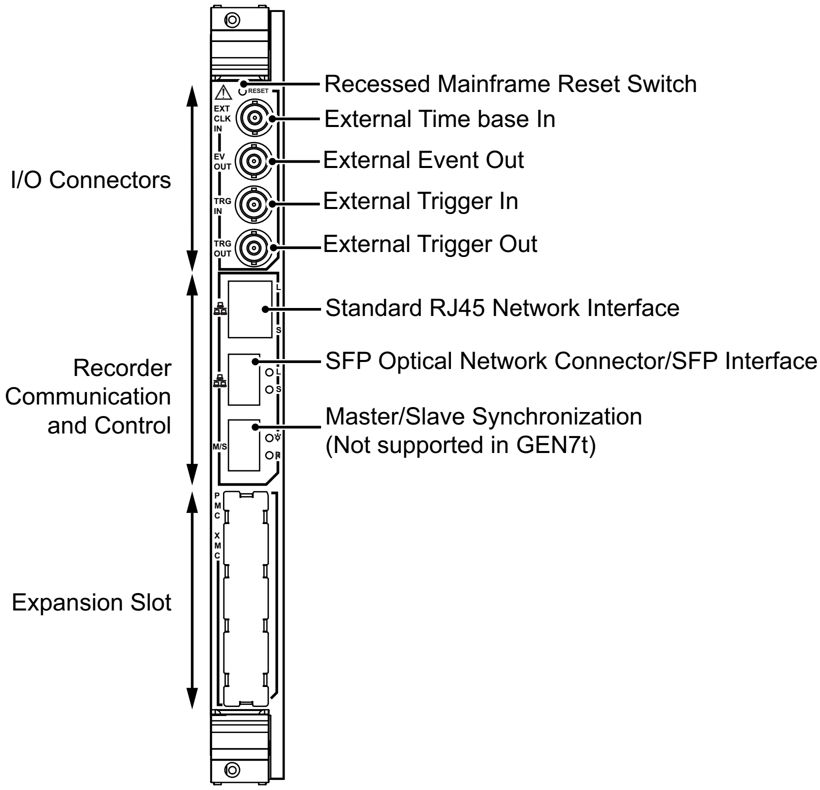

**Figure A.1:** Block Diagram GEN7t Mainframe

| GEN7t System | |
|---|---|
| **Interface/Controller Module**<br>Standard integrated in every GEN DAQ mainframe creates central time base and synchronization. | |
| **Acquisition Slots**<br>Unused slots must be covered using the GEN DAQ blind panel. This closes the mainframe front panels for EMC/EMI and safety compliance but also regulates the internal airflow for correct cooling of the acquisition system. | |
| Number of acquisition card slots | 7 |
| Acquisition cards | All slots support any combination of GEN DAQ acquisition cards |
| Master/Slave card | 1; dedicated Master/Slave slot |
| Digital Event/Timer/Counter connector | 0(1) |
| Thermal control | Every acquisition card and the Interface/Controller module monitors its own temperatures and status. This is used to regulate FAN speeds and reduce noise while optimizing airflow and power consumption. |
| Calibration | Any changes to the acquisition system configuration, may change its internal thermal gradients. As accurate calibration relies on a steady and repeatable thermal environment, calibration will be void if changes are made in the configuration. |
| **Master/Slave slot**<br>Dedicated Master/Slave slot to add one optional Master/Slave card. | |

(1) Digital Event/Timer/Counter supported using the Marker1M card (1-GN6470-2).

| Power | |
|---|---|
| Power Inlet | 90-275 V AC; 47-63 Hz |
| Total Power of unit (maximum) | 450 VA |

IM2 Interface/Controller Module




Systems shipped before January 2012, are equipped with IM1 Interface/Controller Module.

## Recorder Communication and Control

| | |
|---|---|
| Network Interface | |
| Standard 1 Gbit/s Ethernet | 1 Gbit/s, Ethernet, Cat 5e UTP (RJ-45 connector) |
| Optional 1 Gbit/s Ethernet, optical | 1 Gbit/s, optical SFP module using LC connector<br>850 nm optical wavelength, Multi Mode fiber cable, 500 m maximum length or<br>1310 nm optical wavelength, Single Mode fiber cable, 10 km maximum length.<br>Uses dedicated SFP interface |
| Optional 10 Gbit/s Ethernet, optical | Maximum 2 interfaces of 10 Gbit/s optical SFP+ modules using LC connectors<br>850 nm optical wavelength, Multi Mode fiber cable, 66 m maximum length and/or<br>1310 nm optical wavelength, Single Mode fiber cable, 10 km maximum length<br>Uses the XMC/PMC expansion slot |
| TCP/IP | |
| Protocol | IPV4 |
| Address setup | DHCP/Auto IP or fixed IP |
| DHCP setup | When DHCP fails Auto IP setup is used similar to Windows® PC's |
| Gateway setup | Gateway setup supported for control through VPN and/or Internet |
| Maximum Transfer Speed | |
| 1 Gbit/s network to a remote PC | 100 MB/s(1) |
| 10 Gbit/s network to a remote PC | 200 MB/s(1) |
| CPU and Software | |
| CPU | ATOM based |
| Operating System | Linux(2) |

(1) Tested using several combinations of acquisition cards using a Windows® 7 PC with Intel i7 CPU and SSD RAID drive with write speeds exceeding 700 MB/s sustained.

(2) Linux GPL open source code can be downloaded on HBM website.

| Time base and Master/Slave Synchronization | |
|---|---|
| Central Time base(1) | |
| Accuracy | ± 3.5 ppm; aging after 10 years ± 10 ppm(2) |
| Clock base | Binary, Decimal or External |
| Master/Slave Synchronization | Supported by the optional Master/Slave card<br>Master/Slave Synchronization connector only supported by GEN2i mainframes |

(1) The Interface/Controller module provides a central time base for all acquisition cards.

(2) Systems shipped before January 2012: ± 30 ppm.

| I/O Connectors | |
|---|---|
| External Time base In | TTL compatible |
| Pulse width | 100 ns min. |
| Maximum frequency | 5 MHz |
| Active edge | Rising |
| Rounding resolution | 4.01 µs; 250 kS/s and 20 kS/s acquisition cards |
| | 1.01 µs; 1 MS/s and 200 kS/s acquisition cards |
| | 510 ns; 2 MS/s and 200 kS/s (GN611) acquisition cards |
| | 60 ns; 100 MS/s and 25 MS/s acquisition cards |
| Input to sample moment delay | 350 – 400 ns, plus maximum 1 full "rounding resolution" |
| Input overvoltage protection | ± 30 V DC |
| External Trigger In | TTL compatible |
| Resolution | 50 ns |
| Minimum pulse width | 500 ns |
| Active edge | Selectable rising or falling |
| Input overvoltage protection | ± 30 V DC |
| Delay(1) | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| Top Dead Center Rotational input | Used to indicate top dead center in rotational external time base |
| External Trigger Out | TTL compatible |
| Active level | Selectable High/Low/Hold High |
| Pulse width | High or Low selected: 12.8 µs<br>Hold High selected : Active from first trigger to end of recording |
| Output impedance | 50 Ω |
| Short circuit protected | Continuous |
| Delay(1) | 516 ± 1 µs + maximum 1 sample period when Clock base: decimal, Filter: wideband(2) |
| | 504 ± 1 µs + maximum 1 sample period when Clock base: binary, Filter: wideband(2) |
| External Event Out | TTL compatible |
| Function | Selectable Alarm or Recording Active output |
| Active level | Selectable High/Low for Alarm output<br>Recording active High output |
| Pulse width | Alarm: Active from start of alarm condition until condition ends<br>Recording: Active until recording stops |
| Output impedance | 50 Ω |
| Short circuit protected | Continuous |
| Delay(1) | 515 ± 1 µs + maximum 1 sample period when Clock base: decimal, Filter: wideband(2) |
| | 503 ± 1 µs + maximum 1 sample period when Clock base: binary, Filter: wideband(2) |

(1) Delays are equal for all acquisition cards.

(2) If analog and/or digital filter is used extra delay will be added depending on type of filter and signal frequency.

## Local Storage options[1]

| | |
|---|---|
| **Solid State Disk[2]**<br>Built inside the GEN DAQ series mainframes to optimally secure data storage. Recorded data can be copied to permanent archive using Perception software. | |
| Size | 300 GByte |
| Maximum continuous storage speed | 50 MB/s[3], limited by PNRF recording file management on the Interface/Controller module |
| Maximum sweep storage speed | Depends on sweep length and number of channels used |
| File system | Linux EXT4 |
| Connection | SATA-300 |
| Location | Built-in on interface module, not removable |
| Disk | Only HBM qualified disks are supported |
| **iSCSI Storage**<br>Ethernet based SCSI connections to external disks supporting iSCSI; Supports external NAS disks (Network Attached Storage).<br>Embedded Linux from GEN Series Interface/Controller Module directly reads and writes data to the iSCSI disk. | |
| Protocols used | RFC 3720 iSCSI initiator, RFC 3721 naming and discovery |
| Name format structure | iqn.yyyy-mm.domain:device.ID |
| Optional authorization | CHAP, username and password negotiation |
| Maximum continuous storage speed | 40 MB/s[3][4], limited by PNRF recording file management and iSCSI software overhead on the Interface/Controller Module |
| Maximum sweep storage speed | Depends on sweep length and number of channels used |
| File system | Linux EXT4 (not directly readable by Windows® without using 3rd party tools).<br>Recorded data can be read by Perception using a GEN DAQ mainframe connected to the iSCSI drive or any Linux system connected to the iSCSI drive using a SAMBA server. |
| Disk partition size | Maximum 2 TB disk volume |
| GEN DAQ series access | Exclusive iSCSI access required |
| Windows® access | Create network share by using Linux SAMBA server |

(1) Not supported by Instrument panel software. Can only be used in standard Perception software.

(2) Denotes an option that requires factory installation.

(3) Tested using several combinations of acquisition cards.

(4) Appropriate NAS server required to keep up with maximum data rate.
Tested using Synology® DS212+ and RS3412 using 1 Gbit/s or 10 Gbit/s Ethernet links.

## Expansion Slot options (1 slot available)

| | |
|---|---|
| IRIG | IRIG A and B, AM modulated or DCLS (DC level shifted) |
| IRIG/GPS | IRIG A and B, AM modulated or DCLS (DC level shifted)<br>GPS, comes with GPS antenna and 15 m (590") GPS cable (used for time synchronization only) |
| 10 Gbit/s Ethernet | Maximum 2 interfaces of 10 Gbit/s SFP+ modules using LC connectors |

## IRIG, IRIG/GPS (options, to be ordered separately)

| | |
|---|---|
| **IRIG**<br>Factory installed option. Supported by IRIG and IRG/GPS option | |
| Time Code Translator (Input) | |
| Time Code formats | IRIG A and IRIG B, IEEE 1344 compliant<br>AM Modulated or DC level shift (DCLS) |
| Modulation ratio | 3:1 to 6:1 |
| Input amplitude | 500 mV to 5 V Peak-to-Peak |
| Input impedance | >10 kΩ |
| Time Code Output | |
| Time Code format | IRIG B, IEEE 1344 compliant |
| Modulation ratio | 3:1 |
| Output amplitude | 4 V Peak-to-Peak (fixed) into 50 Ω |
| DC level shift | TTL/CMOS |
| AM modulated input/output connectors | 2 SMB sockets; one for input and one for output |
| DCLS connector | Micro DP, 15-pin; some signals internally linked to Interface/Controller Module |
| Time synchronization accuracy | <5 µs modulated, <1 µs (DCLS) |
| GEN DAQ series functions | Capture start of recording time<br>Synchronize Master Time Base oscillator frequency |
| Time required to full synchronization after IRIG signal detected | |
| No recording active | 1 to 5 minutes |
| Recording or pause active | 1 to 5 minutes plus 25 s per ms recording time deviation from IRIG time |
| User notifications while recording | Time marks on IRIG signal lost/restored and IRIG time synchronized |
| Short term tracking stability | 5.0 E-8 |
| Long term tracking “Fly-wheeling” | 5.0 E-7 |
| **GPS**<br>Factory installed option. Only supported by IRG/GPS option | |
| GPS connector | Micro DP, 9-pin |
| GPS antenna | 1; included |
| GPS antenna cable | 50 m (164 ft); included |
| Time synchronization accuracy | <1 µs |
| GEN DAQ series functions | Capture start of recording time<br>Synchronize Master Time Base oscillator frequency |
| GPS localization time | 2 to 15 minutes |
| Time required to full synchronization after GPS localization completed | |
| No recording active | 1 to 10 minutes |
| Recording or pause active | 1 to 10 minutes plus 25 s per ms recording time deviation from IRIG time |
| User notifications while recording | Time marks on GPS satellites lost/restored and GPS time synchronized |
| Short term tracking stability | 5.0 E-8 |
| Long term tracking “Fly-wheeling” | 5.0 E-7 |

| Master/Slave Card (option, to be ordered separately) | |
|---|---|
| Maximum number of mainframes | 9; one Master controlling up to eight Slaves |
| LED signaling | Optical link synchronized, not connected, function disabled |
| Connection topology | Star connection; each Slave directly connected to Master by individual cables |
| Cable type | 850 nm Multi Mode (50/125 µm) optical cable (single 3 m (10 ft) cable included) |
| Maximum cable length | 500 m (1640 ft) |
| Cable length delay compensation | Automatic delay compensation supported |
| Time required to full synchronization after Master/Slave signal detected | |
| No recording active | 1 to 5 minutes |
| Recording or pause active | 1 to 5 minutes plus 25 s per ms recording time deviation from Master time |
| User notifications while recording | Time marks on Master/Slave signal lost/restored and Master/Slave time synchronized |
| Basic Synchronization | |
| First sample | Synchronizes the first sample in the recording for each mainframe |
| Synchronized time base | Prevents frequency drift of the sample rates within each mainframe |
| Channel trigger exchange | Synchronously exchanges every channel trigger connected to the Master/Slave trigger bus to/from each connected mainframe |
| Mainframe to mainframe phase shift | ± 100 ns |
| Extended Synchronization(1) | |
| Synchronous recording actions | Not supported by Master/Slave card |
| Synchronous manual trigger | Not supported by Master/Slave card |

(1) Extended Synchronization only supported by GEN2i Master/Slave Synchronization connector.

| Physical, Weight and Dimensions | |
|---|---|
| Weight | 10 kg (22 lb), add ≈ 1 kg (2.2 lbs) per acquisition card installed |
| Dimensions ( Height * Width * Depth) | 48.69 cm (19.17") * 24.70 cm (9.72") * 38.62 cm (15.20") |
| Cooling Fans | Two; air flow controlled by internal temperature sensors |
| Grounding | Mains; 4 mm Banana plug |
| Casing/Handle | Aluminum and Plastic cover/One carrying handle |

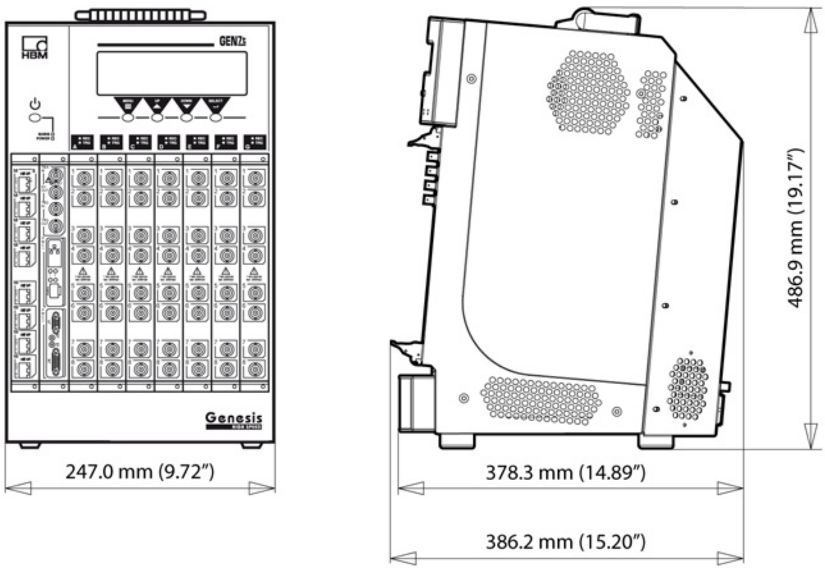



**Figure A.2:** GEN7t model dimensions

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

## Harmonized standards for CE compliance, according to the following directives

Low voltage directive (LVD): 2006/95/EC
Electromagnetic compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Perception Software (option, to be ordered separately)

| | |
|---|---|
| DAQ software | Perception standard package. Refer to Perception specification sheet for details. |
| DAQ software options | Analysis, Advanced Report, Video Playback, Multi Workbooks, Information, Basic FFT, Sensor Database and more |
| DAQ Software and Instrument panel languages | English, German, French, Chinese, Japanese, Korean, Russian, Portuguese (Brazilian) |
| PNRF Free Viewer (Free of Charge) | Opens every PNRF and NRF recording to review the recorded data. Supports display cursors and display markers, quick word reporting, print display, print settings, export to ASCII, Excel, imPRESSion, RTPro and TEAM Data. Does not support any of the standard Perception options. |
| Perception Offline (Free of Charge) | Comes with Perception Configuration Manager. Emulates one or more GEN DAQ systems by loading the GEN DAQ system configuration out of a VWB or PNRF file. Using the Perception Offline version full Perception and GEN DAQ setups can be prepared without the need to have the real systems present. Does not support loading or creating PNRF recordings. |

## Application Programmers Interfaces (API)

| | |
|---|---|
| **PNRF reader (free of charge)** | |
| Functions | Read PNRF, NRF and LRF recording files directly in your own application |
| COM interface | The PNRF reader comes as COM interface and can be used from any application or programming language which supports COM automation |
| PNRF Software Development Kit (SDK) | Installs PNRF dll's and supplies Visual Basic, C# and C++ getting started examples |
| Matlab® integration | Matlab® PNRF reader install and example available within the PNRF SDK |
| LabVIEW™ integration | Available directly from National Instruments |
| **DCE/RPC (Distributed Computing Environment/Remote Procedure Calls)** | |
| Functions | Control Perception software from an external computer/application on Windows®, Linux, Unix, Mac OS X |
| COM interface | All RPC commands have a COM wrapper for easier Windows® software integration |
| Available basic commands | Load and Save Perception setup files, Setup Recording, set and review Hardware Settings, Start/Stop/Pause/Trigger, monitor Live data |
| Examples (free of charge) | C++ and C# getting started example programs supplied for Windows®, source code included. Unsupported Linux getting started example on request only. |
| LabVIEW™ integration (free of charge) | LabVIEW™ getting started example using RPC/COM available |
| **CSI (Customer Software Interface)** | |
| Functions | Create software extension inside the Perception software by adding CSI user sheets, custom automation and extended analysis functions. Basic Windows C# sheet template included. Available for all Microsoft .NET® 4 supporting languages. |
| Available basic controls & commands | Access to every Perception part: Start/Stop/Pause and Trigger, Start Manager, Acquisition System, Hardware Settings, Displays, Meters, User Tables, Formulas, Calculations, Data Manager, Data Sources, User variables, Notifications, Logging, Conversion Functions, Automation Actions, Sheet Manager and more, to create a dedicated application GUI that hides the entire Perception standard GUI |
| Examples (free of charge) | C# getting started example programs supplied, source code included |
| **Training/Support Program** | |
| HBM offers paid professional training and support programs on all API interfaces (PNRF reader, RPC and CSI). Training program will be C# based, on-site or at central HBM location. On-site training can be customer specific. Support can be the development of a full custom software application or answering questions of software engineers. | |

## Acquisition Cards

| Model | Type | Isolation | Max. SR(1) | Resolu-tion | Memory/ card | Channels | Event, T/C(2) | Fast Streaming |
|---|---|---|---|---|---|---|---|---|
| GN810 | Single Ended | no | 200 kS/s | 16 bit | 128 MB | 8 | 0, 0 | no |
| GN811 | Single Ended | no | 1 MS/s | 16 bit | 256 MB | 8 | 0, 0 | no |
| GN812 | Unbalanced Differential | yes | 1 MS/s | 16 bit | 512 MB | 8 | 0, 0 | no |
| GN813 | Unbalanced Differential | yes | 1 MS/s | 16 bit | 512 MB | 8 | 0, 0 | no |
| GN814 | Unbalanced Differential | yes | 200 kS/s | 16 bit | 128 MB | 8 | 0, 0 | no |
| GN410 | Bridge/Differential | yes | 200 kS/s | 16 bit | 128 MB | 4 | 0, 0 | no |
| GN411 | Bridge/Differential | yes | 1 MS/s | 16 bit | 512 MB | 4 | 0, 0 | no |
| GN440 | Differential/IEPE/Shunt | yes | 200 kS/s | 16 bit | 128 MB | 4 | 0, 0 | no |
| GN441 | Differential/IEPE/Shunt | yes | 1 MS/s | 16 bit | 512 MB | 4 | 0, 0 | no |
| GN1611 | Differential | no | 20 kS/s | 16 bit | 200 MB | 16 | 16, 0 | no |
| GN3211 | Differential | no | 20 kS/s | 16 bit | 200 MB | 32 | 16, 0 | no |
| GN1610 | Differential/IEPE/Charge | no | 250 kS/s | 16/24 bit | 2 GB | 16 | 16, 2 | no |
| GN3210 | Differential/IEPE/Charge | no | 250 kS/s | 16/24 bit | 2 GB | 32 | 16, 2 | no |
| GN413 | Differential/Single Ended | no | 25 MS/s | 15 bit | 128 MB | 4 | 0, 0 | no |
| GN412 | Differential/Single Ended | no | 100 MS/s | 14 bit | 2 GB | 4 | 0, 0 | no |
| GN401 | Multi Mode Optical Fiber | yes | 100 MS/s | --(3) | 2 GB | 4(3) | 0, 0 | no |
| GN402 | Single Mode Optical Fiber | yes | 100 MS/s | --(3) | 2 GB | 4(3) | 0, 0 | no |
| GN611 | Balanced Differential | yes | 200 kS/s | 16/18 bit | 200 MB | 6 | 16, 2 | no |
| GN610 | Balanced Differential | yes | 2 MS/s | 16/18 bit | 2 GB | 6 | 16, 2 | no |
| GN816 | Unbalanced Differential | yes | 200 kS/s | 16/18 bit | 200 MB | 8 | 16, 2 | yes |
| GN815 | Unbalanced Differential | yes | 2 MS/s | 16/18 bit | 2 GB | 8 | 16, 2 | yes |
| GN6470 | Binary | no | 1 MS/s | 1 bit | 512 MB | 64 | 0, 0 | no |
| GN4070 | Optical & Binary | yes & no | 1 MS/s | 1 bit | 512 MB | 8 & 32 | 0, 0 | no |

(1) Maximum Sample Rate/channel (not multiplexed).
(2) Digital Events, Timer/Counter channels (Supported by GEN7i, GEN3i, GEN3t and GEN2i Digital Event/Timer/Counter connector only).
(3) This card supports a maximum of four optical fiber transmitter channels.

## Optical Fiber Transmitter Channels

**Transmitter**
Every transmitter is a single channel unit. Every unit has an unbalanced differential input, amplifier, analog anti alias filter and ADC with an optical data and control link to the receiver card. The receiver card has the recording logic, sample rate selection and memory.

| Model | Receiver Card | Power | Sample rate | Resolution | Isolation |
|---|---|---|---|---|---|
| GN110 | Fiber100M 6600 | Battery | 100 MS/s | 14 bit | User application defined |
| GN111 | Fiber100M 6600 | Battery | 25 MS/s | 15 bit | User application defined |
| GN112 | Fiber100M 6600 | 120/240 V AC | 100 MS/s | 14 bit | 1800 V RMS |
| GN113 | Fiber100M 6600 | 120/240 V AC | 25 MS/s | 15 bit | 1800 V RMS |
| GN114 | Fiber100M 7600 | External 12 V DC | 100 MS/s | 14 bit | User application defined |

## Special Function Cards

| | |
|---|---|
| 5B Integration card | Uses one GEN DAQ slot, holds up to six 5B modules. 5B modules, I/O connectors and cabling not included. An acquisition card is required for actual recording.<br>The 5B Series signal conditioning modules provide a low cost method of connecting analog signals with data acquisition systems. They are designed to convert thermocouples, RTD's, strain gauges, frequencies, potentiometers, slide wires and other signals into standardized, isolated analog outputs. |

## Ordering Information[1]

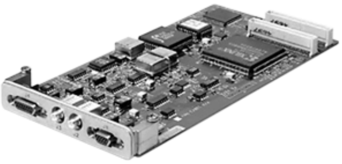
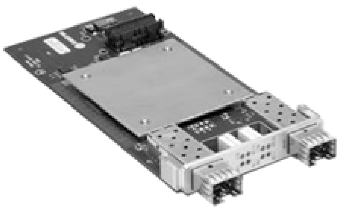
| Article | | Description | Order No. |
|---|---|---|---|
| GEN7t Standalone mainframe |  | GEN7t Tower mainframe with 7 acquisition card slots and 1 dedicated Master/Slave slot. Includes Interface/Controller module with 1 Gbit standard Ethernet interface. Maximum 100 MB/s streaming rate to appropriate PC. Includes iSCSI storage support to enable direct storage on NAS server. Available options include on-board solid state disk, optical Ethernet, IRIG, IRIG/GPS and 10 Gbit optical Ethernet.<br>Requires Perception software with hardware control option to operate the system. Perception software is not included. | 1-GEN7t-2 |

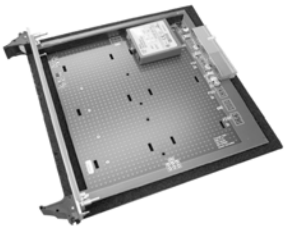
(1) All GEN DAQ series systems are intended for exclusive professional and industrial use.

| Software Options, to be ordered separately[1] | | |
|---|---|---|
| **Article** | **Description** | **Order No.** |
| Perception Standard | For setup and control of a single Gen Series mainframe as well as display of recorded data during and after recording. Runs on 32 and 64 bits versions of Windows® XP, Vista, 7 and 8. Uses maximum 2 GByte of your PC's memory. | 1-PERC-ST-01-2 |
| Perception Advanced | Same as Perception Standard but includes the options: Analysis, Reports, Info Sheets, Exports, Workbooks and Video Playback. | 1-PERC-AD-01-2 |
| Perception Professional | Same as Perception Standard but includes the options Analysis, Reports, Info Sheets, Exports, Workbooks, Video Playback, Basic FFT and Sensor Database. | 1-PERC-PRO-01-2 |
| Perception Enterprise | Same as Perception Professional but runs on native 64 bits Windows® XP, Vista, 7 and 8 only. This version supports the use of more than 2 GByte memory in your PC. Specifically important for systems using multiple mainframes, extensive use of the FFT option and/or large amounts of calculations. | 1-PERC-E64-01-2 |
| Perception Viewer | Same as Perception Standard but without mainframe setup and control. | 1-PERC-VW-01-2 |
| Perception Viewer Advanced | Same as Perception Advanced but without mainframe setup and control. | 1-PERC-VA-01-2 |
| Analysis | Analysis includes +, -, *, /, max, min, RMS and filters using a formula database. | 1-PERC-OP-AN-01-2 |
| Reporting | Create professional reports including displays, tables, text, graphics. | 1-PERC-OP-RP-01-2 |
| Exports | Additional export formats added to Perception. | 1-PERC-OP-MEX-01-2 |
| Info sheets | Allows custom entries and variable definitions to be stored with data. | 1-PERC-OP-IS-01-2 |
| Multiple Workbooks | Simultaneous multiple display windows on multiple monitor systems. | 1-PERC-OP-MWB-01-2 |
| Video Playback | Simultaneous playback of standard video files. | 1-PERC-OP-VP-01-2 |
| Basic FFT | Live FFT while recording (hardware dependent) and Review FFT. | 1 -PERC-OP-BFFT-01 |
| Multiple Mainframes | Simultaneous control of multiple GEN DAQ mainframes. | 1-PERC-OP-MMF-01-2 |
| Sensor Database | Collection of sensors' information, simplifies the set-up of an acquisition channel. | 1-PERC-OP-SDB-01-2 |
| CSI Interface | Allows the development of and running CSI programs. | 1-PERC-OP-CSI-01-2 |
| RPC/COM | Remote control of Perception, including basic hardware setup and control. | 1-PERC-OP-IF-01-2 |
| SEQUENCE | To control BE3200 Test Sequencer from Perception via USB port.<br>Requires Perception Standard or higher (1-PERC-ST-01-2). | 1-PERC-OP-SEQ-01-2 |
| STL Analysis | Special analysis routines according to the STL standard used in LV, MV and HV labs. Includes import of TGD data (Test Data Generator) for verification.<br>Requires Analysis option (1-PERC-OP-AN-01-2). | 1-PERC-OP-STL-01-2 |
| HPHV-AA | HighPower/HighVoltage automated analysis. Evaluates data of NoLoad, ShortCircuit, Capacitive and Synthetic tests of HV/MV switchgear devices (requires signals from tripping coils and travel to be recorded).<br>Requires STL Analysis option (1-PERC-OP-STL-01-2). | 1-PERC-OP-HHP-01-2 |
| HV-IA | High Voltage Impulse Analysis option; evaluates Lightning, Switching and Current impulses; designed according to IEC60060-1 and IEC61083-2 requirements. Allows evaluation with new k-factor method. | 1-PERC-OP-HIA-01-2 |
| eDrive | Allows easy and application oriented setup and efficiency calculations of electrical inverter / drive tests with minimum interaction. | 1-PERC-OP-EDR-01-2 |

(1) Software options are also sold in multiple license packages and multiple network license seats.

## Options, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| IRIG PMC card |  | Factory installed option.<br>GEN DAQ IRIG interface fits into open XMC/PMC slot of GEN DAQ Interface/Controller module.<br>Cannot be used in combination with 10 Gbit Ethernet XMC card. | 1-G001-1 |
| IRIG/GPS PMC card | | Factory installed option.<br>GEN DAQ IRIG/GPS interface fits into open XMC/PMC slot of GEN DAQ Interface/Controller module, comes with antenna and 15 m cable.<br>Cannot be used in combination with 10 Gbit Ethernet XMC card. | 1-G002-2 |
| Solid State Disk |  | Factory installed option.<br>GEN DAQ Internal SSD drive in GEN DAQ mainframe, 300 GB capacity, 50 MB/s continuous streaming rate. Sweep storage rate depending on sweep length and number of channels. Short sweeps are stored slower due to administration overhead. | 1-G061-2 |
| 1 Gbit Optical Network SFP module 850 nm |  | GEN DAQ 1 Gbit Ethernet SFP, 850 nm Multi Mode, up to 500 m optical cable length supported, LC connector support.<br>1 Gbit SFP modules are not compatible with the 10 Gbit SFP+ modules. | 1-G062-2 |
| 1 Gbit Optical Network SFP module 1310 nm | | GEN DAQ 1 Gbit Ethernet SFP, 1310 nm Single Mode, up to 10 km optical cable length supported, LC connector support.<br>1 Gbit SFP modules are not compatible with the 10 Gbit SFP+ modules. | 1-G063-2 |
| 10 Gbit Ethernet XMC card |  | Factory installed option.<br>GEN DAQ 10 Gbit Ethernet XMC card adds up to 2 extra 10 Gbit Ethernet network connections to a GEN DAQ series mainframe. Supports up to 200 MB/s continuous data transfer from the GEN DAQ mainframe to an appropriate PC. Requires a 10 Gbit optical network SFP+ module. Cannot be used in combination with IRIG or IRIG/GPS PMC card. | 1-G064-2 |
| 10 Gbit Optical Network SFP+ module 850 nm |  | GEN DAQ 10 Gbit Ethernet SFP+, 850 nm Multi Mode, up to 66 m optical cable length supported, LC connector support.<br>10 Gbit SFP+ modules are not compatible with the 1 Gbit SFP modules. | 1-G065-2 |
| 10 Gbit Optical Network SFP+ module 1310 nm | | GEN DAQ 10 Gbit Ethernet SFP+, 1310 nm Single Mode, up to 10 km optical cable length supported, LC connector support.<br>10 Gbit SFP+ modules are not compatible with the 1 Gbit SFP modules. | 1-G066-2 |
| Master/Slave card |  | GEN DAQ Master/Slave option. Uses first slot in GEN16t rack, GEN2i and GEN5i integrated mainframes and the Master/Slave slot in GEN7t tower mainframe. The Master/Slave card is needed in master and any slave mainframe. Supports up to eight slaves using optical connections. Single 3 m (10 ft) optical cable included. | 1-G040-2 |

| Accessories, to be ordered separately | | | |
|---|---|---|---|
| **Article** | | **Description** | **Order No.** |
| Fiber cable standard MM LC-LC |  | GEN DAQ standard zipcord fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, LC-LC connectors, aqua, ISO/IEC 11801 type OM3. Typically used for fixed cable routing or LAB environments.<br>Lengths 3, 10, 20 and 50 meter (10, 33, 66 and 164 ft)<br><br>Used with 850 nm optical 1 Gbit or 10 Gbit Ethernet. (1-G062-2 and 1-G065-2) and Master/ Slave synchronizations. | 1-KAB280-3<br>1-KAB280-10<br>1-KAB280-20<br>1-KAB280-50 |
| Fiber optic Single Mode standard cable |  | GEN DAQ standard zipcord fiber optic duplex Single Mode 9/125 µm cable, 0.5 dB/km loss, LC-LC connectors, yellow, ISO/IEC 11801 type OS2. Typically used for fixed cable routing or LAB environments.<br>Lengths 2, 10, 20, 50 and 100 meter (6.5, 33, 66, 164 and 328 ft)<br><br>Used with 1310 nm optical 1 Gbit or 10 Gbit Ethernet (1-G063-2 and 1-G066-2). | 1-KAB288-2<br>1-KAB288-10<br>1-KAB288-20<br>1-KAB288-50<br>1-KAB288-100 |
| Fiber optic Single Mode heavy duty cable |  | GEN DAQ heavy duty fiber optic duplex Single Mode 9/125 µm cable, 0.5 dB/km loss, LC-LC connectors, black, ISO/IEC 11801 type OS2. Typically used for test cell environments.<br>Lengths 10, 20, 50, 100, 150 and 300 meter (33, 66, 164, 328, 492 and 984 ft)<br><br>Used with 1310 nm optical 1 Gbit or 10 Gbit Ethernet (1-G063-2 and 1-G066-2). | 1-KAB289-10<br>1-KAB289-20<br>1-KAB289-50<br>1-KAB289-100<br>1-KAB289-150<br>1-KAB289-300 |
| 5B Integration card |  | GEN DAQ 5B Integration card. Uses one GEN DAQ slot, holds up to six 5B modules. 5B modules, I/O connectors and cabling not included. Basic card required for acquisition. | 1-G028-2 |

## A.2 B3720-1.0 en (GEN series GEN16t Transient Recorder and Data Acquisition System)

- **Rack mount 19" mainframe**
- **16 slots for acquisition cards**
- **Accepts any mix of GEN DAQ acquisition cards**
- **Up to 512 analog channels**
- **100 MB/s continuous streaming rate**
- **1 Gbit optical Ethernet**
- **10 Gbit optical Ethernet with  200 MB/s continuous streaming rate**
- **IRIG/GPS time synchronization**
- **Master/Slave synchronization**

GEN16t is a robust rack mount transient recorder and data acquisition system and part of the proven GEN DAQ series data acquisition systems. GEN16t comes with a high-speed standard 1 Gbit Ethernet interface capable of streaming recorded data directly to the PC at data rates up to 100 MB/s. Optional 1 Gbit Optical Ethernet allows isolated control of the mainframe as well as cable lengths up to 10 km while maintaining the full streaming performance. The optional 10 Gbit optical Ethernet interface raises the streaming rate to 200 MB/s to allow higher streaming speed.
When more reliable or distributed storage of recorded data is required the GEN16t mainframe supports a built-in Solid State Disk or can store recorded data directly on a Network Attached Storage (NAS) device.
To synchronize the absolute time to other systems the GEN16t supports the optional IRIG and IRIG/GPS card while synchronizing multiple GEN DAQ systems can be done using the optional Master/Slave card.
GEN16t is configured and controlled using Perception software. This combination results in a sophisticated instrument for ultra-fast recording, analysis and reporting.

### GEN16t Block Diagram

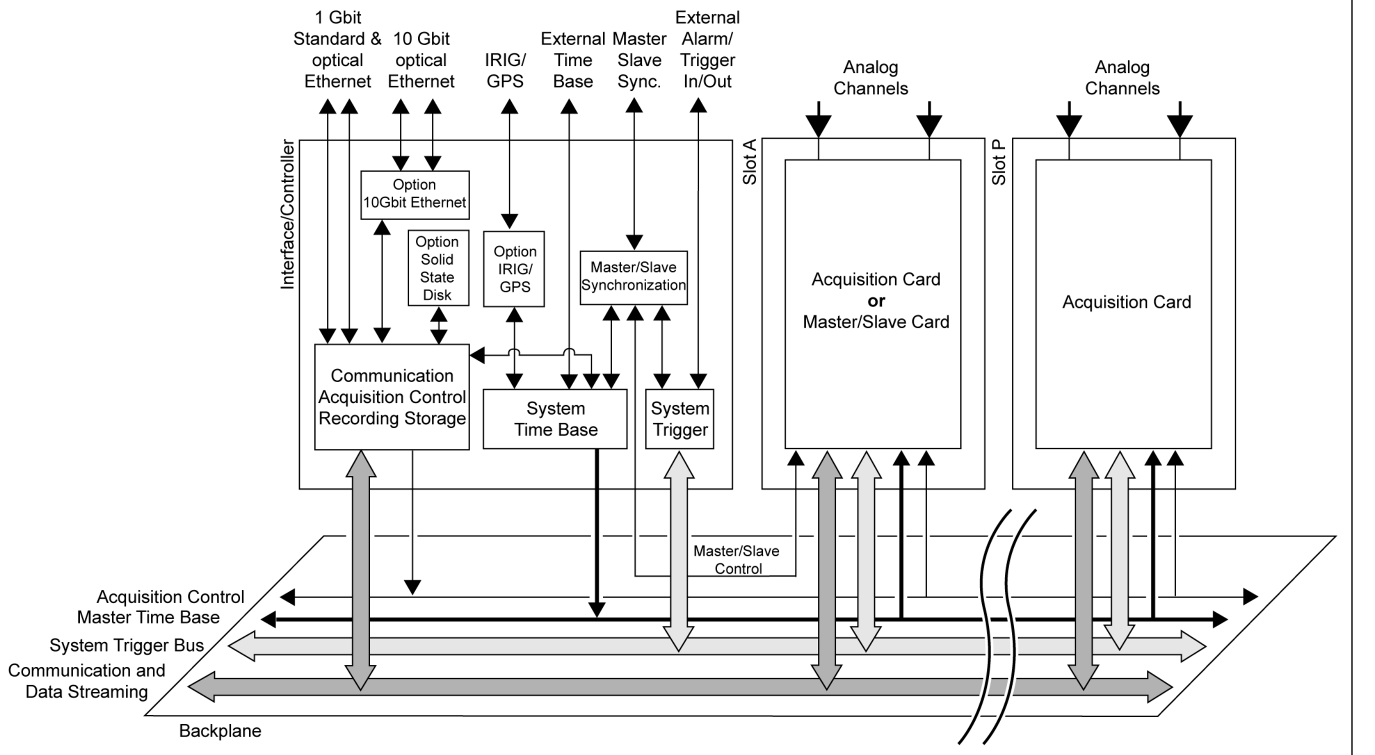



**Figure A.3:** Block Diagram GEN16t Mainframe

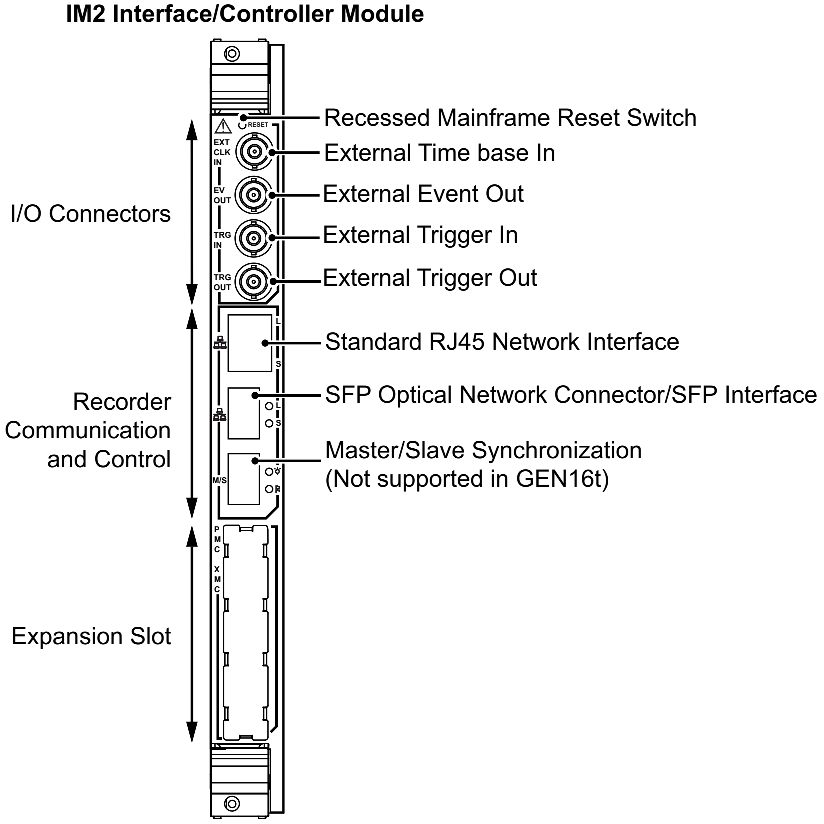
## GEN16t System

| | |
|---|---|
| **Interface/Controller Module**<br>Standard integrated in every GEN DAQ mainframe creates central time base and synchronization. | |
| **Acquisition Slots**<br>Unused slots must be covered using the GEN DAQ blind panel. This closes the mainframe front panels for EMC/EMI and safety compliance but also regulates the internal airflow for correct cooling of the acquisition system. | |
| Number of acquisition card slots | 16 |
| Acquisition cards | All slots support any combination of GEN DAQ acquisition cards |
| Master/Slave card | 1; Master/Slave card supported in Slot A only |
| Digital Event/Timer/Counter connector | 0 (1) |
| Thermal control | Every acquisition card and the Interface/Controller module monitors its own temperatures and status. This is used to regulate fan speeds and reduce noise while optimizing airflow and power consumption. |
| Calibration | Any changes to the acquisition system configuration, may change its internal thermal gradients. As accurate calibration relies on a steady and repeatable thermal environment, calibration will be void if changes are made in the configuration. |
| **Master/Slave slot**<br>Acquisition card Slot A has special features to add one optional Master/Slave card. When Master/Slave card is installed this slot can not be used for Acquisition cards. | |

(1) Digital Event/Timer/Counter supported using the Marker1M card (1-GN6470-2).

## Power

| | |
|---|---|
| Power Inlet | 100 - 240 V AC; 47-63 Hz |
| Total Power of unit (maximum) | 1200 VA |




Systems shipped before January 2012, are equipped with IM1 Interface/Controller Module.

## Recorder Communication and Control

| | |
|---|---|
| Network Interface | |
| Standard 1 Gbit/s Ethernet | 1 Gbit/s, Ethernet, Cat 5e UTP (RJ-45 connector) |
| Optional 1 Gbit/s Ethernet, optical | 1 Gbit/s, optical SFP module using LC connector<br>850 nm optical wavelength, Multi Mode fiber cable, 500 m maximum length or<br>1310 nm optical wavelength, Single Mode fiber cable, 10 km maximum length.<br>Uses dedicated SFP interface |
| Optional 10 Gbit/s Ethernet, optical | Maximum 2 interfaces of 10 Gbit/s optical SFP+ modules using LC connectors<br>850 nm optical wavelength, Multi Mode fiber cable, 66 m maximum length and/or<br>1310 nm optical wavelength, Single Mode fiber cable, 10 km maximum length<br>Uses the XMC/PMC expansion slot |
| TCP/IP | |
| Protocol | IPV4 |
| Address setup | DHCP/Auto IP or fixed IP |
| DHCP setup | When DHCP fails Auto IP setup is used similar to Windows® PC's |
| Gateway setup | Gateway setup supported for control through VPN and/or Internet |
| Maximum Transfer Speed | |
| 1 Gbit/s network to a remote PC | 100 MB/s(1) |
| 10 Gbit/s network to a remote PC | 200 MB/s(1) |
| CPU and Software | |
| CPU | ATOM based |
| Operating System | Linux(2) |

(1) Tested using several combinations of acquisition cards using a Windows® 7 PC with Intel i7 CPU and SSD RAID drive with write speeds exceeding 700 MB/s sustained.

(2) Linux GPL open source code can be downloaded on HBM website.

| Time base and Master/Slave Synchronization | |
|---|---|
| Central Time base(1) | |
| Accuracy | ± 3.5 ppm; aging after 10 years ± 10 ppm(2) |
| Clock base | Binary, Decimal or External |
| Master/Slave Synchronization | Supported by the optional Master/Slave card<br>Master/Slave Synchronization connector only supported by GEN2i mainframes |

(1) The Interface/Controller module provides a central time base for all acquisition cards.

(2) Systems shipped before January 2012: ± 30 ppm.

| I/O Connectors | |
|---|---|
| External Time base In | TTL compatible |
| Pulse width | 100 ns min. |
| Maximum frequency | 5 MHz |
| Active edge | Rising |
| Rounding resolution | 4.01 µs; 250 kS/s and 20 kS/s acquisition cards |
| | 1.01 µs; 1 MS/s and 200 kS/s acquisition cards |
| | 510 ns; 2 MS/s and 200 kS/s (GN611) acquisition cards |
| | 60 ns; 100 MS/s and 25 MS/s acquisition cards |
| Input to sample moment delay | 350 – 400 ns, plus maximum 1 full "rounding resolution" |
| Input overvoltage protection | ± 30 V DC |
| External Trigger In | TTL compatible |
| Resolution | 50 ns |
| Minimum pulse width | 500 ns |
| Active edge | Selectable rising or falling |
| Input overvoltage protection | ± 30 V DC |
| Delay(1) | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| Top Dead Center Rotational input | Used to indicate top dead center in rotational external time base |
| External Trigger Out | TTL compatible |
| Active level | Selectable High/Low/Hold High |
| Pulse width | High or Low selected: 12.8 µs<br>Hold High selected : Active from first trigger to end of recording |
| Output impedance | 50 Ω |
| Short circuit protected | Continuous |
| Delay(1) | 516 ± 1 µs + maximum 1 sample period when Clock base: decimal, Filter: wideband(2) |
| | 504 ± 1 µs + maximum 1 sample period when Clock base: binary, Filter: wideband(2) |
| External Event Out | TTL compatible |
| Function | Selectable Alarm or Recording Active output |
| Active level | Selectable High/Low for Alarm output<br>Recording active High output |
| Pulse width | Alarm: Active from start of alarm condition until condition ends<br>Recording: Active until recording stops |
| Output impedance | 50 Ω |
| Short circuit protected | Continuous |
| Delay(1) | 515 ± 1 µs + maximum 1 sample period when Clock base: decimal, Filter: wideband(2) |
| | 503 ± 1 µs + maximum 1 sample period when Clock base: binary, Filter: wideband(2) |

(1) Delays are equal for all acquisition cards.

(2) If analog and/or digital filter is used extra delay will be added depending on type of filter and signal frequency.

| Local Storage options[1] | |
|---|---|
| **Solid State Disk[2]**<br>Built inside the GEN DAQ series mainframes to optimally secure data storage. Recorded data can be copied to permanent archive using Perception software. | |
| Size | 300 GByte |
| Maximum continuous storage speed | 50 MB/s[3], limited by PNRF recording file management on the Interface/Controller module |
| Maximum sweep storage speed | Depends on sweep length and number of channels used |
| File system | Linux EXT4 |
| Connection | SATA-300 |
| Location | Built-in on interface module, not removable |
| Disk | Only HBM qualified disks are supported |
| **iSCSI Storage**<br>Ethernet based SCSI connections to external disks supporting iSCSI; Supports external NAS disks (Network Attached Storage). Embedded Linux from GEN Series Interface/Controller Module directly reads and writes data to the iSCSI disk. | |
| Protocols used | RFC 3720 iSCSI initiator, RFC 3721 naming and discovery |
| Name format structure | iqn.yyyy-mm.domain:device.ID |
| Optional authorization | CHAP, username and password negotiation |
| Maximum continuous storage speed | 40 MB/s[3][4], limited by PNRF recording file management and iSCSI software overhead on the Interface/Controller Module |
| Maximum sweep storage speed | Depends on sweep length and number of channels used |
| File system | Linux EXT4 (not directly readable by Windows® without using 3rd party tools).<br>Recorded data can be read by Perception using a GEN DAQ mainframe connected to the iSCSI drive or any Linux system connected to the iSCSI drive using a SAMBA server. |
| Disk partition size | Maximum 2 TB disk volume |
| GEN DAQ series access | Exclusive iSCSI access required |
| Windows® access | Create network share by using Linux SAMBA server |

(1) Not supported by Instrument panel software. Can only be used in standard Perception software.

(2) Denotes an option that requires factory installation.

(3) Tested using several combinations of acquisition cards.

(4) Appropriate NAS server required to keep up with maximum data rate.
Tested using Synology® DS212+ and RS3412 using 1 Gbit/s or 10 Gbit/s Ethernet links.

| Expansion Slot options (1 slot available) | |
|---|---|
| IRIG | IRIG A and B, AM modulated or DCLS (DC level shifted) |
| IRIG/GPS | IRIG A and B, AM modulated or DCLS (DC level shifted)<br>GPS, comes with GPS antenna and 15 m (590") GPS cable (used for time synchronization only) |
| 10 Gbit/s Ethernet | Maximum 2 interfaces of 10 Gbit/s SFP+ modules using LC connectors |

| IRIG, IRIG/GPS (options, to be ordered separately) | |
|---|---|
| **IRIG**<br>Factory installed option. Supported by IRIG and IRG/GPS option | |
| Time Code Translator (Input) | |
| Time Code formats | IRIG A and IRIG B, IEEE 1344 compliant<br>AM Modulated or DC level shift (DCLS) |
| Modulation ratio | 3:1 to 6:1 |
| Input amplitude | 500 mV to 5 V Peak-to-Peak |
| Input impedance | >10 kΩ |
| Time Code Output | |
| Time Code format | IRIG B, IEEE 1344 compliant |
| Modulation ratio | 3:1 |
| Output amplitude | 4 V Peak-to-Peak (fixed) into 50 Ω |
| DC level shift | TTL/CMOS |
| AM modulated input/output connectors | 2 SMB sockets; one for input and one for output |
| DCLS connector | Micro DP, 15-pin; some signals internally linked to Interface/Controller Module |
| Time synchronization accuracy | <5 µs modulated, <1 µs (DCLS) |
| GEN DAQ series functions | Capture start of recording time<br>Synchronize Master Time Base oscillator frequency |
| Time required to full synchronization after IRIG signal detected | |
| No recording active | 1 to 5 minutes |
| Recording or pause active | 1 to 5 minutes plus 25 s per ms recording time deviation from IRIG time |
| User notifications while recording | Time marks on IRIG signal lost/restored and IRIG time synchronized |
| Short term tracking stability | 5.0 E-8 |
| Long term tracking “Fly-wheeling” | 5.0 E-7 |
| **GPS**<br>Factory installed option. Only supported by IRG/GPS option | |
| GPS connector | Micro DP, 9-pin |
| GPS antenna | 1; included |
| GPS antenna cable | 50 m (164 ft); included |
| Time synchronization accuracy | <1 µs |
| GEN DAQ series functions | Capture start of recording time<br>Synchronize Master Time Base oscillator frequency |
| GPS localization time | 2 to 15 minutes |
| Time required to full synchronization after GPS localization completed | |
| No recording active | 1 to 10 minutes |
| Recording or pause active | 1 to 10 minutes plus 25 s per ms recording time deviation from IRIG time |
| User notifications while recording | Time marks on GPS satellites lost/restored and GPS time synchronized |
| Short term tracking stability | 5.0 E-8 |
| Long term tracking “Fly-wheeling” | 5.0 E-7 |

## Master/Slave Card (option, to be ordered separately)

| | |
|---|---|
| Maximum number of mainframes | 9; one Master controlling up to eight Slaves |
| LED signaling | Optical link synchronized, not connected, function disabled |
| Connection topology | Star connection; each Slave directly connected to Master by individual cables |
| Cable type | 850 nm Multi Mode (50/125 µm) optical cable (single 3 m (10 ft) cable included) |
| Maximum cable length | 500 m (1640 ft) |
| Cable length delay compensation | Automatic delay compensation supported |
| Time required to full synchronization after Master/Slave signal detected | |
| No recording active | 1 to 5 minutes |
| Recording or pause active | 1 to 5 minutes plus 25 s per ms recording time deviation from Master time |
| User notifications while recording | Time marks on Master/Slave signal lost/restored and Master/Slave time synchronized |
| Basic Synchronization | |
| First sample | Synchronizes the first sample in the recording for each mainframe |
| Synchronized time base | Prevents frequency drift of the sample rates within each mainframe |
| Channel trigger exchange | Synchronously exchanges every channel trigger connected to the Master/Slave trigger bus to/from each connected mainframe |
| Mainframe to mainframe phase shift | ± 100 ns |
| Extended Synchronization(1) | |
| Synchronous recording actions | Not supported by Master/Slave card |
| Synchronous manual trigger | Not supported by Master/Slave card |

(1) Extended Synchronization only supported by GEN2i Master/Slave Synchronization connector.

## Physical, Weight and Dimensions

| | |
|---|---|
| Weight | 22.7 kg (50 LB), add ≈ 1 kg (2.2 lbs) per acquisition card installed |
| Dimensions ( Height * Width * Depth) | 411 mm (16.20") * 482 mm (18.99") * 501 mm (19.72") |
| Cooling Fans | Six; air flow controlled by internal temperature sensors |
| Grounding | Mains; 4 mm Banana plug |
| Casing/Handle | Aluminum and Plastic cover/One carrying handle |

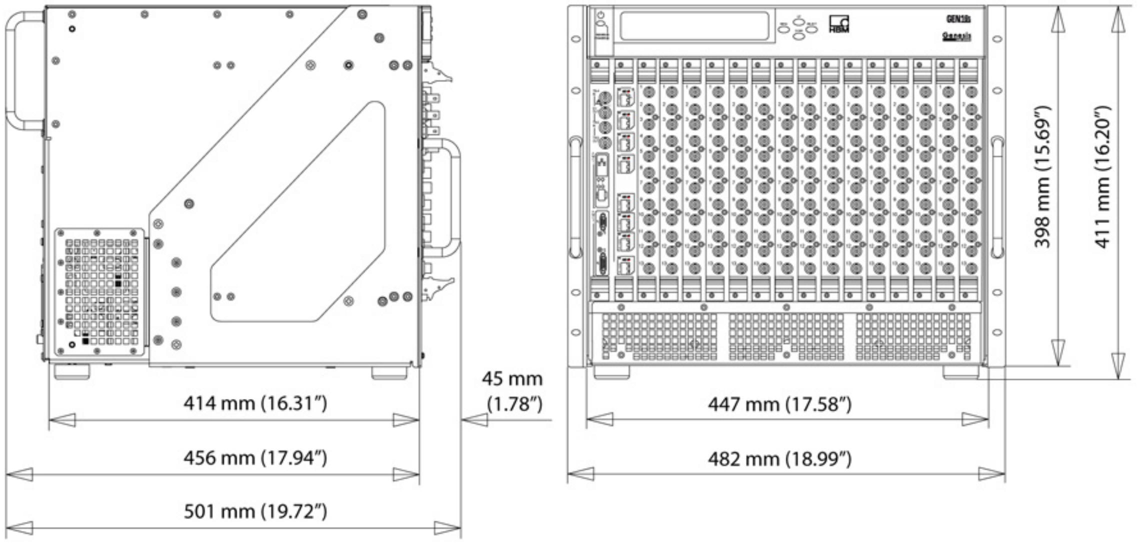



**Figure A.4:** GEN16t model dimensions

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

## Harmonized standards for CE compliance, according to the following directives

Low voltage directive (LVD): 2006/95/EC
Electromagnetic compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Perception Software (option, to be ordered separately)

| | |
|---|---|
| DAQ software | Perception standard package. Refer to Perception specification sheet for details. |
| DAQ software options | Analysis, Advanced Report, Video Playback, Multi Workbooks, Information, Basic FFT, Sensor Database and more |
| DAQ Software and Instrument panel languages | English, German, French, Chinese, Japanese, Korean, Russian, Portuguese (Brazilian) |
| PNRF Free Viewer (Free of Charge) | Opens every PNRF and NRF recording to review the recorded data. Supports display cursors and display markers, quick word reporting, print display, print settings, export to ASCII, Excel, imPRESSion, RTPro and TEAM Data. Does not support any of the standard Perception options. |
| Perception Offline (Free of Charge) | Comes with Perception Configuration Manager. Emulates one or more GEN DAQ systems by loading the GEN DAQ system configuration out of a VWB or PNRF file. Using the Perception Offline version full Perception and GEN DAQ setups can be prepared without the need to have the real systems present. Does not support loading or creating PNRF recordings. |

## Application Programmers Interfaces (API)

| | |
|---|---|
| **PNRF reader (free of charge)** | |
| Functions | Read PNRF, NRF and LRF recording files directly in your own application |
| COM interface | The PNRF reader comes as COM interface and can be used from any application or programming language which supports COM automation |
| PNRF Software Development Kit (SDK) | Installs PNRF dll's and supplies Visual Basic, C# and C++ getting started examples |
| Matlab® integration | Matlab® PNRF reader install and example available within the PNRF SDK |
| LabVIEW™ integration | Available directly from National Instruments |
| **DCE/RPC (Distributed Computing Environment/Remote Procedure Calls)** | |
| Functions | Control Perception software from an external computer/application on Windows®, Linux, Unix, Mac OS X |
| COM interface | All RPC commands have a COM wrapper for easier Windows® software integration |
| Available basic commands | Load and Save Perception setup files, Setup Recording, set and review Hardware Settings, Start/Stop/Pause/Trigger, monitor Live data |
| Examples (free of charge) | C++ and C# getting started example programs supplied for Windows®, source code included. Unsupported Linux getting started example on request only. |
| LabVIEW™ integration (free of charge) | LabVIEW™ getting started example using RPC/COM available |
| **CSI (Customer Software Interface)** | |
| Functions | Create software extension inside the Perception software by adding CSI user sheets, custom automation and extended analysis functions. Basic Windows C# sheet template included. Available for all Microsoft .NET® 4 supporting languages. |
| Available basic controls & commands | Access to every Perception part: Start/Stop/Pause and Trigger, Start Manager, Acquisition System, Hardware Settings, Displays, Meters, User Tables, Formulas, Calculations, Data Manager, Data Sources, User variables, Notifications, Logging, Conversion Functions, Automation Actions, Sheet Manager and more, to create a dedicated application GUI that hides the entire Perception standard GUI |
| Examples (free of charge) | C# getting started example programs supplied, source code included |
| **Training/Support Program** | |
| HBM offers paid professional training and support programs on all API interfaces (PNRF reader, RPC and CSI). Training program will be C# based, on-site or at central HBM location. On-site training can be customer specific. Support can be the development of a full custom software application or answering questions of software engineers. | |

## Acquisition Cards

| Model | Type | Isolation | Max. SR(1) | Resolu-tion | Memory/ card | Channels | Event, T/C(2) | Fast Streaming |
|---|---|---|---|---|---|---|---|---|
| GN810 | Single Ended | no | 200 kS/s | 16 bit | 128 MB | 8 | 0, 0 | no |
| GN811 | Single Ended | no | 1 MS/s | 16 bit | 256 MB | 8 | 0, 0 | no |
| GN812 | Unbalanced Differential | yes | 1 MS/s | 16 bit | 512 MB | 8 | 0, 0 | no |
| GN813 | Unbalanced Differential | yes | 1 MS/s | 16 bit | 512 MB | 8 | 0, 0 | no |
| GN814 | Unbalanced Differential | yes | 200 kS/s | 16 bit | 128 MB | 8 | 0, 0 | no |
| GN410 | Bridge/Differential | yes | 200 kS/s | 16 bit | 128 MB | 4 | 0, 0 | no |
| GN411 | Bridge/Differential | yes | 1 MS/s | 16 bit | 512 MB | 4 | 0, 0 | no |
| GN440 | Differential/IEPE/Shunt | yes | 200 kS/s | 16 bit | 128 MB | 4 | 0, 0 | no |
| GN441 | Differential/IEPE/Shunt | yes | 1 MS/s | 16 bit | 512 MB | 4 | 0, 0 | no |
| GN1611 | Differential | no | 20 kS/s | 16 bit | 200 MB | 16 | 16, 0 | no |
| GN3211 | Differential | no | 20 kS/s | 16 bit | 200 MB | 32 | 16, 0 | no |
| GN1610 | Differential/IEPE/Charge | no | 250 kS/s | 16/24 bit | 2 GB | 16 | 16, 2 | no |
| GN3210 | Differential/IEPE/Charge | no | 250 kS/s | 16/24 bit | 2 GB | 32 | 16, 2 | no |
| GN413 | Differential/Single Ended | no | 25 MS/s | 15 bit | 128 MB | 4 | 0, 0 | no |
| GN412 | Differential/Single Ended | no | 100 MS/s | 14 bit | 2 GB | 4 | 0, 0 | no |
| GN401 | Multi Mode Optical Fiber | yes | 100 MS/s | --(3) | 2 GB | 4(3) | 0, 0 | no |
| GN402 | Single Mode Optical Fiber | yes | 100 MS/s | --(3) | 2 GB | 4(3) | 0, 0 | no |
| GN611 | Balanced Differential | yes | 200 kS/s | 16/18 bit | 200 MB | 6 | 16, 2 | no |
| GN610 | Balanced Differential | yes | 2 MS/s | 16/18 bit | 2 GB | 6 | 16, 2 | no |
| GN816 | Unbalanced Differential | yes | 200 kS/s | 16/18 bit | 200 MB | 8 | 16, 2 | yes |
| GN815 | Unbalanced Differential | yes | 2 MS/s | 16/18 bit | 2 GB | 8 | 16, 2 | yes |
| GN6470 | Binary | no | 1 MS/s | 1 bit | 512 MB | 64 | 0, 0 | no |
| GN4070 | Optical & Binary | yes & no | 1 MS/s | 1 bit | 512 MB | 8 & 32 | 0, 0 | no |

(1) Maximum Sample Rate/channel (not multiplexed).
(2) Digital Events, Timer/Counter channels (Supported by GEN7i, GEN3i, GEN3t and GEN2i Digital Event/Timer/Counter connector only).
(3) This card supports a maximum of four optical fiber transmitter channels.

## Optical Fiber Transmitter Channels

**Transmitter**
Every transmitter is a single channel unit. Every unit has an unbalanced differential input, amplifier, analog anti alias filter and ADC with an optical data and control link to the receiver card. The receiver card has the recording logic, sample rate selection and memory.

| Model | Receiver Card | Power | Sample rate | Resolution | Isolation |
|---|---|---|---|---|---|
| GN110 | Fiber100M 6600 | Battery | 100 MS/s | 14 bit | User application defined |
| GN111 | Fiber100M 6600 | Battery | 25 MS/s | 15 bit | User application defined |
| GN112 | Fiber100M 6600 | 120/240 V AC | 100 MS/s | 14 bit | 1800 V RMS |
| GN113 | Fiber100M 6600 | 120/240 V AC | 25 MS/s | 15 bit | 1800 V RMS |
| GN114 | Fiber100M 7600 | External 12 V DC | 100 MS/s | 14 bit | User application defined |

## Special Function Cards

| | |
|---|---|
| 5B Integration card | Uses one GEN DAQ slot, holds up to six 5B modules. 5B modules, I/O connectors and cabling not included. An acquisition card is required for actual recording.<br>The 5B Series signal conditioning modules provide a low cost method of connecting analog signals with data acquisition systems. They are designed to convert thermocouples, RTD's, strain gauges, frequencies, potentiometers, slide wires and other signals into standardized, isolated analog outputs. |

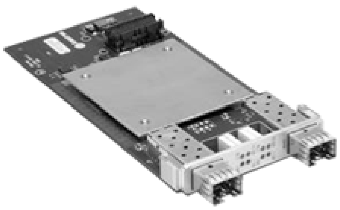
| Ordering Information[1] | | | |
|---|---|---|---|
| **Article** | | **Description** | **Order No.** |
| GEN16t Rack mount mainframe |  | GEN16t 19"rack mount mainframe with 16 acquisition card slots. Includes Interface/ Controller module with 1 Gbit standard Ethernet interface. Maximum 100 MB/s streaming rate to appropriate PC. Includes iSCSI storage support to enable direct storage on NAS server. Available options include on-board solid state disk, optical Ethernet, IRIG, IRIG/GPS and 10 Gbit optical Ethernet.<br>Requires Perception software with hardware control option to operate the system. Perception software is not included. | 1-GEN16t-2 |

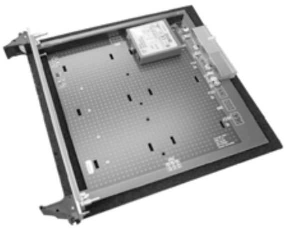
(1) All GEN DAQ series systems are intended for exclusive professional and industrial use.

| Software Options, to be ordered separately[1] | | |
|---|---|---|
| **Article** | **Description** | **Order No.** |
| Perception Standard | For setup and control of a single Gen Series mainframe as well as display of recorded data during and after recording. Runs on 32 and 64 bits versions of Windows® XP, Vista, 7 and 8. Uses maximum 2 GByte of your PC's memory. | 1-PERC-ST-01-2 |
| Perception Advanced | Same as Perception Standard but includes the options:<br>Analysis, Reports, Info Sheets, Exports, Workbooks and Video Playback. | 1-PERC-AD-01-2 |
| Perception Professional | Same as Perception Standard but includes the options<br>Analysis, Reports, Info Sheets, Exports, Workbooks, Video Playback, Basic FFT and Sensor Database. | 1-PERC-PRO-01-2 |
| Perception Enterprise | Same as Perception Professional but runs on native 64 bits Windows® XP, Vista, 7 and 8 only. This version supports the use of more than 2 GByte memory in your PC. Specifically important for systems using multiple mainframes, extensive use of the FFT option and/or large amounts of calculations. | 1-PERC-E64-01-2 |
| Perception Viewer | Same as Perception Standard but without mainframe setup and control. | 1-PERC-VW-01-2 |
| Perception Viewer Advanced | Same as Perception Advanced but without mainframe setup and control. | 1-PERC-VA-01-2 |
| Analysis | Analysis includes +, -, *, /, max, min, RMS and filters using a formula database. | 1-PERC-OP-AN-01-2 |
| Reporting | Create professional reports including displays, tables, text, graphics. | 1-PERC-OP-RP-01-2 |
| Exports | Additional export formats added to Perception. | 1-PERC-OP-MEX-01-2 |
| Info sheets | Allows custom entries and variable definitions to be stored with data. | 1-PERC-OP-IS-01-2 |
| Multiple Workbooks | Simultaneous multiple display windows on multiple monitor systems. | 1-PERC-OP-MWB-01-2 |
| Video Playback | Simultaneous playback of standard video files. | 1-PERC-OP-VP-01-2 |
| Basic FFT | Live FFT while recording (hardware dependent) and Review FFT. | 1 -PERC-OP-BFFT-01 |
| Multiple Mainframes | Simultaneous control of multiple GEN DAQ mainframes. | 1-PERC-OP-MMF-01-2 |
| Sensor Database | Collection of sensors' information, simplifies the set-up of an acquisition channel. | 1-PERC-OP-SDB-01-2 |
| CSI Interface | Allows the development of and running CSI programs. | 1-PERC-OP-CSI-01-2 |
| RPC/COM | Remote control of Perception, including basic hardware setup and control. | 1-PERC-OP-IF-01-2 |
| SEQUENCE | To control BE3200 Test Sequencer from Perception via USB port.<br>Requires Perception Standard or higher (1-PERC-ST-01-2). | 1-PERC-OP-SEQ-01-2 |
| STL Analysis | Special analysis routines according to the STL standard used in LV, MV and HV labs. Includes import of TGD data (Test Data Generator) for verification.<br>Requires Analysis option (1-PERC-OP-AN-01-2). | 1-PERC-OP-STL-01-2 |
| HPHV-AA | HighPower/HighVoltage automated analysis. Evaluates data of NoLoad, ShortCircuit, Capacitive and Synthetic tests of HV/MV switchgear devices (requires signals from tripping coils and travel to be recorded).<br>Requires STL Analysis option (1-PERC-OP-STL-01-2). | 1-PERC-OP-HHP-01-2 |
| HV-IA | High Voltage Impulse Analysis option; evaluates Lightning, Switching and Current impulses; designed according to IEC60060-1 and IEC61083-2 requirements. Allows evaluation with new k-factor method. | 1-PERC-OP-HIA-01-2 |
| eDrive | Allows easy and application oriented setup and efficiency calculations of electrical inverter / drive tests with minimum interaction. | 1-PERC-OP-EDR-01-2 |

(1) Software options are also sold in multiple license packages and multiple network license seats.

## Options, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| IRIG PMC card |  | Factory installed option.<br>GEN DAQ IRIG interface fits into open XMC/ PMC slot of GEN DAQ Interface/Controller module.<br>Cannot be used in combination with 10 Gbit Ethernet XMC card. | 1-G001-1 |
| IRIG/GPS PMC card | | Factory installed option.<br>GEN DAQ IRIG/GPS interface fits into open XMC/PMC slot of GEN DAQ Interface/Controller module, comes with antenna and 15 m cable.<br>Cannot be used in combination with 10 Gbit Ethernet XMC card. | 1-G002-2 |
| Solid State Disk |  | Factory installed option.<br>GEN DAQ Internal SSD drive in GEN DAQ mainframe, 300 GB capacity, 50 MB/s continuous streaming rate. Sweep storage rate depending on sweep length and number of channels. Short sweeps are stored slower due to administration overhead. | 1-G061-2 |
| 1 Gbit Optical Network SFP module 850 nm |  | GEN DAQ 1 Gbit Ethernet SFP, 850 nm Multi Mode, up to 500 m optical cable length supported, LC connector support.<br>1 Gbit SFP modules are not compatible with the 10 Gbit SFP+ modules. | 1-G062-2 |
| 1 Gbit Optical Network SFP module 1310 nm | | GEN DAQ 1 Gbit Ethernet SFP, 1310 nm Single Mode, up to 10 km optical cable length supported, LC connector support.<br>1 Gbit SFP modules are not compatible with the 10 Gbit SFP+ modules. | 1-G063-2 |
| 10 Gbit Ethernet XMC card |  | Factory installed option.<br>GEN DAQ 10 Gbit Ethernet XMC card adds up to 2 extra 10 Gbit Ethernet network connections to a GEN DAQ series mainframe. Supports up to 200 MB/s continuous data transfer from the GEN DAQ mainframe to an appropriate PC. Requires a 10 Gbit optical network SFP+ module. Cannot be used in combination with IRIG or IRIG/GPS PMC card. | 1-G064-2 |
| 10 Gbit Optical Network SFP+ module 850 nm |  | GEN DAQ 10 Gbit Ethernet SFP+, 850 nm Multi Mode, up to 66 m optical cable length supported, LC connector support.<br>10 Gbit SFP+ modules are not compatible with the 1 Gbit SFP modules. | 1-G065-2 |
| 10 Gbit Optical Network SFP+ module 1310 nm | | GEN DAQ 10 Gbit Ethernet SFP+, 1310 nm Single Mode, up to 10 km optical cable length supported, LC connector support.<br>10 Gbit SFP+ modules are not compatible with the 1 Gbit SFP modules. | 1-G066-2 |
| Master/Slave card |  | GEN DAQ Master/Slave option. Uses first slot in GEN16t rack, GEN2i and GEN5i integrated mainframes and the Master/Slave slot in GEN7t tower mainframe. The Master/Slave card is needed in master and any slave mainframe. Supports up to eight slaves using optical connections. Single 3 m (10 ft) optical cable included. | 1-G040-2 |

| Accessories, to be ordered separately | | | |
|---|---|---|---|
| **Article** | | **Description** | **Order No.** |
| Fiber cable standard MM LC-LC |  | GEN DAQ standard zipcord fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, LC-LC connectors, aqua, ISO/IEC 11801 type OM3. Typically used for fixed cable routing or LAB environments.<br>Lengths 3, 10, 20 and 50 meter (10, 33, 66 and 164 ft)<br><br>Used with 850 nm optical 1 Gbit or 10 Gbit Ethernet. (1-G062-2 and 1-G065-2) and Master/Slave synchronizations. | 1-KAB280-3<br>1-KAB280-10<br>1-KAB280-20<br>1-KAB280-50 |
| Fiber optic Single Mode standard cable |  | GEN DAQ standard zipcord fiber optic duplex Single Mode 9/125 µm cable, 0.5 dB/km loss, LC-LC connectors, yellow, ISO/IEC 11801 type OS2. Typically used for fixed cable routing or LAB environments.<br>Lengths 2, 10, 20, 50 and 100 meter (6.5, 33, 66, 164 and 328 ft)<br><br>Used with 1310 nm optical 1 Gbit or 10 Gbit Ethernet (1-G063-2 and 1-G066-2). | 1-KAB288-2<br>1-KAB288-10<br>1-KAB288-20<br>1-KAB288-50<br>1-KAB288-100 |
| Fiber optic Single Mode heavy duty cable |  | GEN DAQ heavy duty fiber optic duplex Single Mode 9/125 µm cable, 0.5 dB/km loss, LC-LC connectors, black, ISO/IEC 11801 type OS2. Typically used for test cell environments.<br>Lengths 10, 20, 50, 100, 150 and 300 meter (33, 66, 164, 328, 492 and 984 ft)<br><br>Used with 1310 nm optical 1 Gbit or 10 Gbit Ethernet (1-G063-2 and 1-G066-2). | 1-KAB289-10<br>1-KAB289-20<br>1-KAB289-50<br>1-KAB289-100<br>1-KAB289-150<br>1-KAB289-300 |
| 5B Integration card |  | GEN DAQ 5B Integration card. Uses one GEN DAQ slot, holds up to six 5B modules. 5B modules, I/O connectors and cabling not included. Basic card required for acquisition. | 1-G028-2 |

## A.3 B2629–2.0 en (GEN series GN401)

| Capabilities Overview | |
|---|---|
| Receiver model | GN401 |
| Transmitter models | GN110, GN111, GN112 and GN113 |
| Maximum sample rate per channel | 100 MS/s (ADC and DAC)<br>GN111 and GN113 have a maximum 25 MS/s sample rate |
| Memory per receiver | 2 GB (1 GS) |
| Analog channels | 4 outputs per receiver (GN401). One output per transmitter<br>1 input per transmitter (GN110, GN111, GN112 or GN113) |
| ADC resolution | 14 bit (ADC and DAC)<br>GN111 and GN113: 15 bit using four time over sampling |
| Isolation | yes; transmitter to receiver and transmitter to earth |
| Input type | Isolated, unbalanced differential inputs |
| Real-time calculations | no |
| Fast data streaming | no |

## GN401 Block diagram

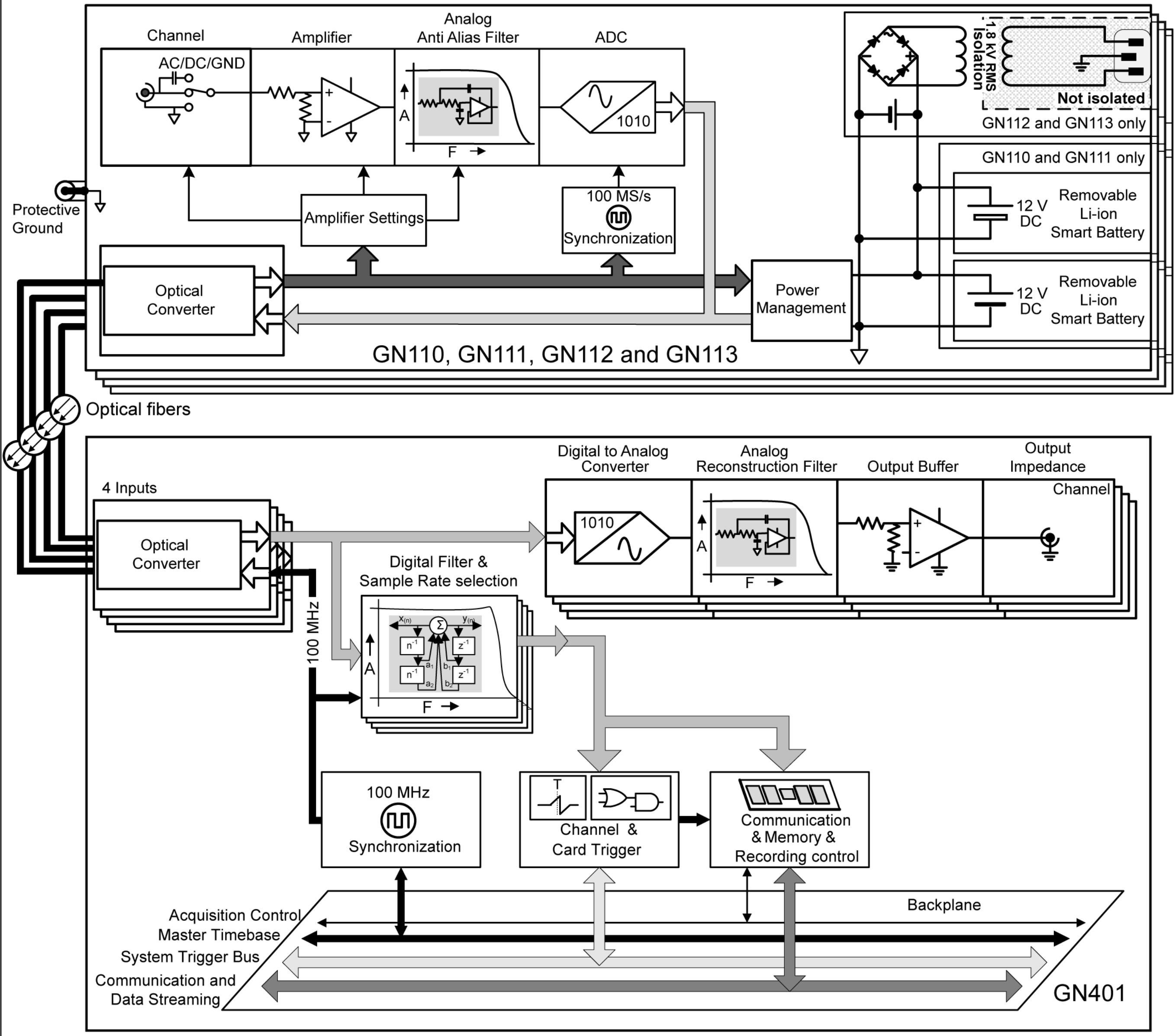



**Figure A.5:** Block Diagram GN401 with GN110, GN111, GN112 or GN113

| Analog input GN110, GN111, GN112 and GN113 (Transmitter) | |
|---|---|
| Channels | 1 |
| Connector | 1; Metal BNC |
| Input type | Isolated, unbalanced differential inputs (BNC connected to isolated common) |
| Input Coupling | |
| Coupling modes | AC / DC / GND |
| AC coupling frequency | 1.6 Hz (±10 %); - 3 dB |

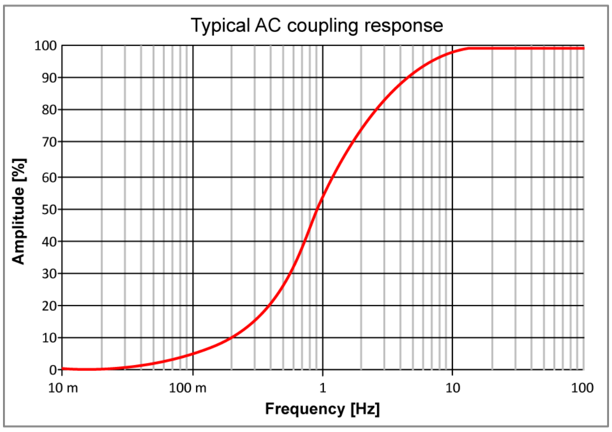



**Figure A.6:** Typical AC coupling response

| | |
|---|---|
| Impedance | 1 MΩ (± 2 %) // 38 pF (± 5 %) |
| Ranges | ± 20 mV, ± 50 mV, ± 100 mV, ± 200 mV, ± 500 mV, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50V and ± 100 V |
| Offset | ± 50 % in 1000 steps (0.1 %)<br>± 100 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.1 % of Full Scale ± 50 µV |
| Bessel filter | 0.1 % of Full Scale ± 50 µV |
| Offset error drift | GN110 and GN111: ±(60 ppm + 10 µV)/°C (±(36 ppm + 6 µV)/°F)<br>GN112 and GN113: ±(100 ppm + 10 µV)/°C (±(60 ppm + 6 µV)/°F) |
| DC Gain error | |
| Wideband | 0.1 % of Full Scale ± 50 µV |
| Bessel filter | 0.1 % of Full Scale ± 50 µV |
| Gain error drift | GN110 and GN111: ±100 ppm/°C (± 60ppm/°F)<br>GN112 and GN113: ±(100 ppm + 10 µV)/°C (±(60 ppm + 6 µV)/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.1 % of Full Scale ± 50 µV |
| Bessel filter | 0.1 % of Full Scale ± 50 µV |
| RMS Noise (50 Ω terminated) | |
| Wideband | 0.05 % of Full Scale ± 100 µV |
| Bessel filter | 0.05 % of Full Scale ± 100 µV |
| Common Mode (referred to ground and protective ground not connected)<br>Requires a protected LAB environment and EN50191:2000 compliant work procedures | |
| Rejection Ratio (CMRR) | > 72 dB @ 80 Hz (GN110 and GN111: > 100 dB typical) |
| Voltage | 1.8 KV RMS (GN112 and GN113)<br>>1.8 kV RMS (GN110 and GN111); Limits set by fiber cable and transmitter air gap isolation |
| Input bias current | < 2 nA |
| Rise time | 14 ns |

## Analog input GN110, GN111, GN112 and GN113 (Transmitter)

| Input overload protection | |
|---|---|
| Over voltage impedance change | The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200 % of the selected input range or 250 V whichever is the smallest value. |
| Maximum nondestructive voltage | ± 125 V DC; Ranges < ± 2 V<br>± 250 V DC; Ranges ≥ ± 2 V |
| Overload recovery time | Restored to 0.1 % accuracy in less than 50 ns after 200 % overload<br>Restored to 10 % accuracy in less than 10 ns after 200 % overload |

## Analog to Digital Conversion

| | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 100 MS/s |
| ADC resolution; one ADC per channel | 14 bit |
| ADC Type | CMOS pipelined multistep converter, LTC2254 |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Not supported |
| Maximum binary sample rate | N/A |
| External time base sample rate | 0 S/s to 10 MS/s |
| External time base level | TTL |
| External time base minimum pulse width | 50 ns |

(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

## Amplifier Bandwidth and Filtering

| Using different filter selections (Wideband/Bessel/Bessel IIR) or different filter bandwidths will lead to phase mismatches between channels. | |
|---|---|
| Wideband | When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected. Should not be used if working in frequency domain with recorded data. |
| Bessel (Fc @ -3 dB) | This analog Bessel filter can be used to reduce the higher bandwidth signals, but is also used to prevent aliasing at the 100 and 50 MS/s sample rates. For lower sample rates the digital Bessel IIR filter must be used to prevent aliasing. Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| Bessel IIR (Fc @ -3 dB) | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter. Can only be used for sample rates up to 50 MS/s. Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |

## Wideband

When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

| | |
|---|---|
| Wideband bandwidth | Between 27 MHz and 36 MHz (-3 dB) |
| Passband flatness (1) | 0.1 dB; DC to 1 MHz |

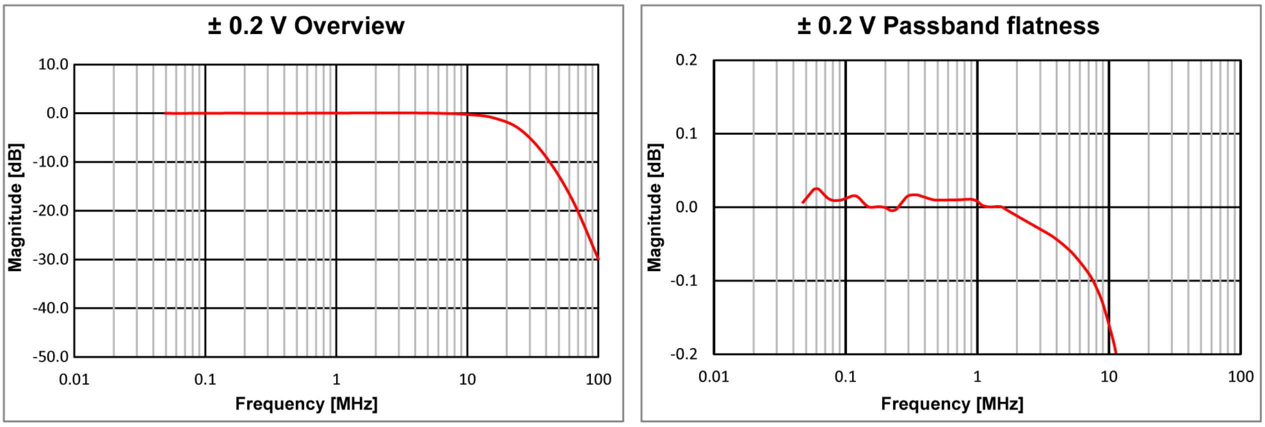



**Figure A.7:** Typical ± 0.2 V Wideband overview and passband flatness

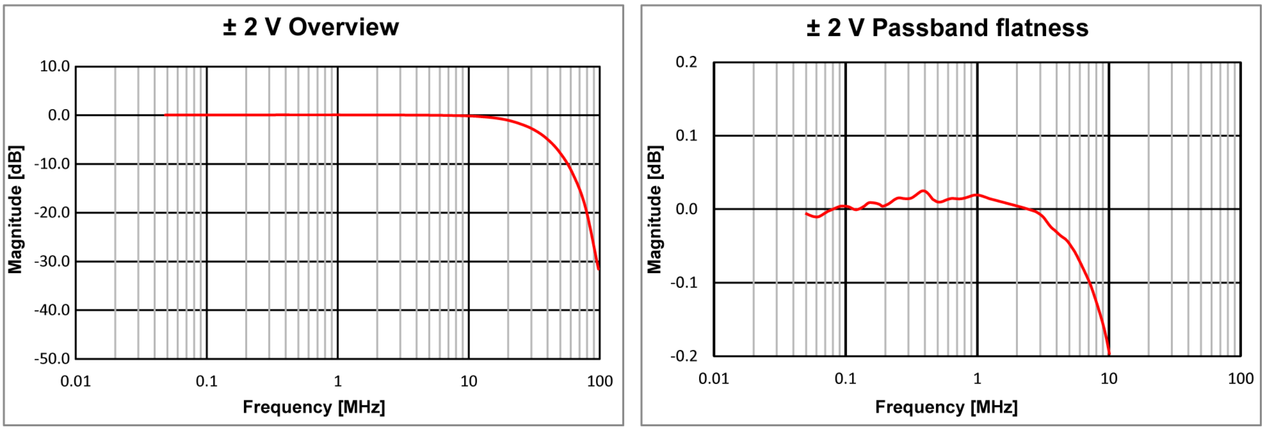



**Figure A.8:** Typical ± 2 V Wideband overview and passband flatness

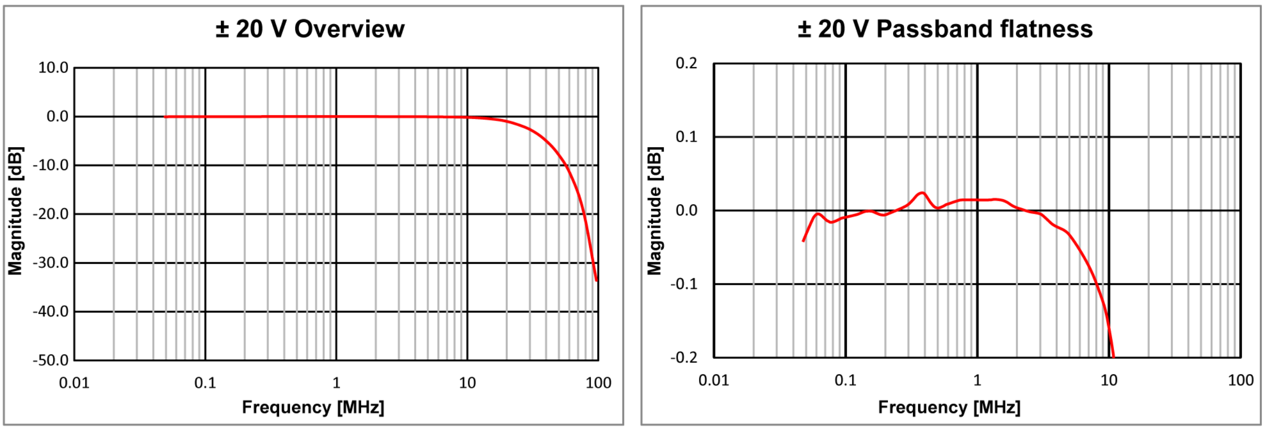



**Figure A.9:** Typical ± 20 V Wideband overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## Bessel and Bessel IIR filter

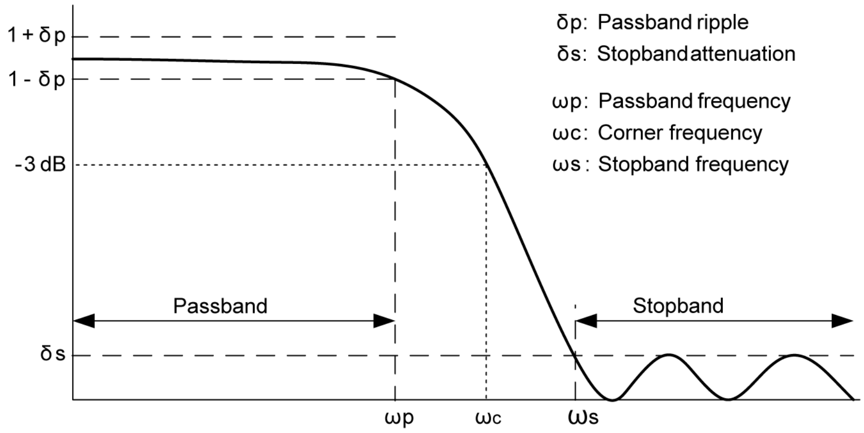



**Figure A.10:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of the analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 10 MHz ± 1 MHz (-3 dB) |
| Analog anti aliasing filter characteristic | 6-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 8-pole Bessel style IIR |
| Bessel IIR filter user selection | User selectable fixed frequencies. If anti aliasing must be prevented, care must be taken to adapt selected filter frequency when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | 50 kHz, 100 kHz, 125 kHz, 200 kHz, 250 kHz, 400 kHz, 500 kHz, 1 MHz, 1.25 MHz, 2 MHz, 2.5 MHz, 4 MHz, 5 MHz; fixed bandwidth selections |
| Bessel IIR passband flatness (ωp)(1) | 0.1 dB; DC to 1 MHz @ ωc = 5 MHz |
| Bessel IIR filter stop band attenuation (δs) | -60 dB |
| Bessel IIR filter roll-off | -48 dB/Octave |

(1) Measured using Fluke 5700 calibrator, DC normalized

## Bessel and Bessel IIR filter

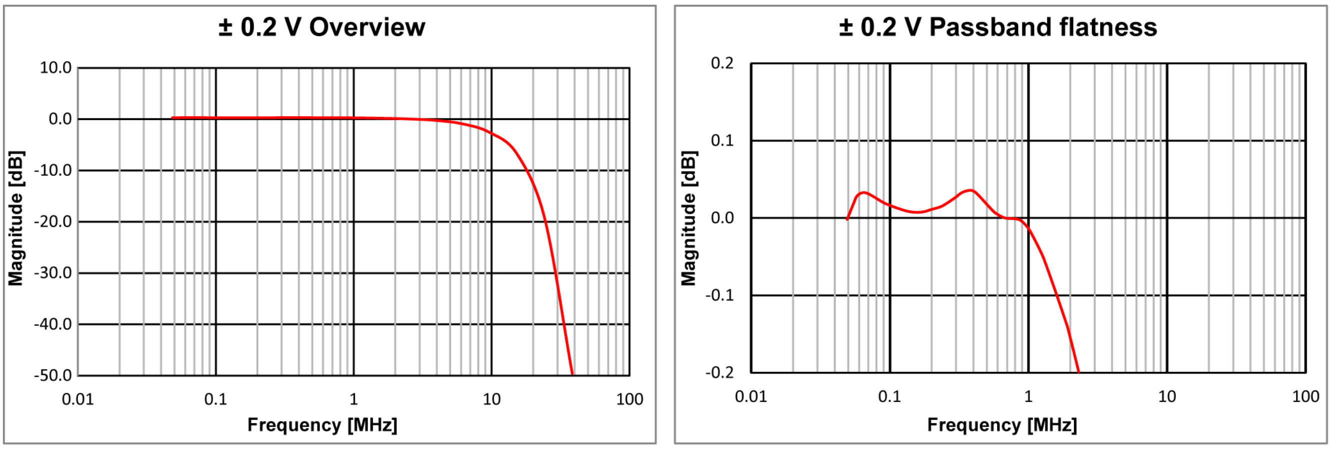



**Figure A.11:** Typical ± 0.2 V Bessel 10 MHz overview and passband flatness

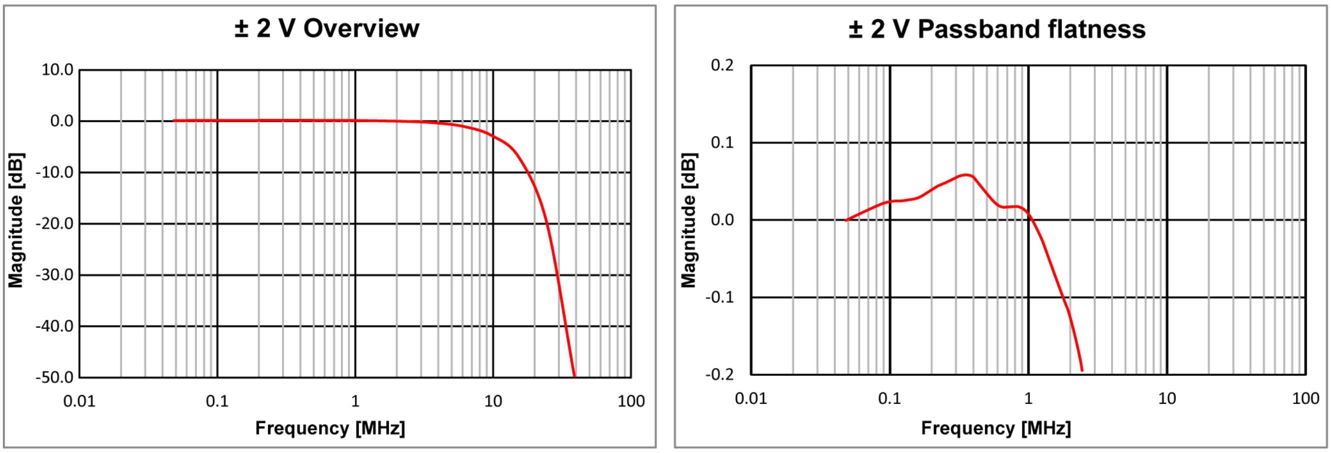



**Figure A.12:** Typical ± 2 V Bessel 10 MHz overview and passband flatness

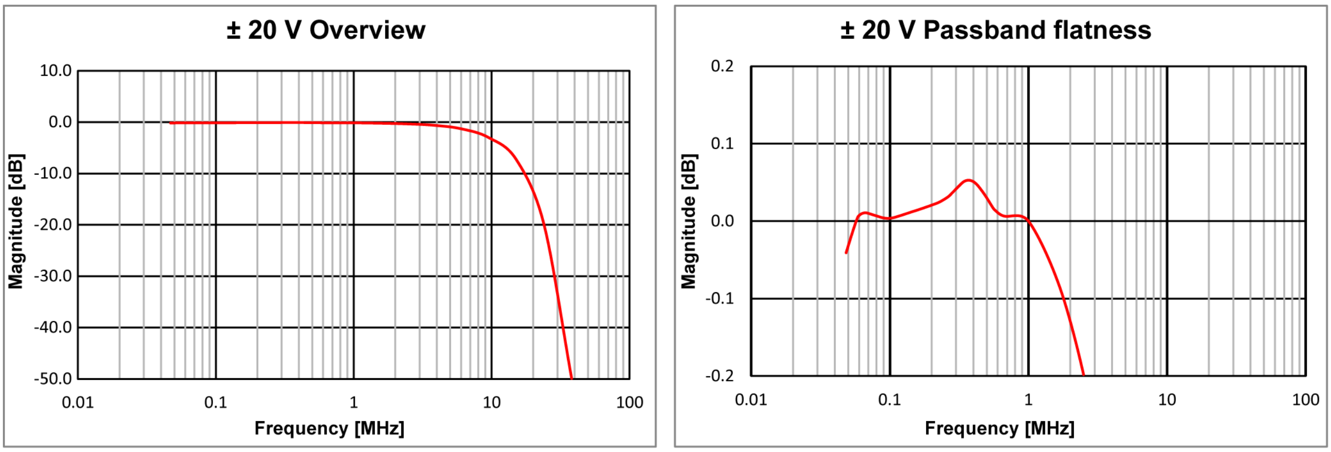



**Figure A.13:** Typical ± 20 V Bessel 10 MHz overview and passband flatness

## Channel to Channel Phase Match

Using different filter selections (Wideband/Bessel/Bessel IIR) or different filter bandwidths will lead to phase mismatches between channels.

| | |
|---|---|
| Channel to Channel phase difference | Maximum ± 10 ns |
| Fiber cable length compensation | Yes, automatically when optical communication is established |
| Fiber cable delay | 5 ns/m; Delay compensated by cable length compensation |

## On-board Memory

| | |
|---|---|
| Per card | 2 GB (1 GS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

## Digital Events/Timer/Counter

| | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

## Triggering

| | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High / Low / Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High / Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base |
| Cross channel triggering | |
| Channels on card | Logical OR; Analog triggers of all channels<br>Logical AND; Qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes when using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; Single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Pulse detect/reject | Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY : 16 bit (0.0015 %) for both levels<br>dT : 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak-level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak-level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger holdoff | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum holdoff time sample rate dependent |

| Triggering | |
|---|---|
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |
| Event counter | Counted channel trigger events before card trigger is activated<br>1 to 256 trigger events |

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 μs ± 1 μs + maximum 1 sample period using decimal time base<br>503 μs ± 1 μs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow/Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 2 Ch | 4 Ch | 1 Ch | 2 Ch | 4 Ch | 1 Ch | 2 Ch | 4 Ch |
| Max. sweep memory | 900 MS | 450 MS | 225 MS | not used | | | 720 MS | 360 MS | 180 MS |
| Max. sweep sample rate | 100 MS/s | | | not used | | | 100 MS/s | | |
| Max. continuous FIFO | not used | | | 900 MS | 450 MS | 225 MS | 180 MS | 90 MS | 45 MS |
| Max. continuous sample rate | not used | | | 20 MS/s | | | Sweep Sample Rate / 2<br>Maximum 20 MS/s | | |
| Max. continuous streaming rate | not used | | | 20 MS/s<br>40 MB/s | 40 MS/s<br>80 MB/s | 80 MS/s[1]<br>160 MB/s[1] | 20 MS/s<br>40 MB/s | 40 MS/s<br>80 MB/s | 80 MS/s[1]<br>160 MB/s[1] |

(1) At time of release of this specification only GEN3i/GEN3t and GEN7i mainframes can continuously stream this data rate.

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

## Multiple Sweeps

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

| Slow Fast Sweep | |
|---|---|
| Maximum number of sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2, or 20 MS/s per channel, whichever is the smallest sample rate |
| Maximum sample rate switches | 400 sample rate switches per second, 200 000 switches maximum, switching stops when sweep ends |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Dual | |
|---|---|
| **Dual Sweep Specification** | |
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Fiber optic link | |
|---|---|
| Light source | Class 1 laser product |
| Transfer rate | 2 Gbit/s |
| Wavelength | 850 nm |
| Connector | LC duplex on GN401<br>SCRJ/IP67 duplex on GN110, GN111, GN112 and GN113 |
| Cable | |
| Isolation | $10^{15}$ Ω/m |
| Maximum length | 800 m (26245 ft); using ISO/IEC 11801 type OM2, OM3 or OM4 cable and no extra couplers.<br>Each extra LC-LC or SCRJ-SCRJ coupler reduces cable length by typical 100 m (328 ft) |
| Type | Duplex Multi Mode, 50/125 µm, ISO/IEC 11801 type OM2 |

| Analog output GN401 (receiver) | |
|---|---|
| Channels | 4; 1 per transmitter channel (GN110, GN111, GN112 and GN113) |
| Connector | 4; Metal BNC, one BNC per channel on receiver front panel |
| Conversion | 100 MS/s D-to-A converter per channel |
| DAC Resolution | 14 bit (0.006 %) |
| Outputs | |
| Output filter | Lowpass 10 MHz @ – 3 dB; 6$^{th}$ order Bessel reconstruction filter |
| Output impedance | 13 Ω typical |
| Calibrated full scale Output level | ± 5 V; 1 MΩ load |

| Power requirement GN110 and GN111 (transmitter) | |
|---|---|
| Battery | 11.1 V @ 6600 mAh, removable, rechargeable, Li-ion<br>2 batteries installed |
| Power consumption | 6 VA typical, 8 VA maximum |
| Operation Time | 24 hours; 2 batteries installed (12 hours; 1 battery installed) |
| Battery Recharge | 12.6 V DC, 2.5 to 4 Amps @ 25 °C (77 °F) |

| Power requirement GN112 and GN113 (transmitter) | |
|---|---|
| Power supply | 115/230 V AC @ 47 - 63 Hz (Manual voltage selector) |
| Power consumption | 12 VA maximum |
| Power supply isolation | |
| Protective ground connected | 0 V, both sides grounded |
| Protective ground not connected | 1.8 kV RMS (IEC 61010-1:2010)<br>Requires a protected LAB environment and EN50191:2000 compliant work procedures |
| Fuse(s) | 2 x 250 mA; Slow blow |
| Battery | 12 V @ 300 mAh; Internal, rechargeable, NiMH |
| Battery back-up time | 5 minutes (with new and fully charged battery) |

| Physical, Weight and Dimensions GN110 and GN111 | |
|---|---|
| Weight | 4.6 kg (10 lb) including two batteries |
| Dimensions | |
| Width including handles, etc. | 175 mm (6.89”) |
| Depth | 277 mm (10.91”) |
| Height | 119 mm (4.69”) |
| Shielding and casing | Single metal shielding in plastic housing. Correct operation has been verified by placing the transmitter cabinet within 1 meter of an EMC field created by a 80 kA current |
| Cooling Fans | 0 |
| Handle | One carrying handle |
| Protective ground | M6 screw terminal |

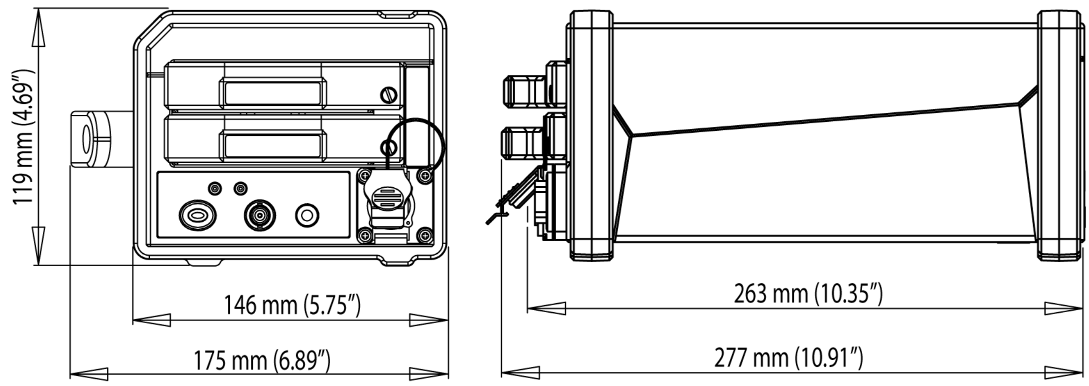



**Figure A.14:** Dimensions GN110 and GN111 transmitter

| Physical, Weight and Dimensions GN112 and GN113 | |
|---|---|
| Weight | 3 kg (6.6 lb) |
| Dimensions | |
| Width including handles, etc. | 175 mm (6.89”) |
| Depth | 267mm (10.51”) |
| Height | 119 mm (4.69”) |
| Shielding and casing | Single metal shielding in plastic housing. Correct operation has been verified by placing the transmitter cabinet within 1 meter of an EMC field created by a 80 kA current |
| Cooling Fans | 1 |
| Handle | One carrying handle |
| Protective ground | M6 screw terminal |

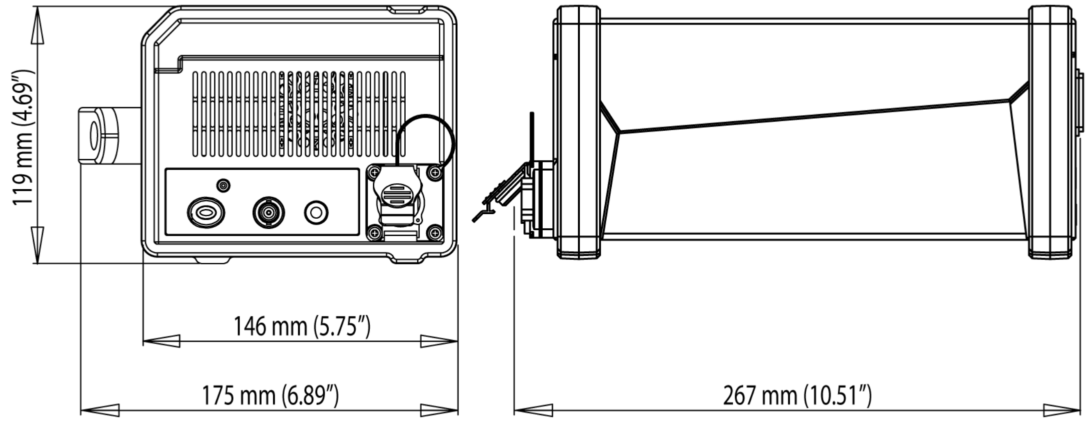



**Figure A.15:** Dimensions GN112 and GN113 transmitter

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | GN110 and GN111: -15 °C to +50 °C (+5 °F to +122 °F)<br>GN112 and GN113: 0 °C to +40 °C (+32 °F to +104 °F)<br>GN401: 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low voltage directive (LVD): 2006/95/EC
Electromagnetic compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth |

## Harmonized standards for CE compliance, according to the following directives

Low voltage directive (LVD): 2006/95/EC
Electromagnetic compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 10 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Rechargeable Li-ion SM202 battery (option, to be ordered separately)

| | |
|---|---|
| Chemical system | Lithium Ion (Li-Ion) |
| Battery voltage | 11.1 V |
| Typical weight | 460 g |
| Typical capacity | 6600 mAh |
| Smart battery | 1.1 Compliant |
| Maximum charge voltage | 12.6 V |
| Maximum charge current | 4.0 A |
| Typical charging time | 3 hours @ 4 A Charging Current |
| Discharge temperature | -20 °C to +60 °C |
| Charge temperature | +0 °C to +40 °C |
| Storage temperature | -20 °C to +50 °C |

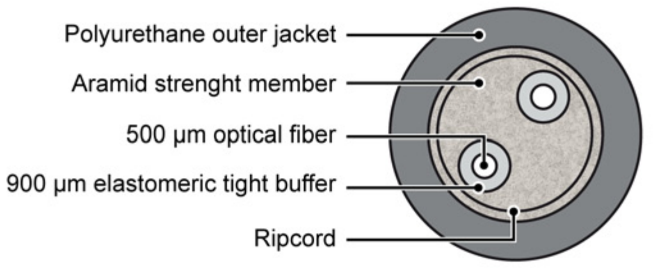

**Figure A.16:** Li-ion SM202 battery with carrier

| Li-ion battery charger (option, to be ordered separately) | |
|---|---|
| Li-ion ten bay and two bay battery chargers | |
| Smart battery support | SmBus Level 3 |
| Maximum charge current | 3 A, or limited by smart battery |
| Battery recalibration | SmBus 1.2 A @ 12 V |
| Charge strategy | Parallel for two batteries. Ten bay charges two batteries parallel then next two batteries etc. |

**Figure A.17:** Ten (Left) and Two (right) bay Li-ion chargers

## Fiber cables (option, to be ordered separately)

Heavy duty fiber optic duplex cable (1-KAB278-xxx)




| | |
|---|---|
| Connector type | LC - SCRJ/IP67 |
| Glass rating | OM2; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size | 6 mm (0.24") |
| Jacket rating | Polyurethane, halogen free, non-corrosive |
| Jacket coating | High chemical resistance against acids/alkalis |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 10, 20, 50, 100, 150 and 300 m (33, 66, 164, 328, 492 and 984 ft) |
| Operating temperature | - 40 °C to + 80 °C |

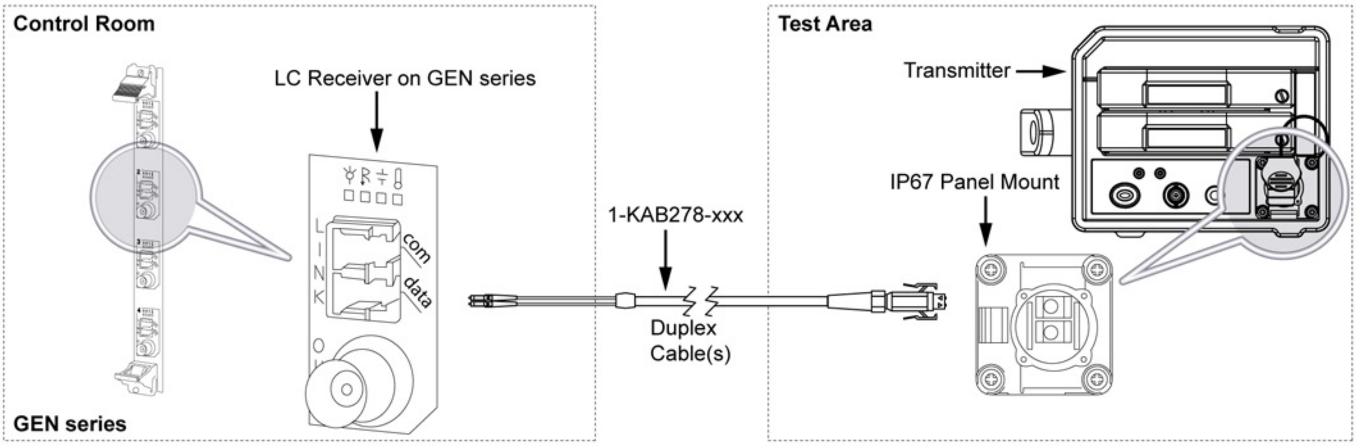
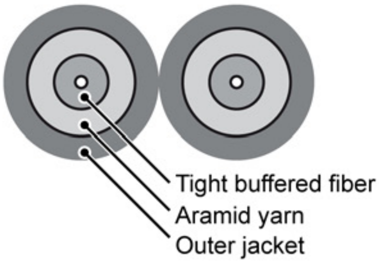



**Figure A.18:** Application area of a fiber optic duplex cable (Example 1)

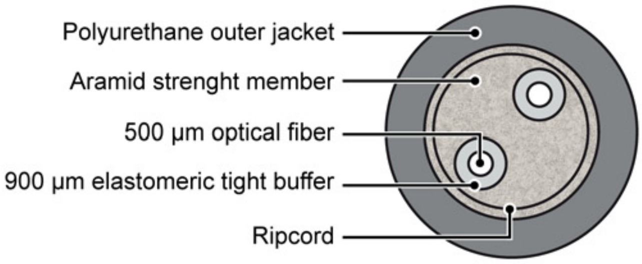
## Fiber cables (option, to be ordered separately)

Standard fiber optic duplex cable (1-KAB277-xxx)




| | |
|---|---|
| Connector type | LC - SCRJ |
| Glass rating | OM2; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size | 2 mm (0.08") |
| Jacket rating | Low-smoke zero-halogen |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 10, 20, 50 and 100 m (33, 66, 164 and 328 ft) |
| Operating temperature | - 40 °C to + 80 °C |

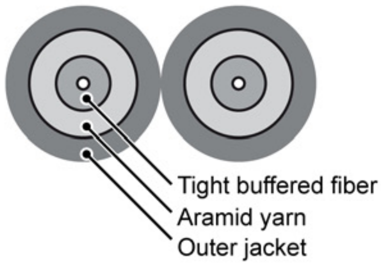
Heavy duty fiber optic duplex patch cable (1-KAB279-xxx)




| | |
|---|---|
| Connector type | SCRJ/IP67 - SCRJ/IP67 |
| Glass rating | OM2; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size | 6 mm (0.24") |
| Jacket rating | Polyurethane, halogen free, non-corrosive |
| Jacket coating | High chemical resistance against acids/alkalis |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 20 and 50 m (66 and 164 ft) |
| Operating temperature | - 40 °C to + 80 °C |

## Fiber cables (option, to be ordered separately)

Standard fiber optic duplex patch cable (1-KAB280-xxx)




| | |
|---|---|
| Connector type | LC - LC |
| Glass rating | OM3; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size | 2 mm (0.08") |
| Jacket rating | Low-smoke zero-halogen |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 3, 10, 20 and 50 m (10, 33, 66 and 164 ft) |
| Operating temperature | - 40 °C to + 80 °C |

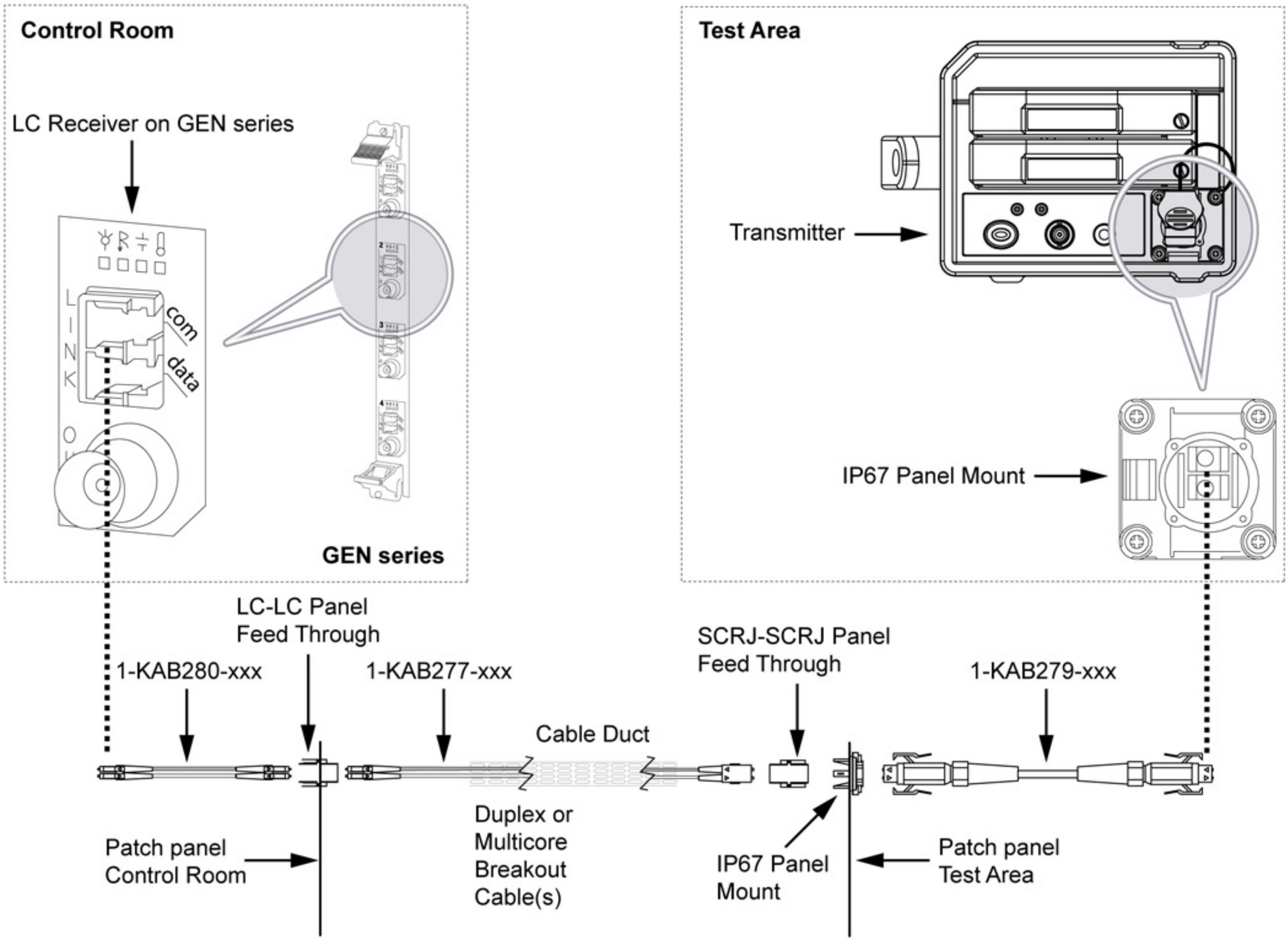



**Figure A.19:** Application area of a fiber optic duplex cable (Example 2)

## Ordering information[1]

| Article | | Description | Order No. |
|---|---|---|---|
| GN110<br>1 ch Transmitter |  | GN110 optical isolated transmitter HV, 100 MS/s, 14 bit, 25 MHz, two Li-ion batteries, SCRJ/IP67 connector. | 1-GN110-2 |
| GN111<br>1 ch Transmitter |  | GN111 optical isolated transmitter HV, 25 MS/s, 15 bit, 10 MHz, two Li-ion batteries, SCRJ/IP67 connector. | 1-GN111-2 |
| GN112<br>1 ch Transmitter |  | GN112 optical isolated transmitter MV, 100 MS/s, 14 bit, 25 MHz, built-in power supply with 1.8 kV RMS isolation, SCRJ/IP67 connector. | 1-GN112-2 |
| GN113<br>1 ch Transmitter |  | GN113 optical isolated transmitter MV, 25 MS/s, 15 bit, 10 MHz, built-in power supply with 1.8 kV RMS isolation, SCRJ/IP67 connector. | 1-GN113-2 |
| GN401<br>4 ch Receiver |  | GN401 optical isolated receiver, 4 channels, 4 x LC in, 4 x BNC out, 2 GB memory<br><br>Note: When mixing 100 MS/s and 25 MS/s transmitters maximum receiver sample rate will be limited to 25 MS/s for all four channels. | 1-GN401-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| Li-ion SM202 Battery |  | Spare rechargeable Li-ion battery unit for 6600HV and ISOBE5600t | 1-G034-2 |
| Li-ion SM202 Battery with carrier |  | Spare rechargeable Li-ion battery unit with carrier for 6600HV and ISOBE5600t | 1-G301-2 |
| 2 bay Li-ion battery charger |  | Li-ion two bay battery charger for 6600HV and ISOBE5600t batteries. Accepts two batteries without removing the carrier | 1-G109-2 |
| 10 bay Li-ion battery charger |  | Li-ion 10 bay battery charger for 6600HV and ISOBE5600t batteries, accepts 10 batteries without removing the carrier | 1-G033-2 |
| Fiber cable standard MM LC-SCRJ |  | GEN DAQ standard fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, LC-SCRJ connectors, orange, ISO/IEC 11801 type OM2. Typically used for fixed cable routing or LAB environments.<br>Lengths 10, 20, 50 and 100 meter (33, 66, 164 and 328 ft) | 1-KAB277-10<br>1-KAB277-20<br>1-KAB277-50<br>1-KAB277-100 |
| Fiber cable heavy duty MM LC-SCRJ |  | GEN DAQ heavy duty fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, LC-SCRJ/IP67 connectors, orange, ISO/IEC 11801 type OM2. Typically used for test cell environments.<br>Lengths 10, 20, 50, 100, 150 and 300 meter (33, 66, 164, 328, 492 and 984 ft) | 1-KAB278-10<br>1-KAB278-20<br>1-KAB278-50<br>1-KAB278-100<br>1-KAB278-150<br>1-KAB278-300 |
| Fiber cable heavy duty MM SCRJ-SCRJ |  | GEN DAQ heavy duty fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, SCRJ-SCRJ/IP67 connectors, orange, ISO/IEC 11801 type OM2. Typically used for test cell environments as patch panel to transmitter connections.<br>Lengths 20 and 50 meter (66, 164 ft) | 1-KAB279-20<br>1-KAB279-50 |
| Fiber cable standard MM LC-LC |  | GEN DAQ standard zipcord fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, LC-LC connectors, aqua, ISO/IEC 11801 type OM3. Typically used for fixed cable routing or LAB environments.<br>Lengths 3, 10, 20 and 50 meter (10, 33, 66 and 164 ft) | 1-KAB280-3<br>1-KAB280-10<br>1-KAB280-20<br>1-KAB280-50 |

**Note** *Other fiber cable lengths can be ordered through special projects team.*

### A.4 B3248-1.0 en (GEN series GN412 and GN413)

| Capabilities Overview | | |
|---|---|---|
| **Component** | **Value** | |
| Model | **Fast Differential Digitizers 25 MS/s** | **Fast Differential Digitizers 100 MS/s** |
| Sample rate | 1 kS/s to 25 MS/s | 1 kS/s to 100 MS/s |
| Memory per card | 64 MS (128 MB) | 900 MS (1800 MB) |
| Analog channels | 4 | |
| ADC resolution | 15-bit (0.003 %) | 14-bit (0.006 %) |
| Input type | Differential | |

| General Specifications | | | |
|---|---|---|---|
| **Analog Input Section** | | | |
| **Component** | **Unit Description** | **Value** | |
| Model | | **Fast Differential Digitizers 25 MS/s** | **Fast Differential Digitizers 100 MS/s** |
| Channels | Per slot | 4 | |
| Type | | Differential | |
| Connectors | Metal BNC, outer shell grounded | 2 | |
| Ranges | Full Scale in 1, 2, 5 steps | ± 10 mV, ± 100 mV, ± 200 mV, ± 400 mV, ± 1 V, ± 2 V, ± 4 V, ± 10 V, ± 20mV, ± 40 V, ± 100 V, ± 200 V | |
| Offset (zero position) | Equal to span; maximum 50 % in the ± 100 V range | Automatic | |
| Offset error | | 0.1 % FS ± 0.1 mV | |
| Coupling | AC<br>DC, GND | -3 dB @ 1.6 Hz ± 10 % | |
| Impedance | for ranges ≤ ± 1 V | 2 x 1 MΩ//21 pF | |
| | for ranges > ± 1 V | 2 x 1 MΩ//25 pF | |
| Maximum Static Error | | 0.1 % FS ± 0.1 mV | |
| Gain Error | | ± 0.1 % ± 0.1 mV | |
| Noise | RMS | 0.05 % FS ± 0.1 mV | |
| Analog bandwidth (1) | | 10 MHz @ -3 dB | 25 MHz@ -3 dB |
| Rise time (1) | @ maximum BW | 35 ns | 14 ns |
| CMRR | For ranges ≤ ± 1 V | ≥ 70 dB | |
| | For ranges > ± 1 V | ≥ 60 dB | |
| CM voltage | For ranges ≤ ± 1 V | 4 Vpeak | |
| | For ranges ≥ ± 20 V | 250 Vpeak | |
| | For all other ranges | 40 Vpeak | |
| Overload protection | Peak protected | 250 Vpeak | |

(1) Analog bandwidth specifications. Values will differ when the digital IIR filter is used at the same time.

## Analog to Digital Conversion

| Component | | Value | |
|---|---|---|---|
| Model | | **Fast Differential Digitizers 25 MS/s** | **Fast Differential Digitizers 100 MS/s** |
| Sample rate | | 25 MS/s | 100 MS/s |
| Sampling | | Single ADC per channel, synchronous between all channels | |
| ADC resolution | | 15-bit (0.003 %) | 14-bit (0.006 %) |
| | Enhanced resolution for sample rates ≤ 10 MS/s | 16-bit | |
| Bessel filter specifics | | | |
| | Analog anti-aliasing | 6th order Bessel lowpass, 10 MHz @ -3dB | |
| Bessel or IIR specifics | | | |
| | Digital | 6th order Bessel (IIR) lowpass, in 12 steps<br>5 MHz to 50 kHz | |

## On-board Memory

| Component | Value | |
|---|---|---|
| Model | **Fast Differential Digitizers 25 MS/s** | **Fast Differential Digitizers 100 MS/s** |
| Per card | 25 MS/s | 100 MS/s |
| Per channel<br>(with all 4 channels used) | 16 MS (64 MS) | 100 MS (400 MS) |

## Triggering

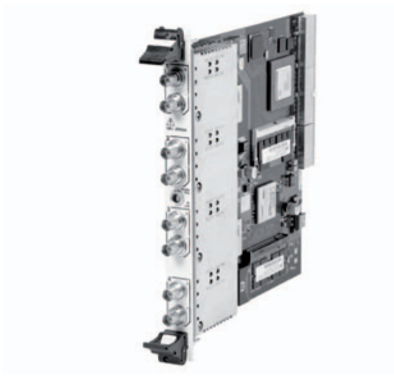
| Component | | Unit Description | Value |
|---|---|---|---|
| Channel trigger | | Fully independent, per channel | 1 |
| Pre- and post-trigger length | | | 0 to full memory |
| Trigger rate | | Up to 400 triggers per second, zero re-arm time | 1 per 2.5 ms |
| Trigger total | | Total number of triggers per recording | 10,000 |
| Resolution | | For each level | 16 bit (0.0015 %) |
| Hysteresis | | Defines the trigger insensitivity | 0.1 to 100 % of Full Scale |
| Cross channel triggering | | Analog triggers of all channels | Logical OR |
| | | Qualifiers of all channels | Logical AND |
| Analog trigger modes | | | |
| | Basic | Single level | Positive or negative crossing |
| | Dual Level | Two individual levels, OR-ed | One positive and one negative crossing |
| Analog qualifier modes | | | |
| | Basic | Arm the acquisition with a single level | Positive or negative crossing |
| | Dual (level) | Arm the acquisition with two individual levels, OR-ed | One positive and one negative crossing |

| Real-time Analysis | |
|---|---|
| Component | Description |
| StatStream © | Each channel includes real-time extraction of Max, Min, Mean, Peak-to- Peak, and RMS values |

| Acquisition Modes | |
|---|---|
| Component | Description |
| Sweeps | Triggered acquisition to on-board Random Access Memory (RAM) without sample rate limitations. |
| Continuous | Direct storage to PC or mainframe hard disk without file size limitations. Triggered or not triggered. |
| Dual | Combination of sweeps and continuous mode: recorder type streaming to disk with simultaneously triggered sweeps in RAM. |
| Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. |

| Storage Modes | |
|---|---|
| Component | Description |
| Recorder | Spooled directly to hard-disk of control PC; unlimited file size or duration |
| Scope | Store in transient memory |
| Transient | Store in transient memory, single or A-B-A time base |

| Miscellaneous | | |
|---|---|---|
| **Component** | **Unit Description** | **Value** |
| Probe power | External connector can provide power for probe | 9 V @ 0.4 A |

| Ordering Information | | | |
|---|---|---|---|
| Component | | **Unit Description** | **Order number** |
| Fast differential 25M |  | **Diff 25MS, 128M** 4 channel 25 MS/s Diff HighSpeed Digitizer, 128 MB RAM (16 MS/ch), 15 bit | 1-GN413-2 |
| Fast differential 100M | | 4 channel 100 MS/s Diff HighSpeed Digitizer, 1800 MB RAM (225 MS/ch), 14 bit Digitizer | 1-GN412-2 |

| Accessories | | |
|---|---|---|
| Model | Unit Description | Order number |
| 2GB Memory Upgrade | 2 GB Memory Upgrade for 100 MS/s digitizers and fiber receiver cards only (done at factory, includes re-calibration, for older cards with 800 MB memory) | 1-G030-2 |

### A.5 B3618-4.0 en (GEN series GN610)

| Capabilities Overview | |
|---|---|
| Model | GN610 |
| Maximum sample rate per channel | 2 MS/s |
| Memory per card | 2 GB |
| Analog channels | 6 |
| Sample resolution | 16/18 bit |
| Isolation | Channel to channel and channel to chassis |
| Input type | Analog isolated balanced differential (1) |
| Real-time calculations | 32; Cycle and Timer based calculations with triggering on calculated results |
| Sensor support | No |
| TEDS support | No |
| Digital Event/Timer/Counter support | 16 digital events and 2 timer/counter channels |
| Fast data streaming | No |

(1) No probes supported

## GEN series GN610 Block diagram

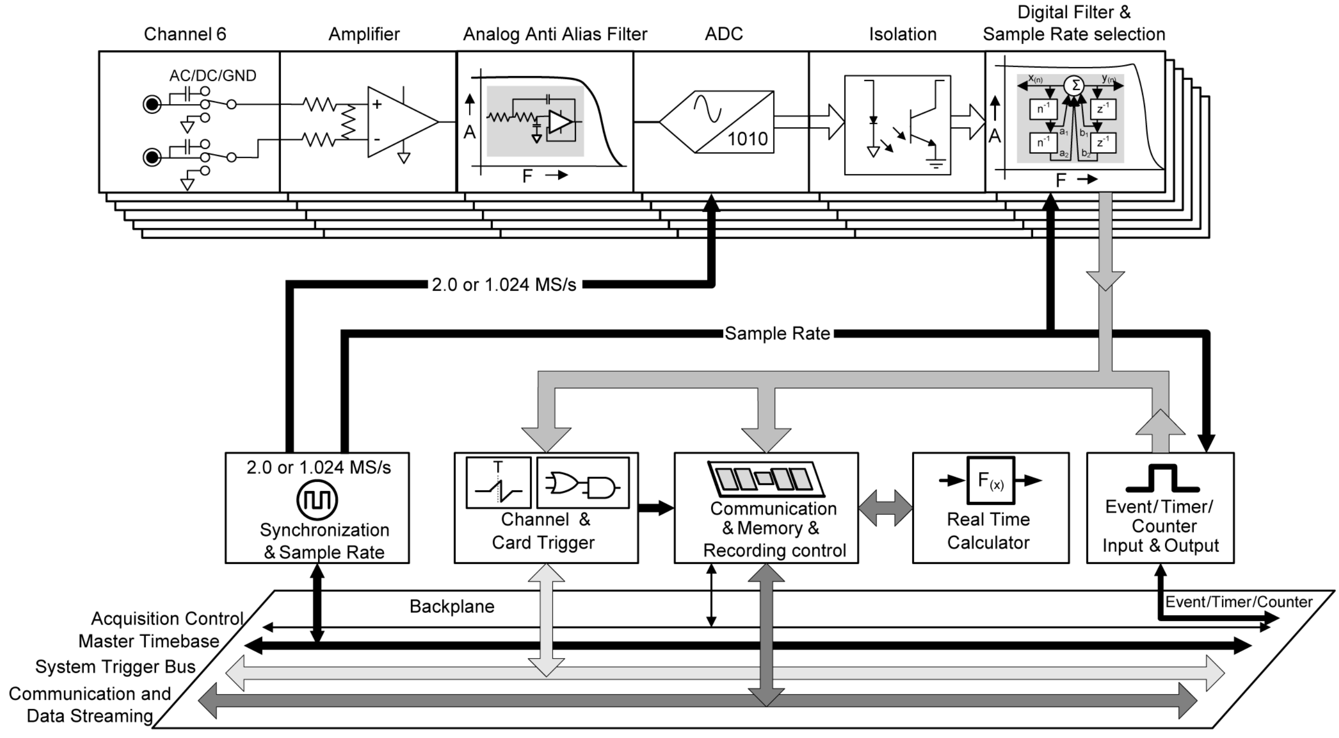
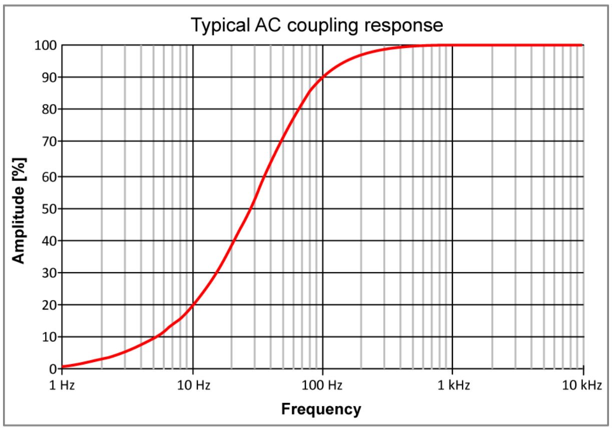



**Figure A.20:** Block Diagram GEN series GN610

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 6 |
| Connectors | Fully isolated 4 mm banana plugs (Plastic), 2 per channel (red and black) |
| Input type | Analog isolated balanced differential |
| Input coupling | |
| Coupling modes | AC, DC, GND |
| AC coupling frequency | 48 Hz ± 5 Hz (-3 dB) |
|   **Figure A.21:** Typical AC coupling response | |
| Impedance | 2 * 1 MΩ ± 1 % // 33 pF ± 10% ranges larger than ± 5 V. All other ranges 57 pF ± 10% |
| Ranges | ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1000 V |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 1000 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.02 % of Full Scale ± 400 µV |
| All IIR filters | 0.02 % of Full Scale ± 10 µV |
| Offset error drift | ±(20 ppm + 10 µV)/°C (±(12 ppm + 6 µV)/°F) |
| DC Gain error | |
| Wideband | 0.1 % of Full Scale ± 20 µV |
| All IIR filters | 0.1 % of Full Scale ± 10 µV |
| Gain error drift | ±30 ppm/°C (±17 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.075 % of Full Scale ± 400 µV |
| All IIR filters | 0.075 % of Full Scale ± 10 µV |
| RMS Noise (50 Ω terminated) | |
| Wideband | 0.035 % of Full Scale ± 50 µV |
| All IIR filters | 0.035 % of Full Scale ± 50 µV |

## Analog Input Section

| Common Mode (referred to system ground) | | |
|---|---|---|
| Ranges | Less than or equal to ± 5 V | Larger than ± 5 V |
| Rejection Ratio (CMRR) | > 80 dB @ 80 Hz (-110 dB typical) | > 60 dB @ 80 Hz (-80 dB typical) |
| Voltage | 7 V RMS | 1000 V RMS |

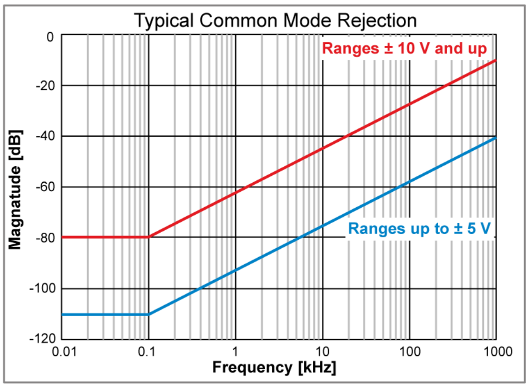



**Figure A.22:** Typical Common Mode Rejection

| Input overload protection | |
|---|---|
| Over voltage impedance change | The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200 % of the selected input range or 1250 V whichever is the smallest value. |
| Maximum nondestructive voltage | ± 2000 V DC |
| Maximum overload without auto range | 200 % of selected range |
| Automatic auto range | When overload creates over heating of the amplifier, the amplifier will change its range up in steps of factor 10 until overload disappears. When the actual overload is above 1000 V, the input signal will be disconnected and the amplifier input will be grounded. When temperature returns to normal the original selected range will be restored. Automatic auto range can not be turned off. |
| Overload recovery time | Restored to 0.1 % accuracy in less than 5 µs after 200 % overload |

## Isolation

| | | CAT II | CAT III |
|---|---|---|---|
| Channel to chassis (earth) | 1000 V RMS | 600 V RMS (1) | 300 V RMS(1) |
| Channel to channel | 2000 V RMS | (2) | (2) |

(1) IEC61010-1 Category voltage ratings are RMS voltages.

(2) Channel to channel CAT II and CAT III ratings are not a valid method to specify.

| Analog to Digital Conversion | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 2 MS/s |
| ADC resolution; one ADC per channel | 18 bit |
| ADC type | Successive Approximation Register (SAR); Analog Devices AD7641BCPZ |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; produces rounded BIN values when calculating FFT's |
| Maximum binary sample rate | 1.024 MS/s |
| External time base frequency | 0 S/s to 1 MS/s |
| External time base frequency divider | Divide external clock by 1 to $2^{20}$ |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller Modules shipped before 2012: ±30 ppm.

| Amplifier Bandwidth and Filtering | |
|---|---|
| Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Wideband | When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected. Should not be used if working in frequency domain with recorded data. |
| Bessel IIR | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| Butterworth IIR | When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| Elliptic IIR | When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

| Wideband | |
|---|---|
| When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected. | |
| Wideband bandwidth | Between 900 kHz and 1500 kHz (-3 dB) |
| Passband flatness | 0.1 dB; DC to 200 kHz(1) |

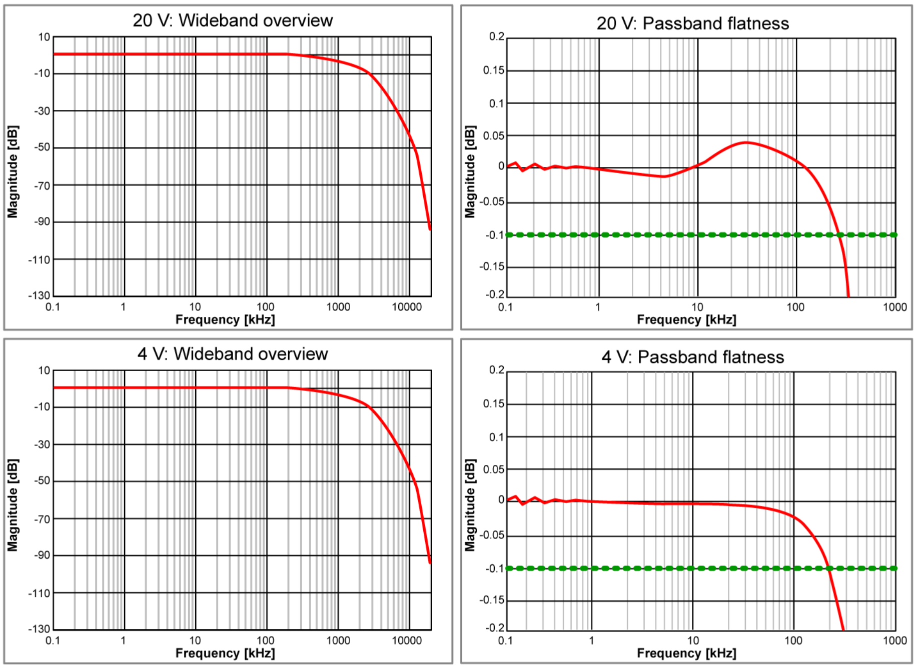



**Figure A.23:** Typical Wideband overview and passband flatness

(1) Measured using a Fluke 5700A calibrator, DC normalized

## Bessel IIR Filter

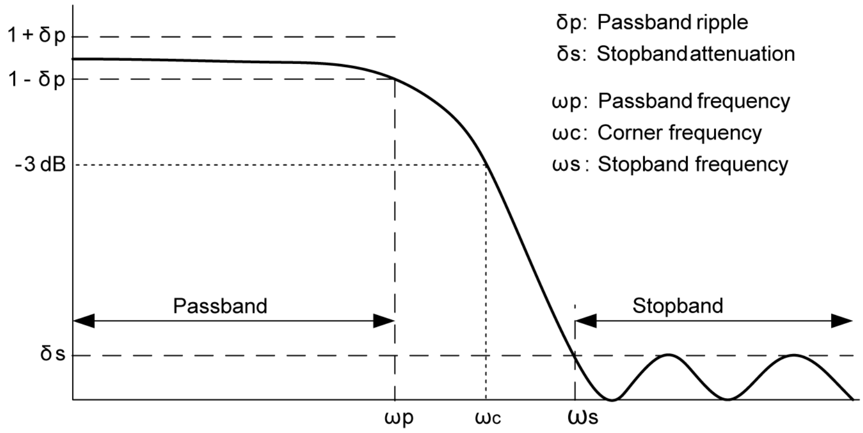



**Figure A.24:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 400 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 8-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | User selectable from 0.4 Hz to 200 kHz |
| Bessel IIR passband ripple (δp) | 0.1 dB(1) |
| Bessel IIR passband (ωp) | DC to 35 kHz @ ωc = 200 kHz(1) |
| Bessel IIR filter stopband attenuation (δs) | -60 dB<br>With Bessel IIR filter bandwidth selection ωc = 200 kHz a peak at -55 dB will occur between 1.6 MHz and 1.8 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| Bessel IIR filter roll-off | -48 dB/octave |

## Bessel IIR Filter

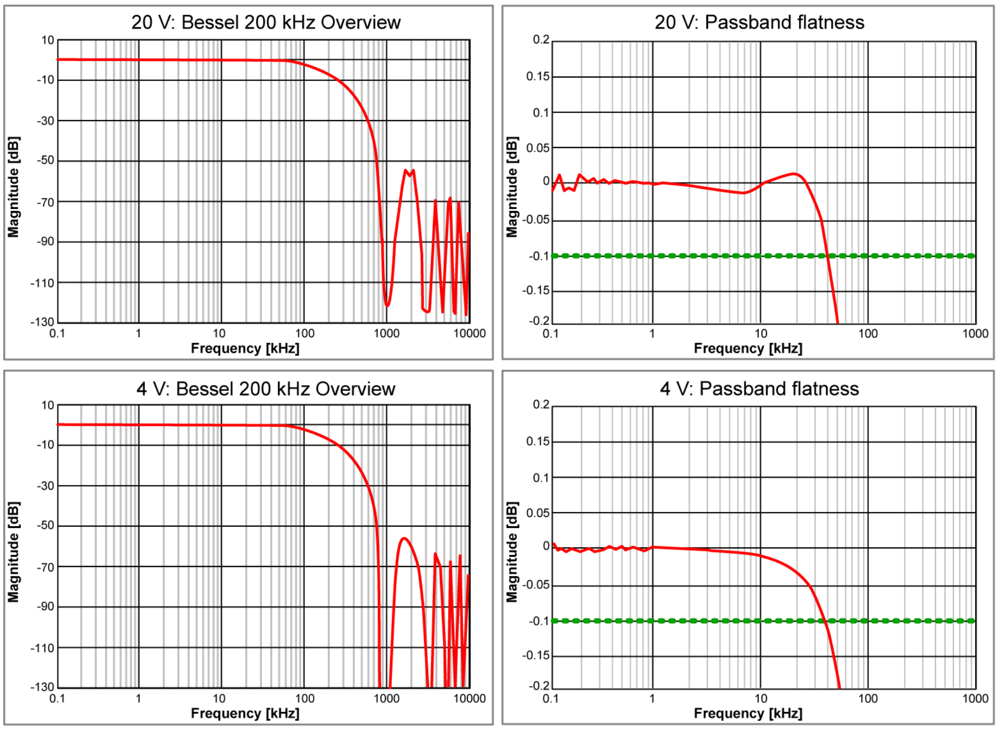



**Figure A.25:** Typical Bessel IIR 200 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Butterworth IIR Filter

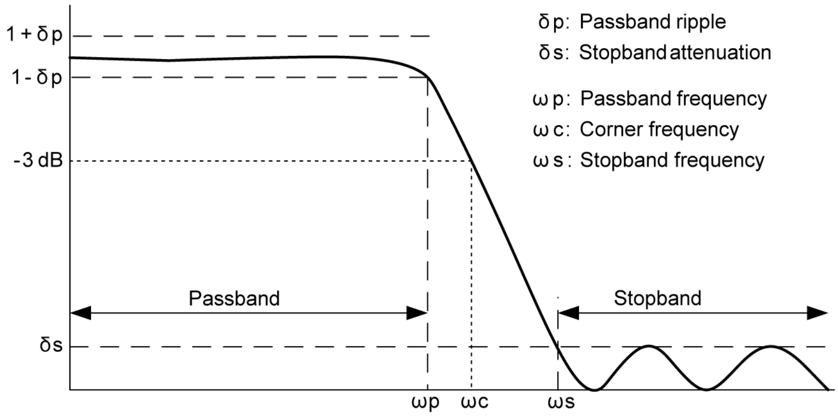



**Figure A.26:** Digital Butterworth IIR Filter

When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 450 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Butterworth IIR filter characteristic | 8-pole Butterworth style IIR |
| Butterworth IIR filter user selection | Auto tracking to sample rate divided by: 4(1), 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed. |
| Butterworth IIR filter bandwidth (ωc) | User selectable from 1 Hz to 250 kHz |
| Butterworth IIR passband ripple (δp) | 0.1 dB(2) |
| Butterworth IIR passband (ωp) | DC to 150 kHz @ ωc = 200 kHz(2) |
| Butterworth IIR filter stopband attenuation (δs) | -75 dB |
| Butterworth IIR filter roll-off | -48 dB/octave |

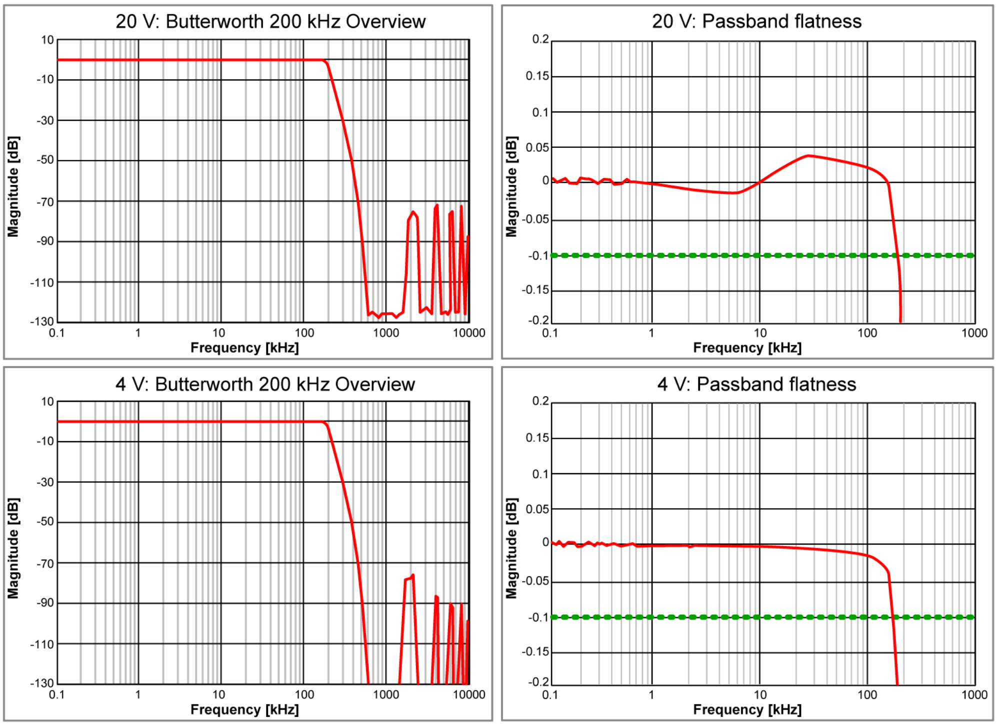



**Figure A.27:** Typical Butterworth IIR 200 kHz overview and passband flatness

(1) Divide by 4 not possible for sample rate 2 MS/s

(2) Measured using Fluke 5700A calibrator, DC normalized

## Elliptic IIR Filter

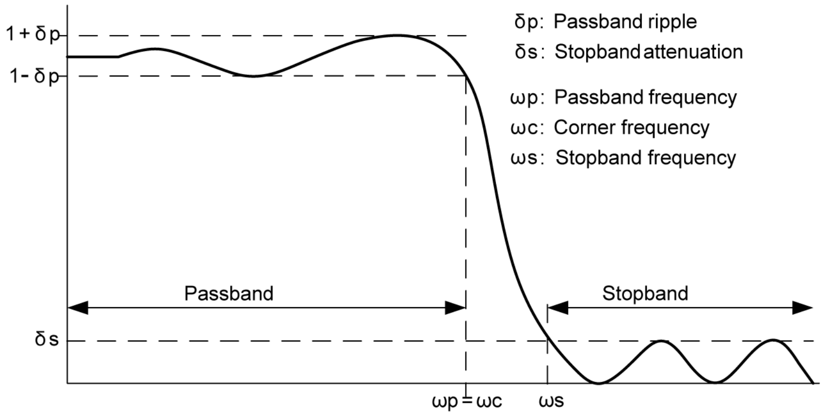



**Figure A.28:** Digital Elliptic IIR Filter

When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 450 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Elliptic IIR filter characteristic | 7-pole Elliptic style IIR |
| Elliptic IIR filter user selection | Auto tracking to sample rate divided by: 4(1), 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Elliptic IIR filter bandwidth (ωc) | 1 Hz to 250 kHz |
| Elliptic IIR passband ripple (δp) | 0.1 dB(2) |
| Elliptic IIR passband (ωp) | DC to filter bandwidth (ωc)(2) |
| Elliptic IIR filter stopband attenuation (δs) | -75 dB |
| Elliptic IIR filter roll-off | -72 dB/octave |

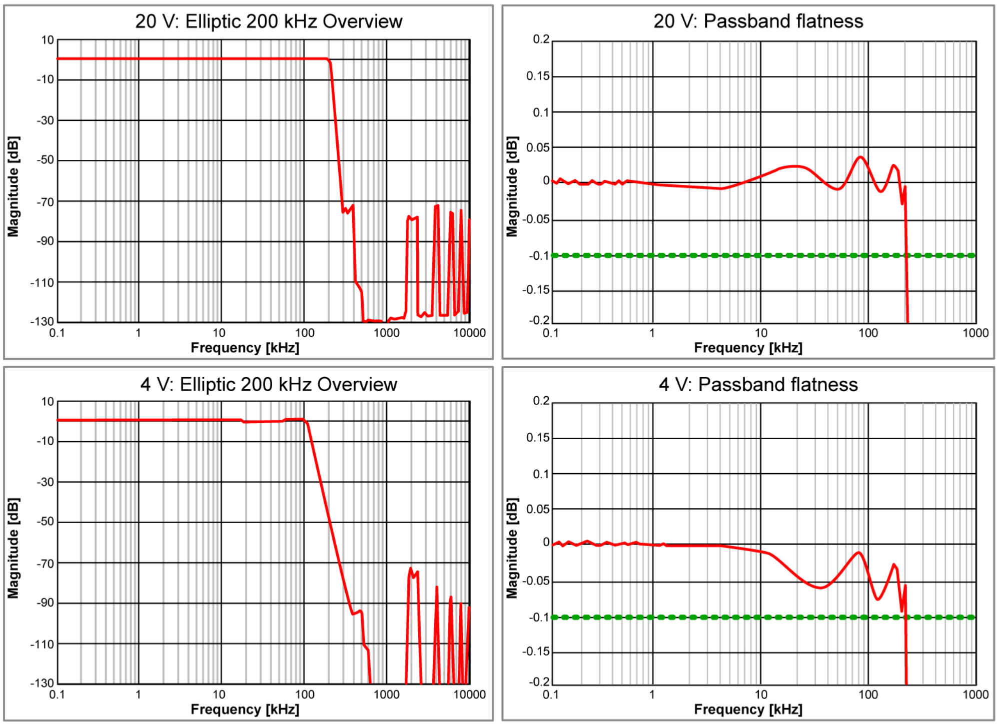



**Figure A.29:** Typical Elliptic IIR 200 kHz overview and passband flatness

(1) Divide by 4 not possible for sample rate 2 MS/s

(2) Measured using Fluke 5700A calibrator, DC normalized

## Channel to Channel Phase Match

Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

| | | |
|---|---|---|
| Wideband | 100 kHz Sine | 800 kHz Sine |
| Channels on card | 0.5 deg (14 ns) | 3.5 deg (12 ns) |
| GN610 Channels within mainframe | 0.5 deg (14 ns) | 3.5 deg (12 ns) |
| Bessel IIR, Filter frequency 200 kHz @ 2 MS/s | | |
| Channels on card | 0.6 deg (17 ns) | |
| GN610 Channels within mainframe | 0.6 deg (17 ns) | |
| Butterworth IIR, Filter frequency 200 kHz @ 2 MS/s | | |
| Channels on card | 0.5 deg (14 ns) | |
| GN610 Channels within mainframe | 0.5 deg (14 ns) | |
| Elliptic IIR, Filter frequency 200 kHz @ 2 MS/s | | |
| Channels on card | 0.5 deg (14 ns) | |
| GN610 Channels within mainframe | 0.5 deg (14 ns) | |
| GN610 channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) | |

## Channel to Channel Crosstalk

Channel to channel crosstalk is measured with a 50 Ω termination resistor on the input and using sine wave signals on the channel above and below the channel under test. To test channel 2, channel 2 is terminated with 50 Ω and channel 1 and 3 are connected to the sine wave generator.

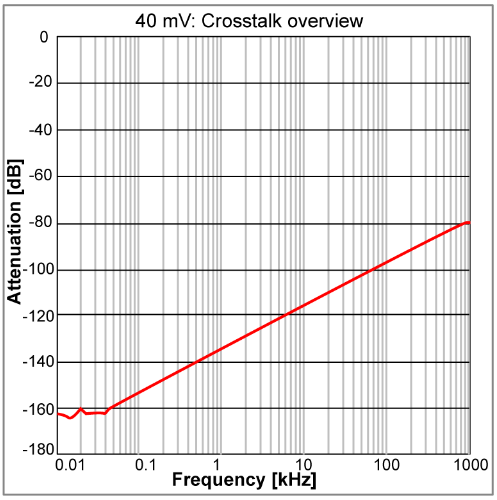



**Figure A.30:** Typical Channel to Channel crosstalk

## On-board Memory

| | |
|---|---|
| Per card | 2 GB (1 GS @ 16 bits storage) |
| Organization | Automatically distributed amongst channels enabled for storage or real-time calculations |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample<br>18 bits, 4 bytes/sample (required for Timer/Counter usage) |

## Digital Event/Timer/Counter [1]

| | |
|---|---|
| Digital input events | 16 per card |
| Levels | TTL input levels, user programmable invert |
| Inputs | 1 pin per input, some pins are shared with Timer/Counter inputs |
| Over voltage protection | ± 30 V DC continuously |
| Minimum pulse width | 100 ns |
| Maximum frequency | 5 MHz |
| Digital output events | 2 per card |
| Levels | TTL output levels, short circuit protected |
| Output event 1 | User selectable: Trigger, Alarm, set High or Low |
| Output event 2 | User selectable: Recording active, set High or Low |
| Digital output event user selections | |
| Trigger | 1 high pulse per trigger (on every channel trigger of this card only)<br>12.8 µs minimum pulse width<br>200 µs ± 1 µs ± 1 sample period pulse delay |
| Alarm | High when alarm condition is activated, low when not activated (alarm conditions of this card only)<br>200 µs ± 1 µs ± 1 sample period alarm event delay |
| Recording active | High when recording, low when in idle or pause mode<br>Recording active output delay 450 ns |
| Set High or Low | Output set High or Low; can be controlled by Custom Software Interface (CSI) extensions; delay depending on specific software implementation |
| Timer/Counter | 2 per card; only available in 18 bit mode |
| Levels | TTL input levels |
| Inputs | All pins are shared with digital event inputs |
| Timer-Counter modes | Uni- and bi-directional count<br>Bi-directional quadrature count<br>Uni- and bi-directional frequency/RPM measurement |
| Uni- and bi-directional count | |
| Inputs | 3 pins; signal, reset and direction (only used in bidirectional count) |
| Maximum input frequency | 5 MHz |
| Maximum count value | 0 to $2^{31}$; unidirectional count. $-2^{31}$ to $+2^{31}$; bidirectional count |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |
| Direction input | Only used when in bi-directional count<br>Low: increment counter<br>High: decrement counter |
| Bi-directional quadrature count | |
| Inputs | 3 pins; signal, direction and reset |
| Maximum input frequency | 2 MHz, minimum high or low time 200 ns. Minimum phase difference between signal and direction 100 ns. |
| Accuracy | Single, dual and quad precision |
| Maximum count value | $-2^{31}$ to $+2^{31}$ |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |

| Digital Event/Timer/Counter [1] | |
|---|---|
| Uni- and bi-directional frequency/RPM measurement | |
| Inputs | 2 pins; signal, direction |
| Maximum input frequency | 5 MHz |
| Accuracy | 0.1 % |
| Gate measuring time | Sample period to 50 s; user selectable to control update rate independent of sample rate |
| Direction input | Only used when in bi-directional frequency/RPM mode<br>Low: Positive frequency/RPM, e.g. left rotations<br>High: Negative frequency/RPM, e.g. right rotations |
| External start | User selectable Rising/Falling edge signal will start a new recording |
| External stop | User selectable Rising/Falling edge signal will stop the recording |

(1) Only if supported by mainframe

## Triggering

| | |
|---|---|
| Channel trigger/qualifier | 1 fully independent per channel either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Trigger in edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Trigger in delay | ± 1 µs + maximum 1 sample period (Identical for decimal and binary time base) |
| Send to external trigger out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Trigger out level | High/Low/Hold High; mainframe selectable, identical for all cards |
| Trigger out pulse width | High/Low: 12.8 µs<br>Hold High: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe; see mainframe datasheet for details |
| Trigger out delay | Selectable (10 µs to 516 µs) ± 1 µs + maximum 1 sample period using decimal time base<br>Selectable (9.76 µs to 504 µs) ± 1 µs + maximum 1 sample period using binary time base<br>Default 516(504) µs for decimal (binary) time base, to be compatible with standard behavior.<br>Minimum selectable delay is the smallest delay available for all acquisition cards used within the mainframe |
| Cross channel triggering | |
| Channels on card | Logical OR; analog triggers of all channels<br>Logical AND; qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; two individual levels, logical OR |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/Disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/Disable trigger with dual level |
| Event channel trigger (1) | |
| Event channels | Individual event trigger per event channel |
| Levels | Trigger on rising edge or trigger on falling edge |
| Qualifiers | Active High or Active Low for every event channel |

(1) Only if supported by mainframe

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| **StatStream®** | |
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |
| **Real-Time Calculations (Perception V6.50 and higher)** | |

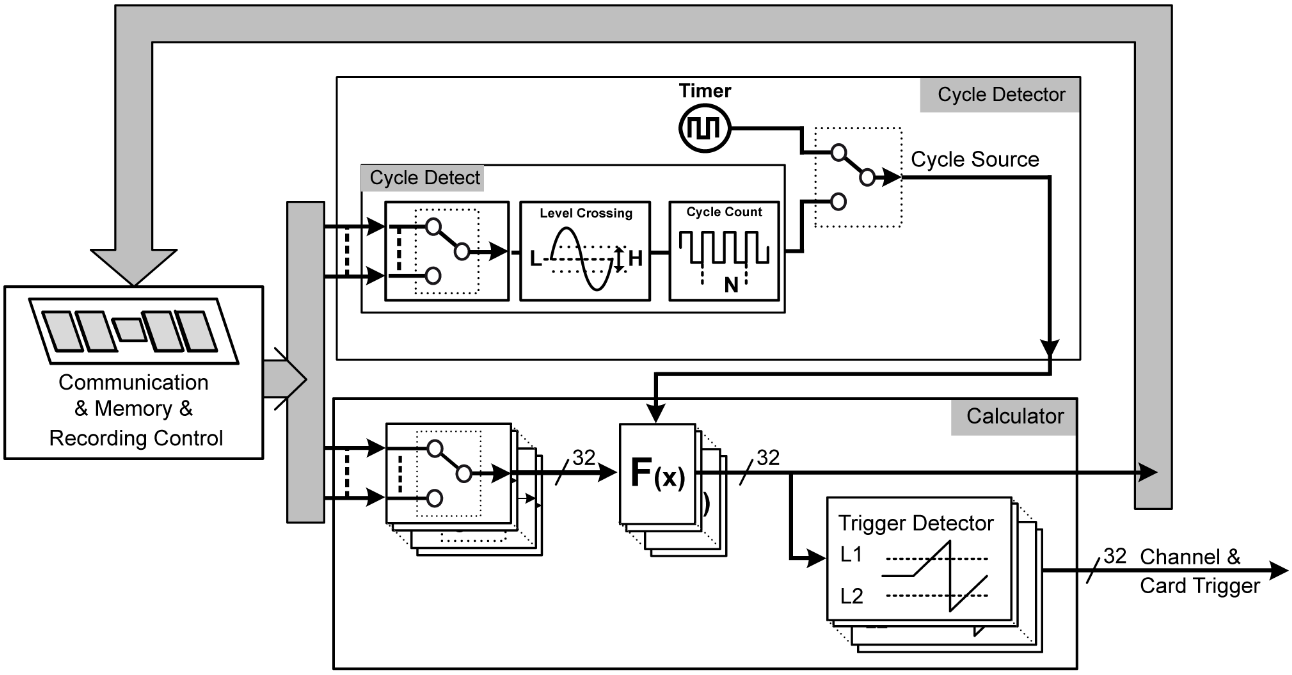



**Figure A.31:** Real-Time Calculations

## Real-Time Analysis

| | |
|---|---|
| Cycle Source | Determines the periodic based real-time calculations<br>Supports timer or signal level crossing based period generation |
| Timer | |
| Time interval | 1.0 ms (1 kHz) to 60 s (0.0167 Hz) |
| Cycle detect | |
| Level crossing | Monitors one analog channel using a user selectable signal level and signal hysteresis to dynamically determine the cyclic nature of the signal. |
| Cycle count | Sets the counted number of cycles used for periodic calculation output |
| Cycle period(1) | Maximum detectable Cycle period 0.25 s (4 Hz)<br>Minimum detectable period 0.91 ms (1.1 kHz)<br>Calculations stops when Cycle period exceeds maximum cycle period (0.25 s).<br>Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms).<br>Exceeding Cycle period or automatic Cycle count increases are indicated with time event notification in channel data. |
| Real-Time calculator | |
| Number of calculators | 32; at sample rates 200 kS/s or lower. At higher sample rates number of calculators is reduced to match available DSP power. |
| Calculator DSP load | Each calculator can execute 1 calculation. Not every calculation uses the same DSP power. Selecting the highest computation power calculations could lead to reduction of total number of calculators. Different combinations lead to different computation power and can't be specified. Perception software will reflect the impact on selected combinations. |
| Calculations | Cycle and Frequency on Cycle signal only. RMS, Minimum, Maximum, Mean, Peak to Peak, Area, Energy and MeanOfMultiply on analog channels and Frequency on Timer/Counter channels that measure frequency.(2) |
| Cycle | Square wave signal, 50 % duty cycle.<br>Represent Cycle Source; rising edge indicates start of new calculation period. |
| Frequency | Detected cycle interval is converted to a frequency (1 / cycle time of input signal) |
| Trigger detector | |
| Number of detectors | 32; One per Real-Time calculator |
| Trigger level | User defined per detector. Generates trigger when calculated signal crosses the level. |
| Trigger output delay | Triggers on calculated signals are 100 ms delayed. Internally time corrected for correct sweep triggering. Internally an additional 100 ms pre-trigger length is added to every channel using this trigger as trigger source to enable the time correction. This reduces the maximum sweep length by 100 ms. |

(1) Cycle period range depends on signal wave shape and hysteresis setting. Specified for Sine wave with 25 % Full Scale hysteresis.

(2) To enable triggering on Timer/Counter frequency measurements.

## Acquisition Modes

| | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Acquisition Mode Details

**16 Bit resolution**

| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 6 Ch | 6 Ch & Events | 1 Ch | 6 Ch | 6 Ch & Events | 1 Ch | 6 Ch | 6 Ch & Events |
| Max. sweep memory | 1 GS | 166 MS | 142 MS | not used | | | 800 MS | 133 MS | 113 MS |
| Max. sweep sample rate | 2 MS/s | | | not used | | | 2 MS/s | | |
| Max. continuous FIFO | not used | | | 1 GS | 166 MS | 142 MS | 199 MS | 33 MS | 28 MS |
| Max. continuous sample rate | not used | | | 2 MS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 2 MS/s<br>4 MB/s | 12 MS/s<br>24 MB/s | 14 MS/s<br>28 MB/s | 2 MS/s<br>4 MB/s | 12 MS/s<br>24 MB/s | 14 MS/s<br>28 MB/s |

**18 Bit resolution**

| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 6 Ch | 6 Ch & Events & Timer/ Counter | 1 Ch | 6 Ch | 6 Ch & Events & Timer/ Counter | 1 Ch | 6 Ch | 6 Ch & Events & Timer/ Counter |
| Max. sweep memory | 500 MS | 83 MS | 55 MS | not used | | | 400 MS | 66 MS | 44 MS |
| Max. sweep sample rate | 2 MS/s | | | not used | | | 2 MS/s | | |
| Max. continuous FIFO | not used | | | 500 MS | 83 MS | 55 MS | 99 MS | 16 MS | 10 MS |
| Max. continuous sample rate | not used | | | 2 MS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 2 MS/s<br>8 MB/s | 12 MS/s<br>48 MB/s | 18 MS/s<br>72 MB/s | 2 MS/s<br>8 MB/s | 12 MS/s<br>48 MB/s | 18 MS/s<br>72 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

| Multiple Sweeps | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

| Slow Fast Sweep | |
|---|---|
| Maximum number of Sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2 |
| Maximum fast sample rate switches | 400 sample rate switches per second, 200 000 switches maximum<br>Recording stops at end of sweep even if specified sample rates switches did not happen |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Dual

| Dual Sweep Specification | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Shielded Cable 1-KAB290-xx (option, to be ordered separately)

This cable is specially designed to be used with the GN610 and GN611 cards

| | |
|---|---|
| Cable setup | 2 wires with shield and isolation<br>3 shrouded banana plugs on each side; Red, Black and Yellow |

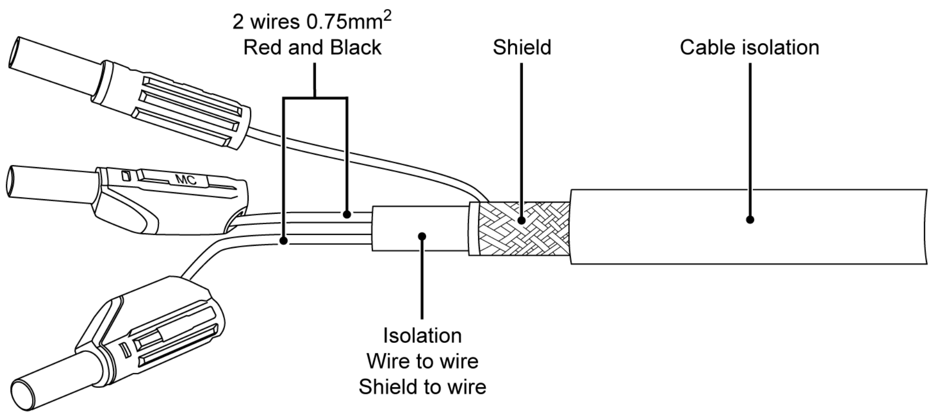



**Figure A.32:** Shielded cable setup

| | |
|---|---|
| Wire thickness | 2 * 0.75 mm$^2$ |
| Maximum wire resistance | 0.250 Ω / m (0.0763 Ω / ft) |
| Weight | Approximately 143 g / m (1.54 ounce / ft) |
| Outside cable diameter | Approximately 9 mm (0.354 inch) |
| Minimum bend radius | 10 times cable diameter |
| Isolation | |
| Resistance | 20 MΩ / km |
| Voltage | 600 V RMS CAT II; wire to wire; wire to shield; shield to outside |
| Capacitance | |
| Wire to wire | Approximately 110 pF / m (33.54 pF / ft) |
| Wire to shield | Approximately 150 pF / m (45.73 pF / ft) |
| Temperature range | |
| Operational | -15 °C (+5 °F) to +80 °C (+176 °F) |
| Non-operational (storage) | -40 °C (-40 °F) to +80 °C (+176 °F) |
| Available lengths | 1.5 m (4.92 ft), 3.0 m (9.84 ft), 6.0 m (19.7 ft) |

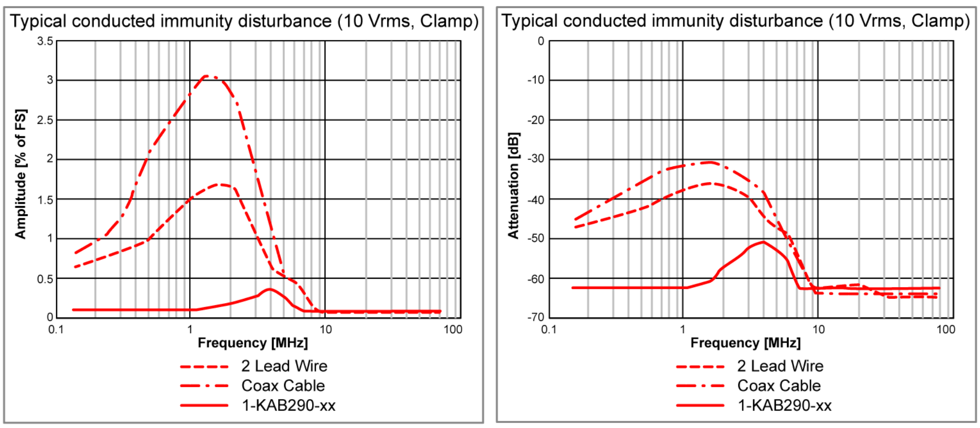



**Figure A.33:** Typical conducted immunity, tested using ± 10 V range

## Artificial Star Adapter (option, to be ordered separately)

The artificial star adapter creates an artificial star point for measuring 3 phase signals

| | |
|---|---|
| Maximum input voltage | 1000 V DC (707 V RMS) between each of the phases |
| Inputs | 3; 4 mm safety banana plugs |
| Outputs | 6; 4 mm safety banana pins; plugs straight into GN610/GN611 cards |
| Artificial star N | Reference plug only. Not to be used as input |
| Safety | Conform IEC61010-1 600 V RMS CAT II |
| Application use | The 3 phase signals L1, L2 and L3 can be connected with inputs L1, L2, L3 of the artificial star adapter. The connection N* is the voltage present on the artificial “star point”. |

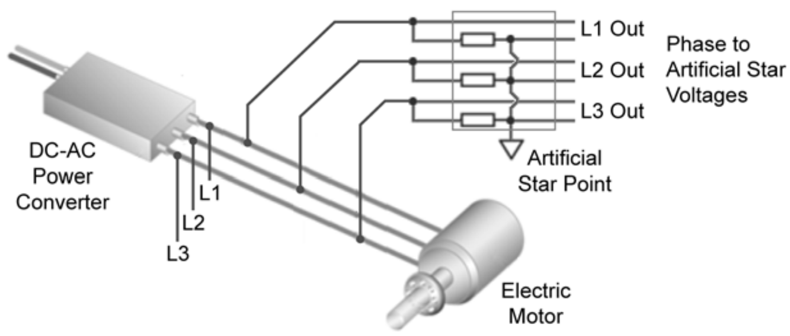



**Figure A.34:** Typical use of artificial star adapter

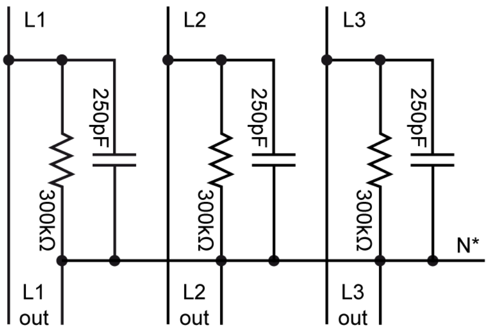



**Figure A.35:** Electrical schematic

| | |
|---|---|
| Weight | 170 g |
| Material housing | Poly Urethane, vacuum resin casting |
| Set-up | 2 boxes can be plugged onto a single GN610/GN611 card<br>2 GN610/GN611 cards with Artificial star adapters will fit next to each other |
| Temperature range | |
| Operational temperature | 0 °C to +40 °C (+32 to +104 °F) |
| Non-operational (storage) | -25 °C to +70 °C (-13 °F to +158 °F) |

## Artificial Star Adapter (option, to be ordered separately)

The artificial star adapter creates an artificial star point for measuring 3 phase signals

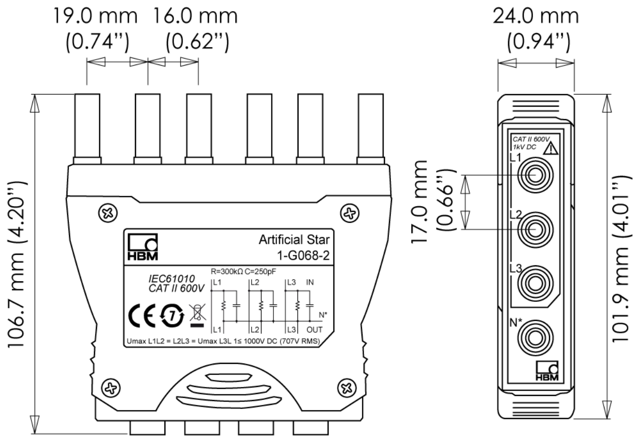



**Figure A.36:** Artificial star adapter

## Ordering information[1]

| Article | | Description | Order No. |
|---|---|---|---|
| Basic 1 kV ISO<br>2 MS/s |  | 6 channel, 18 bit, 2 MS/s, ± 20 mV to ± 1000 V input range, 2 GB RAM, 1 kV isolated balanced differential input (600 V RMS CAT II isolation), 4 mm fully isolated banana plugs. Real-time cycle based calculations with triggering on calculated results<br><br>Supported by Perception V6.30 and higher | 1-GN610-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| Test Leads and clips |  | Black/red lead set 600 V RMS CAT II, 1.5 meter (4.9 ft) with safety-shrouded banana plugs and alligator clips | 1-KAB282-1.5 |
| BNC to banana adapter |  | Set of six pieces, safety isolated female BNC to dual 4 mm protected banana adaptor.<br>1000 V RMS CAT II, 600 V RMS CAT III and 1 A current safety ratings. Can be used with GN610 and GN611 input cards | 1-G067-2 |
| Artificial<br>star adapter |  | The artificial star adapter is a plug-on interface card for measuring 3 phase signals with the high voltage cards 1-GN610-2 and 1-GN611-2. This card is intended for measuring 3 phase signals while creating a virtual/artificial star point | 1-G068-2 |
| Isolated<br>shielded<br>test leads |  | Black/red lead set combined within shielded housing.<br>600 V RMS CAT II, safety-shrouded stackable banana plugs. Significantly reduces signal disturbance pickup by using earthed shield.<br>Available lengths 1.5 m (4.92 ft), 3.0 m (9.84 ft) and 6.0 m (19.69 ft) | 1-KAB290-1.5<br>1-KAB290-3<br>1-KAB290-6 |

## A.6 B3716-4.0 en (GEN series GN611)

| Capabilities Overview | |
|---|---|
| Model | GN611 |
| Maximum sample rate per channel | 200 kS/s |
| Memory per card | 200 MB |
| Analog channels | 6 |
| Sample resolution | 16/18 bit |
| Isolation | Channel to channel and channel to chassis |
| Input type | Analog isolated balanced differential (1) |
| Sensor support | No |
| TEDS support | No |
| Real-time calculations | 32; Cycle and Timer based calculations with triggering on calculated results |
| Digital Event/Timer/Counter support | 16 digital events and 2 timer/counter channels |
| Fast data streaming | No |

(1) No probes supported

### GEN series GN611 Block diagram

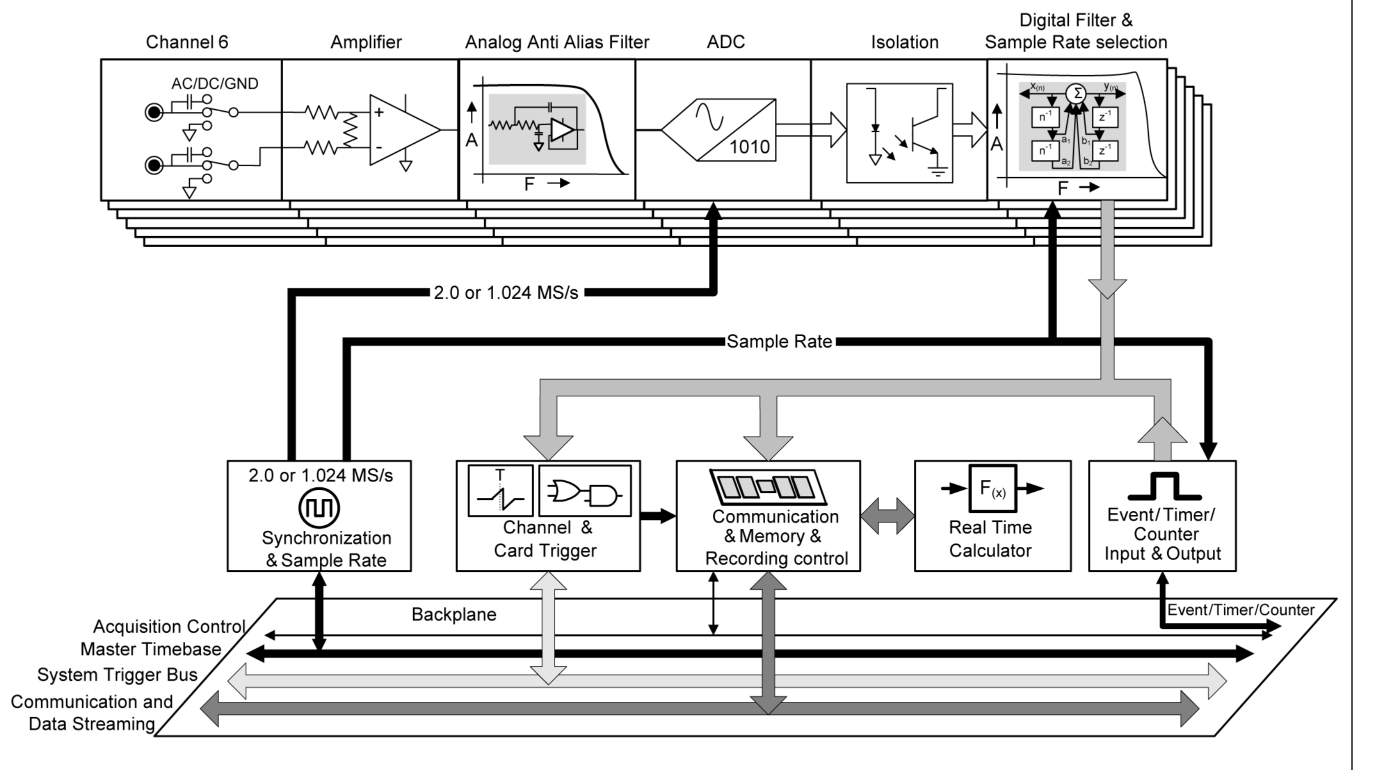



**Figure A.37:** Block Diagram GEN series GN611

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

## Analog Input Section

| | |
|---|---|
| Channels | 6 |
| Connectors | Fully isolated 4 mm banana plugs (Plastic), 2 per channel (red and black) |
| Input type | Analog isolated balanced differential |
| Input coupling | |
| Coupling modes | AC, DC, GND |
| AC coupling frequency | 48 Hz ± 5 Hz (-3 dB) |

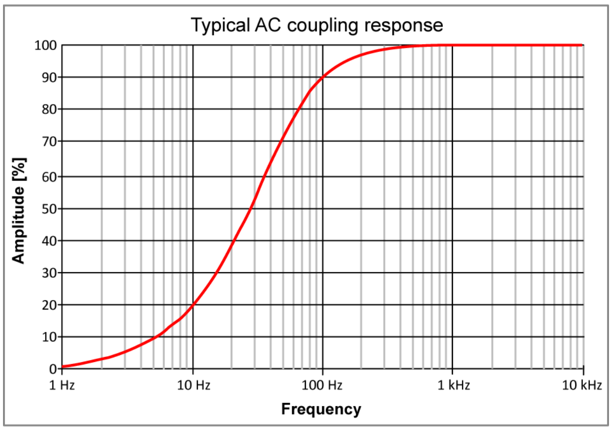



**Figure A.38:** Typical AC coupling response

| | |
|---|---|
| Impedance | 2 * 1 MΩ ± 1 % // 33 pF ± 10% ranges larger than ± 5 V. All other ranges 57 pF ± 10% |
| Ranges | ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1000 V |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 1000 V range has fixed 0 % offset |
| DC Offset error | |
| All IIR filters | 0.02 % of Full Scale ± 10 µV |
| Offset error drift | ±(20 ppm + 10 µV)/°C (±(12 ppm + 6 µV)/°F) |
| DC Gain error | |
| All IIR filters | 0.1 % of Full Scale ± 10 µV |
| Gain error drift | ±30 ppm/°C (±17 ppm/°F) |
| Maximum static error (MSE) | |
| All IIR filters | 0.075 % of Full Scale ± 10 µV |
| RMS Noise (50 Ω terminated) | |
| All IIR filters | 0.035 % of Full Scale ± 50 µV |

## Analog Input Section

| | | |
|---|---|---|
| Common Mode (referred to system ground) | | |
| Ranges | Less than or equal to ± 5 V | Larger than ± 5 V |
| Rejection Ratio (CMRR) | > 80 dB @ 80 Hz (-110 dB typical) | > 60 dB @ 80 Hz (-80 dB typical) |
| Voltage | 7 V RMS | 1000 V RMS |

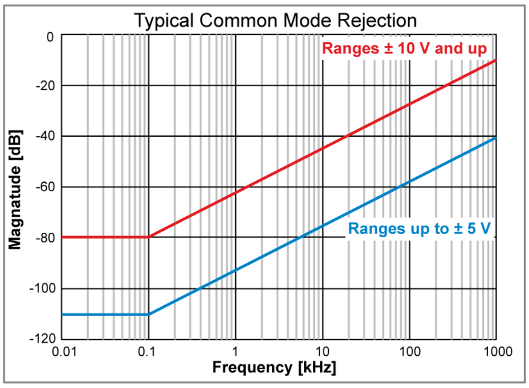



**Figure A.39:** Typical Common Mode Rejection

| | |
|---|---|
| Input overload protection | |
| Over voltage impedance change | The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200 % of the selected input range or 1250 V whichever is the smallest value. |
| Maximum nondestructive voltage | ± 2000 V DC |
| Maximum overload without auto range | 200 % of selected range |
| Automatic auto range | When overload creates over heating of the amplifier, the amplifier will change its range up in steps of factor 10 until overload disappears. When the actual overload is above 1000 V, the input signal will be disconnected and the amplifier input will be grounded. When temperature returns to normal the original selected range will be restored. Automatic auto range can not be turned off. |
| Overload recovery time | Restored to 0.1 % accuracy in less than 5 µs after 200 % overload |

## Isolation

| | | CAT II | CAT III |
|---|---|---|---|
| Channel to chassis (earth) | 1000 V RMS | 600 V RMS (1) | 300 V RMS(1) |
| Channel to channel | 2000 V RMS | (2) | (2) |

(1) IEC61010-1 Category voltage ratings are RMS voltages.

(2) Channel to channel CAT II and CAT III ratings are not a valid method to specify.

| Analog to Digital Conversion | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 200 kS/s |
| ADC resolution; one ADC per channel | 18 bit |
| ADC type | Successive Approximation Register (SAR); Analog Devices AD7641BCPZ |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; produces rounded BIN values when calculating FFT's |
| Maximum binary sample rate | 204.8 kS/s |
| External time base frequency | 0 S/s to 200 kS/s |
| External time base frequency divider | Divide external clock by 1 to $2^{20}$ |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller Modules shipped before 2012: ±30 ppm.

| Amplifier Bandwidth and Filtering | |
|---|---|
| Using different filter selections (Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Bessel IIR | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| Butterworth IIR | When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| Elliptic IIR | When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Bessel IIR Filter

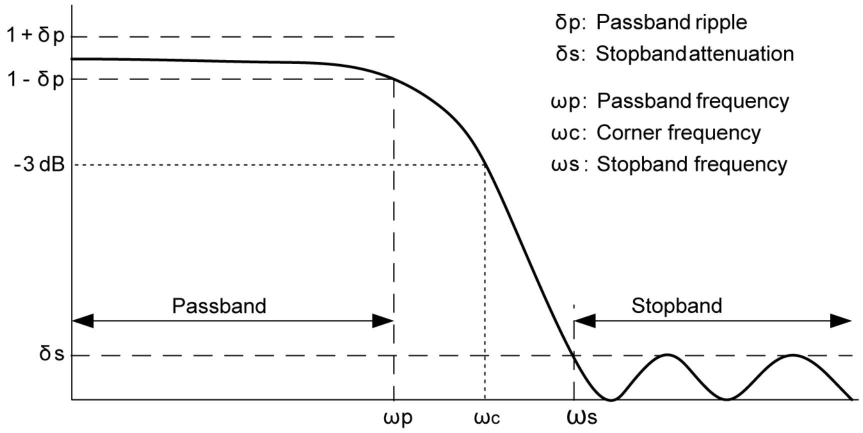



**Figure A.40:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 400 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 8-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | User selectable from 0.4 Hz to 20 kHz |
| Bessel IIR passband ripple (δp) | 0.1 dB[(1)] |
| Bessel IIR passband (ωp | DC to 3.5 kHz @ ωc = 20 kHz[(1)] |
| Bessel IIR filter stopband attenuation (δs) | -60 dB |
| Bessel IIR filter roll-off | -48 dB/octave |

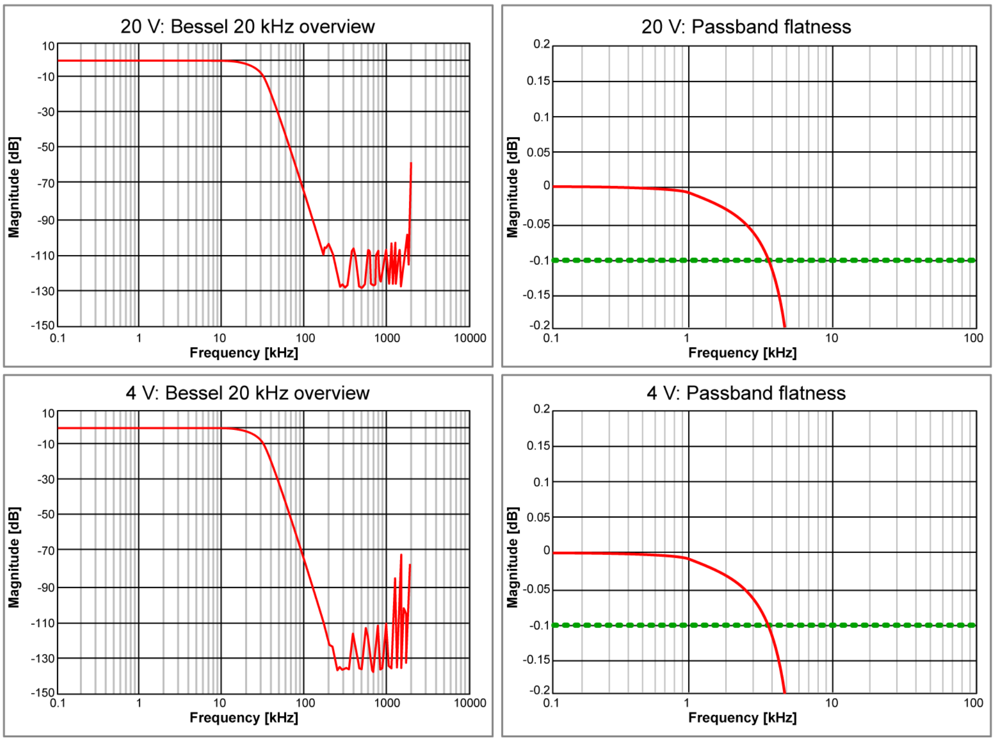



**Figure A.41:** Typical Bessel IIR 20 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Butterworth IIR Filter

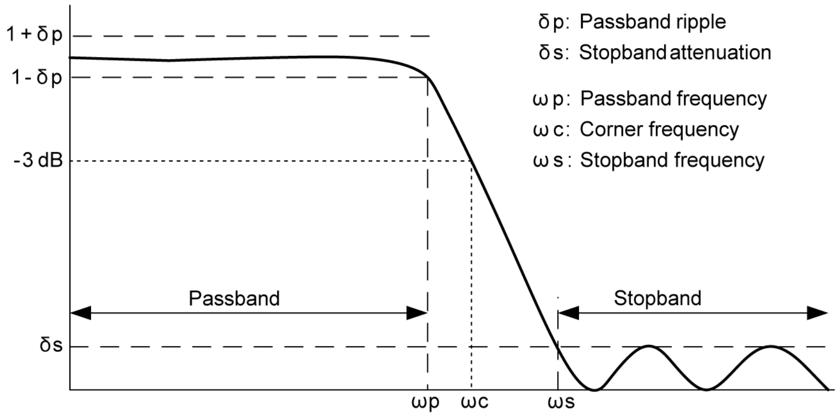



**Figure A.42:** Digital Butterworth IIR Filter

When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 450 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Butterworth IIR filter characteristic | 8-pole Butterworth style IIR |
| Butterworth IIR filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed. |
| Butterworth IIR filter bandwidth (ωc) | User selectable from 1 Hz to 50 kHz |
| Butterworth IIR passband ripple (δp) | 0.1 dB(1) |
| Butterworth IIR passband (ωp) | DC to 35 kHz @ ωc = 50 kHz(1) |
| Butterworth IIR filter stopband attenuation (δs) | -75 dB |
| Butterworth IIR filter roll-off | -48 dB/octave |

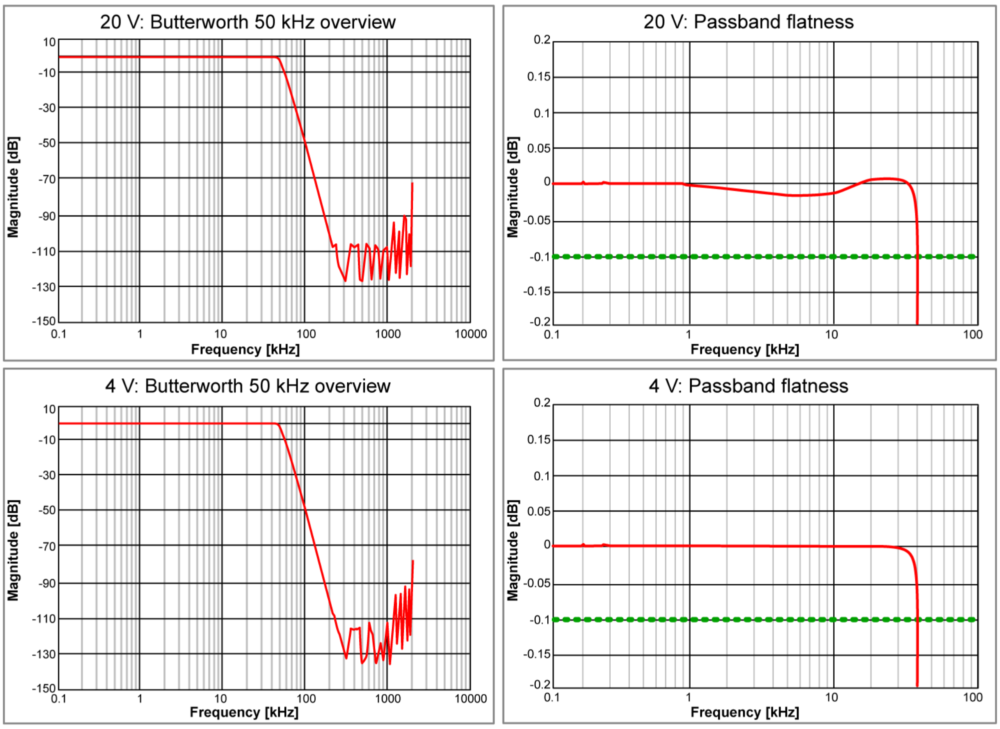



**Figure A.43:** Typical Butterworth IIR 50 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Elliptic IIR Filter

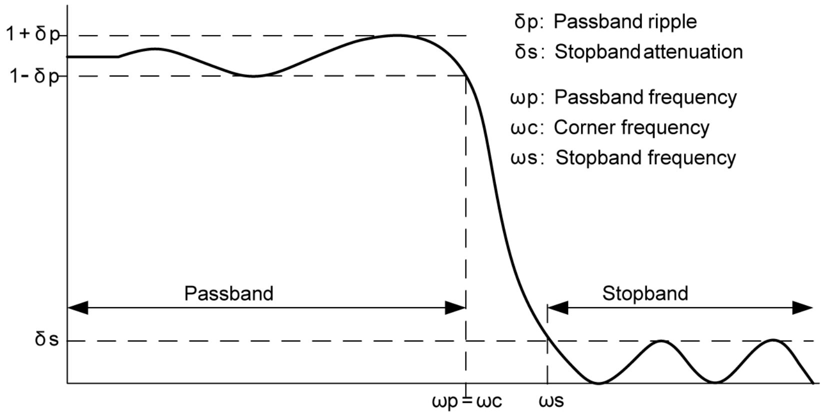



**Figure A.44:** Digital Elliptic IIR Filter

When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 450 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Elliptic IIR filter characteristic | 7-pole Elliptic style IIR |
| Elliptic IIR filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Elliptic IIR filter bandwidth (ωc) | User selectable from 1 Hz to 50 kHz |
| Elliptic IIR passband ripple (δp) | 0.1 dB(1) |
| Elliptic IIR passband (ωp) | DC to filter bandwidth (ωc)(1) |
| Elliptic IIR filter stopband attenuation (δs) | -75 dB |
| Elliptic IIR filter roll-off | -72 dB/octave |

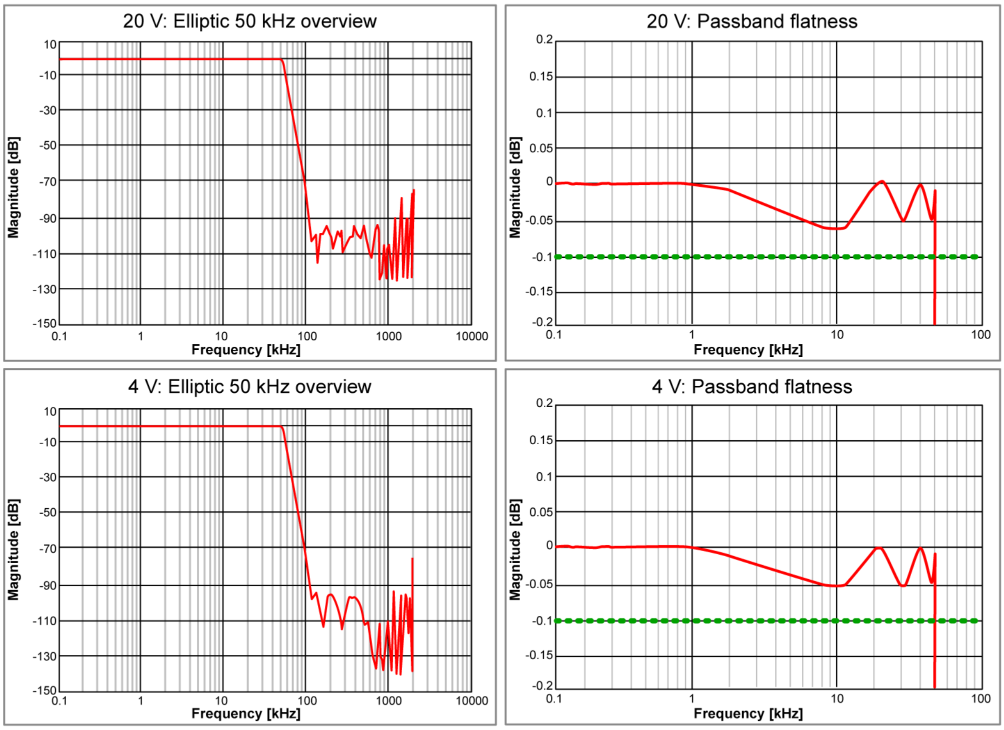



**Figure A.45:** Typical Elliptic IIR 50 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Channel to Channel Phase Match

| Using different filter selections (Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
|---|---|
| Bessel IIR, Filter frequency 20 kHz @ 200 kS/s; 10 kHz sine wave | |
| Channels on card | 0.6 deg (0.17 µs) |
| GN611 Channels within mainframe | 0.6 deg (0.17 µs) |
| Butterworth IIR, Filter frequency 50 kHz @ 200 kS/s; 10 kHz sine wave | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN611 Channels within mainframe | 0.5 deg (0.14 µs) |
| Elliptic IIR, Filter frequency 50 kHz @ 200 kS/s; 10 kHz sine wave | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN611 Channels within mainframe | 0.5 deg (0.14 µs) |
| GN611 channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

## Channel to Channel Crosstalk

Channel to channel crosstalk is measured with a 50 Ω termination resistor on the input and using sine wave signals on the channel above and below the channel under test. To test channel 2, channel 2 is terminated with 50 Ω and channel 1 and 3 are connected to the sine wave generator.

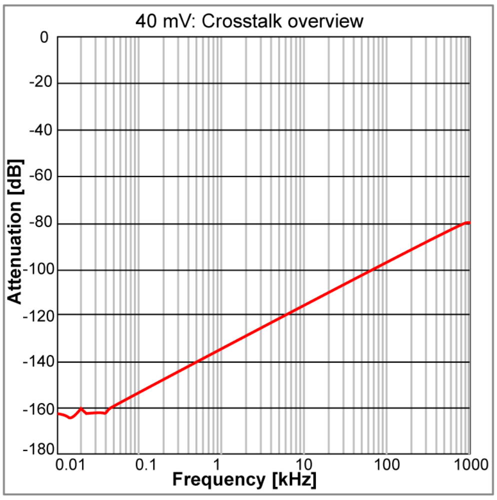



**Figure A.46:** Typical Channel to Channel crosstalk

## On-board Memory

| | |
|---|---|
| Per card | 200 MB (100 MS @ 16 bits storage) |
| Organization | Automatically distributed amongst channels enabled for storage or real-time calculations |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample<br>18 bits, 4 bytes/sample (required for Timer/Counter usage) |

## Digital Event/Timer/Counter (1)

| | |
|---|---|
| Digital input events | 16 per card |
| Levels | TTL input levels, user programmable invert |
| Inputs | 1 pin per input, some pins are shared with Timer/Counter inputs |
| Over voltage protection | ± 30 V DC continuously |
| Minimum pulse width | 100 ns |
| Maximum frequency | 5 MHz |
| Digital output events | 2 per card |
| Levels | TTL output levels, short circuit protected |
| Output event 1 | User selectable: Trigger, Alarm, set High or Low |
| Output event 2 | User selectable: Recording active, set High or Low |
| Digital output event user selections | |
| Trigger | 1 high pulse per trigger (on every channel trigger of this card only)<br>12.8 µs minimum pulse width<br>200 µs ± 1 µs ± 1 sample period pulse delay |
| Alarm | High when alarm condition is activated, low when not activated (alarm conditions of this card only)<br>200 µs ± 1 µs ± 1 sample period alarm event delay |
| Recording active | High when recording, low when in idle or pause mode<br>Recording active output delay 450 ns |
| Set High or Low | Output set High or Low; can be controlled by Custom Software Interface (CSI) extensions; delay depending on specific software implementation |
| Timer/Counter | 2 per card; only available in 18 bit mode |
| Levels | TTL input levels |
| Inputs | All pins are shared with digital event inputs |
| Timer-Counter modes | Uni- and bi-directional count<br>Bi-directional quadrature count<br>Uni- and bi-directional frequency/RPM measurement |
| Uni- and bi-directional count | |
| Inputs | 3 pins; signal, reset and direction (only used in bidirectional count) |
| Maximum input frequency | 5 MHz |
| Maximum count value | 0 to $2^{31}$; unidirectional count. $-2^{31}$ to $+2^{31}$; bidirectional count |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |
| Direction input | Only used when in bi-directional count<br>Low: increment counter<br>High: decrement counter |
| Bi-directional quadrature count | |
| Inputs | 3 pins; signal, direction and reset |
| Maximum input frequency | 2 MHz, minimum high or low time 200 ns. Minimum phase difference between signal and direction 100 ns. |
| Accuracy | Single, dual and quad precision |
| Maximum count value | $-2^{31}$ to $+2^{31}$ |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |

| Digital Event/Timer/Counter (1) | |
|---|---|
| Uni- and bi-directional frequency/RPM measurement | |
| Inputs | 2 pins; signal, direction |
| Maximum input frequency | 5 MHz |
| Accuracy | 0.1 % |
| Gate measuring time | Sample period to 50 s; user selectable to control update rate independent of sample rate |
| Direction input | Only used when in bi-directional frequency/RPM mode<br>Low: Positive frequency/RPM, e.g. left rotations<br>High: Negative frequency/RPM, e.g. right rotations |
| External start | User selectable Rising/Falling edge signal will start a new recording |
| External stop | User selectable Rising/Falling edge signal will stop the recording |

(1) Only if supported by mainframe

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 fully independent per channel either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Trigger in edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Trigger in delay | ± 1 µs + maximum 1 sample period (Identical for decimal and binary time base) |
| Send to external trigger out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Trigger out level | High/Low/Hold High; mainframe selectable, identical for all cards |
| Trigger out pulse width | High/Low: 12.8 µs<br>Hold High: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe; see mainframe datasheet for details |
| Trigger out delay | Selectable (10 µs to 516 µs) ± 1 µs + maximum 1 sample period using decimal time base<br>Selectable (9.76 µs to 504 µs) ± 1 µs + maximum 1 sample period using binary time base<br>Default 516(504) µs for decimal (binary) time base, to be compatible with standard behavior.<br>Minimum selectable delay is the smallest delay available for all acquisition cards used within the mainframe |
| Cross channel triggering | |
| Channels on card | Logical OR; analog triggers of all channels<br>Logical AND; qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; two individual levels, logical OR |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/Disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/Disable trigger with dual level |
| Event channel trigger (1) | |
| Event channels | Individual event trigger per event channel |
| Levels | Trigger on rising edge or trigger on falling edge |
| Qualifiers | Active High or Active Low for every event channel |

(1) Only if supported by mainframe

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| **StatStream®** | |
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |
| **Real-Time Calculations (Perception V6.50 and higher)** | |

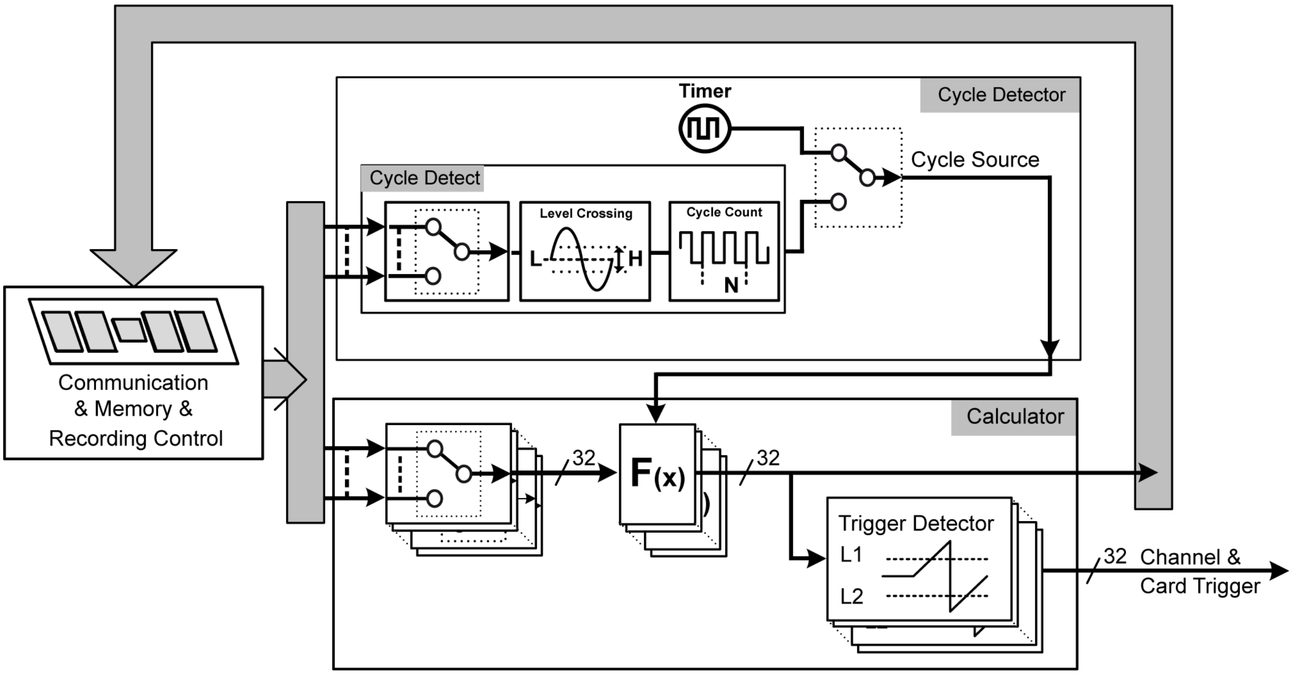



**Figure A.47:** Real-Time Calculations

| Real-Time Analysis | |
|---|---|
| Cycle Source | Determines the periodic based real-time calculations<br>Supports timer or signal level crossing based period generation |
| Timer | |
| Time interval | 1.0 ms (1 kHz) to 60 s (0.0167 Hz) |
| Cycle detect | |
| Level crossing | Monitors one analog channel using a user selectable signal level and signal hysteresis to dynamically determine the cyclic nature of the signal. |
| Cycle count | Sets the counted number of cycles used for periodic calculation output |
| Cycle period(1) | Maximum detectable Cycle period 0.25 s (4 Hz)<br>Minimum detectable period 0.91 ms (1.1 kHz)<br>Calculations stops when Cycle period exceeds maximum cycle period (0.25 s).<br>Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms).<br>Exceeding Cycle period or automatic Cycle count increases are indicated with time event notification in channel data. |
| Real-Time calculator | |
| Number of calculators | 32 |
| Calculator DSP load | Each calculator can execute 1 calculation. Not every calculation uses the same DSP power. Selecting the highest computation power calculations could lead to reduction of total number of calculators. Different combinations lead to different computation power and can't be specified. Perception software will reflect the impact on selected combinations. |
| Calculations | Cycle and Frequency on Cycle signal only. RMS, Minimum, Maximum, Mean, Peak to Peak, Area, Energy and MeanOfMultiply on analog channels and Frequency on Timer/Counter channels that measure frequency.(2) |
| Cycle | Square wave signal, 50 % duty cycle.<br>Represent Cycle Source; rising edge indicates start of new calculation period. |
| Frequency | Detected cycle interval is converted to a frequency (1 / cycle time of input signal) |
| Trigger detector | |
| Number of detectors | 32; One per Real-Time calculator |
| Trigger level | User defined per detector. Generates trigger when calculated signal crosses the level. |
| Trigger output delay | Triggers on calculated signals are 100 ms delayed. Internally time corrected for correct sweep triggering. Internally an additional 100 ms pre-trigger length is added to every channel using this trigger as trigger source to enable the time correction. This reduces the maximum sweep length by 100 ms. |

(1) Cycle period range depends on signal wave shape and hysteresis setting. Specified for sine wave with 25 % Full Scale hysteresis.
(2) To enable triggering on Timer/Counter frequency measurements.

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Acquisition Mode Details

**16 Bit resolution**

| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 6 Ch | 6 Ch & Events | 1 Ch | 6 Ch | 6 Ch & Events | 1 Ch | 6 Ch | 6 Ch & Events |
| Max. sweep memory | 100 MS | 16 MS | 14 MS | not used | | | 80 MS | 13 MS | 11 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 100 MS | 16 MS | 14 MS | 18 MS | 3 MS | 2.5 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 0.2 MS/s<br>0.4 MB/s | 1.2 MS/s<br>2.4 MB/s | 1.4 MS/s<br>2.8 MB/s | 0.2 MS/s<br>0.4 MB/s | 1.2 MS/s<br>2.4 MB/s | 1.4 MS/s<br>2.8 MB/s |

**18 Bit resolution**

| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 6 Ch | 6 Ch & Events & Timer/ Counter | 1 Ch | 6 Ch | 6 Ch & Events & Timer/ Counter | 1 Ch | 6 Ch | 6 Ch & Events & Timer/ Counter |
| Max. sweep memory | 50 MS | 8 MS | 5 MS | not used | | | 40 MS | 6.5 MS | 4 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 50 MS | 8 MS | 5 MS | 9 MS | 1.5 MS | 1 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 0.2 MS/s<br>0.8 MB/s | 1.2 MS/s<br>4.8 MB/s | 1.8 MS/s<br>7.2 MB/s | 0.2 MS/s<br>0.8 MB/s | 1.2 MS/s<br>4.8 MB/s | 1.8 MS/s<br>7.2 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

| Multiple Sweeps | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

| Slow Fast Sweep | |
|---|---|
| Maximum number of Sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2 |
| Maximum fast sample rate switches | 400 sample rate switches per second, 200 000 switches maximum<br>Recording stops at end of sweep even if specified sample rates switches did not happen |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Dual

| Dual Sweep Specification | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

## Harmonized standards for CE compliance, according to the following directives

Low voltage directive (LVD): 2006/95/EC
Electromagnetic compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Shielded Cable 1-KAB290-xx (option, to be ordered separately)

This cable is specially designed to be used with the GN610 and GN611 cards

| | |
|---|---|
| Cable setup | 2 wires with shield and isolation<br>3 shrouded banana plugs on each side; Red, Black and Yellow |

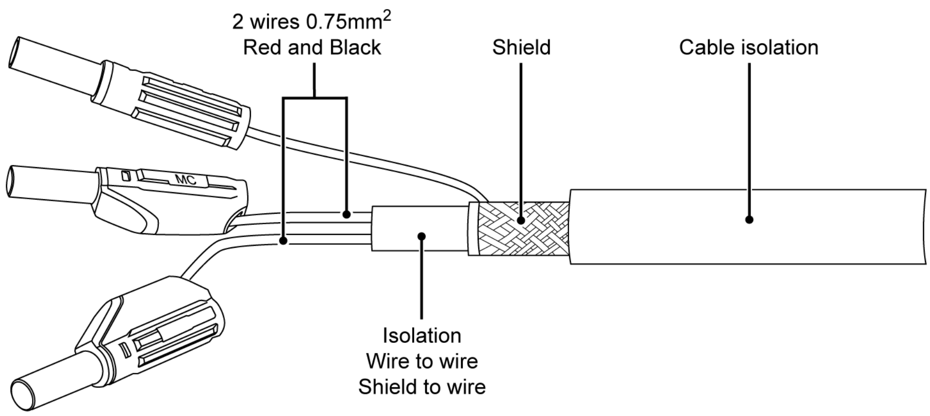



**Figure A.48:** Shielded cable setup

| | |
|---|---|
| Wire thickness | 2 * 0.75 mm$^2$ |
| Maximum wire resistance | 0.250 Ω / m (0.0763 Ω / ft) |
| Weight | Approximately 143 g / m (1.54 ounce / ft) |
| Outside cable diameter | Approximately 9 mm (0.354 inch) |
| Minimum bend radius | 10 times cable diameter |
| Isolation | |
| Resistance | 20 MΩ / km |
| Voltage | 600 V RMS CAT II; wire to wire; wire to shield; shield to outside |
| Capacitance | |
| Wire to wire | Approximately 110 pF / m (33.54 pF / ft) |
| Wire to shield | Approximately 150 pF / m (45.73 pF / ft) |
| Temperature range | |
| Operational | -15 °C (+5 °F) to +80 °C (+176 °F) |
| Non-operational (storage) | -40 °C (-40 °F) to +80 °C (+176 °F) |
| Available lengths | 1.5 m (4.92 ft), 3.0 m (9.84 ft), 6.0 m (19.7 ft) |

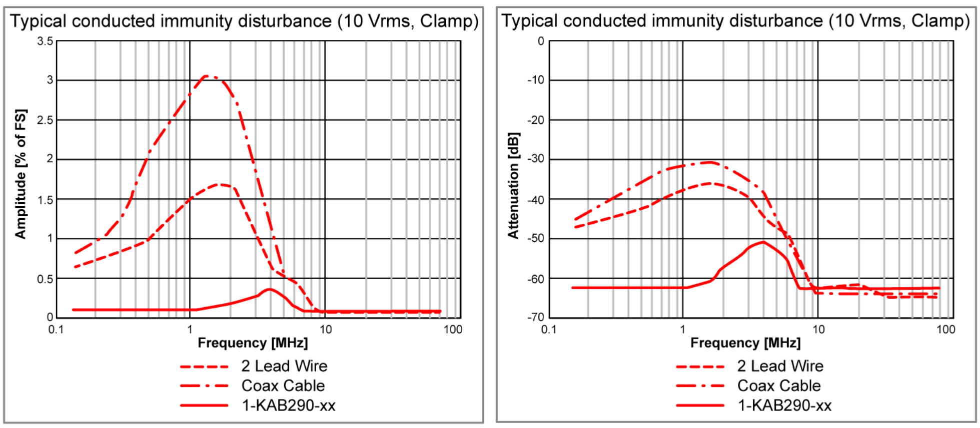



**Figure A.49:** Typical conducted immunity, tested using ± 10 V range

| Artificial Star Adapter (option, to be ordered separately) | |
|---|---|
| The artificial star adapter creates an artificial star point for measuring 3 phase signals | |
| Maximum input voltage | 1000 V DC (707 V RMS) between each of the phases |
| Inputs | 3; 4 mm safety banana plugs |
| Outputs | 6; 4 mm safety banana pins; plugs straight into GN610/GN611 cards |
| Artificial star N | Reference plug only. Not to be used as input |
| Safety | Conform IEC61010-1 600 V RMS CAT II |
| Application use | The 3 phase signals L1, L2 and L3 can be connected with inputs L1, L2, L3 of the artificial star adapter. The connection N* is the voltage present on the artificial “star point”. |

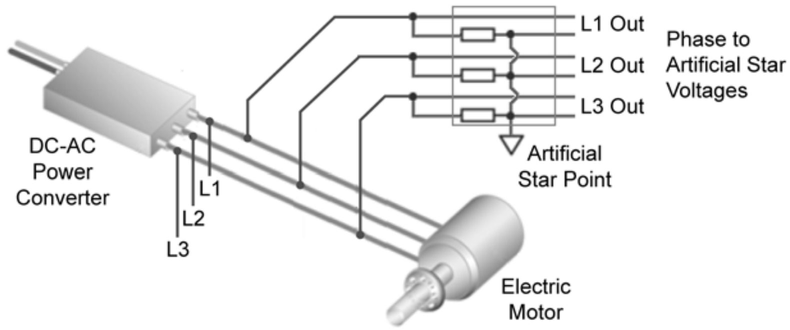



**Figure A.50:** Typical use of artificial star adapter

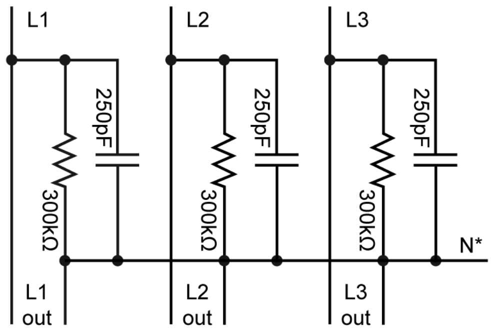



**Figure A.51:** Electrical schematic

| | |
|---|---|
| Weight | 170 g |
| Material housing | Poly Urethane, vacuum resin casting |
| Set-up | 2 boxes can be plugged onto a single GN610/GN611 card<br>2 GN610/GN611 cards with Artificial star adapters will fit next to each other |
| Temperature range | |
| Operational temperature | 0 °C to +40 °C (+32 to +104 °F) |
| Non-operational (storage) | -25 °C to +70 °C (-13 °F to +158 °F) |

## Artificial Star Adapter (option, to be ordered separately)

The artificial star adapter creates an artificial star point for measuring 3 phase signals

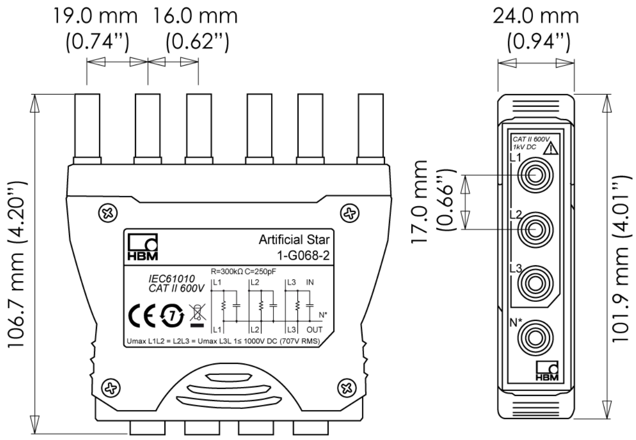



**Figure A.52:** Artificial star adapter

## Ordering information [1]

| Article | | Description | Order No. |
|---|---|---|---|
| Basic 1 kV ISO<br>200 kS/s |  | 6 channel, 18 bit, 200 kS/s, ± 20 mV to ± 1000 V input range, 200 MB RAM, 1 kV isolated balanced differential input (600 V RMS CAT II isolation), 4 mm fully isolated banana plugs. Real-time cycle based calculations with triggering on calculated results.<br><br>Supported by Perception V6.30 and higher | 1-GN611-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| Test Leads and clips |  | Black/red lead set 600 V RMS CAT II, 1.5 meter (4.9 ft) with safety-shrouded banana plugs and alligator clips | 1-KAB282-1.5 |
| BNC to banana adapter |  | Set of six pieces, safety isolated female BNC to dual 4 mm protected banana adaptor.<br>1000 V RMS CAT II, 600 V RMS CAT III and 1 A current safety ratings. Can be used with GN610 and GN611 input cards | 1-G067-2 |
| Artificial star adapter |  | The artificial star adapter is a plug-on interface card for measuring 3 phase signals with the high voltage cards 1-GN610-2 and 1-GN611-2. This card is intended for measuring 3 phase signals while creating a virtual/artificial star point | 1-G068-2 |
| Isolated shielded test leads |  | Black/red lead set combined within shielded housing.<br>600 V RMS CAT II, safety-shrouded stackable banana plugs. Significantly reduces signal disturbance pickup by using earthed shield.<br>Available lengths 1.5 m (4.92 ft), 3.0 m (9.84 ft) and 6.0 m (19.69 ft) | 1-KAB290-1.5<br>1-KAB290-3<br>1-KAB290-6 |

## A.7 B2632-3.0 en (GEN series GN810)

| Capabilities Overview | |
|---|---|
| Model | GN810 |
| Maximum sample rate per channel | 200 kS/s |
| Memory per card | 128 MB |
| Analog channels | 8 |
| ADC resolution | 16 bit |
| Digital event/Timer/Counter support | no |
| Isolation | no |
| Input type | Analog single ended |
| Fast data streaming | no |

### GEN series GN810 Block diagram

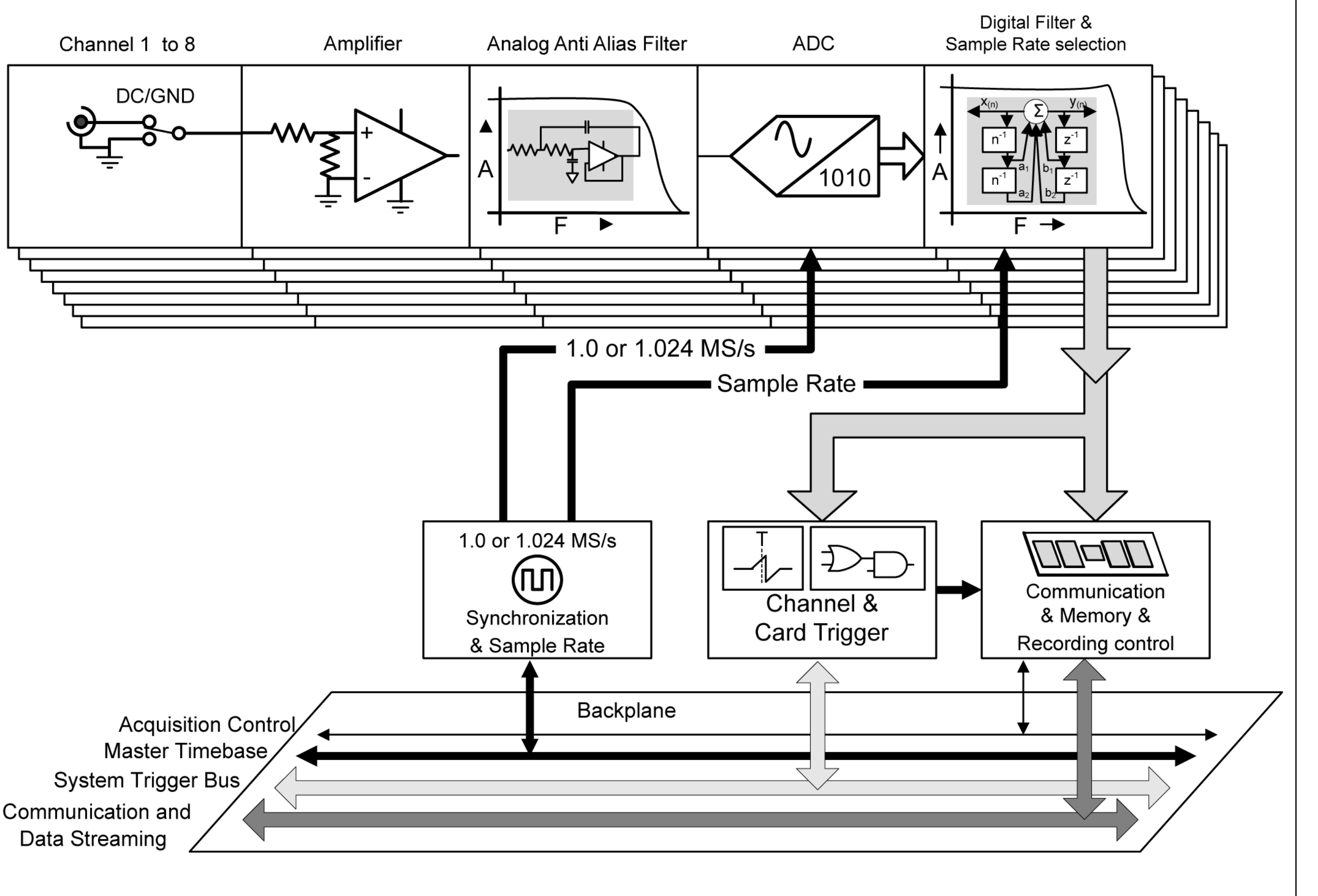



**Figure A.53:** Block diagram GEN series GN810

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 8 |
| Connectors | Metal BNC, 1 per channel |
| Input type | Analog single ended |
| Input coupling | DC, GND |
| Impedance | 1 MΩ ± 1% // 65 pF ± 10% |
| Ranges | ± 1 V, ± 2 V, ± 5.0 V, ± 10 V, ± 20 V, ± 50 V<br>Each fixed range supports a variable gain with 1000 steps (0.1 %).<br>Variable gain creates 1000 extra ranges between 2 fixed ranges. |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 50 V range has fixed 0 % offset |
| DC Offset error | |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Offset error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| DC Gain error | |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Gain error drift | ± 70 ppm/°C (± 130 ppm/°F) |
| Maximum static error (MSE) | |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| RMS Noise | |
| Bessel IIR and FIR | 0.02 % of Full Scale ± 10 µV |
| Input overload protection | |
| Maximum voltage | ± 250 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 1 µs after 200 % overload |

| Analog to Digital Conversion | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 200 kS/s |
| ADC resolution; one ADC per channel | 16 bit |
| ADC Type | Successive Approximation Register (SAR); TI ADS8401IB |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm [(1)]; aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; when Calculating FFT's produces rounded/integer BIN sizes |
| Maximum binary sample rate | 204.8 kS/s |
| External time base sample rate | 0 S/s to 200 kS/s |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

| Amplifier Bandwidth and Filtering | |
|---|---|
| Using different filter selections (Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Bessel IIR (Fc @ -3 dB) | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| FIR (Fc @ -0.1 dB) | Standard FIR filter with corner frequency (Fc) defined at -0.1 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| FIR (Fc @ -3 dB)<br>Supported by Perception V6.40 and higher | Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Bessel IIR filter

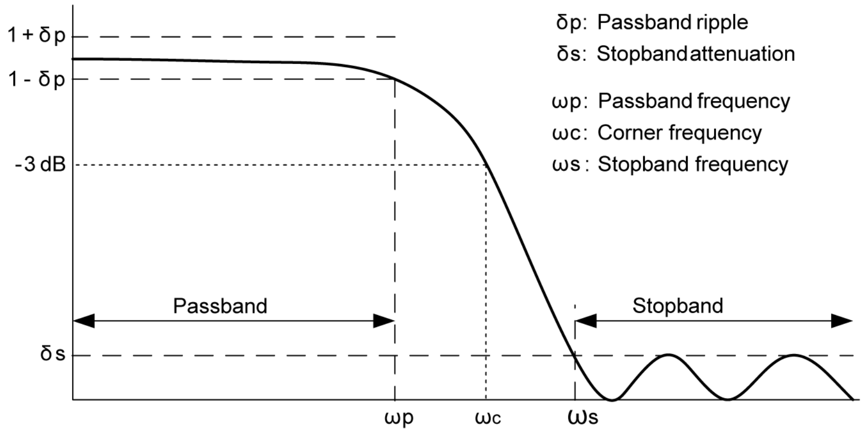



**Figure A.54:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 220 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 6-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 20 kHz |
| Bessel IIR passband flatness (ωp)(1) | 0.1 dB; DC to 3 kHz @ ωc = 20 kHz |
| Bessel IIR filter stop band attenuation (δs) | -60 dB |
| Bessel IIR filter roll-off | -36 dB/Octave |

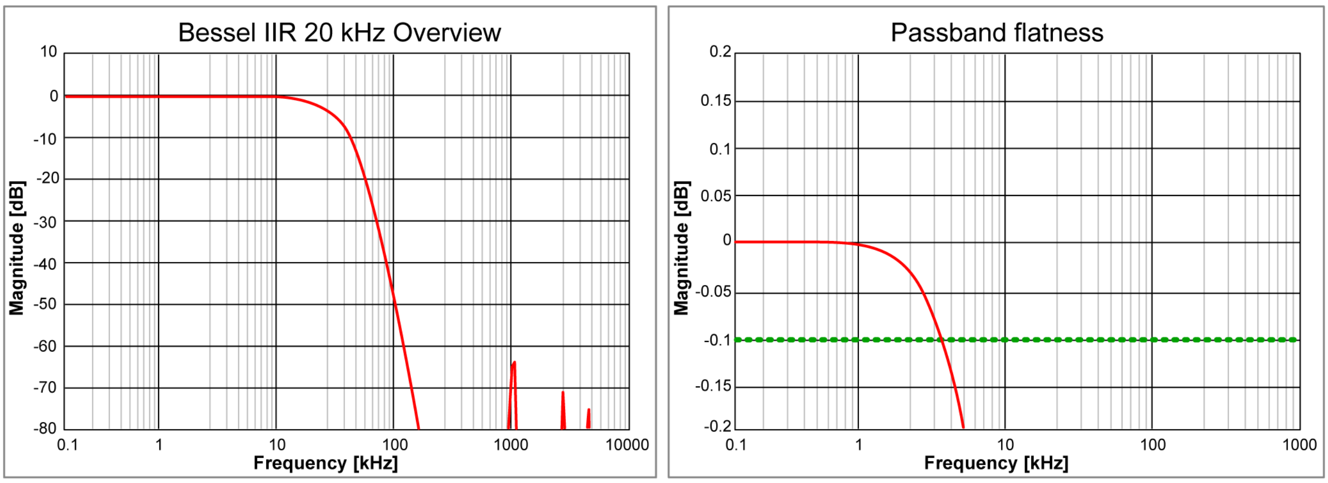



**Figure A.55:** Bessel IIR ωc = 20 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -0.1 dB) filter

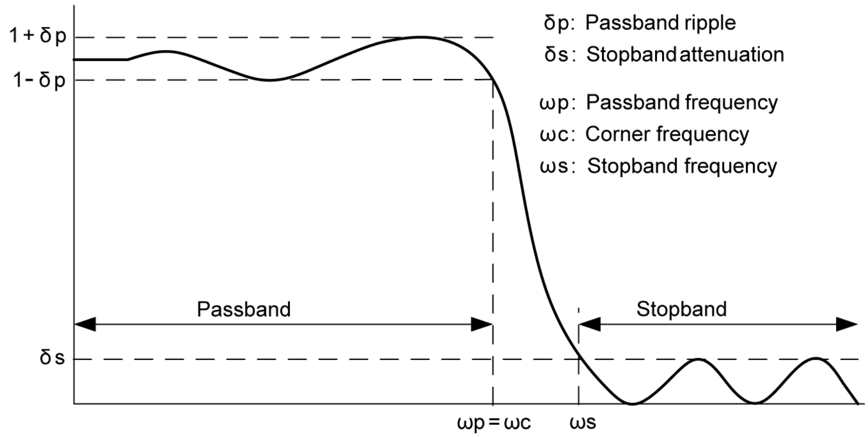



**Figure A.56:** Digital FIR (Fc @ -0.1 dB) filter

When FIR (Fc @ -0.1 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -0.1 dB) filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -0.1 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -0.1 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40 |
| FIR (Fc @ -0.1 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -0.1 dB) filter user selection from 0.031 Hz to 50 kHz |
| FIR (Fc @ -0.1 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to filter bandwidth (ωc) |
| FIR (Fc @ -0.1 dB) filter stopband attenuation (δs) | -60 dB |
| FIR (Fc @ -0.1 dB) filter roll-off | -72 dB/Octave |

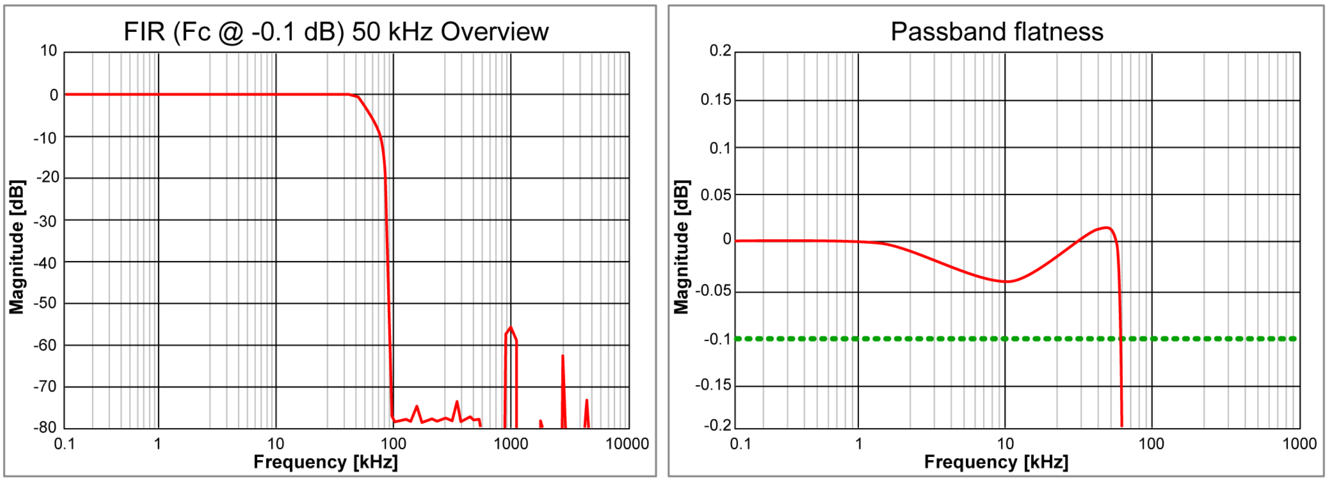



**Figure A.57:** Typical FIR (Fc @ -0.1 dB) ωc = 50 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -3 dB) filter

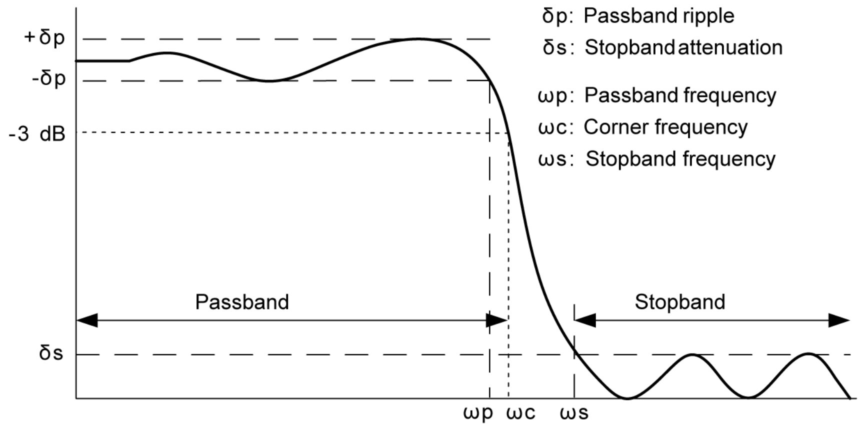
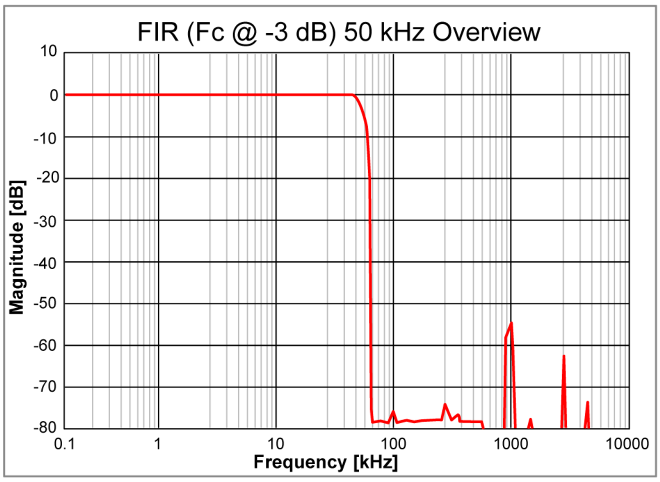



**Figure A.58:** Digital FIR (Fc @ -3 dB) filter

When FIR (Fc @ -3 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -3 dB) filter. Adapted FIR filter with ωp reduced by a factor of ≈1.4 compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -3 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -3 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40 |
| FIR (Fc @ -3 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -3 dB) filter user selection from 0.031 Hz to 50 kHz |
| FIR (Fc @ -3 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to ≈ωc/1.4 (Adapted FIR filter behavior) |
| FIR (Fc @ -3 dB) filter stopband attenuation (δs) | -60 dB |
| FIR (Fc @ -3 dB) filter roll-off | -72 dB/Octave |



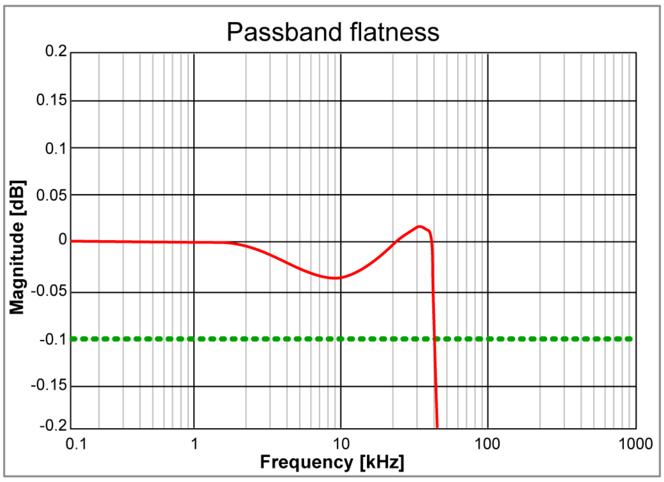




**Figure A.59:** Typical FIR (Fc @ -3 dB) ωc = 50 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

| Channel to Channel Phase Match | |
|---|---|
| Using different filter selections (Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Bessel IIR (Fc @ -3 dB), 20 kHz Filter frequency; 10 kHz sine wave | |
| Channels on card | 0.4 deg (0.1 µs) |
| GN810 Channels within mainframe | 0.4 deg (0.1 µs) |
| FIR (Fc@ -0.1dB) and FIR (Fc @ -3 dB), 50 kHz Filter frequency; 10 kHz sine wave | |
| Channels on card | 0.4 deg (0.1 µs) |
| GN810 Channels within mainframe | 0.4 deg (0.1 µs) |
| GN810 Channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

| On-board Memory | |
|---|---|
| Per card | 128 MB (64 MS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

| Digital Events/Timer/Counter | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High / Low / Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High / Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base<br>504 µs ± 1 µs + maximum 1 sample period using binary time base |
| Cross channel triggering | |
| Channels on card | Logical OR; Analog triggers of all channels<br>Logical AND; Qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes when using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; Single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Pulse detect/reject | Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY : 16 bit (0.0015 %) for both levels<br>dT : 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak-level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak-level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger holdoff | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum holdoff time sample rate dependent |
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |

| Triggering | |
|---|---|
| Event counter | Counted channel trigger events before card trigger is activated<br>1 to 256 trigger events |

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow/Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch |
| Max. sweep memory | 60 MS | 30 MS | 7.5 MS | not used | | | 48 MS | 24 MS | 6 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 60 MS | 30 MS | 7.5 MS | 12 MS | 6 MS | 1.5 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep Sample Rate / 2<br>Maximum 50 kS/s | | |
| Max. continuous streaming rate | not used | | | 0.2 MS/s<br>0.4 MB/s | 0.4 MS/s<br>0.8 MB/s | 1.6 MS/s<br>3.2 MB/s | 0.05 MS/s<br>0.1 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.8 MS/s<br>1.6 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

## Multiple Sweeps

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

## Slow Fast Sweep

| | |
|---|---|
| Maximum number of sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2, or 50 kS/s per channel, whichever is the smallest sample rate |
| Maximum sample rate switches | 400 sample rate switches per second, 200 000 switches maximum, switching stops when sweep ends |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Dual | |
|---|---|
| **Dual Sweep Specification** | |
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering Information(1)

| Article | | Description | Order No. |
|---|---|---|---|
| Basic200k |  | 8 Channel, 16 bits, 200 kS/s, ± 1 V to ± 50 V input range, 128 MB RAM (8 MS/channel), single ended, with single metal BNC for each channel | 1-GN810-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

### A.8 B2640-3.0 en (GEN series GN811)

| Capabilities Overview | |
|---|---|
| Model | GN811 |
| Maximum sample rate per channel | 1 MS/s |
| Memory per card | 256 MB |
| Analog channels | 8 |
| ADC resolution | 16 bit |
| Digital event/Timer/Counter support | no |
| Isolation | no |
| Input type | Analog single ended |
| Fast data streaming | no |

## GEN series GN811 Block diagram

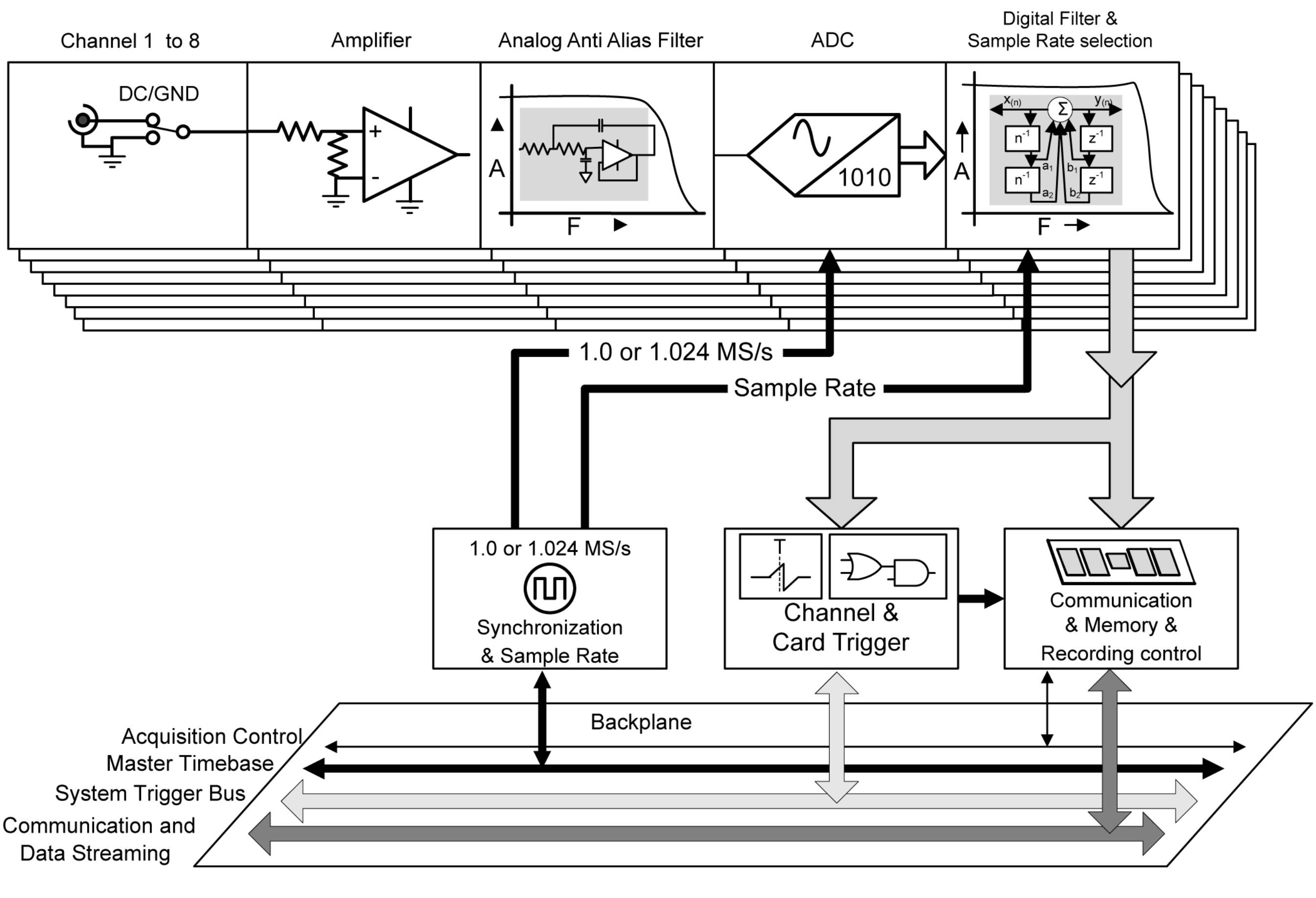



**Figure A.60:** Block diagram GEN series GN811

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 8 |
| Connectors | Metal BNC, 1 per channel |
| Input type | Analog single ended |
| Input coupling | DC, GND |
| Impedance | 1 MΩ ± 1% // 65 pF ± 10% |
| Ranges | ± 1 V, ± 2 V, ± 5.0 V, ± 10 V, ± 20 V, ± 50 V<br>Each fixed range supports a variable gain with 1000 steps (0.1 %).<br>Variable gain creates 1000 extra ranges between 2 fixed ranges. |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 50 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Offset error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| DC Gain error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Gain error drift | ± 70 ppm/°C (± 130 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| RMS Noise | |
| Wideband | 0.02 % of Full Scale ± 10 µV |
| Bessel IIR and FIR | 0.02 % of Full Scale ± 10 µV |
| Input overload protection | |
| Maximum voltage | ± 250 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 1 µs after 200 % overload |

| Analog to Digital Conversion | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 1 MS/s |
| ADC resolution; one ADC per channel | 16 bit |
| ADC Type | Successive Approximation Register (SAR); TI ADS8401IB |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; when Calculating FFT's produces rounded/integer BIN sizes |
| Maximum binary sample rate | 1.024 MS/s |
| External time base sample rate | 0 S/s to 500 kS/s |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

## Amplifier Bandwidth and Filtering

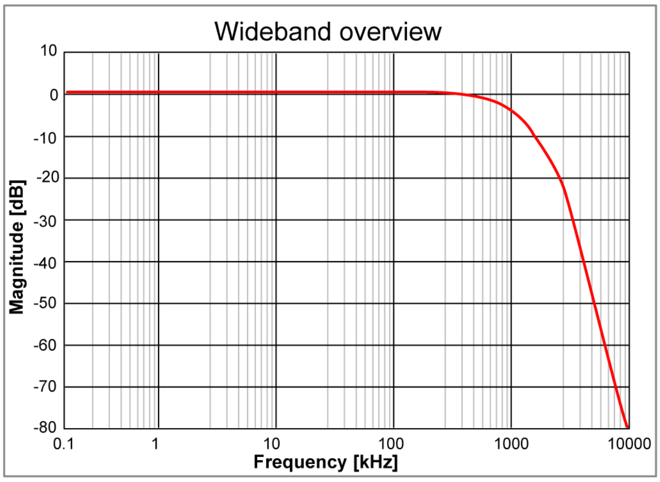
Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

| | |
|---|---|
| Wideband | When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.<br>Should not be used if working in frequency domain with recorded data. |
| Bessel IIR (Fc @ -3 dB) | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| FIR (Fc @ -0.1 dB) | Standard FIR filter with corner frequency (Fc) defined at -0.1 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| FIR (Fc @ -3 dB)<br>Supported by Perception V6.40 and higher | Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Wideband

When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

| | |
|---|---|
| Wideband bandwidth | Between 540 kHz and 690 kHz (-3 dB) |
| Passband flatness (1) | 0.1 dB; DC to 150 kHz |



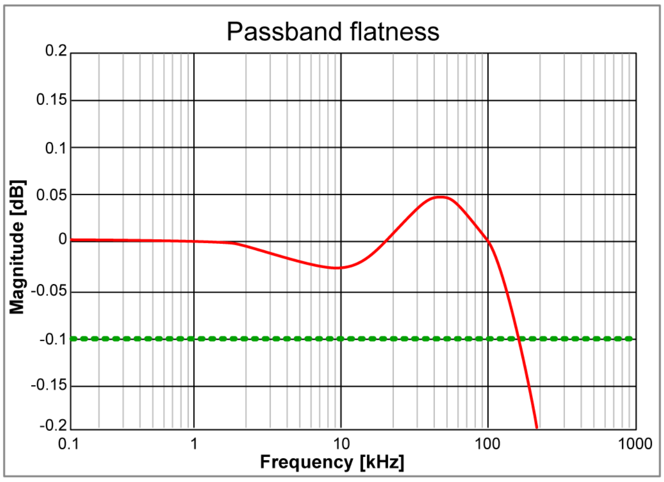




**Figure A.61:** Typical wideband overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## Bessel IIR filter

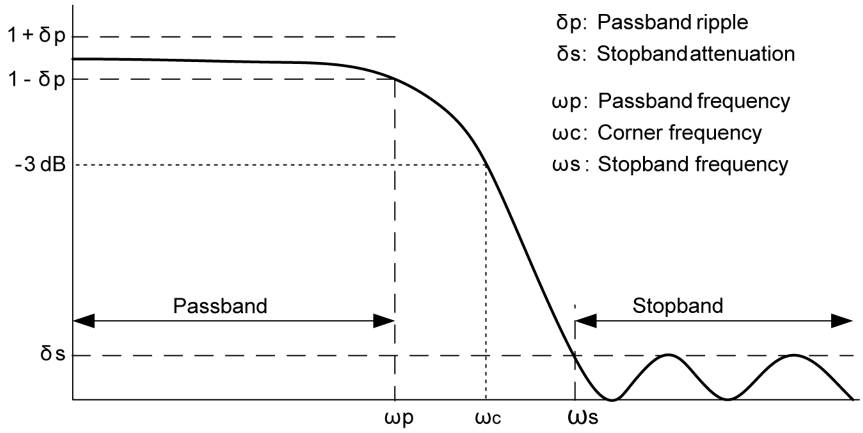



**Figure A.62:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 220 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 6-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 100 kHz |
| Bessel IIR passband flatness (ωp)[1] | 0.1 dB; DC to 20 kHz @ ωc = 100 kHz |
| Bessel IIR filter stop band attenuation (δs) | -60 dB<br>With Bessel IIR filter bandwidth selection ωc = 100 kHz a peak at -55 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| Bessel IIR filter roll-off | -36 dB/Octave |

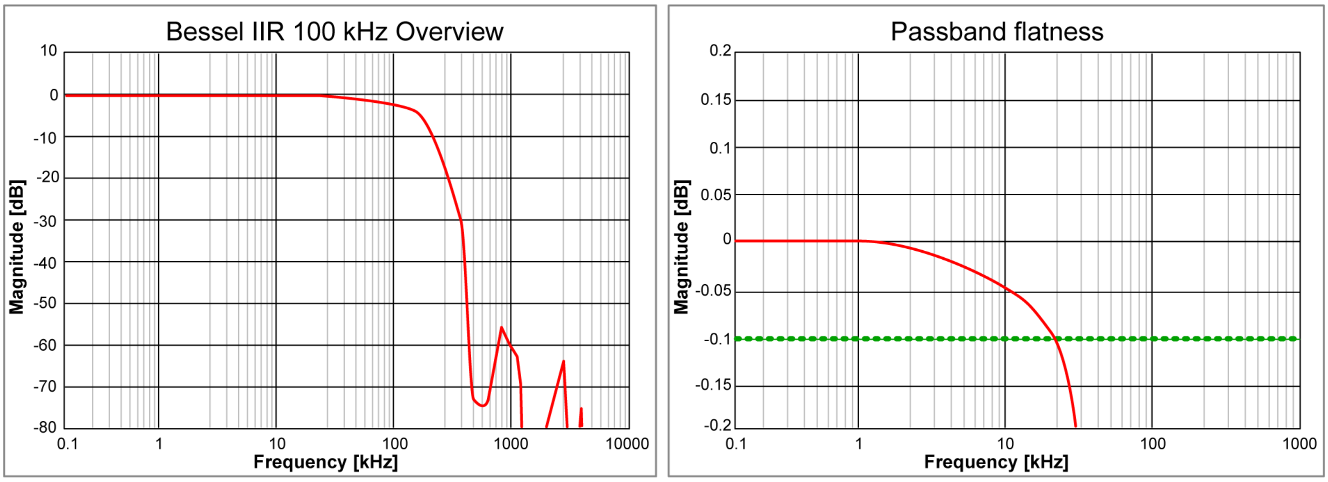



**Figure A.63:** Typical Bessel IIR ωc = 100 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -0.1 dB) filter

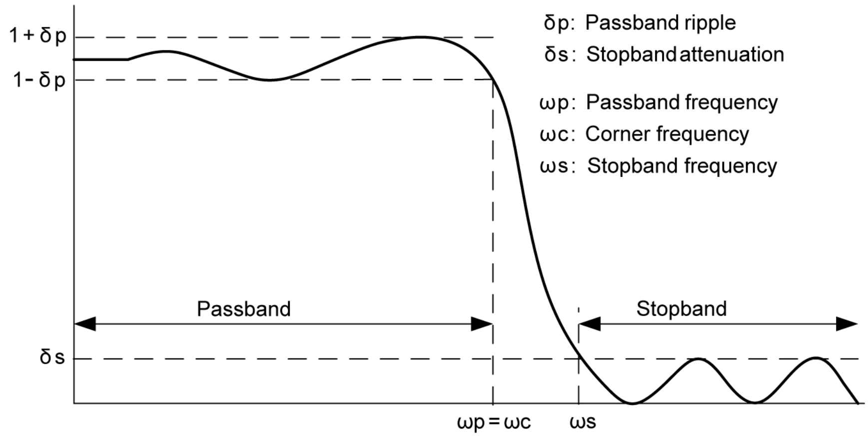



**Figure A.64:** Digital FIR (Fc @ -0.1 dB) filter

When FIR (Fc @ -0.1 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -0.1 dB) filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -0.1 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -0.1 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| FIR (Fc @ -0.1 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -0.1 dB) filter user selection from 0.031 Hz to 250 kHz |
| FIR (Fc @ -0.1 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to filter bandwidth (ωc)<br>0.1 dB; DC to 125 kHz; FIR (Fc @ -0.1 dB) filter bandwidth selection ωc = 250 kHz, limited by the 370 kHz analog anti alias filter amplitude response. All other bandwidth selections not affected |
| FIR (Fc @ -0.1 dB) filter stopband attenuation (δs) | -60 dB<br>With FIR (Fc @ -0.1 dB) filter bandwidth selection ωc = 250 kHz a peak at -35 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| FIR (Fc @ -0.1 dB) filter roll-off | -72 dB/Octave |

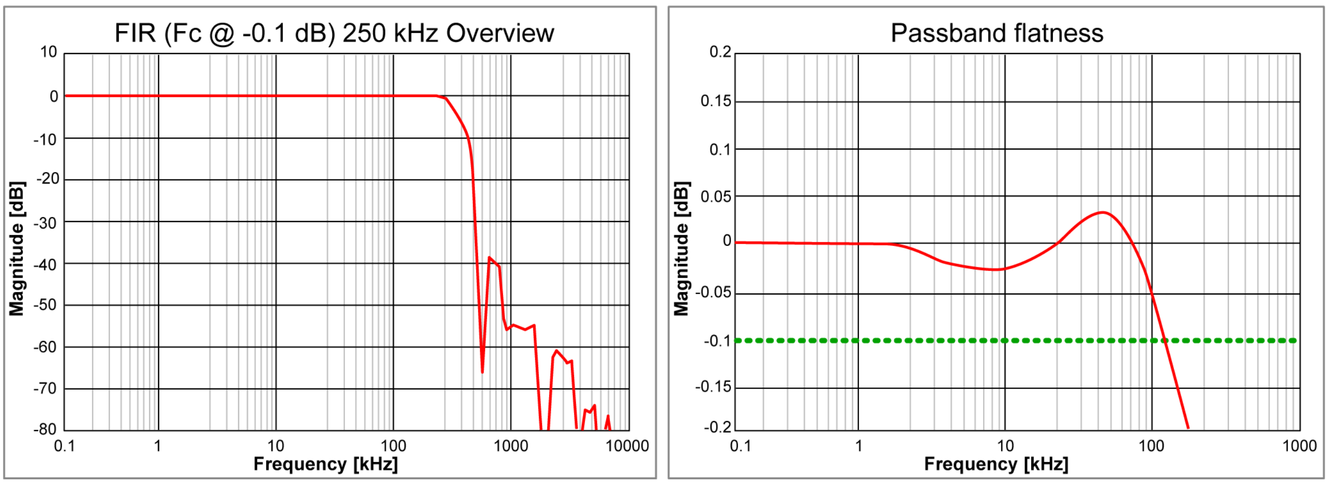



**Figure A.65:** Typical FIR (Fc @ -0.1 dB) ωc = 250 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -3 dB) filter

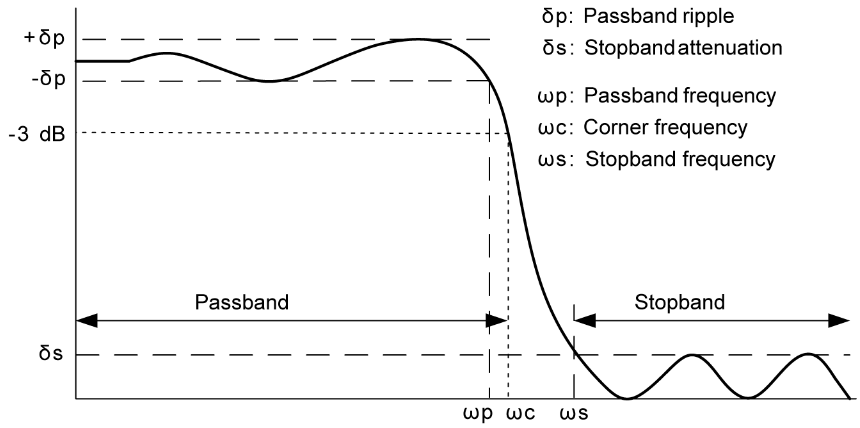



**Figure A.66:** Digital FIR (Fc @ -3 dB) filter

When FIR (Fc @ -3 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -3 dB) filter. Adapted FIR filter with ωp reduced by a factor of ≈1.4 compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -3 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -3 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| FIR (Fc @ -3 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -3 dB) filter user selection from 0.031 Hz to 250 kHz |
| FIR (Fc @ -3 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to ≈ωc/1.4 (Adapted FIR filter behavior)<br>0.1 dB; DC to 125 kHz; FIR (Fc @ -3 dB) filter bandwidth selection ωc = 250 kHz, limited by the 370 kHz analog anti alias filter amplitude response. All other bandwidth selections not affected |
| FIR (Fc @ -3 dB) filter stopband attenuation (δs) | -60 dB<br>With FIR (Fc @ -3 dB) filter bandwidth selection ωc = 250 kHz a peak at -35 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| FIR (Fc @ -3 dB) filter roll-off | -72 dB/Octave |

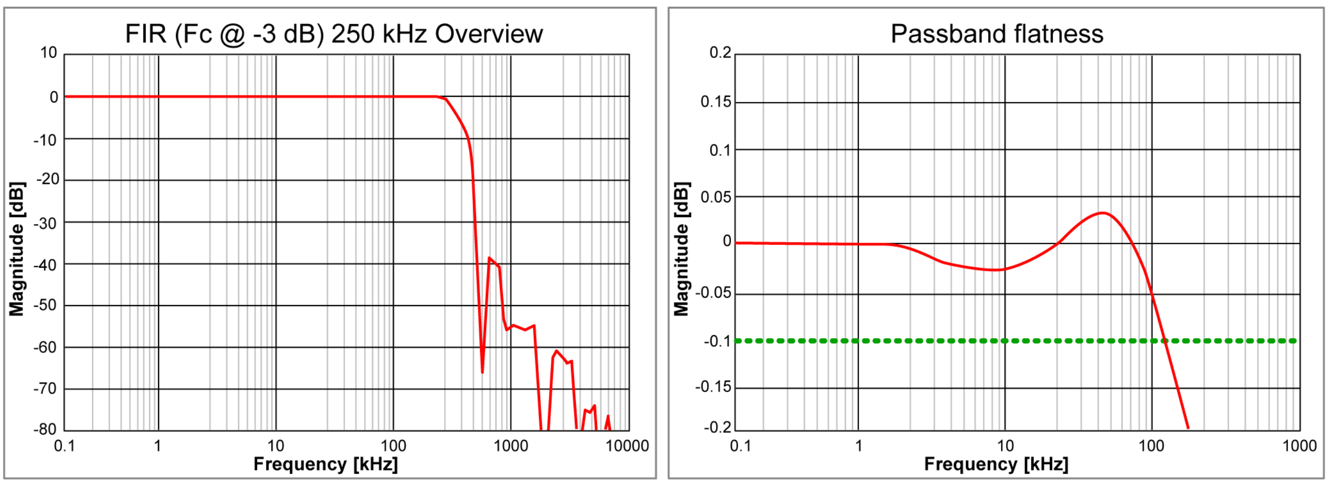



**Figure A.67:** Typical FIR (Fc @ -3 dB) ωc = 250 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

| Channel to Channel Phase Match | |
|---|---|
| Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Wideband | 100 kHz Sine |
| Channels on card | 0.7 deg (0.02 µs) |
| GN811 Channels within mainframe | 0.7 deg (0.02 µs) |
| Bessel IIR (Fc @ -3 dB), 100 kHz Filter frequency | |
| Channels on card | 0.7 deg (0.02 µs) |
| GN811 Channels within mainframe | 0.7 deg (0.02 µs) |
| FIR (Fc@ -0.1dB) and FIR (Fc @ -3 dB), 250 kHz Filter frequency | |
| Channels on card | 0.7 deg (0.02 µs) |
| GN811 Channels within mainframe | 0.7 deg (0.02 µs) |
| GN811 Channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

| On-board Memory | |
|---|---|
| Per card | 256 MB (128 MS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

| Digital Events/Timer/Counter | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High / Low / Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High / Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base<br>504 µs ± 1 µs + maximum 1 sample period using binary time base |
| Cross channel triggering | |
| Channels on card | Logical OR; Analog triggers of all channels<br>Logical AND; Qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes when using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; Single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Pulse detect/reject | Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY : 16 bit (0.0015 %) for both levels<br>dT : 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak-level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak-level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger holdoff | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum holdoff time sample rate dependent |
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |

| Triggering | |
|---|---|
| Event counter | Counted channel trigger events before card trigger is activated<br>1 to 256 trigger events |

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow/Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch |
| Max. sweep memory | 124 MS | 62 MS | 15.5 MS | not used | | | 99 MS | 50 MS | 12 MS |
| Max. sweep sample rate | 1 MS/s | | | not used | | | 1 MS/s | | |
| Max. continuous FIFO | not used | | | 124 MS | 62 MS | 15.5 MS | 24 MS | 12 MS | 3 MS |
| Max. continuous sample rate | not used | | | 1 MS/s | | | Sweep Sample Rate / 2<br>Maximum 50 kS/s | | |
| Max. continuous streaming rate | not used | | | 1 MS/s<br>2 MB/s | 2 MS/s<br>4 MB/s | 8 MS/s<br>16 MB/s | 0.05 MS/s<br>0.1 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.8 MS/s<br>1.6 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

## Multiple Sweeps

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

## Slow Fast Sweep

| | |
|---|---|
| Maximum number of sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2, or 50 kS/s per channel, whichever is the smallest sample rate |
| Maximum sample rate switches | 400 sample rate switches per second, 200 000 switches maximum, switching stops when sweep ends |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Dual

| Dual Sweep Specification | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering Information(1)

| Article | | Description | Order No. |
|---|---|---|---|
| Basic1M |  | 8 Channel, 16 bits,1 MS/s, ± 1 V to ± 50 V input range, 256 MB RAM (16 MS/channel), single ended, with single metal BNC for each channel | 1-GN811-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

### A.9 B2634-3.0 en (GEN series GN812)

| Capabilities Overview | |
|---|---|
| Model | GN812 |
| Maximum sample rate per channel | 1 MS/s |
| Memory per card | 512 MB |
| Analog channels | 8 |
| ADC resolution | 16 bit |
| Digital event/Timer/Counter support | no |
| Isolation | yes; channel to channel and channel to chassis |
| Input type | Analog isolated single ended, unbalanced differential (1) |
| Fast data streaming | no |

(1) An unbalanced differential input can be used to do isolated single ended and differential measurements.

**GEN series GN812 Block diagram**

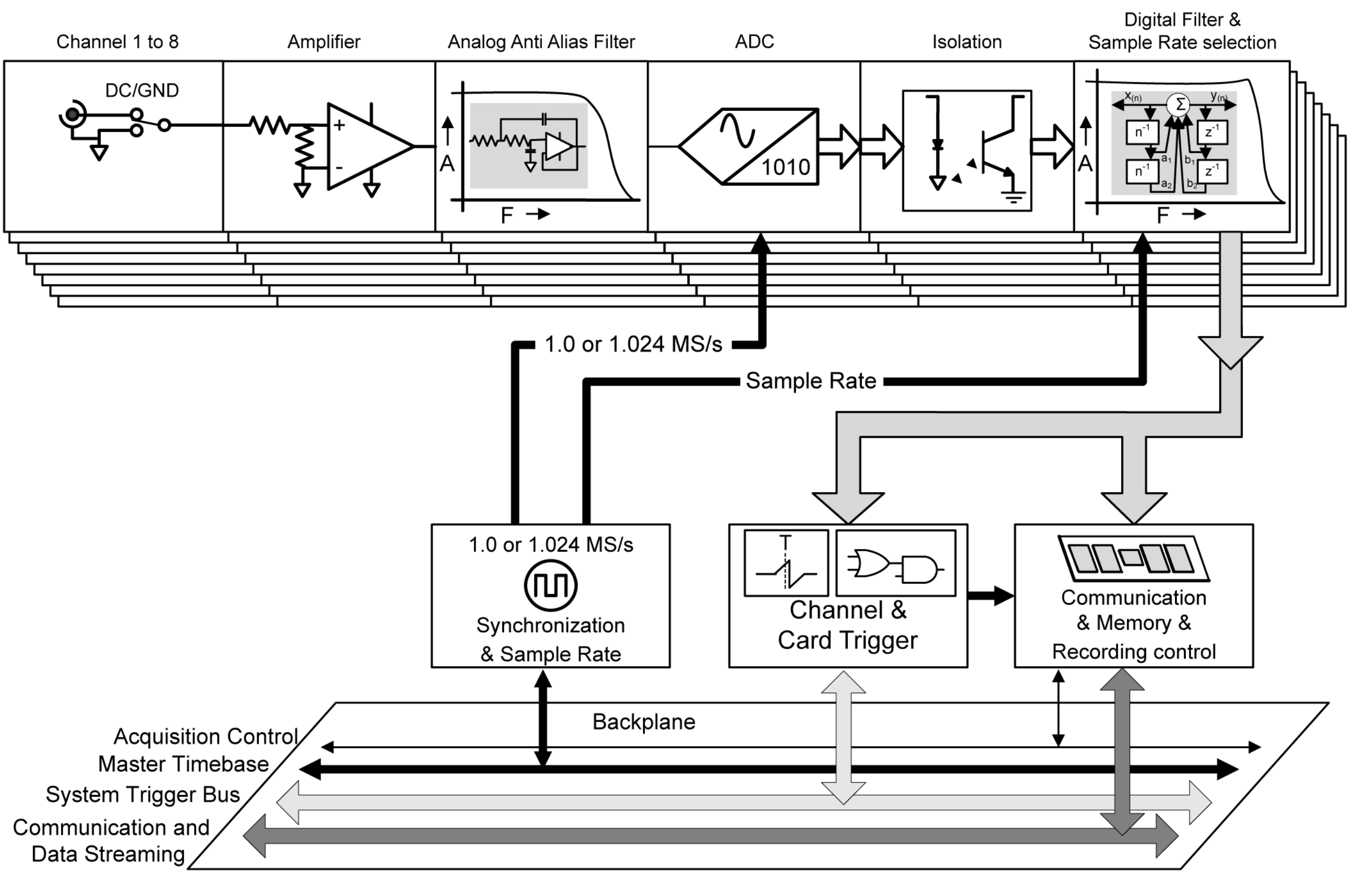



**Figure A.68:** Block diagram GEN series GN812

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 8 |
| Connectors | Fully isolated BNC (Plastic), 1 per channel |
| Input type | Analog isolated single ended, unbalanced differential |
| Input coupling | DC, GND |
| Impedance | 1 MΩ ± 1% // 65 pF ± 10% |
| Ranges | ± 1 V, ± 2 V, ± 5.0 V, ± 10 V, ± 20 V, ± 50 V<br>Each fixed range supports a variable gain with 1000 steps (0.1 %).<br>Variable gain creates 1000 extra ranges between 2 fixed ranges. |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 50 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Offset error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| DC Gain error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Gain error drift | ± 70 ppm/°C (± 130 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| RMS Noise | |
| Wideband | 0.02 % of Full Scale ± 10 µV |
| Bessel IIR and FIR | 0.02 % of Full Scale ± 10 µV |
| Common Mode | |
| Rejection Ratio (CMRR) | > 72 dB @ 80 Hz |
| Voltage | 250 V DC |
| Input overload protection | |
| Maximum voltage | ± 250 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 1 µs after 200 % overload |

| Isolation | |
|---|---|
| Channel to chassis | ± 250 V DC |
| Channel to channel | ± 500 V DC |
| Nondestructive, to chassis (earth) | ± 250 V DC |

| Analog to Digital Conversion | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 1 MS/s |
| ADC resolution; one ADC per channel | 16 bit |
| ADC Type | Successive Approximation Register (SAR); TI ADS8401IB |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; when Calculating FFT's produces rounded/integer BIN sizes |
| Maximum binary sample rate | 1.024 MS/s |
| External time base sample rate | 0 S/s to 500 kS/s |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

## Amplifier Bandwidth and Filtering

Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

| | |
|---|---|
| Wideband | When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.<br>Should not be used if working in frequency domain with recorded data. |
| Bessel IIR (Fc @ -3 dB) | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| FIR (Fc @ -0.1 dB) | Standard FIR filter with corner frequency (Fc) defined at -0.1 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| FIR (Fc @ -3 dB)<br>Supported by Perception V6.40 and higher | Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Wideband

When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

| | |
|---|---|
| Wideband bandwidth | Between 540 kHz and 690 kHz (-3 dB) |
| Passband flatness (1) | 0.1 dB; DC to 150 kHz |

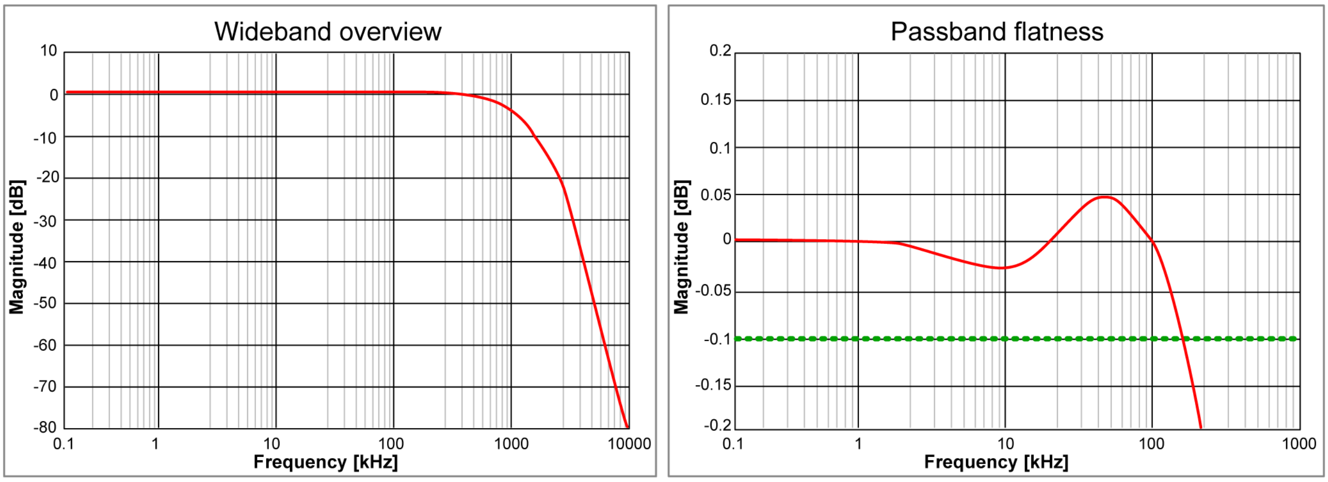



**Figure A.69:** Typical wideband overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## Bessel IIR filter

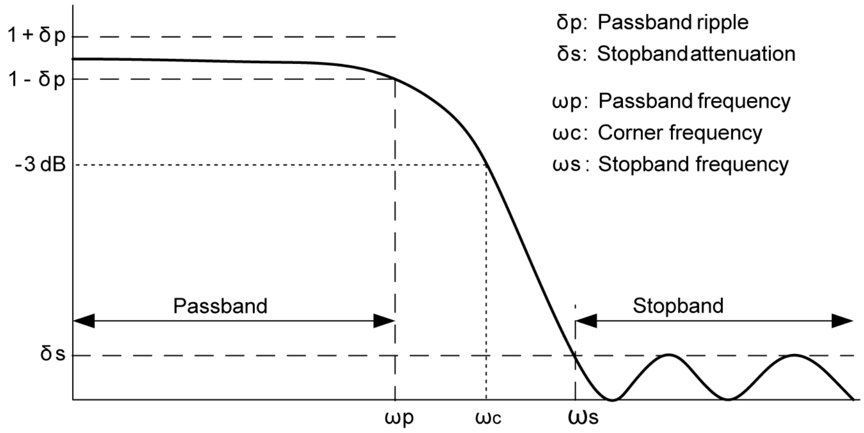



**Figure A.70:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 220 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 6-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 100 kHz |
| Bessel IIR passband flatness (ωp)(1) | 0.1 dB; DC to 20 kHz @ ωc = 100 kHz |
| Bessel IIR filter stop band attenuation (δs) | -60 dB<br>With Bessel IIR filter bandwidth selection ωc = 100 kHz a peak at -55 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| Bessel IIR filter roll-off | -36 dB/Octave |

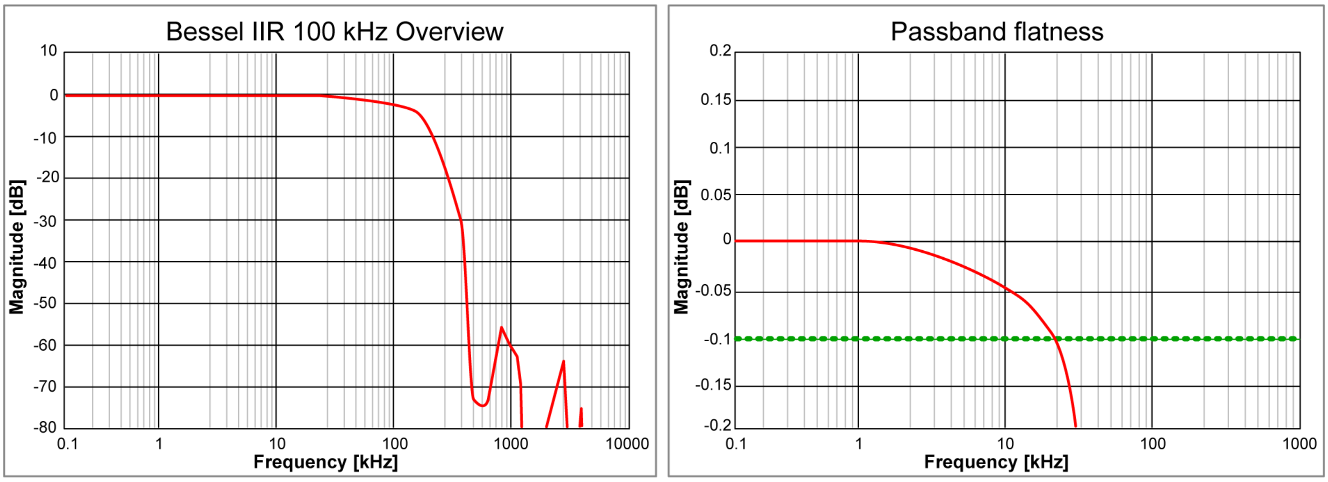



**Figure A.71:** Typical Bessel IIR ωc = 100 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -0.1 dB) filter

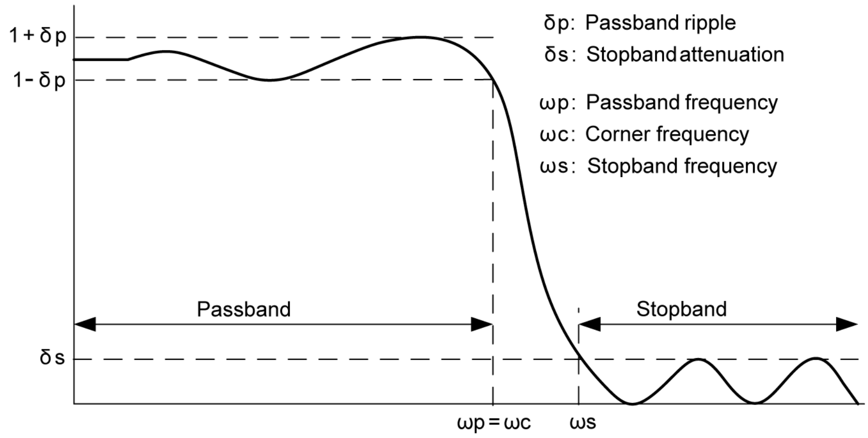



**Figure A.72:** Digital FIR (Fc @ -0.1 dB) filter

When FIR (Fc @ -0.1 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -0.1 dB) filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -0.1 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -0.1 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| FIR (Fc @ -0.1 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -0.1 dB) filter user selection from 0.031 Hz to 250 kHz |
| FIR (Fc @ -0.1 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to filter bandwidth (ωc)<br>0.1 dB; DC to 125 kHz; FIR (Fc @ -0.1 dB) filter bandwidth selection ωc = 250 kHz, limited by the 370 kHz analog anti alias filter amplitude response. All other bandwidth selections not affected |
| FIR (Fc @ -0.1 dB) filter stopband attenuation (δs) | -60 dB<br>With FIR (Fc @ -0.1 dB) filter bandwidth selection ωc = 250 kHz a peak at -35 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| FIR (Fc @ -0.1 dB) filter roll-off | -72 dB/Octave |

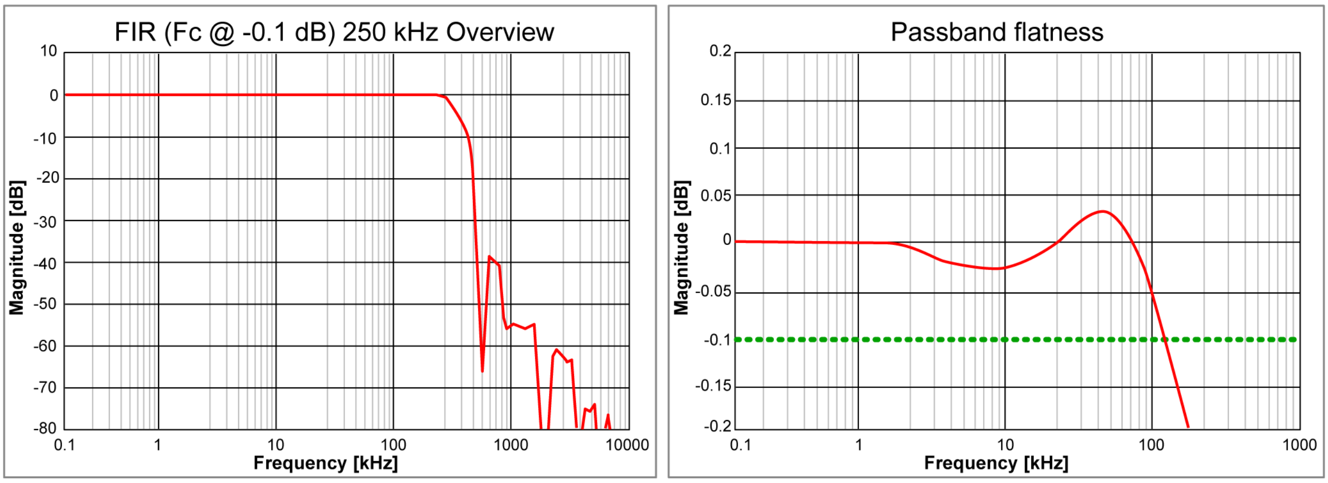



**Figure A.73:** Typical FIR (Fc @ -0.1 dB) ωc = 250 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -3 dB) filter

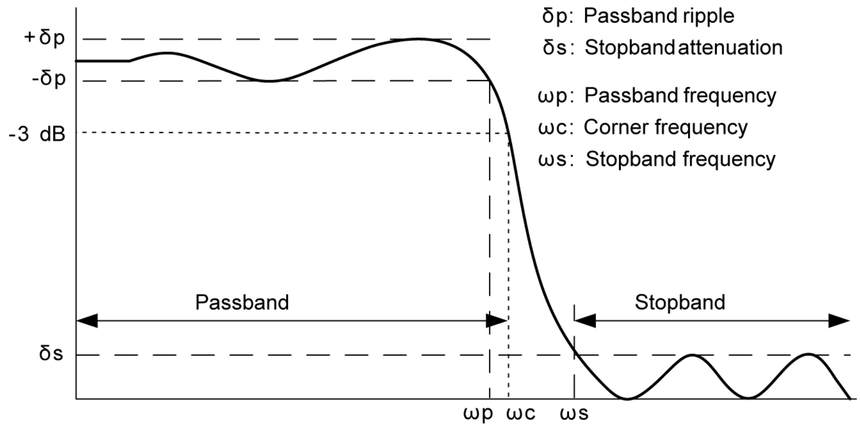



**Figure A.74:** Digital FIR (Fc @ -3 dB) filter

When FIR (Fc @ -3 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -3 dB) filter. Adapted FIR filter with ωp reduced by a factor of ≈1.4 compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -3 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -3 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| FIR (Fc @ -3 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -3 dB) filter user selection from 0.031 Hz to 250 kHz |
| FIR (Fc @ -3 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to ≈ωc/1.4 (Adapted FIR filter behavior)<br>0.1 dB; DC to 125 kHz; FIR (Fc @ -3 dB) filter bandwidth selection ωc = 250 kHz, limited by the 370 kHz analog anti alias filter amplitude response. All other bandwidth selections not affected |
| FIR (Fc @ -3 dB) filter stopband attenuation (δs) | -60 dB<br>With FIR (Fc @ -3 dB) filter bandwidth selection ωc = 250 kHz a peak at -35 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| FIR (Fc @ -3 dB) filter roll-off | -72 dB/Octave |

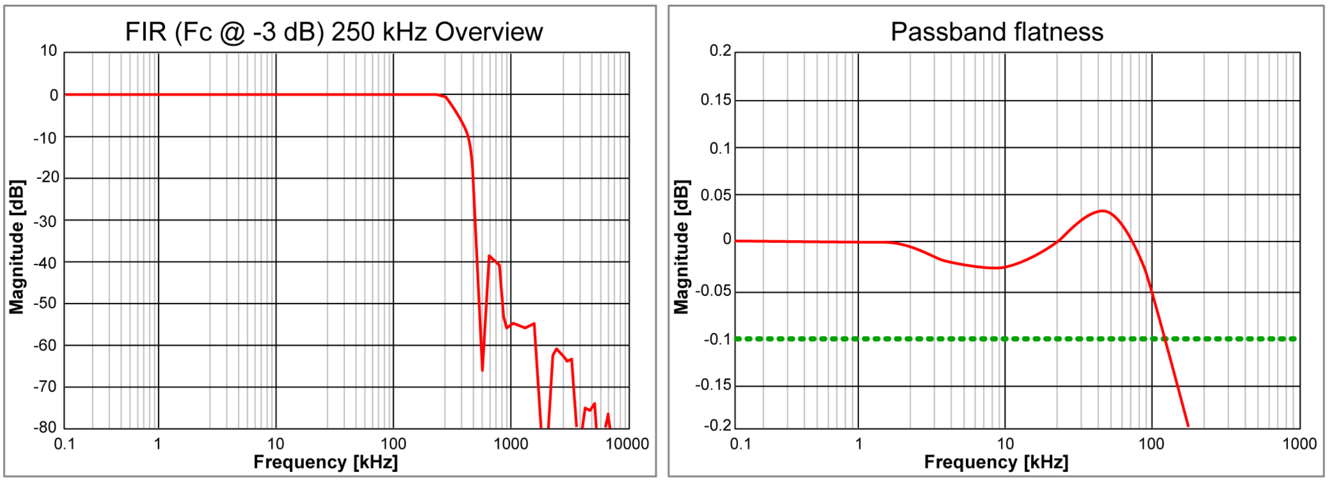



**Figure A.75:** Typical FIR (Fc @ -3 dB) ωc = 250 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

| Channel to Channel Phase Match | |
|---|---|
| Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Wideband | 100 kHz Sine |
| Channels on card | 0.7 deg (0.02 µs) |
| GN812 Channels within mainframe | 0.7 deg (0.02 µs) |
| Bessel IIR (Fc @ -3 dB), 100 kHz Filter frequency | |
| Channels on card | 0.7 deg (0.02 µs) |
| GN812 Channels within mainframe | 0.7 deg (0.02 µs) |
| FIR (Fc@ -0.1dB) and FIR (Fc @ -3 dB), 250 kHz Filter frequency | |
| Channels on card | 0.7 deg (0.02 µs) |
| GN812 Channels within mainframe | 0.7 deg (0.02 µs) |
| GN812 Channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

| On-board Memory | |
|---|---|
| Per card | 512 MB (256 MS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

| Digital Events/Timer/Counter | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High / Low / Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High / Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base<br>504 µs ± 1 µs + maximum 1 sample period using binary time base |
| Cross channel triggering | |
| Channels on card | Logical OR; Analog triggers of all channels<br>Logical AND; Qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes when using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; Single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Pulse detect/reject | Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY : 16 bit (0.0015 %) for both levels<br>dT : 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak-level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak-level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger holdoff | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum holdoff time sample rate dependent |
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |

| Triggering | |
|---|---|
| Event counter | Counted channel trigger events before card trigger is activated<br>1 to 256 trigger events |

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow/Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch |
| Max. sweep memory | 252 MS | 126 MS | 31.5 MS | not used | | | 200 MS | 100 MS | 25 MS |
| Max. sweep sample rate | 1 MS/s | | | not used | | | 1 MS/s | | |
| Max. continuous FIFO | not used | | | 252 MS | 126 MS | 31.5 MS | 50 MS | 25 MS | 6 MS |
| Max. continuous sample rate | not used | | | 1 MS/s | | | Sweep Sample Rate / 2<br>Maximum 50 kS/s | | |
| Max. continuous streaming rate | not used | | | 1 MS/s<br>2 MB/s | 2 MS/s<br>4 MB/s | 8 MS/s<br>16 MB/s | 0.05 MS/s<br>0.1 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.8 MS/s<br>1.6 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

## Multiple Sweeps

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

## Slow Fast Sweep

| | |
|---|---|
| Maximum number of sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2, or 50 kS/s per channel, whichever is the smallest sample rate |
| Maximum sample rate switches | 400 sample rate switches per second, 200 000 switches maximum, switching stops when sweep ends |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Dual | |
|---|---|
| **Dual Sweep Specification** | |
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering Information(1)

| Article | | Description | Order No. |
|---|---|---|---|
| Basic1M ISO |  | 8 Channel, 16 bits,1 MS/s, ± 1 V to ± 50 V input range, 512 MB RAM (32 MS/channel), isolated, unbalanced differential, with single isolated BNC for each channel | 1-GN812-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

### A.10 B2635-4.0 en (GEN series GN813)

| Capabilities Overview | |
|---|---|
| Model | GN813 |
| Maximum sample rate per channel | 1 MS/s |
| Memory per card | 512 MB |
| Analog channels | 8 |
| ADC resolution | 16 bit |
| Digital event/Timer/Counter support | no |
| Isolation | yes; channel to channel and channel to chassis |
| Input type | Analog isolated single ended, unbalanced differential (1) |
| Fast data streaming | no |

(1) An unbalanced differential input can be used to do isolated single ended and differential measurements.

## GEN series GN813 Block diagram

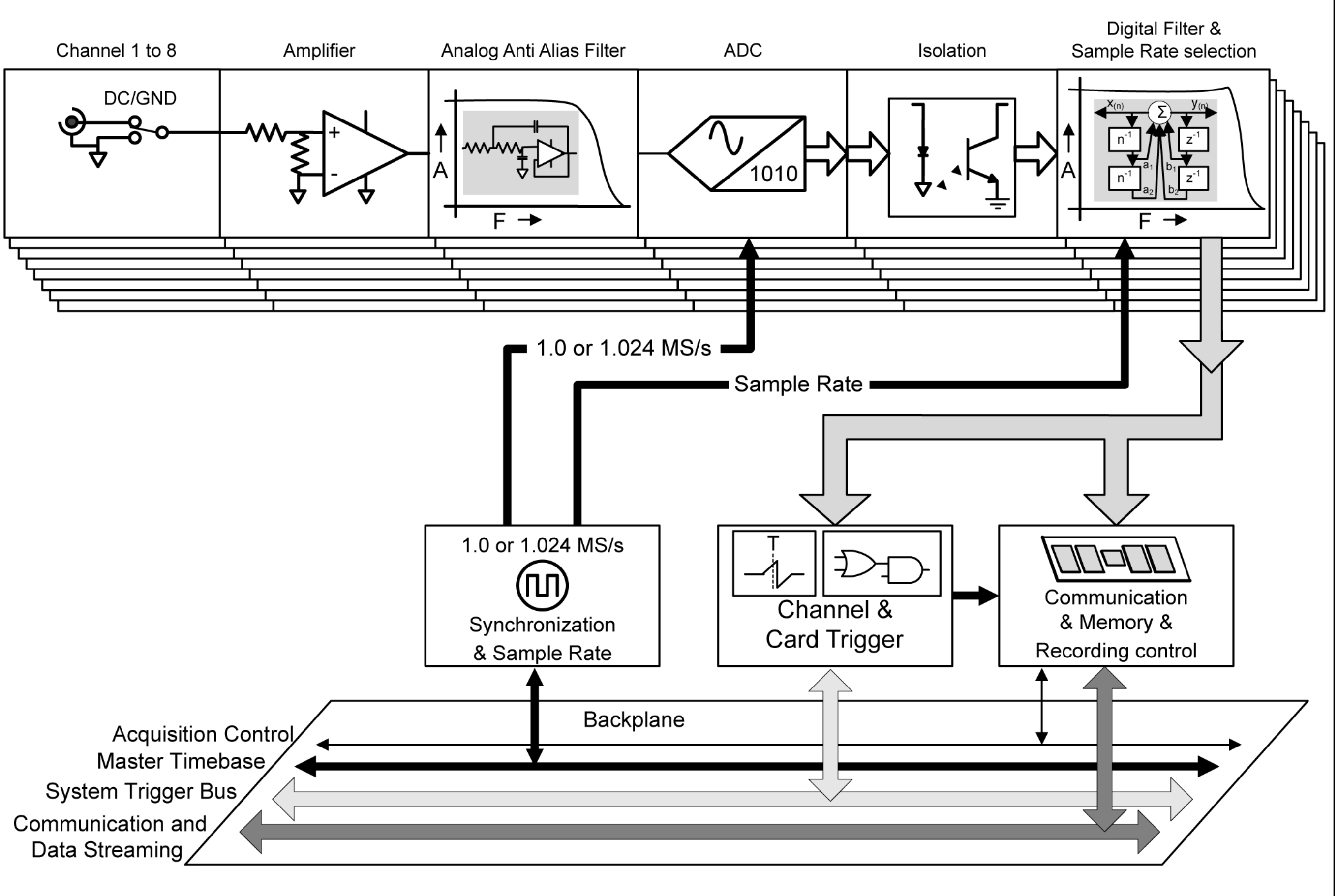



**Figure A.76:** Block diagram GEN series GN813

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 8 |
| Connectors | Fully isolated BNC (Plastic), 1 per channel |
| Input type | Analog isolated single ended, unbalanced differential |
| Input coupling | DC, GND |
| Impedance | 1 MΩ ± 1% // 55 pF ± 10% |
| Ranges | ± 2.0 V, ± 4.0 V, ± 10.0 V, ± 20 V, ± 40 V, ± 100 V<br>Each fixed range supports a variable gain with 1000 steps (0.1 %).<br>Variable gain creates 1000 extra ranges between 2 fixed ranges. |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 100 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 μV |
| Offset error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| DC Gain error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 μV |
| Gain error drift | ± 70 ppm/°C (± 130 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 μV |
| RMS Noise | |
| Wideband | 0.02 % of Full Scale ± 10 μV |
| Bessel IIR and FIR | 0.02 % of Full Scale ± 10 μV |
| Common Mode | |
| Rejection Ratio (CMRR) | > 72 dB @ 80 Hz |
| Voltage | 250 V DC |
| Input overload protection | |
| Maximum voltage | ± 250 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 1 μs after 200 % overload |

| Isolation | |
|---|---|
| Channel to chassis | ± 250 V DC |
| Channel to channel | ± 500 V DC |
| Nondestructive, to chassis (earth) | ± 250 V DC |

| Analog to Digital Conversion | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 1 MS/s |
| ADC resolution; one ADC per channel | 16 bit |
| ADC Type | Successive Approximation Register (SAR); TI ADS8401IB |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; when Calculating FFT's produces rounded/integer BIN sizes |
| Maximum binary sample rate | 1.024 MS/s |
| External time base sample rate | 0 S/s to 500 kS/s |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

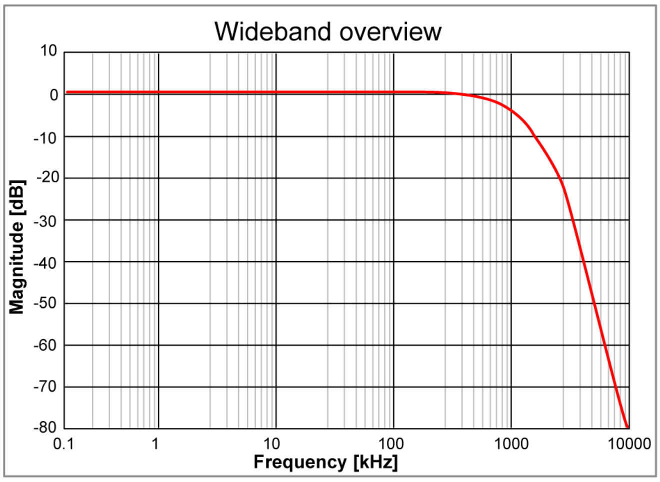
(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

| Amplifier Bandwidth and Filtering | |
|---|---|
| Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Wideband | When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.<br>Should not be used if working in frequency domain with recorded data. |
| Bessel IIR (Fc @ -3 dB) | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| FIR (Fc @ -0.1 dB) | Standard FIR filter with corner frequency (Fc) defined at -0.1 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| FIR (Fc @ -3 dB)<br>Supported by Perception V6.40 and higher | Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Wideband

When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

| | |
|---|---|
| Wideband bandwidth | Between 540 kHz and 690 kHz (-3 dB) |
| Passband flatness (1) | 0.1 dB; DC to 150 kHz |



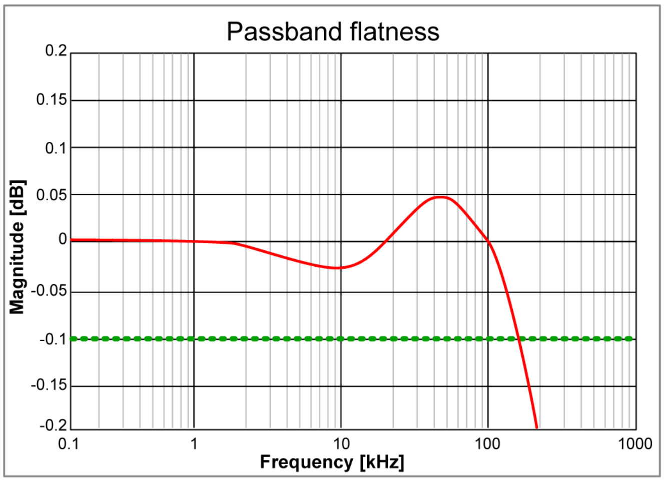




**Figure A.77:** Typical wideband overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## Bessel IIR filter

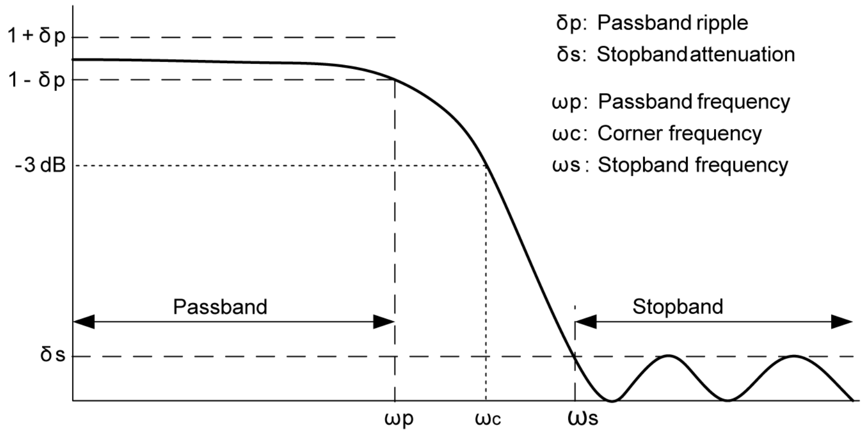



**Figure A.78:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 220 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 6-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 100 kHz |
| Bessel IIR passband flatness (ωp)(1) | 0.1 dB; DC to 20 kHz @ ωc = 100 kHz |
| Bessel IIR filter stop band attenuation (δs) | -60 dB<br>With Bessel IIR filter bandwidth selection ωc = 100 kHz a peak at -55 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| Bessel IIR filter roll-off | -36 dB/Octave |

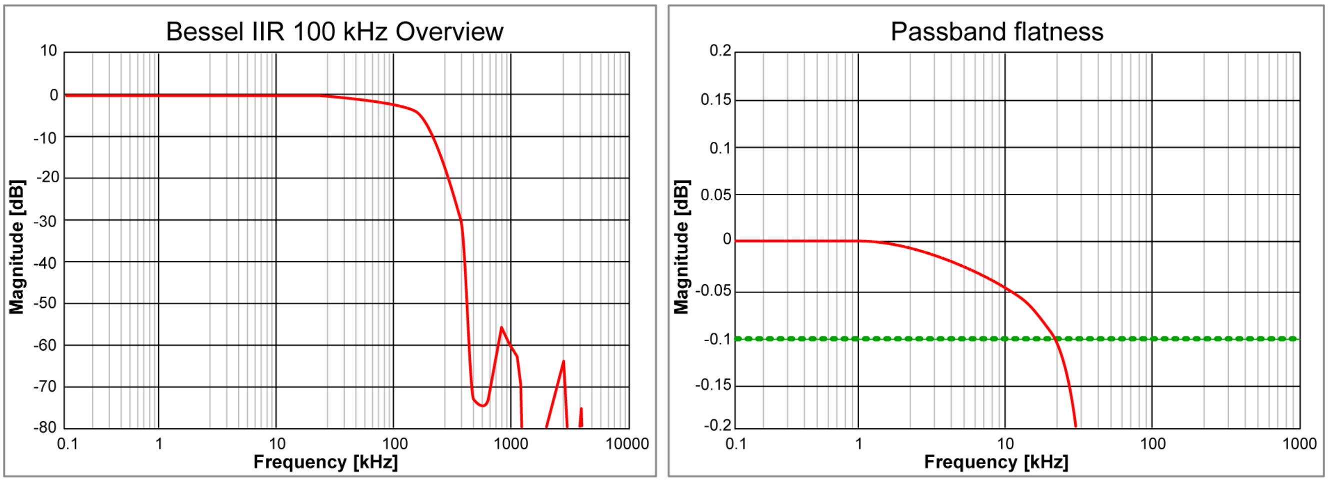



**Figure A.79:** Typical Bessel IIR ωc = 100 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -0.1 dB) filter

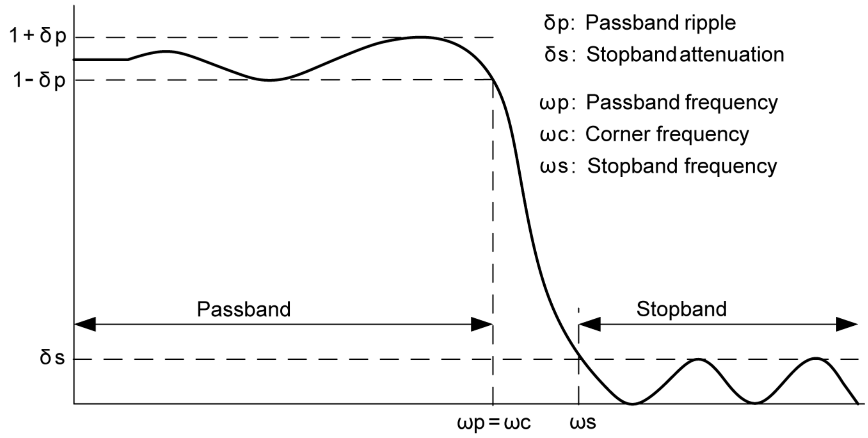



**Figure A.80:** Digital FIR (Fc @ -0.1 dB) filter

When FIR (Fc @ -0.1 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -0.1 dB) filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -0.1 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -0.1 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| FIR (Fc @ -0.1 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -0.1 dB) filter user selection from 0.031 Hz to 250 kHz |
| FIR (Fc @ -0.1 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to filter bandwidth (ωc)<br>0.1 dB; DC to 125 kHz; FIR (Fc @ -0.1 dB) filter bandwidth selection ωc = 250 kHz, limited by the 370 kHz analog anti alias filter amplitude response. All other bandwidth selections not affected |
| FIR (Fc @ -0.1 dB) filter stopband attenuation (δs) | -60 dB<br>With FIR (Fc @ -0.1 dB) filter bandwidth selection ωc = 250 kHz a peak at -35 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| FIR (Fc @ -0.1 dB) filter roll-off | -72 dB/Octave |

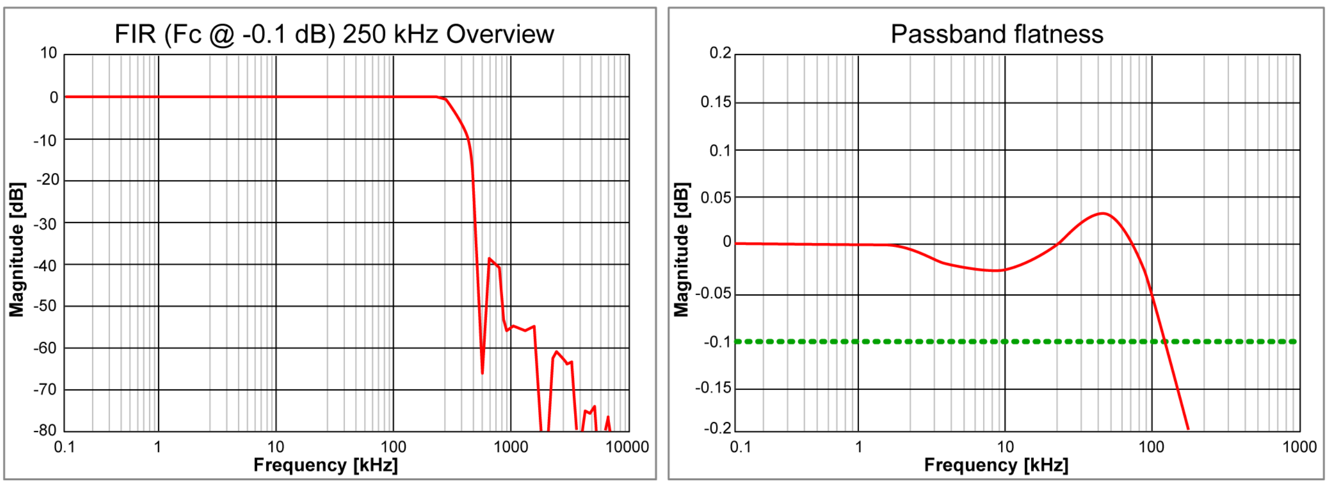



**Figure A.81:** Typical FIR (Fc @ -0.1 dB) ωc = 250 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -3 dB) filter

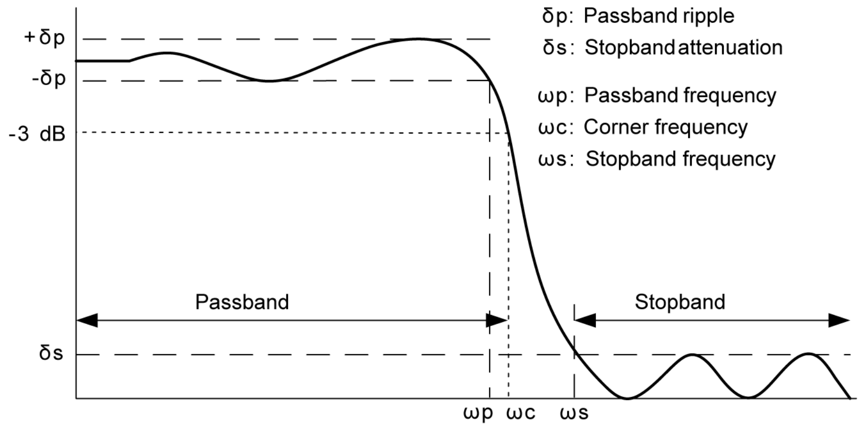



**Figure A.82:** Digital FIR (Fc @ -3 dB) filter

When FIR (Fc @ -3 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -3 dB) filter. Adapted FIR filter with ωp reduced by a factor of ≈1.4 compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -3 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -3 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| FIR (Fc @ -3 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -3 dB) filter user selection from 0.031 Hz to 250 kHz |
| FIR (Fc @ -3 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to ≈ωc/1.4 (Adapted FIR filter behavior)<br>0.1 dB; DC to 125 kHz; FIR (Fc @ -3 dB) filter bandwidth selection ωc = 250 kHz, limited by the 370 kHz analog anti alias filter amplitude response. All other bandwidth selections not affected |
| FIR (Fc @ -3 dB) filter stopband attenuation (δs) | -60 dB<br>With FIR (Fc @ -3 dB) filter bandwidth selection ωc = 250 kHz a peak at -35 dB will occur between 500 kHz and 1 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections the digital filter will reduce this peak to -60 dB |
| FIR (Fc @ -3 dB) filter roll-off | -72 dB/Octave |

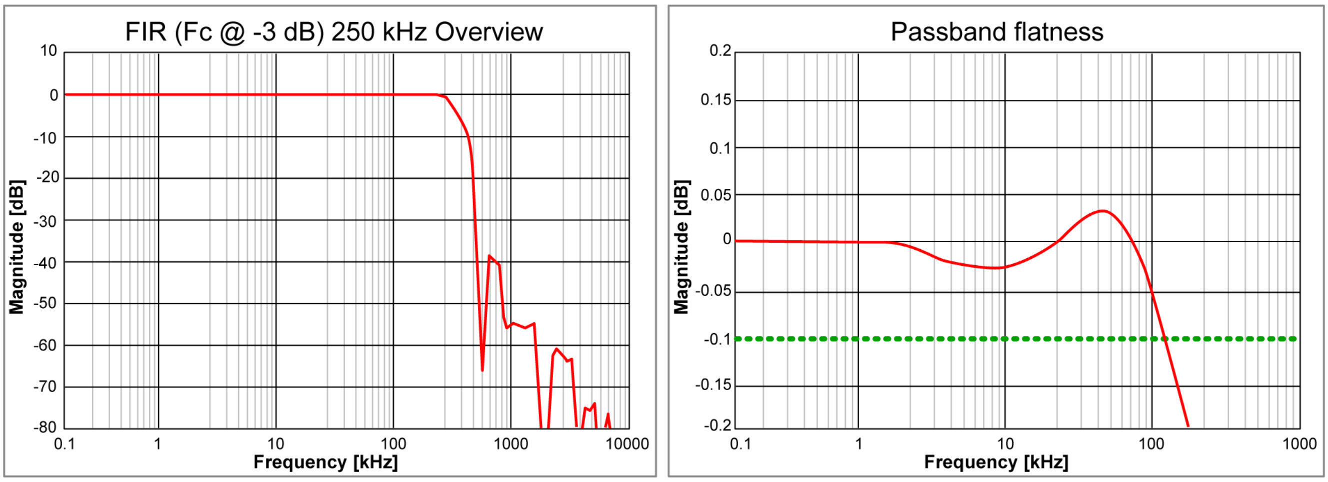



**Figure A.83:** Typical FIR (Fc @ -3 dB) ωc = 250 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## Channel to Channel Phase Match

| | |
|---|---|
| Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Wideband | 100 kHz Sine |
| Channels on card | 0.7 deg (0.02 µs) |
| GN813 Channels within mainframe | 0.7 deg (0.02 µs) |
| Bessel IIR (Fc @ -3 dB), 100 kHz Filter frequency | |
| Channels on card | 0.7 deg (0.02 µs) |
| GN813 Channels within mainframe | 0.7 deg (0.02 µs) |
| FIR (Fc@ -0.1dB) and FIR (Fc @ -3 dB), 250 kHz Filter frequency | |
| Channels on card | 0.7 deg (0.02 µs) |
| GN813 Channels within mainframe | 0.7 deg (0.02 µs) |
| GN813 Channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

## On-board Memory

| | |
|---|---|
| Per card | 512 MB (256 MS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

## Digital Events/Timer/Counter

| | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High / Low / Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High / Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base<br>504 µs ± 1 µs + maximum 1 sample period using binary time base |
| Cross channel triggering | |
| Channels on card | Logical OR; Analog triggers of all channels<br>Logical AND; Qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes when using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; Single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Pulse detect/reject | Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY : 16 bit (0.0015 %) for both levels<br>dT : 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak-level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak-level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger holdoff | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum holdoff time sample rate dependent |
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |

| Triggering | |
|---|---|
| Event counter | Counted channel trigger events before card trigger is activated<br>1 to 256 trigger events |

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow/Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch |
| Max. sweep memory | 252 MS | 126 MS | 31.5 MS | not used | | | 200 MS | 100 MS | 25 MS |
| Max. sweep sample rate | 1 MS/s | | | not used | | | 1 MS/s | | |
| Max. continuous FIFO | not used | | | 252 MS | 126 MS | 31.5 MS | 50 MS | 25 MS | 6 MS |
| Max. continuous sample rate | not used | | | 1 MS/s | | | Sweep Sample Rate / 2<br>Maximum 50 kS/s | | |
| Max. continuous streaming rate | not used | | | 1 MS/s<br>2 MB/s | 2 MS/s<br>4 MB/s | 8 MS/s<br>16 MB/s | 0.05 MS/s<br>0.1 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.8 MS/s<br>1.6 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

## Multiple Sweeps

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

## Slow Fast Sweep

| | |
|---|---|
| Maximum number of sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2, or 50 kS/s per channel, whichever is the smallest sample rate |
| Maximum sample rate switches | 400 sample rate switches per second, 200 000 switches maximum, switching stops when sweep ends |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Dual

| Dual Sweep Specification | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Environmental Specifications | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

| Harmonized standards for CE compliance, according to the following directives<br>Low Voltage Directive (LVD): 2006/95/EC<br>ElectroMagnetic Compatibility directive (EMC): 2004/108/EC | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering Information(1)

| Article | | Description | Order No. |
|---|---|---|---|
| Basic1M ISO XT |  | 8 Channel, 16 bits,1 MS/s, ± 2 V to ± 100 V input range, 512 MB RAM (32 MS/channel), isolated, unbalanced differential, with single isolated BNC for each channel | 1-GN813-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| 1kV DC Probe(1) | Probe Rack with 16 probes<br> | 1 : 10 Voltage divider; DC coupled, ± 1 kV input; for isolated Basic1M XT ISO Card with extended input range only; requires DC probe rack to be mounted; 1.25 m (49 inch) cable | 1-G041-2 |
| 1kV AC Probe(1) | | 1 : 1 AC coupler probe. AC coupled, ± 100 V AC measurement. Input allows up to ± 1 kV DC with a ± 100 V AC modulated signal. DC part of input signal suppressed on the output. For use with Basic1M XT ISO or Basic200k XT ISO only. | 1-G042-2 |
| DC Probe Rack | | 19 inch rack for 1 kV DC probes; 1 U height, holds a maximum of 16 DC probes | 1-G019-2 |
| AC Probe Rack | | 19 inch rack for 1 kV AC probes; 1 U height, holds a maximum of 16 AC probes | 1-G020-2 |

(1) Not recommended for new purchases. Use 1-GN610-2 or 1-GN611-2 instead.

### A.11 B2889-5.0 en (GEN series GN814)

| Capabilities Overview | |
|---|---|
| Model | GN814 |
| Maximum sample rate per channel | 200 kS/s |
| Memory per card | 128 MB |
| Analog channels | 8 |
| ADC resolution | 16 bit |
| Digital event/Timer/Counter support | no |
| Isolation | yes; channel to channel and channel to chassis |
| Input type | Analog isolated single ended, unbalanced differential (1) |
| Fast data streaming | no |

(1) An unbalanced differential input can be used to do isolated single ended and differential measurements.

**GEN series GN814 Block diagram**

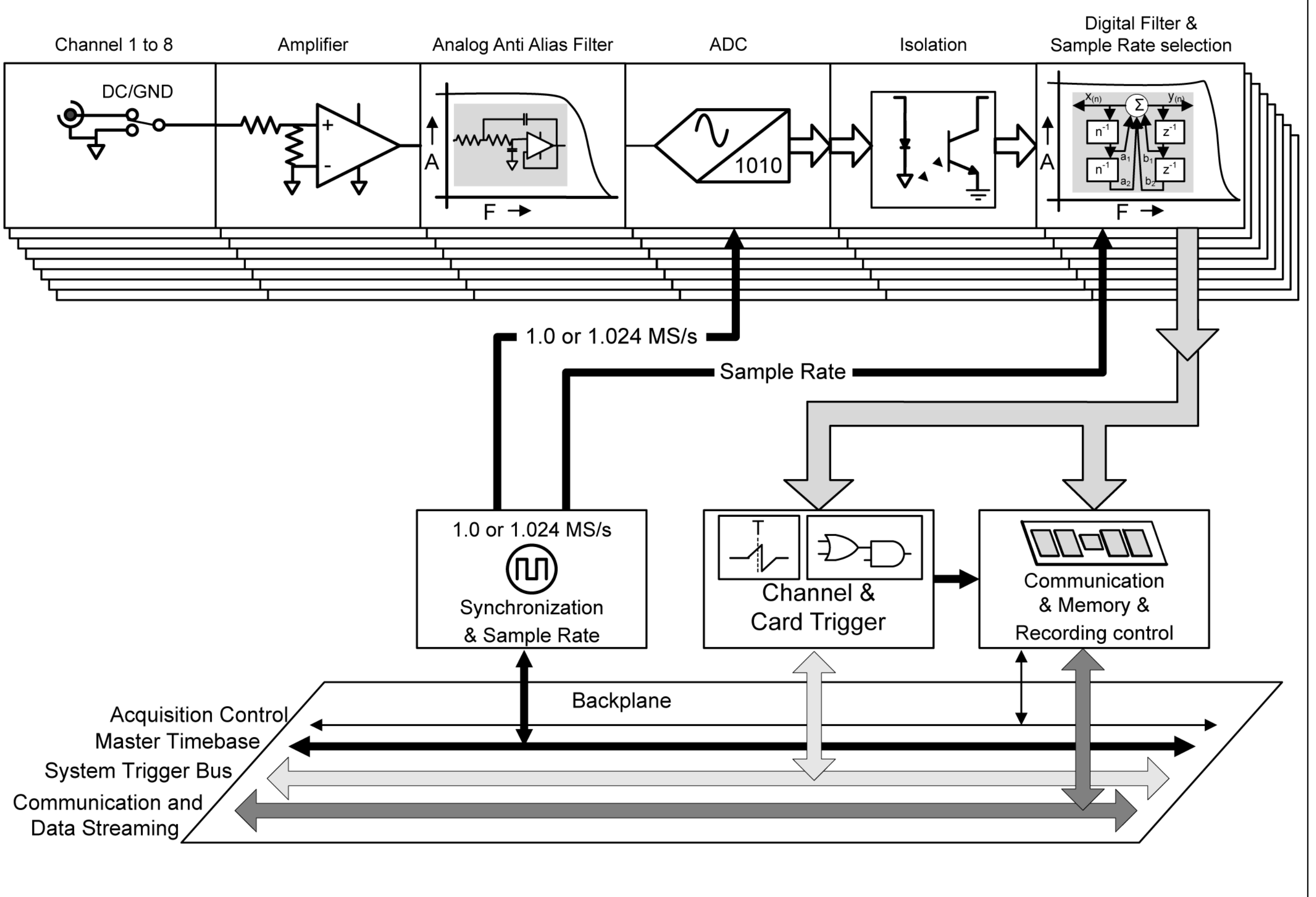



**Figure A.84:** Block diagram GEN series GN814

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

## Analog Input Section

| | |
|---|---|
| Channels | 8 |
| Connectors | Fully isolated BNC (Plastic), 1 per channel |
| Input type | Analog isolated single ended, unbalanced differential |
| Input coupling | DC, GND |
| Impedance | 1 MΩ ± 1% // 55 pF ± 10% |
| Ranges | ± 2.0 V, ± 4.0 V, ± 10.0 V, ± 20 V, ± 40 V, ± 100 V<br>Each fixed range supports a variable gain with 1000 steps (0.1 %).<br>Variable gain creates 1000 extra ranges between 2 fixed ranges. |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 100 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Offset error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| DC Gain error | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| Gain error drift | ± 70 ppm/°C (± 130 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.1 % of Full Scale ± 2 mV |
| Bessel IIR and FIR | 0.1 % of Full Scale ± 10 µV |
| RMS Noise | |
| Wideband | 0.02 % of Full Scale ± 10 µV |
| Bessel IIR and FIR | 0.02 % of Full Scale ± 10 µV |
| Common Mode | |
| Rejection Ratio (CMRR) | > 72 dB @ 80 Hz |
| Voltage | 250 V DC |
| Input overload protection | |
| Maximum voltage | ± 250 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 1 µs after 200 % overload |

## Isolation

| | |
|---|---|
| Channel to chassis | ± 250 V DC |
| Channel to channel | ± 500 V DC |
| Nondestructive, to chassis (earth) | ± 250 V DC |

## Analog to Digital Conversion

| | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 200 kS/s |
| ADC resolution; one ADC per channel | 16 bit |
| ADC Type | Successive Approximation Register (SAR); TI ADS8401IB |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; when Calculating FFT's produces rounded/integer BIN sizes |
| Maximum binary sample rate | 204.8 kS/s |
| External time base sample rate | 0 S/s to 200 kS/s |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

## Amplifier Bandwidth and Filtering

Using different filter selections (Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

| | |
|---|---|
| Bessel IIR (Fc @ -3 dB) | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| FIR (Fc @ -0.1 dB) | Standard FIR filter with corner frequency (Fc) defined at -0.1 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| FIR (Fc @ -3 dB)<br>Supported by Perception V6.40 and higher | Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Bessel IIR filter

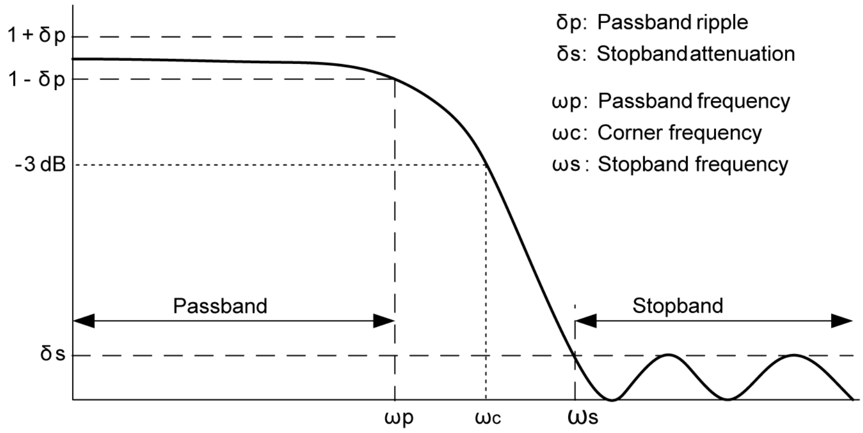



**Figure A.85:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 220 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 6-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 20 kHz |
| Bessel IIR passband flatness (ωp)(1) | 0.1 dB; DC to 3 kHz @ ωc = 20 kHz |
| Bessel IIR filter stop band attenuation (δs) | -60 dB |
| Bessel IIR filter roll-off | -36 dB/Octave |

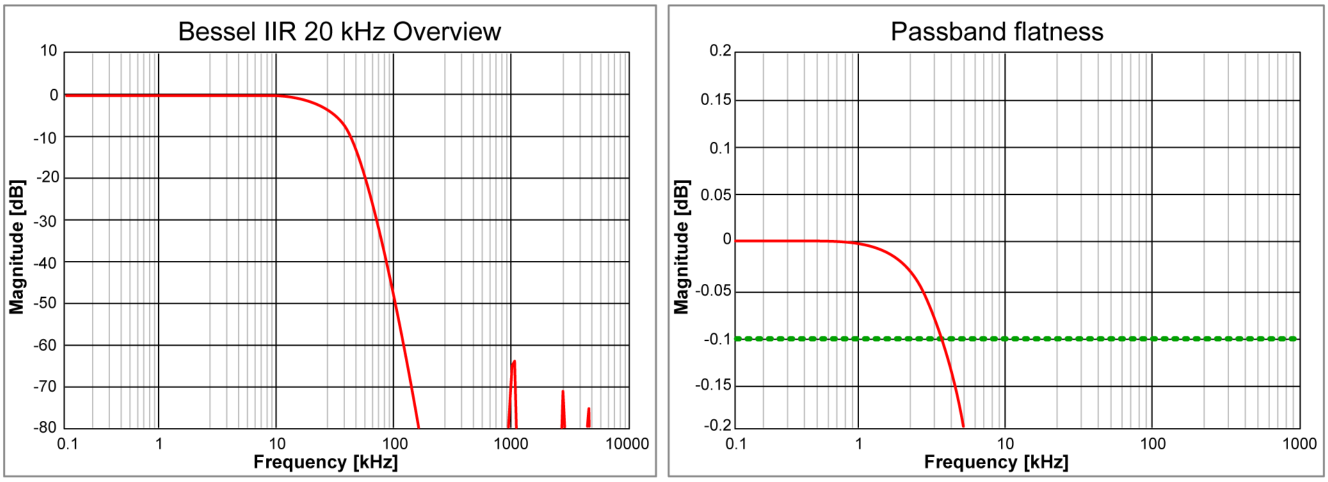



**Figure A.86:** Bessel IIR ωc = 20 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -0.1 dB) filter

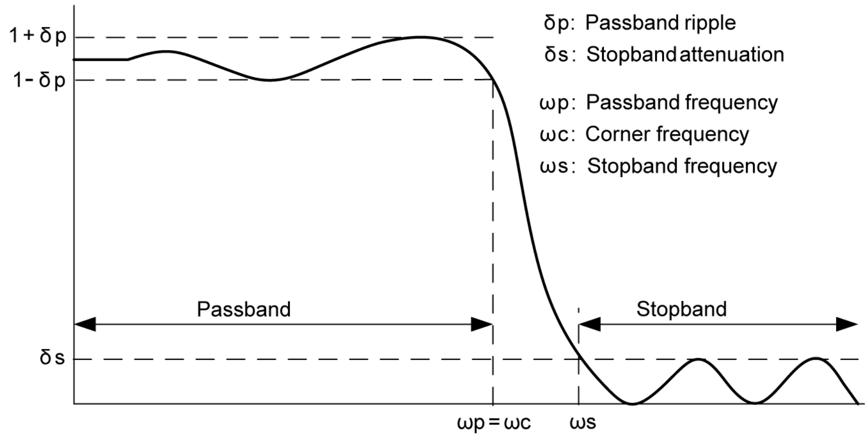



**Figure A.87:** Digital FIR (Fc @ -0.1 dB) filter

When FIR (Fc @ -0.1 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -0.1 dB) filter.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -0.1 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -0.1 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40 |
| FIR (Fc @ -0.1 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -0.1 dB) filter user selection from 0.031 Hz to 50 kHz |
| FIR (Fc @ -0.1 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to filter bandwidth (ωc) |
| FIR (Fc @ -0.1 dB) filter stopband attenuation (δs) | -60 dB |
| FIR (Fc @ -0.1 dB) filter roll-off | -72 dB/Octave |

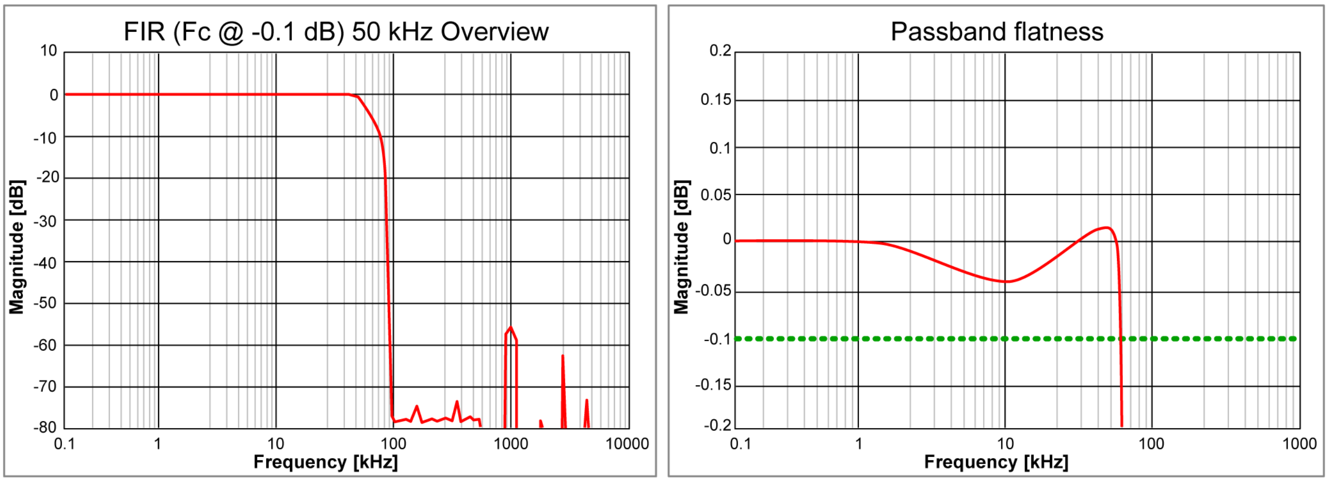



**Figure A.88:** Typical FIR (Fc @ -0.1 dB) ωc = 50 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

## FIR (Fc @ -3 dB) filter

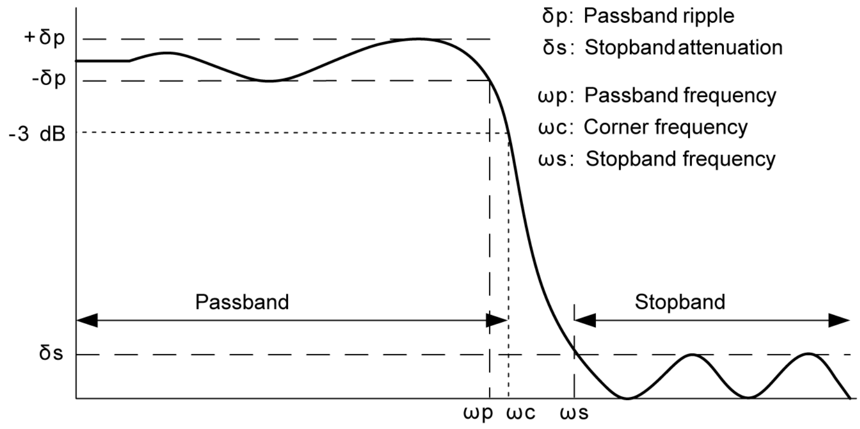



**Figure A.89:** Digital FIR (Fc @ -3 dB) filter

When FIR (Fc @ -3 dB) filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR (Fc @ -3 dB) filter. Adapted FIR filter with ωp reduced by a factor of ≈1.4 compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

| | |
|---|---|
| Analog anti aliasing filter bandwidth | 370 kHz ± 20 kHz (-3 dB) |
| Analog anti aliasing filter characteristic | 7-pole Butterworth, extended passband response |
| FIR (Fc @ -3 dB) filter characteristic | 12-pole FIR; FIR is a pure digital characteristic. Closest analog resemblance to Elliptic filters, however FIR has both overshoot on step response and pre-shoot to step response. This means ringing on the signal starts before the step input starts and the ringing continues after the step input ends. |
| FIR (Fc @ -3 dB) filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40 |
| FIR (Fc @ -3 dB) filter bandwidth (ωc) | Auto tracking the sample rate with the selected FIR (Fc @ -3 dB) filter user selection from 0.031 Hz to 50 kHz |
| FIR (Fc @ -3 dB) filter passband flatness (ωp) (1) | 0.1 dB; DC to ≈ωc/1.4 (Adapted FIR filter behavior) |
| FIR (Fc @ -3 dB) filter stopband attenuation (δs) | -60 dB |
| FIR (Fc @ -3 dB) filter roll-off | -72 dB/Octave |

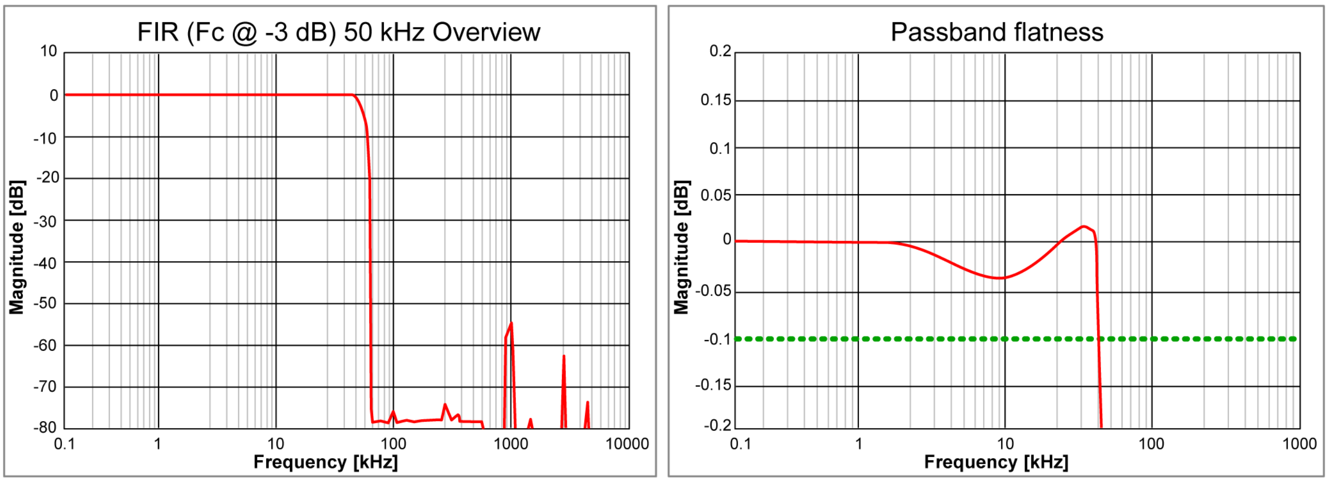



**Figure A.90:** Typical FIR (Fc @ -3 dB) ωc = 50 kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

| Channel to Channel Phase Match | |
|---|---|
| Using different filter selections (Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Bessel IIR (Fc @ -3 dB), 20 kHz Filter frequency; 10 kHz sine wave | |
| Channels on card | 0.4 deg (0.1 µs) |
| GN814 Channels within mainframe | 0.4 deg (0.1 µs) |
| FIR (Fc@ -0.1dB) and FIR (Fc @ -3 dB), 50 kHz Filter frequency; 10 kHz sine wave | |
| Channels on card | 0.4 deg (0.1 µs) |
| GN814 Channels within mainframe | 0.4 deg (0.1 µs) |
| GN814 Channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

| On-board Memory | |
|---|---|
| Per card | 128 MB (64 MS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

| Digital Events/Timer/Counter | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High / Low / Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High / Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base<br>504 µs ± 1 µs + maximum 1 sample period using binary time base |
| Cross channel triggering | |
| Channels on card | Logical OR; Analog triggers of all channels<br>Logical AND; Qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes when using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; Single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Pulse detect/reject | Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY : 16 bit (0.0015 %) for both levels<br>dT : 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak-level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak-level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger holdoff | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum holdoff time sample rate dependent |
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |

| Triggering | |
|---|---|
| Event counter | Counted channel trigger events before card trigger is activated<br>1 to 256 trigger events |

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow/Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch | 1 Ch | 2 Ch | 8 Ch |
| Max. sweep memory | 60 MS | 30 MS | 7.5 MS | not used | | | 48 MS | 24 MS | 6 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 60 MS | 30 MS | 7.5 MS | 12 MS | 6 MS | 1.5 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep Sample Rate / 2<br>Maximum 50 kS/s | | |
| Max. continuous streaming rate | not used | | | 0.2 MS/s<br>0.4 MB/s | 0.4 MS/s<br>0.8 MB/s | 1.6 MS/s<br>3.2 MB/s | 0.05 MS/s<br>0.1 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.8 MS/s<br>1.6 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

## Multiple Sweeps

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn’t fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

## Slow Fast Sweep

| | |
|---|---|
| Maximum number of sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2, or 50 kS/s per channel, whichever is the smallest sample rate |
| Maximum sample rate switches | 400 sample rate switches per second, 200 000 switches maximum, switching stops when sweep ends |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Dual | |
|---|---|
| **Dual Sweep Specification** | |
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) (Supported by Perception V6.30 or higher) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering Information[1]

| Article | | Description | Order No. |
|---|---|---|---|
| Basic200k ISO XT |  | 8 Channel, 16 bits, 200 kS/s, ± 2 V to ± 100 V input range, 128 MB RAM (8 MS/channel), isolated, unbalanced differential, with single isolated BNC for each channel | 1-GN814-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| 1kV DC Probe[1] | Probe Rack with 16 probes<br> | 1 : 10 Voltage divider; DC coupled, ± 1 kV input; for isolated Basic1M XT ISO Card with extended input range only; requires DC probe rack to be mounted; 1.25 m (49 inch) cable | 1-G041-2 |
| 1kV AC Probe[1] | | 1 : 1 AC coupler probe. AC coupled, ± 100 V AC measurement. Input allows up to ± 1 kV DC with a ± 100 V AC modulated signal. DC part of input signal suppressed on the output. For use with Basic1M XT ISO or Basic200k XT ISO only. | 1-G042-2 |
| DC Probe Rack | | 19 inch rack for 1 kV DC probes; 1 U height, holds a maximum of 16 DC probes | 1-G019-2 |
| AC Probe Rack | | 19 inch rack for 1 kV AC probes; 1 U height, holds a maximum of 16 AC probes | 1-G020-2 |

(1) Not recommended for new purchases. Use 1-GN610-2 or 1-GN611-2 instead.

### A.12 B3997-1.0 en (GEN series GN815)

| Capabilities Overview | |
|---|---|
| Model | GN815 |
| Maximum sample rate per channel | 2 MS/s |
| Memory per card | 2 GB |
| Analog channels | 8 |
| Sample resolution | 16/18 bit |
| Isolation | Channel to channel and channel to chassis |
| Input type | Analog isolated unbalanced differential (1) |
| Sensor support | IEPE |
| TEDS support | Class 1, IEPE sensors |
| Real-time calculators | 32; Cycle and Timer based calculations with triggering on calculated results |
| Digital Event/Timer/Counter support | 16 digital events and 2 timer/counter channels |
| Fast data streaming | Yes; Including backward compatible standard data streaming |

(1) The use of probes is supported. As the input is isolated, isolated probes are recommended.

## GEN series GN815 Block diagram

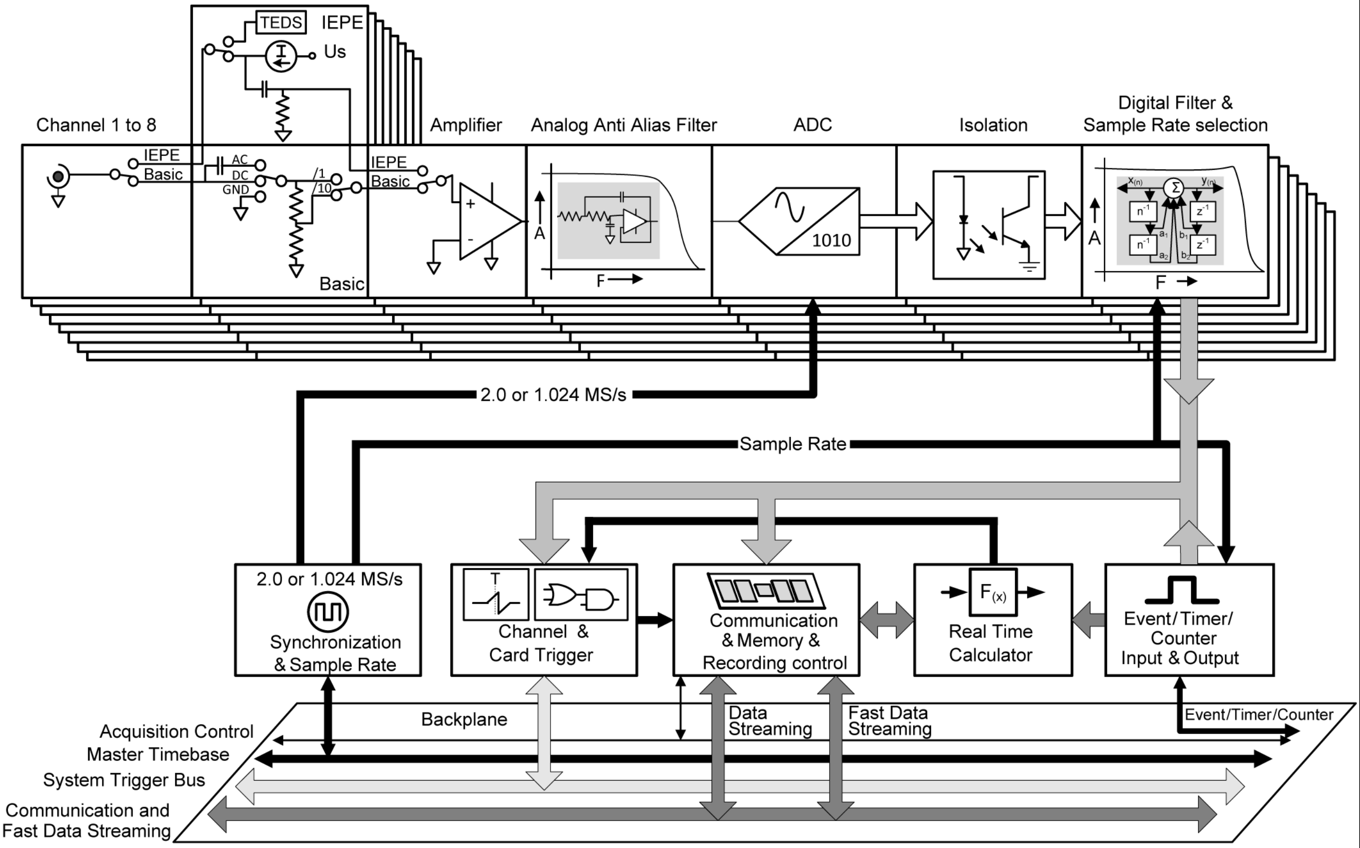



**Figure A.91:** Block Diagram GEN series GN815

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 8 |
| Connectors | Isolated metal BNC |
| Input type | Analog isolated unbalanced differential |
| Input coupling | |
| Coupling modes | AC, DC, GND |
| AC coupling frequency | 1.6 Hz ± 10 %; - 3 dB |

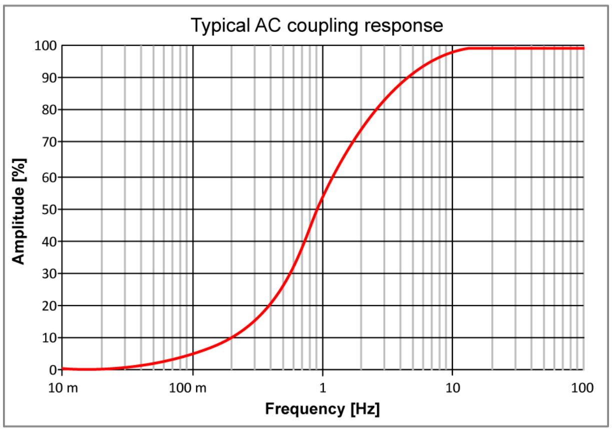



**Figure A.92:** Typical AC coupling response

| | |
|---|---|
| Impedance | 1 MΩ ± 1 % // 58 pF ± 10% ranges larger than ± 1 V. All other ranges 66 pF ± 10% |
| Ranges | ± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50 V |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 50 V range has fixed 0 % offset |
| DC Offset error | |
| Wideband | 0.01 % of Full Scale ± 200 µV |
| All IIR filters | 0.01 % of Full Scale ± 35 µV |
| Offset error drift | ±(45 ppm + 5 µV)/°C (±(25 ppm + 3 µV)/°F) |
| DC Gain error | |
| Wideband | 0.035 % of Full Scale ± 35 µV |
| All IIR filters | 0.035 % of Full Scale ± 35 µV |
| Gain error drift | ±25 ppm/°C (±14 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.035 % of Full Scale ± 200 µV |
| All IIR filters | 0.035 % of Full Scale ± 35 µV |
| RMS Noise (50 Ω terminated) | |
| Wideband | 0.025 % of Full Scale ± 50 µV |
| All IIR filters | 0.015 % of Full Scale ± 20 µV |

## Analog Input Section

| | | |
|---|---|---|
| Common Mode (referred to system ground) | | |
| Ranges | Less than or equal to ± 1 V | Larger than ± 1 V |
| Rejection Ratio (CMRR) | -80 dB @ 80 Hz (-100 dB typical) | -60 dB @ 80 Hz (-80 dB typical) |
| Voltage | 33 V RMS | 33 V RMS |

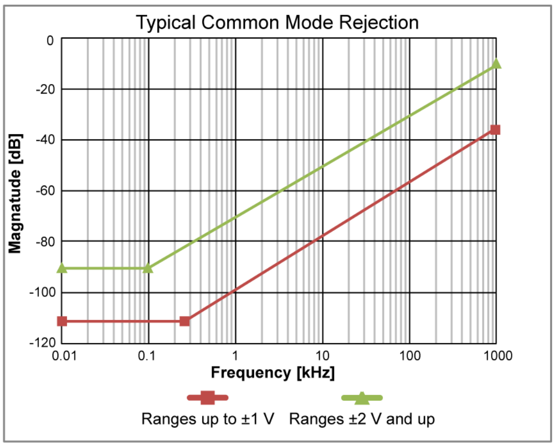



**Figure A.93:** Typical Common Mode Rejection

| | |
|---|---|
| Input overload protection | |
| Over voltage impedance change | The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200 % of the selected input range or 70 V whichever is the smallest value. |
| Maximum nondestructive voltage | ± 70 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 5 µs after 200 % overload |

## IEPE Sensor

| | |
|---|---|
| Input ranges | ± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V |
| Over voltage protection | - 1 V to 22 V |
| IEPE gain error | 0.1 % ± 250 µV |
| IEPE gain error drift | ± 25 ppm/°C (± 14 ppm/°F) |
| IEPE compliance voltage | ≥ 23 V |
| Excitation current | 2, 4, 6, 8 mA, software selectable |
| Excitation current accuracy | ± 5 % |
| Coupling time constant | 1.5 s |
| Lower bandwidth | -3 dB @ 0.11 Hz |
| Maximum cable length | 100 m (RG-58) |
| TEDS support | Yes; class 1 |

## Isolation

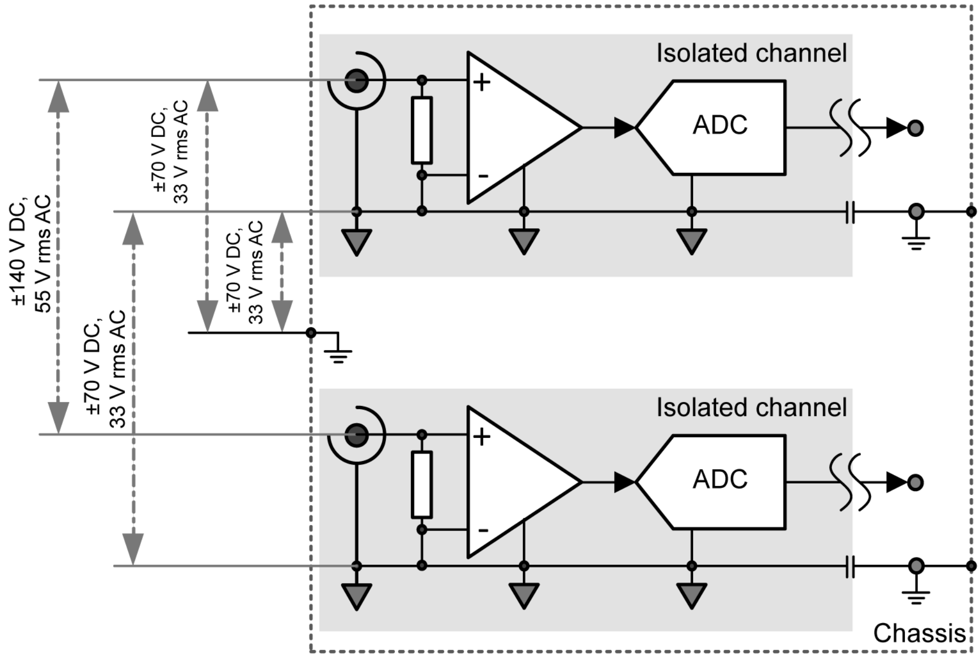



**Figure A.94:** Isolation schematic

| | |
|---|---|
| Channel to chassis (earth) | 33 V RMS, ± 70 V DC |
| Channel to channel<br>(Isolated GND to isolated GND) | 33 V RMS, ± 70 V DC |
| Input signal-to-input signal | 55 V RMS, ± 140 V DC |

## Analog to Digital Conversion

| | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 2 MS/s |
| ADC resolution; one ADC per channel | 18 bit |
| ADC type | Successive Approximation Register (SAR); Analog Devices AD7986BCPZ |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; produces rounded BIN values when calculating FFT's |
| Maximum binary sample rate | 1.024 MS/s |
| External time base frequency | 0 S/s to 1 MS/s |
| External time base frequency divider | Divide external clock by 1 to $2^{20}$ |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller Modules shipped before 2012: ±30 ppm.

## Amplifier Bandwidth and Filtering

| | |
|---|---|
| Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Wideband | When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected. Should not be used if working in frequency domain with recorded data. |
| Bessel IIR | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |

| Amplifier Bandwidth and Filtering | |
|---|---|
| Butterworth IIR | When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| Elliptic IIR | When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Wideband

When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

| | |
|---|---|
| Wideband bandwidth | Between 950 kHz and 1300 kHz (-3 dB) |
| Passband flatness | 0.1 dB; DC to 200 kHz(1) |

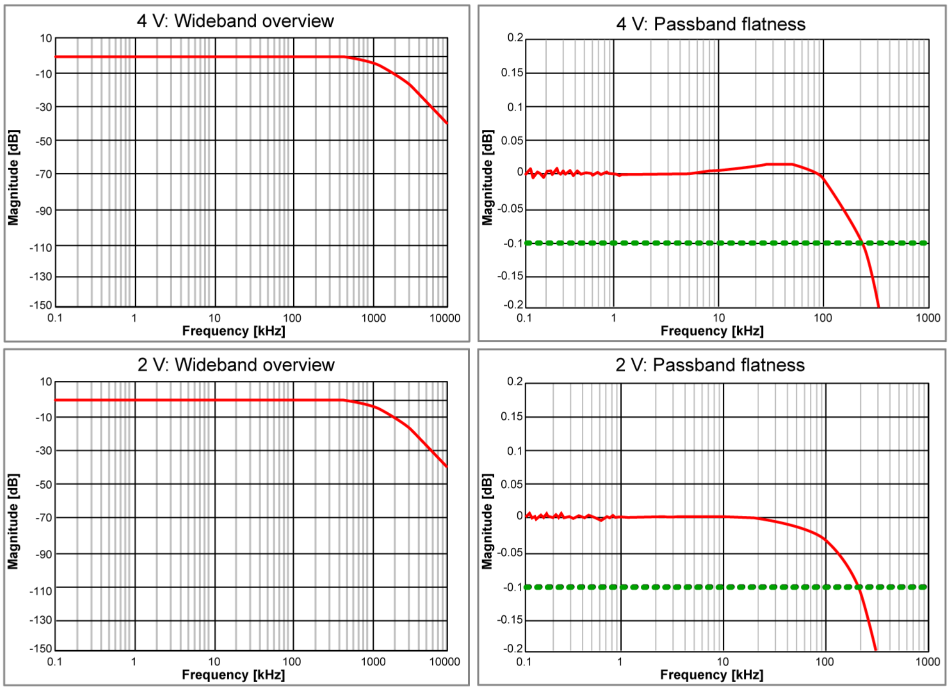



**Figure A.95:** Typical Wideband overview and passband flatness

(1) Measured using a Fluke 5700A calibrator, DC normalized

## Bessel IIR Filter

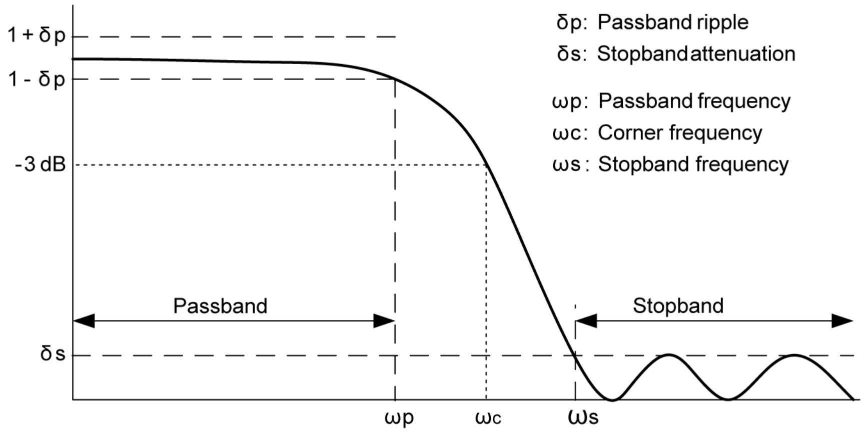



**Figure A.96:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 390 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 8-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | User selectable from 0.4 Hz to 200 kHz |
| Bessel IIR passband ripple (δp) | 0.1 dB(1) |
| Bessel IIR passband (ωp) | DC to 35 kHz @ ωc = 200 kHz(1) |
| Bessel IIR filter stopband attenuation (δs) | -60 dB<br>With Bessel IIR filter bandwidth selection ωc = 200 kHz a peak at -55 dB will occur between 1.6 MHz and 1.8 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections, the digital filter will reduce this peak to -60 dB |
| Bessel IIR filter roll-off | -48 dB/octave |

## Bessel IIR Filter

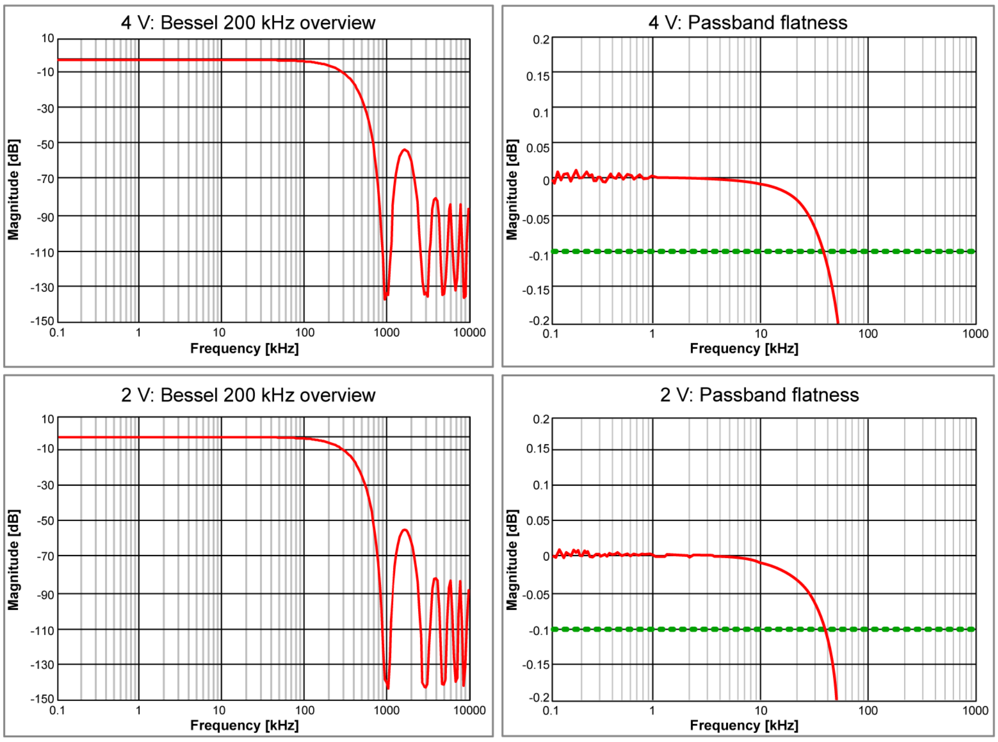



**Figure A.97:** Typical Bessel IIR 200 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Butterworth IIR Filter

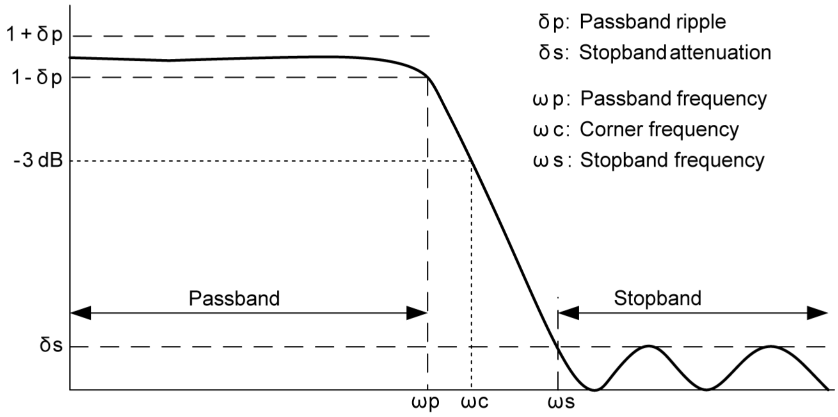



**Figure A.98:** Digital Butterworth IIR Filter

When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 460 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Butterworth IIR filter characteristic | 8-pole Butterworth style IIR |
| Butterworth IIR filter user selection | Auto tracking to sample rate divided by: 4(1), 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed. |
| Butterworth IIR filter bandwidth (ωc) | User selectable from 1 Hz to 250 kHz |
| Butterworth IIR passband ripple (δp) | 0.1 dB(2) |
| Butterworth IIR passband (ωp) | DC to 150 kHz @ ωc = 200 kHz(2) |
| Butterworth IIR filter stopband attenuation (δs) | -75 dB<br>With Butterworth IIR filter bandwidth selection ωc = 250 kHz a peak at -60 dB will occur between 1.8 MHz and 2.2 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections, the digital filter will reduce this peak to -75 dB |
| Butterworth IIR filter roll-off | -48 dB/octave |

## Butterworth IIR Filter

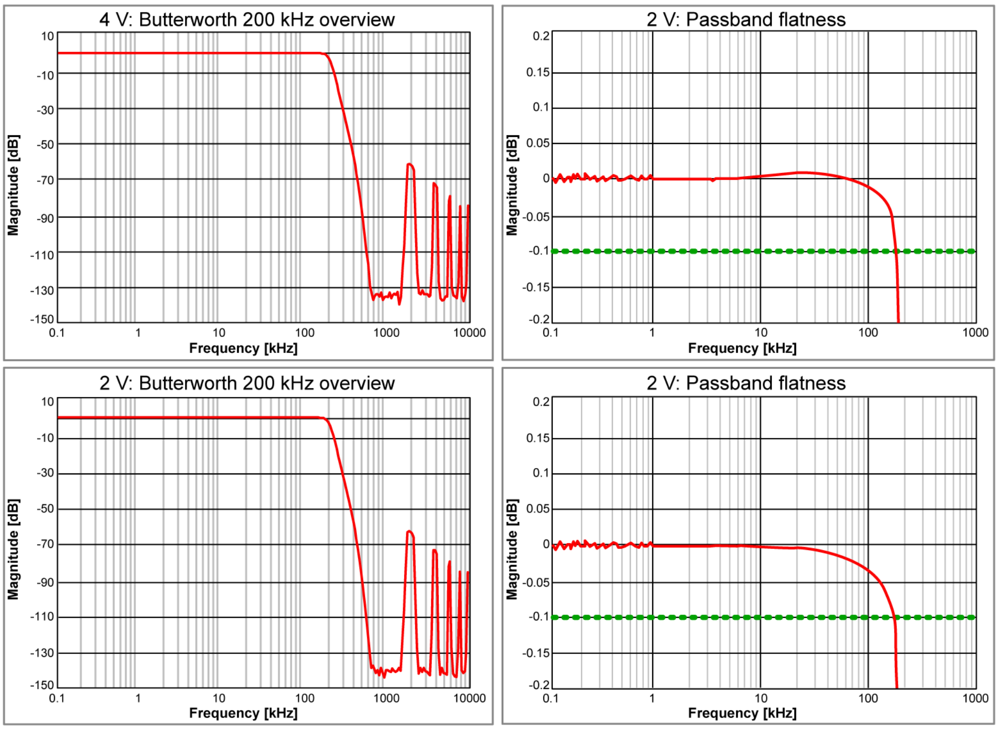



**Figure A.99:** Typical Butterworth IIR 200 kHz overview and passband flatness

(1) Divide by 4 not possible for sample rate 2 MS/s

(2) Measured using Fluke 5700A calibrator, DC normalized

## Elliptic IIR Filter

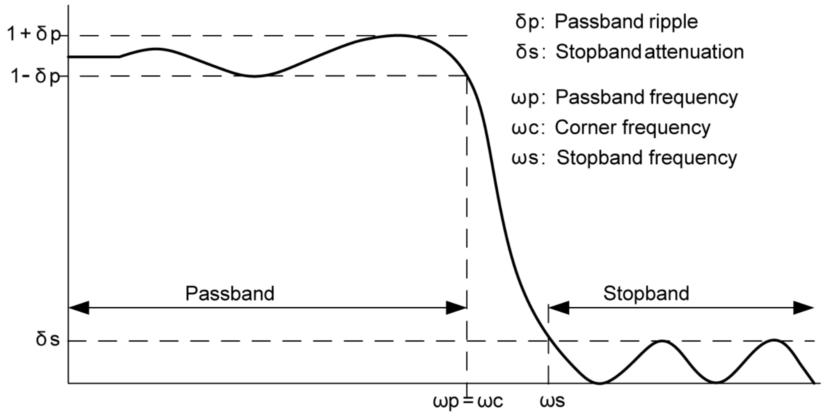



**Figure A.100:** Digital Elliptic IIR Filter

When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 460 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Elliptic IIR filter characteristic | 7-pole Elliptic style IIR |
| Elliptic IIR filter user selection | Auto tracking to sample rate divided by: 4[(1)], 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Elliptic IIR filter bandwidth (ωc) | 1 Hz to 250 kHz |
| Elliptic IIR passband ripple (δp) | 0.1 dB[(2)] |
| Elliptic IIR passband (ωp) | DC to filter bandwidth (ωc)[(2)] |
| Elliptic IIR filter stopband attenuation (δs) | -75 dB<br>With Elliptic IIR filter bandwidth selection ωc = 250 kHz a peak at -60 dB will occur between 1.8 MHz and 2.2 MHz due to limited analog anti alias filter amplitude reduction. At lower bandwidth selections, the digital filter will reduce this peak to -75 dB |
| Elliptic IIR filter roll-off | -72 dB/octave |

## Elliptic IIR Filter

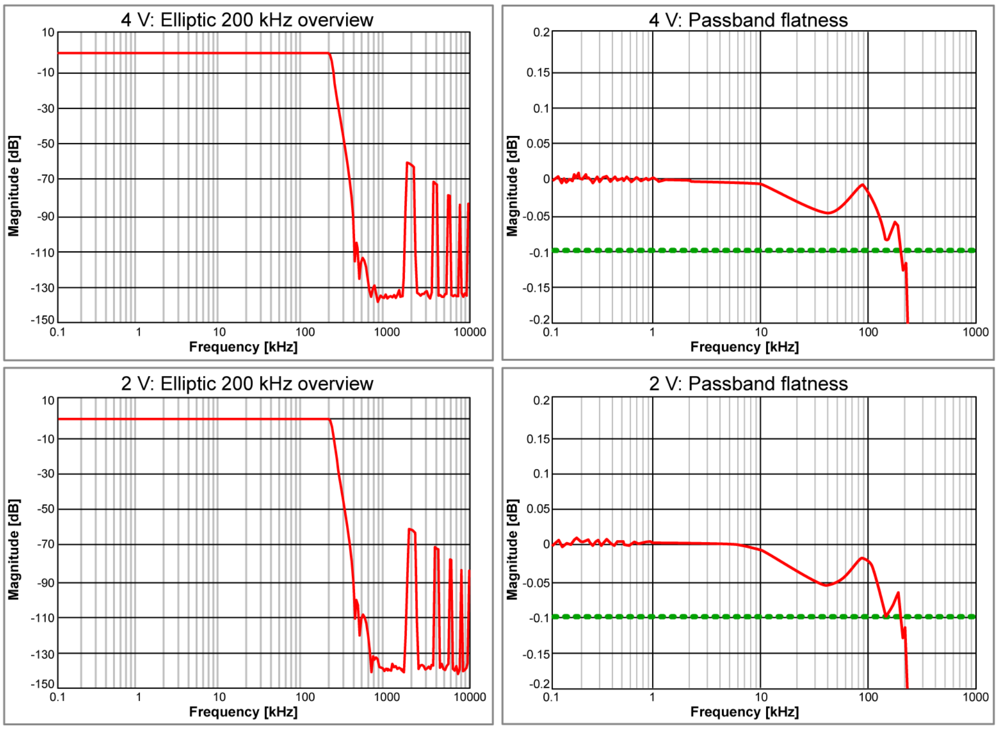



**Figure A.101:** Typical Elliptic IIR 200 kHz overview and passband flatness

(1) Divide by 4 not possible for sample rate 2 MS/s

(2) Measured using Fluke 5700A calibrator, DC normalized

## Channel to Channel Phase Match

Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

| | | |
|---|---|---|
| Wideband | 100 kHz Sine wave | 800 kHz Sine wave |
| Channels on card | 0.5 deg (14 ns) | 2.0 deg (7 ns) |
| GN815 Channels within mainframe | 0.5 deg (14 ns) | 2.0 deg (7 ns) |
| Bessel IIR, Filter frequency 200 kHz @ 2 MS/s | | |
| Channels on card | 0.5 deg (14 ns) | |
| GN815 Channels within mainframe | 0.5 deg (14 ns) | |
| Butterworth IIR, Filter frequency 200 kHz @ 2 MS/s | | |
| Channels on card | 0.5 deg (14 ns) | |
| GN815 Channels within mainframe | 0.5 deg (14 ns) | |
| Elliptic IIR, Filter frequency 200 kHz @ 2 MS/s | | |
| Channels on card | 0.5 deg (14 ns) | |
| GN815 Channels within mainframe | 0.5 deg (14 ns) | |
| GN815 channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) | |

## Channel to Channel Crosstalk

Channel to channel crosstalk is measured with a 50 Ω termination resistor on the input and using sine wave signals on the channel above and below the channel under test. To test channel 2, channel 2 is terminated with 50 Ω and channel 1 and 3 are connected to the sine wave generator.

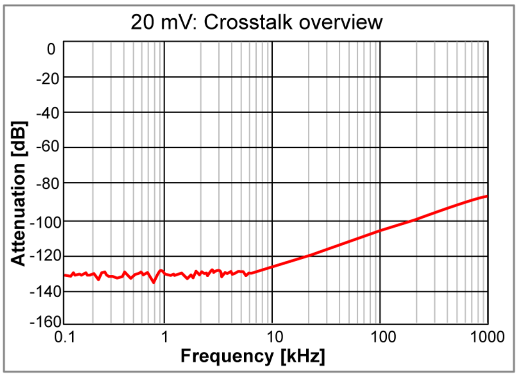



**Figure A.102:** Typical crosstalk overview

## On-board Memory

| | |
|---|---|
| Per card | 2 GB (1 GS @ 16 bits storage) |
| Organization | Automatically distributed amongst channels enabled for storage or real-time calculations |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample<br>18 bits, 4 bytes/sample (required for Timer/Counter usage) |

| Digital Event/Timer/Counter [1] | |
|---|---|
| Digital input events | 16 per card |
| Levels | TTL input levels, user programmable invert |
| Inputs | 1 pin per input, some pins are shared with Timer/Counter inputs |
| Over voltage protection | ± 30 V DC continuously |
| Minimum pulse width | 100 ns |
| Maximum frequency | 5 MHz |
| Digital output events | 2 per card |
| Levels | TTL output levels, short circuit protected |
| Output event 1 | User selectable: Trigger, Alarm, set High or Low |
| Output event 2 | User selectable: Recording active, set High or Low |
| Digital output event user selections | |
| Trigger | 1 high pulse per trigger (on every channel trigger of this card only)<br>12.8 µs minimum pulse width<br>200 µs ± 1 µs ± 1 sample period pulse delay |
| Alarm | High when alarm condition is activated, low when not activated (alarm conditions of this card only)<br>200 µs ± 1 µs ± 1 sample period alarm event delay |
| Recording active | High when recording, low when in idle or pause mode<br>Recording active output delay 450 ns |
| Set High or Low | Output set High or Low; can be controlled by Custom Software Interface (CSI) extensions; delay depending on specific software implementation |
| Timer/Counter | 2 per card; only available in 18 bit mode |
| Levels | TTL input levels |
| Inputs | All pins are shared with digital event inputs |
| Timer-Counter modes | Uni- and bi-directional count<br>Bi-directional quadrature count<br>Uni- and bi-directional frequency/RPM measurement |
| Uni- and bi-directional count | |
| Inputs | 3 pins; signal, reset and direction (only used in bidirectional count) |
| Maximum input frequency | 5 MHz |
| Maximum count value | 0 to $2^{31}$; unidirectional count. $-2^{31}$ to $+2^{31}$; bidirectional count |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |
| Direction input | Only used when in bi-directional count<br>Low: increment counter<br>High: decrement counter |
| Bi-directional quadrature count | |
| Inputs | 3 pins; signal, direction and reset |
| Maximum input frequency | 2 MHz, minimum high or low time 200 ns. Minimum phase difference between signal and direction 100 ns. |
| Accuracy | Single, dual and quad precision |
| Maximum count value | $-2^{31}$ to $+2^{31}$ |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |

| Digital Event/Timer/Counter [1] | |
|---|---|
| Uni- and bi-directional frequency/RPM measurement | |
| Inputs | 2 pins; signal, direction |
| Maximum input frequency | 5 MHz |
| Accuracy | 0.1 % |
| Gate measuring time | Sample period to 50 s; user selectable to control update rate independent of sample rate |
| Direction input | Only used when in bi-directional frequency/RPM mode<br>Low: Positive frequency/RPM, e.g. left rotations<br>High: Negative frequency/RPM, e.g. right rotations |
| External start | User selectable Rising/Falling edge signal will start a new recording |
| External stop | User selectable Rising/Falling edge signal will stop the recording |

(1) Only if supported by mainframe

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 fully independent per channel either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Trigger in edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Trigger in delay | ± 1 µs + maximum 1 sample period (Identical for decimal and binary time base) |
| Send to external trigger out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Trigger out level | High/Low/Hold High; mainframe selectable, identical for all cards |
| Trigger out pulse width | High/Low: 12.8 µs<br>Hold High: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe; see mainframe datasheet for details |
| Trigger out delay | Selectable (10 µs to 516 µs) ± 1 µs + maximum 1 sample period using decimal time base<br>Selectable (9.76 µs to 504 µs) ± 1 µs + maximum 1 sample period using binary time base<br>Default 516(504) µs for decimal (binary) time base, to be compatible with standard behavior.<br>Minimum selectable delay is the smallest delay available for all acquisition cards used within the mainframe |
| Cross channel triggering | |
| Channels on card | Logical OR; analog triggers of all channels<br>Logical AND; qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; two individual levels, logical OR |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/Disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/Disable trigger with dual level |
| Event channel trigger (1) | |
| Event channels | Individual event trigger per event channel |
| Levels | Trigger on rising edge or trigger on falling edge |
| Qualifiers | Active High or Active Low for every event channel |

(1) Only if supported by mainframe

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| **StatStream®** | |
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |
| **Real-Time Calculations (Perception V6.50 and higher)** | |

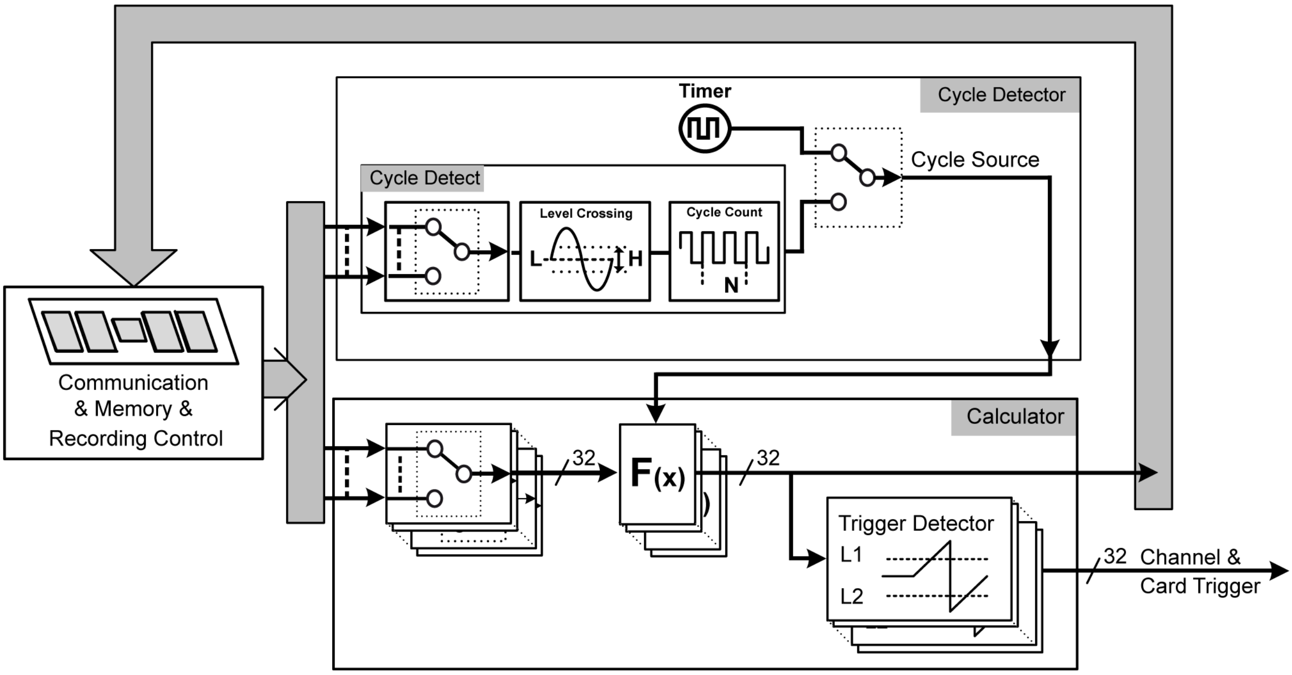



**Figure A.103:** Real-Time Calculations

## Real-Time Analysis

| | |
|---|---|
| Cycle Source | Determines the periodic based real-time calculations<br>Supports timer or signal level crossing based period generation |
| Timer | |
| Time interval | 1.0 ms (1 kHz) to 60 s (0.0167 Hz) |
| Cycle detect | |
| Level crossing | Monitors one analog channel using a user selectable signal level and signal hysteresis to dynamically determine the cyclic nature of the signal. |
| Cycle count | Sets the counted number of cycles used for periodic calculation output |
| Cycle period(1) | Maximum detectable Cycle period 0.25 s (4 Hz)<br>Minimum detectable period 0.91 ms (1.1 kHz)<br>Calculations stops when Cycle period exceeds maximum cycle period (0.25 s).<br>Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms).<br>Exceeding Cycle period or automatic Cycle count increases are indicated with time event notification in channel data. |
| Real-Time calculator | |
| Number of calculators | 32; at sample rates 200 kS/s or lower. At higher sample rates number of calculators is reduced to match available DSP power. |
| Calculator DSP load | Each calculator can execute 1 calculation. Not every calculation uses the same DSP power. Selecting the highest computation power calculations could lead to reduction of total number of calculators. Different combinations lead to different computation power and can't be specified. Perception software will reflect the impact on selected combinations. |
| Calculations | Cycle and Frequency on Cycle signal only. RMS, Minimum, Maximum, Mean, Peak to Peak, Area, Energy and MeanOfMultiply on analog channels and Frequency on Timer/Counter channels that measure frequency.(2) |
| Cycle | Square wave signal, 50 % duty cycle.<br>Represent Cycle Source; rising edge indicates start of new calculation period. |
| Frequency | Detected cycle interval is converted to a frequency (1 / cycle time of input signal) |
| Trigger detector | |
| Number of detectors | 32; One per Real-Time calculator |
| Trigger level | User defined per detector. Generates trigger when calculated signal crosses the level. |
| Trigger output delay | Triggers on calculated signals are 100 ms delayed. Internally time corrected for correct sweep triggering. Internally an additional 100 ms pre-trigger length is added to every channel using this trigger as trigger source to enable the time correction. This reduces the maximum sweep length by 100 ms. |

(1) Cycle period range depends on signal wave shape and hysteresis setting. Specified for Sine wave with 25 % Full Scale hysteresis.

(2) To enable triggering on Timer/Counter frequency measurements.

## Acquisition Modes

| | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Acquisition Mode Details

| **16 Bit resolution** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 8 Ch | 8 Ch & Events | 1 Ch | 8 Ch | 8 Ch & Events | 1 Ch | 8 Ch | 8 Ch & Events |
| Max. sweep memory | 954 MS | 119 MS | 106 MS | not used | | | 762 MS | 95 MS | 84 MS |
| Max. sweep sample rate | 2 MS/s | | | not used | | | 2 MS/s | | |
| Max. continuous FIFO | not used | | | 954 MS | 119 MS | 106 MS | 190 MS | 23 MS | 21 MS |
| Max. continuous sample rate | not used | | | 2 MS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 2 MS/s<br>4 MB/s | 16 MS/s<br>32 MB/s | 18 MS/s<br>36 MB/s | 1 MS/s<br>2 MB/s | 8 MS/s<br>16 MB/s | 9 MS/s<br>18 MB/s |

| **18 Bit resolution** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 8 Ch | 8 Ch & Events & Timer/ Counter | 1 Ch | 8 Ch | 8 Ch & Events & Timer/ Counter | 1 Ch | 8 Ch | 8 Ch & Events & Timer/ Counter |
| Max. sweep memory | 477 MS | 59 MS | 43 MS | not used | | | 381 MS | 47 MS | 34 MS |
| Max. sweep sample rate | 2 MS/s | | | not used | | | 2 MS/s | | |
| Max. continuous FIFO | not used | | | 477 MS | 59 MS | 43 MS | 95 MS | 11 MS | 8 MS |
| Max. continuous sample rate | not used | | | 2 MS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 2 MS/s<br>8 MB/s | 16 MS/s<br>64 MB/s | 22 MS/s<br>88 MB/s | 1 MS/s<br>4 MB/s | 8 MS/s<br>32 MB/s | 11 MS/s<br>44 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

| Multiple Sweeps | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

| Slow Fast Sweep | |
|---|---|
| Maximum number of Sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2 |
| Maximum fast sample rate switches | 400 sample rate switches per second, 200 000 switches maximum<br>Recording stops at end of sweep even if specified sample rates switches did not happen |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Dual | |
|---|---|
| **Dual Sweep Specification** | |
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 10 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering information(1)

| Article | | Description | Order No. |
|---|---|---|---|
| Basic/<br>IEPE2M ISO |  | 8 channel, 18 bit, 2 MS/s, ± 10 mV to ± 50 V input range,<br>2 GB RAM, 33 V RMS isolated unbalanced differential input, single metal isolated BNC per channel. Basic voltage and IEPE sensor with TEDS class 1 support.<br>Real-time cycle and timer based calculations with triggering on calculated results<br><br>Supported by Perception V6.50 and higher | 1-GN815-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

### A.13 B3998-1.0 en (GEN series GN816)

| Capabilities Overview | |
|---|---|
| Model | GN816 |
| Maximum sample rate per channel | 200 kS/s |
| Memory per card | 200 MB |
| Analog channels | 8 |
| Sample resolution | 16/18 bit |
| Isolation | Channel to channel and channel to chassis |
| Input type | Analog isolated unbalanced differential (1) |
| Sensor support | IEPE |
| TEDS support | Class 1, IEPE sensors |
| Real-time calculators | 32; Cycle and Timer based calculations with triggering on calculated results |
| Digital Event/Timer/Counter support | 16 digital events and 2 timer/counter channels |
| Fast data streaming | Yes; Including backward compatible standard data streaming |

(1) The use of probes is supported. As the input is isolated, isolated probes are recommended.

## GEN series GN816 Block diagram

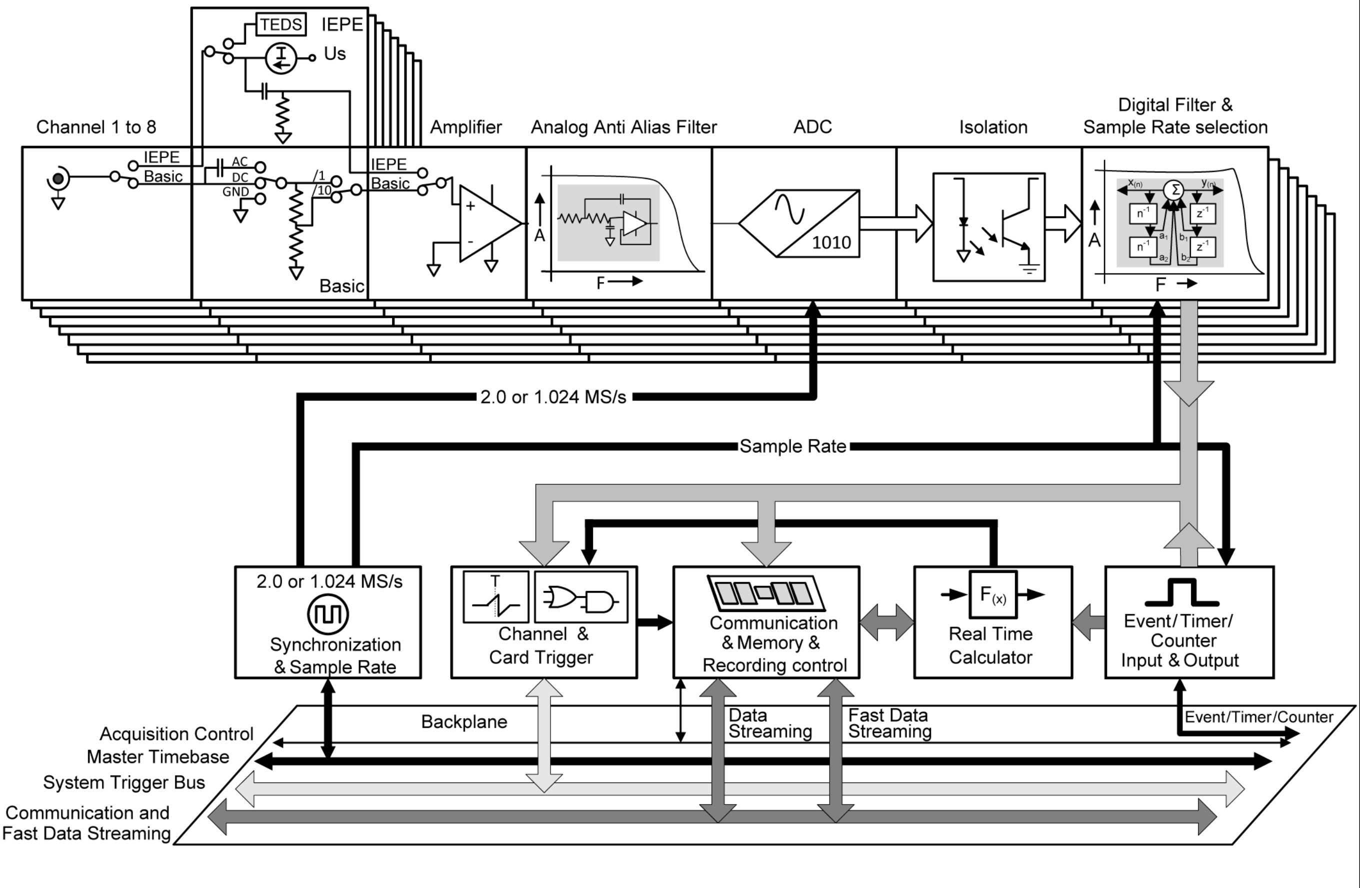



**Figure A.104:** Block Diagram GEN series GN816

**Note** *The listed specifications are valid for cards that are calibrated and used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated due to thermal differences within the configurations: Offset error, Gain error and MSE. Typically the resulting specification will be double.*

| Analog Input Section | |
|---|---|
| Channels | 8 |
| Connectors | Isolated metal BNC |
| Input type | Analog isolated unbalanced differential |
| Input coupling | |
| Coupling modes | AC, DC, GND |
| AC coupling frequency | 1.6 Hz ± 10 %; - 3 dB |

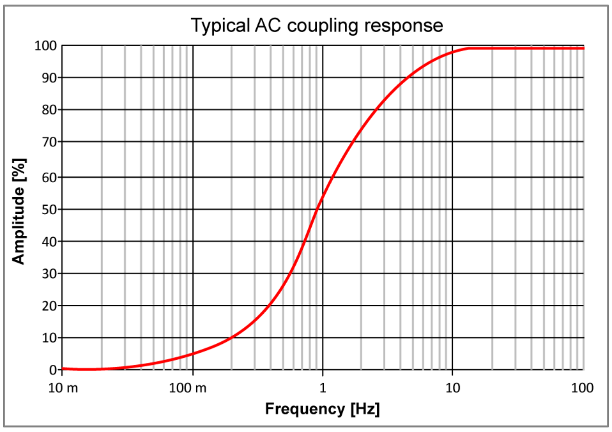



**Figure A.105:** Typical AC coupling response

| | |
|---|---|
| Impedance | 1 MΩ ± 1 % // 58 pF ± 10% ranges larger than ± 1 V. All other ranges 66 pF ± 10% |
| Ranges | ± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50 V |
| Offset | ± 50 % in 1000 steps (0.1 %);<br>± 50 V range has fixed 0 % offset |
| DC Offset error | |
| All IIR filters | 0.01 % of Full Scale ± 35 µV |
| Offset error drift | ±(45 ppm + 5 µV)/°C (±(25 ppm + 3 µV)/°F) |
| DC Gain error | |
| All IIR filters | 0.035 % of Full Scale ± 35 µV |
| Gain error drift | ±25 ppm/°C (±14 ppm/°F) |
| Maximum static error (MSE) | |
| All IIR filters | 0.035 % of Full Scale ± 35 µV |
| RMS Noise (50 Ω terminated) | |
| All IIR filters | 0.015 % of Full Scale ± 20 µV |

| Analog Input Section | | |
|---|---|---|
| Common Mode (referred to system ground) | | |
| Ranges | Less than or equal to ± 1 V | Larger than ± 1 V |
| Rejection Ratio (CMRR) | > -80 dB @ 80 Hz (-100 dB typical) | > -60 dB @ 80 Hz (-80 dB typical) |
| Voltage | 33 V RMS | 33 V RMS |

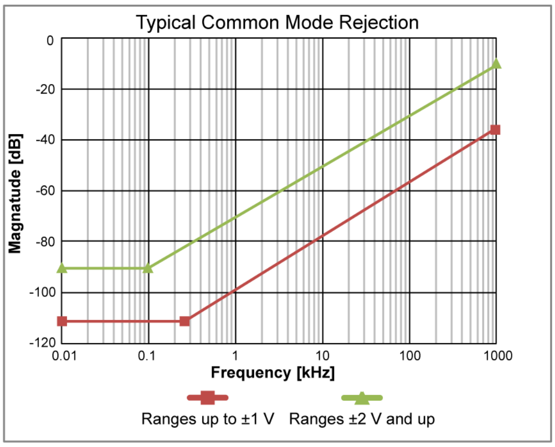



**Figure A.106:** Typical Common Mode Rejection

| | |
|---|---|
| Input overload protection | |
| Over voltage impedance change | The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200 % of the selected input range or 70 V whichever is the smallest value. |
| Maximum nondestructive voltage | ± 70 V DC |
| Overload recovery time | Restored to 0.1 % accuracy in less than 5 µs after 200 % overload |

| IEPE Sensor | |
|---|---|
| Input ranges | ± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V |
| Over voltage protection | - 1 V to 22 V |
| IEPE gain error | 0.1 % ± 250 µV |
| IEPE gain error drift | ± 25 ppm/°C (± 14 ppm/°F) |
| IEPE compliance voltage | ≥ 23 V |
| Excitation current | 2, 4, 6, 8 mA, software selectable |
| Excitation current accuracy | ± 5 % |
| Coupling time constant | 1.5 s |
| Lower bandwidth | -3 dB @ 0.11 Hz |
| Maximum cable length | 100 m (RG-58) |
| TEDS support | Yes; class 1 |

## Isolation

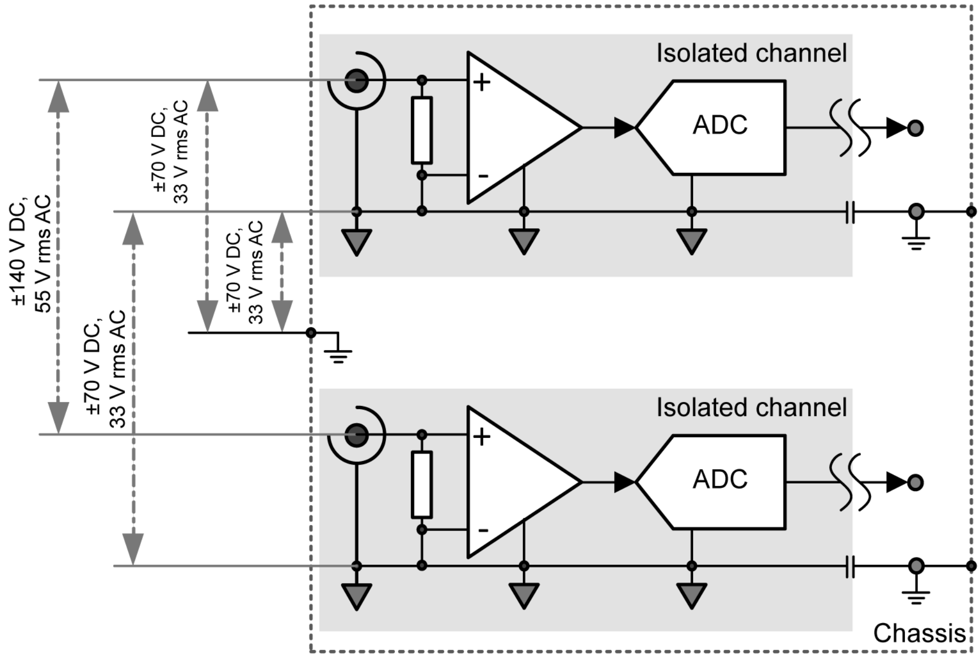



**Figure A.107:** Isolation schematic

| | |
|---|---|
| Channel to chassis (earth) | 33 V RMS, ± 70 V DC |
| Channel to channel<br>(Isolated GND to isolated GND) | 33 V RMS, ± 70 V DC |
| Input signal-to-input signal | 55 V RMS, ± 140 V DC |

## Analog to Digital Conversion

| | |
|---|---|
| Sample rate; per channel | 0.1 S/s to 200 kS/s |
| ADC resolution; one ADC per channel | 18 bit |
| ADC type | Successive Approximation Register (SAR); Analog Devices AD7986BCPZ |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; produces rounded BIN values when calculating FFT's |
| Maximum binary sample rate | 204.8 kS/s |
| External time base frequency | 0 S/s to 200 kS/s |
| External time base frequency divider | Divide external clock by 1 to $2^{20}$ |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1) Mainframes using Interface/Controller Modules shipped before 2012: ±30 ppm.

| Amplifier Bandwidth and Filtering | |
|---|---|
| Using different filter selections (Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Bessel IIR | When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| Butterworth IIR | When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |
| Elliptic IIR | When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.<br>Best used when working in the frequency domain. When working in the time domain this filter is best used for signals that are (close to) sine waves. |

## Bessel IIR Filter

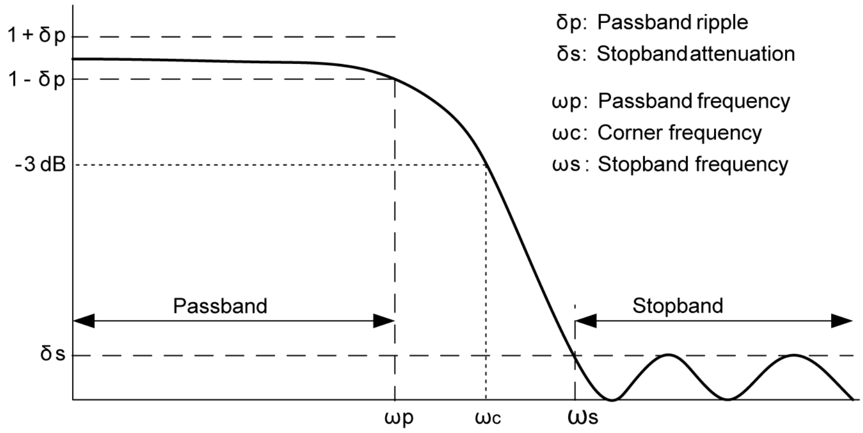



**Figure A.108:** Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 390 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 8-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking to sample rate divided by: 10, 20, 40, 100<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Bessel IIR filter bandwidth (ωc) | User selectable from 0.4 Hz to 20 kHz |
| Bessel IIR passband ripple (δp) | 0.1 dB(1) |
| Bessel IIR passband (ωp | DC to 3.5 kHz @ ωc = 20 kHz(1) |
| Bessel IIR filter stopband attenuation (δs) | -75 dB |
| Bessel IIR filter roll-off | -48 dB/octave |

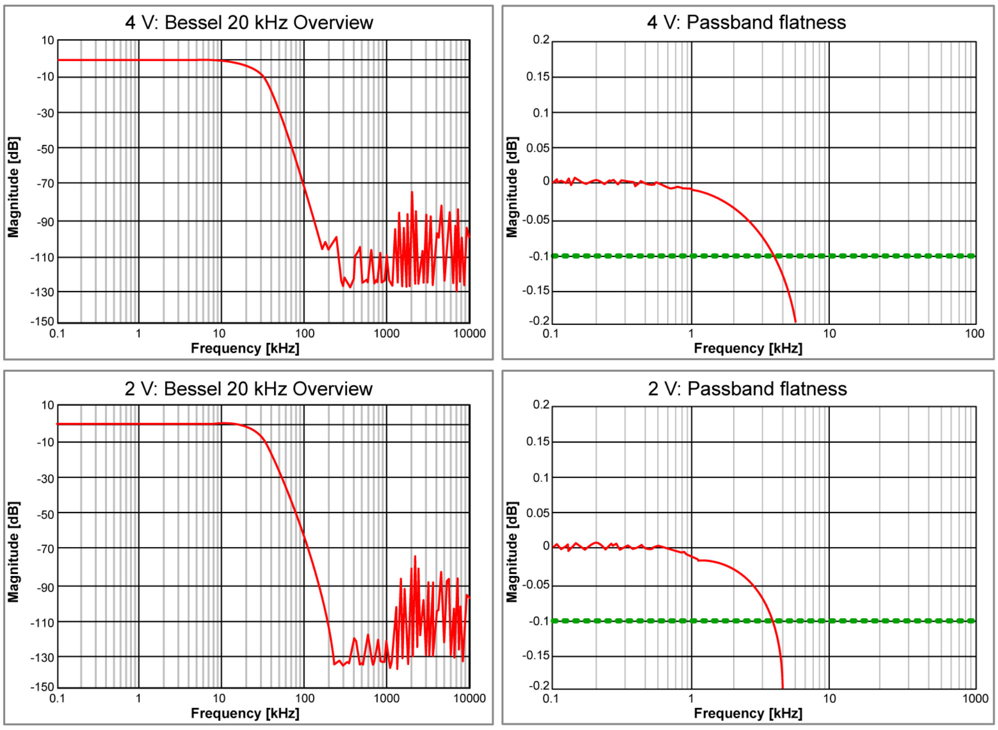



**Figure A.109:** Typical Bessel IIR 20 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Butterworth IIR Filter

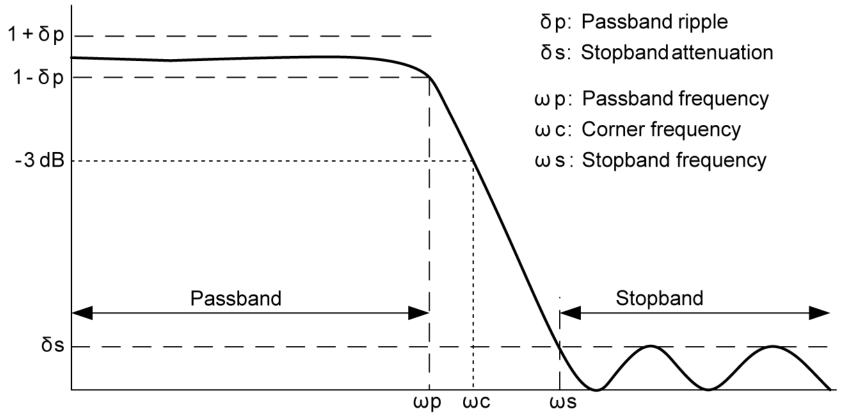



**Figure A.110:** Digital Butterworth IIR Filter

When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Butterworth IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 460 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Butterworth IIR filter characteristic | 8-pole Butterworth style IIR |
| Butterworth IIR filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed. |
| Butterworth IIR filter bandwidth (ωc) | User selectable from 1 Hz to 50 kHz |
| Butterworth IIR passband ripple (δp) | 0.1 dB(1) |
| Butterworth IIR passband (ωp) | DC to 35 kHz @ ωc = 50 kHz(1) |
| Butterworth IIR filter stopband attenuation (δs) | -75 dB |
| Butterworth IIR filter roll-off | -48 dB/octave |

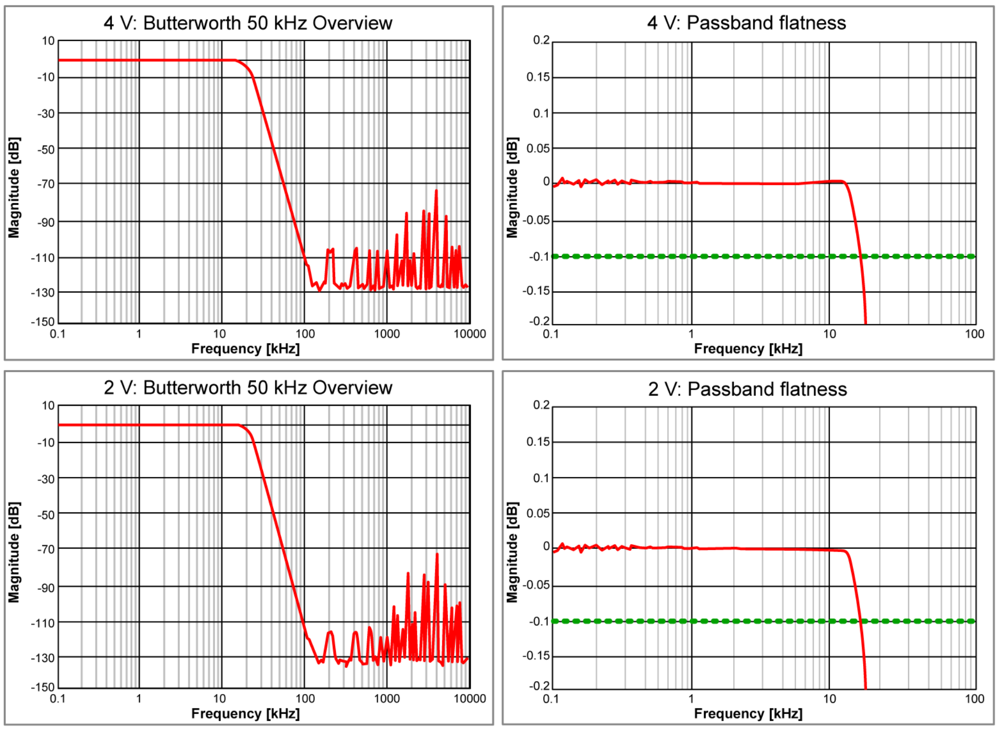



**Figure A.111:** Typical Butterworth IIR 50 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Elliptic IIR Filter

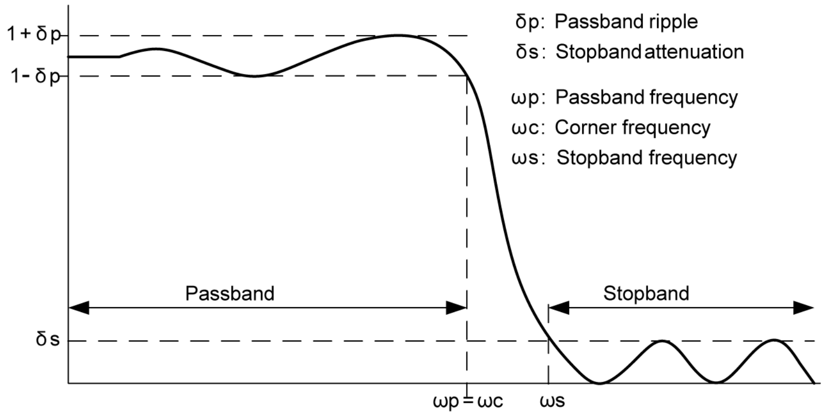



**Figure A.112:** Digital Elliptic IIR Filter

When Elliptic IIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital Elliptic IIR filter.

| | |
|---|---|
| Analog anti alias filter bandwidth | 460 kHz ± 25 kHz (-3 dB) |
| Analog anti alias filter characteristic | 7-pole Butterworth, extended passband response |
| Elliptic IIR filter characteristic | 7-pole Elliptic style IIR |
| Elliptic IIR filter user selection | Auto tracking to sample rate divided by: 4, 10, 20, 40<br>User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed |
| Elliptic IIR filter bandwidth (ωc) | User selectable from 1 Hz to 50 kHz |
| Elliptic IIR passband ripple (δp) | 0.1 dB(1) |
| Elliptic IIR passband (ωp) | DC to filter bandwidth (ωc)(1) |
| Elliptic IIR filter stopband attenuation (δs) | -75 dB |
| Elliptic IIR filter roll-off | -72 dB/octave |

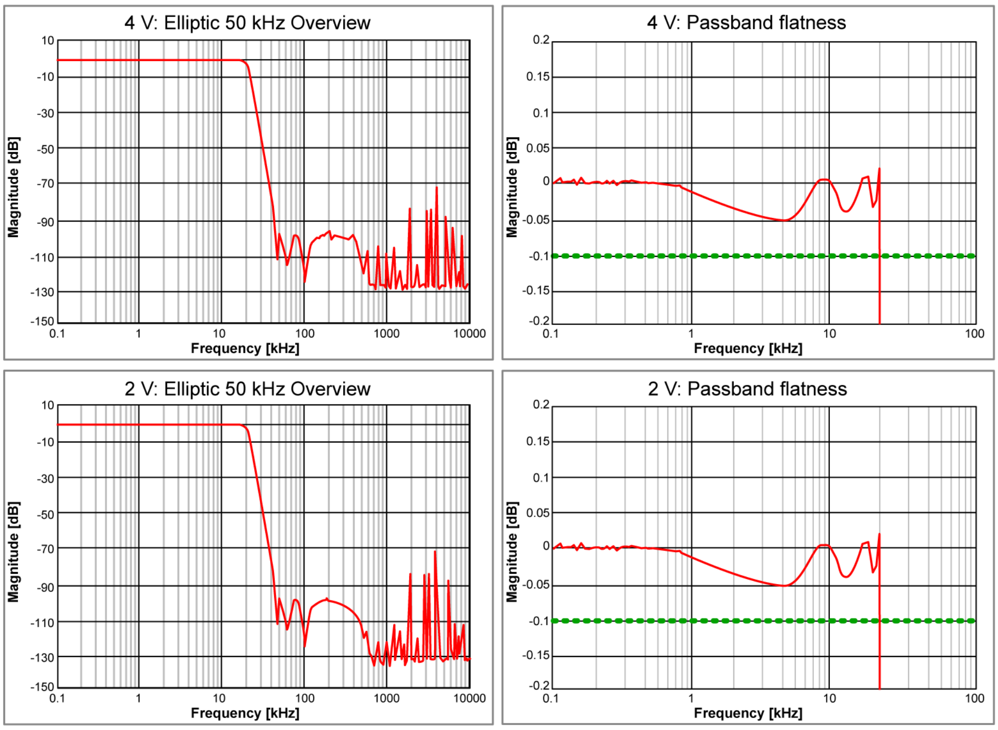



**Figure A.113:** Typical Elliptic IIR 50 kHz overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

| Channel to Channel Phase Match | |
|---|---|
| Using different filter selections (Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels. | |
| Bessel IIR, Filter frequency 20 kHz @ 200 kS/s; 10 kHz Sine wave | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN816 Channels within mainframe | 0.5 deg (0.14 µs) |
| Butterworth IIR, Filter frequency 20 kHz @ 200 kS/s; 10 kHz Sine wave | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN816 Channels within mainframe | 0.5 deg (0.14 µs) |
| Elliptic IIR, Filter frequency 20 kHz @ 200 kS/s; 10 kHz Sine wave | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN816 Channels within mainframe | 0.5 deg (0.14 µs) |
| GN816 channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave) |

## Channel to Channel Crosstalk

Channel to channel crosstalk is measured with a 50 Ω termination resistor on the input and using sine wave signals on the channel above and below the channel under test. To test channel 2, channel 2 is terminated with 50 Ω and channel 1 and 3 are connected to the sine wave generator.

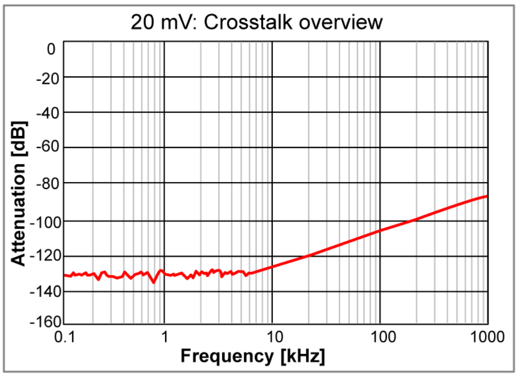



**Figure A.114:** Typical crosstalk overview

| On-board Memory | |
|---|---|
| Per card | 200 MB (100 MS @ 16 bits storage) |
| Organization | Automatically distributed amongst channels enabled for storage or real-time calculations |
| Memory diagnostics | Automatic memory test when system is powered and not recording |
| Storage sample size | 16 bits, 2 bytes/sample<br>18 bits, 4 bytes/sample (required for Timer/Counter usage) |

| Digital Event/Timer/Counter (1) | |
|---|---|
| Digital input events | 16 per card |
| Levels | TTL input levels, user programmable invert |
| Inputs | 1 pin per input, some pins are shared with Timer/Counter inputs |
| Over voltage protection | ± 30 V DC continuously |
| Minimum pulse width | 100 ns |
| Maximum frequency | 5 MHz |
| Digital output events | 2 per card |
| Levels | TTL output levels, short circuit protected |
| Output event 1 | User selectable: Trigger, Alarm, set High or Low |
| Output event 2 | User selectable: Recording active, set High or Low |
| Digital output event user selections | |
| Trigger | 1 high pulse per trigger (on every channel trigger of this card only)<br>12.8 µs minimum pulse width<br>200 µs ± 1 µs ± 1 sample period pulse delay |
| Alarm | High when alarm condition is activated, low when not activated (alarm conditions of this card only)<br>200 µs ± 1 µs ± 1 sample period alarm event delay |
| Recording active | High when recording, low when in idle or pause mode<br>Recording active output delay 450 ns |
| Set High or Low | Output set High or Low; can be controlled by Custom Software Interface (CSI) extensions; delay depending on specific software implementation |
| Timer/Counter | 2 per card; only available in 18 bit mode |
| Levels | TTL input levels |
| Inputs | All pins are shared with digital event inputs |
| Timer-Counter modes | Uni- and bi-directional count<br>Bi-directional quadrature count<br>Uni- and bi-directional frequency/RPM measurement |
| Uni- and bi-directional count | |
| Inputs | 3 pins; signal, reset and direction (only used in bidirectional count) |
| Maximum input frequency | 5 MHz |
| Maximum count value | 0 to $2^{31}$; unidirectional count. $-2^{31}$ to $+2^{31}$; bidirectional count |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |
| Direction input | Only used when in bi-directional count<br>Low: increment counter<br>High: decrement counter |
| Bi-directional quadrature count | |
| Inputs | 3 pins; signal, direction and reset |
| Maximum input frequency | 2 MHz, minimum high or low time 200 ns. Minimum phase difference between signal and direction 100 ns. |
| Accuracy | Single, dual and quad precision |
| Maximum count value | $-2^{31}$ to $+2^{31}$ |
| Reset input | User selectable level invert |
| Reset options | Manual: On user request by software command<br>Start recording: Count value set to 0 at start of recording<br>First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored.<br>Each reset pulse: On each external reset pulse the counter value is reset to 0. |

| Digital Event/Timer/Counter [1] | |
|---|---|
| Uni- and bi-directional frequency/RPM measurement | |
| Inputs | 2 pins; signal, direction |
| Maximum input frequency | 5 MHz |
| Accuracy | 0.1 % |
| Gate measuring time | Sample period to 50 s; user selectable to control update rate independent of sample rate |
| Direction input | Only used when in bi-directional frequency/RPM mode<br>Low: Positive frequency/RPM, e.g. left rotations<br>High: Negative frequency/RPM, e.g. right rotations |
| External start | User selectable Rising/Falling edge signal will start a new recording |
| External stop | User selectable Rising/Falling edge signal will stop the recording |

(1) Only if supported by mainframe

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 fully independent per channel either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Trigger rate | 400 triggers per second |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Trigger in edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Trigger in delay | ± 1 µs + maximum 1 sample period (Identical for decimal and binary time base) |
| Send to external trigger out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Trigger out level | High/Low/Hold High; mainframe selectable, identical for all cards |
| Trigger out pulse width | High/Low: 12.8 µs<br>Hold High: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe; see mainframe datasheet for details |
| Trigger out delay | Selectable (10 µs to 516 µs) ± 1 µs + maximum 1 sample period using decimal time base<br>Selectable (9.76 µs to 504 µs) ± 1 µs + maximum 1 sample period using binary time base<br>Default 516(504) µs for decimal (binary) time base, to be compatible with standard behavior.<br>Minimum selectable delay is the smallest delay available for all acquisition cards used within the mainframe |
| Cross channel triggering | |
| Channels on card | Logical OR; analog triggers of all channels<br>Logical AND; qualifiers of all channels |
| Cards in mainframe | User selectable through system trigger bus<br>Selections: Send/Receive/Transceive (Send & Receive) |
| System trigger bus | |
| Connections | 3 System trigger busses connecting all cards within mainframe<br>1 Master/Slave bus connecting all cards within mainframe and connecting all mainframes using Master/Slave option |
| Operation | Logical OR of all triggers of all cards<br>Logical AND of all qualifiers of all cards |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Direction | Rising/Falling; single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100 % of Full Scale; defines the trigger sensitivity |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; two individual levels, logical OR |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/Disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/Disable trigger with dual level |
| Event channel trigger (1) | |
| Event channels | Individual event trigger per event channel |
| Levels | Trigger on rising edge or trigger on falling edge |
| Qualifiers | Active High or Active Low for every event channel |

(1) Only if supported by mainframe

| Alarm Output | |
|---|---|
| Selection per Card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015 %); for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

| Real-Time Analysis | |
|---|---|
| **StatStream®** | |
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values<br>Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording<br>Supports the fast displaying and zooming within extremely large recordings<br>Supports the fast calculation of statistical channel information |
| **Real-Time Calculations (Perception V6.50 and higher)** | |

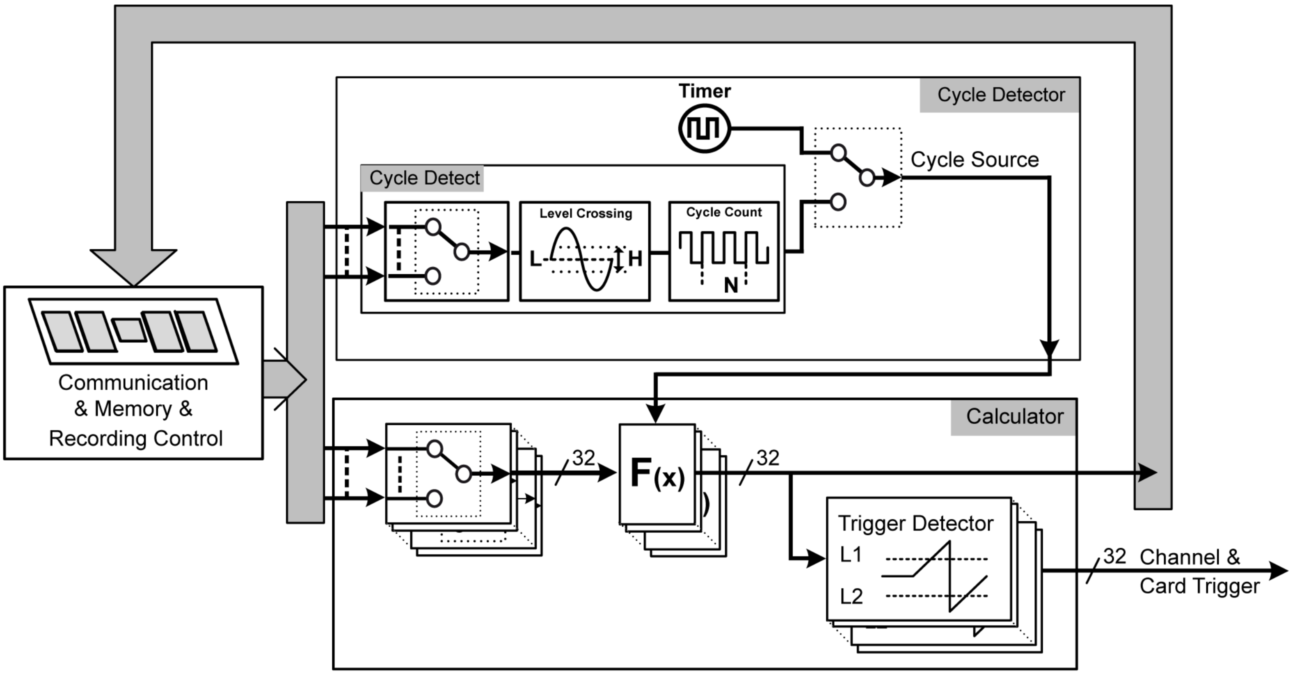



**Figure A.115:** Real-Time Calculations

## Real-Time Analysis

| | |
|---|---|
| Cycle Source | Determines the periodic based real-time calculations<br>Supports timer or signal level crossing based period generation |
| Timer | |
| Time interval | 1.0 ms (1 kHz) to 60 s (0.0167 Hz) |
| Cycle detect | |
| Level crossing | Monitors one analog channel using a user selectable signal level and signal hysteresis to dynamically determine the cyclic nature of the signal. |
| Cycle count | Sets the counted number of cycles used for periodic calculation output |
| Cycle period(1) | Maximum detectable Cycle period 0.25 s (4 Hz)<br>Minimum detectable period 0.91 ms (1.1 kHz)<br>Calculations stops when Cycle period exceeds maximum cycle period (0.25 s).<br>Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms).<br>Exceeding Cycle period or automatic Cycle count increases are indicated with time event notification in channel data. |
| Real-Time calculator | |
| Number of calculators | 32 |
| Calculator DSP load | Each calculator can execute 1 calculation. Not every calculation uses the same DSP power. Selecting the highest computation power calculations could lead to reduction of total number of calculators. Different combinations lead to different computation power and can't be specified. Perception software will reflect the impact on selected combinations. |
| Calculations | Cycle and Frequency on Cycle signal only. RMS, Minimum, Maximum, Mean, Peak to Peak, Area, Energy and MeanOfMultiply on analog channels and Frequency on Timer/Counter channels that measure frequency.(2) |
| Cycle | Square wave signal, 50 % duty cycle.<br>Represent Cycle Source; rising edge indicates start of new calculation period. |
| Frequency | Detected cycle interval is converted to a frequency (1 / cycle time of input signal) |
| Trigger detector | |
| Number of detectors | 32; One per Real-Time calculator |
| Trigger level | User defined per detector. Generates trigger when calculated signal crosses the level. |
| Trigger output delay | Triggers on calculated signals are 100 ms delayed. Internally time corrected for correct sweep triggering. Internally an additional 100 ms pre-trigger length is added to every channel using this trigger as trigger source to enable the time correction. This reduces the maximum sweep length by 100 ms. |

(1) Cycle period range depends on signal wave shape and hysteresis setting. Specified for sine wave with 25 % Full Scale hysteresis.

(2) To enable triggering on Timer/Counter frequency measurements.

## Acquisition Modes

| | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow fast sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. |
| Continuous | Direct storage to PC or mainframe controlled hard disk without file size limitations; triggered or un-triggered; for long duration recorder type applications. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |
| Dual | Combination of Multiple sweeps and Continuous; recorder type streaming to hard disk with simultaneously triggered sweeps in on-board memory. Aggregate sample rate limitations depending on Ethernet speed, PC used and data storage media used. |

## Acquisition Mode Details

**16 Bit resolution**

| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 8 Ch | 8 Ch & Events | 1 Ch | 8 Ch | 8 Ch & Events | 1 Ch | 8 Ch | 8 Ch & Events |
| Max. sweep memory | 100 MS | 12 MS | 10.5 MS | not used | | | 80 MS | 9.5 MS | 8 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 100 MS | 12 MS | 10.5 MS | 20 MS | 2 MS | 2 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 0.2 MS/s<br>0.4 MB/s | 1.6 MS/s<br>3.2 MB/s | 1.8 MS/s<br>3.6 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.8 MS/s<br>1.6 MB/s | 0.9 MS/s<br>1.8 MB/s |

**18 Bit resolution**

| **Recording mode** | **Single Sweep Multiple Sweeps Slow/Fast Sweep** | | | **Continuous** | | | **Dual Rate** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled Channels | | | Enabled Channels | | | Enabled Channels | | |
| | 1 Ch | 8 Ch | 8 Ch & Events & Timer/ Counter | 1 Ch | 8 Ch | 8 Ch & Events & Timer/ Counter | 1 Ch | 8 Ch | 8 Ch & Events & Timer/ Counter |
| Max. sweep memory | 50 MS | 6 MS | 4 MS | not used | | | 40 MS | 4.5 MS | 3 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 50 MS | 6 MS | 4 MS | 10 MS | 1 MS | 0.7 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep Sample Rate / 2 | | |
| Max. continuous streaming rate | not used | | | 0.2 MS/s<br>0.8 MB/s | 1.6 MS/s<br>6.4 MB/s | 2.2 MS/s<br>8.8 MB/s | 0.1 MS/s<br>0.4 MB/s | 0.8 MS/s<br>3.2 MB/s | 1.1 MS/s<br>4.4 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms |

| Multiple Sweeps | |
|---|---|
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweep stretch rate 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding sweep storage rate | Trigger event markers are stored in recording, no sweep data stored. New sweep data recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

| Slow Fast Sweep | |
|---|---|
| Maximum number of Sweeps | 1 |
| Maximum slow sample rate | Fast sample rate divided by 2 |
| Maximum fast sample rate switches | 400 sample rate switches per second, 200 000 switches maximum<br>Recording stops at end of sweep even if specified sample rates switches did not happen |

| Continuous | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Automatic recording stop on storage media full. |
| Circular recording | User specified recording history on storage media. All recorded data stores as quickly as possible on selected storage media. As soon as selected history time is reached, older recorded data is overwritten. Recording can be stopped by user, or any system trigger. |
| Specified time | Automatic recording stop after user specified time or on storage media full |
| Stop on trigger | Automatic recording stop after any system trigger or on storage media full |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, or user selected time or unlimited using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details |
| Exceeding aggregate streaming rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

| Dual | |
|---|---|
| **Dual Sweep Specification** | |
| Pre-trigger segment | 0 % to 100 % of selected sweep length<br>If trigger occurs before pre-trigger segment is recorded, pre-trigger segment is truncated to recorded data only |
| Delayed trigger | Maximum 1000 seconds after a trigger occurred. Sweep is recorded immediately after delayed trigger time with 100 % post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep will restart the post-trigger length. If upon the detection of a new trigger, the extended post-trigger doesn't fit within the sweep memory, sweep stretch will not happen. Maximum sweepstretch rate 1 sweep stretch per 2.5 ms |
| Sweep storage | In dual mode the storage of the continuous data is prioritized above the storage of the sweep data. If enough storage rate is available, the sweep storage starts immediately after the trigger for this sweep is detected. Sweep memory becomes available for reuse as soon as storage of the entire sweep for all enabled channels of this card has been completed. Sweeps will be stored one by one starting with the first recorded sweep. |
| Sweep storage rate | Determined by continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. See mainframe datasheet for details. |
| Exceeding sweep storage rate | Continuous recorded data not stopped, trigger event markers are stored in recording, no new sweep data stored. New sweep recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize continuous streaming rate |
| Maximum recording time | Until storage media filled, all recorded data will be stored including sweeps, or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters; see mainframe datasheet for details<br>When exceeding average aggregate streaming rate, sweep storage speed is automatically reduced to increase aggregate streaming rate, until sweep storage completely stops. |
| Exceeding aggregate storage rate | When selecting a streaming rate higher than the aggregate streaming rate of the system, the continuous memory will act as a FIFO. As soon as this FIFO fills up, the recording suspends (temporarily no data is recorded). During this period, the internal FIFO memory is transferred to storage medium. When internal memory (Continuous and Sweep memory) is completely empty again, the recording automatically resumes. User notifications added to recording file for post recording identification of storage overrun. |

## Environmental Specifications

| | |
|---|---|
| Temperature Range | |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0 % to 80 %; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft); operational |
| Shock: IEC 60068-2-27 | |
| Operational | Half-sine 10 g/11 ms; 3-axis, 1000 shocks in positive and negative direction |
| Non-operational | Half-sine 25 g/6 ms; 3-axis, 3 shocks in positive and negative direction |
| Vibration: IEC 60068-2-34 | |
| Operational | 1 g RMS, ½ h; 3-axis, random 5 to 500 Hz |
| Non-operational | 2 g RMS, 1 h; 3-axis, random 5 to 500 Hz |
| Operational Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ad | -5 °C (+23 °F) for 2 hours |
| Dry heat test IEC 60068-2-2 Test Bd | +40 °C (+104 °F) for 2 hours |
| Damp heat test IEC 60068-2-3 Test Ca | +40 °C (+104 °F), humidity >93 % RH for 4 days |
| Non-Operational (Storage) Environmental Tests | |
| Cold test IEC 60068-2-1 Test Ab | -25 °C (-13 °F) for 72 hours |
| Dry heat test IEC 60068-2-2 Test Bb | +70 °C (+158 °F) humidity <50 % RH for 96 hours |
| Change of temperature test<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH<br>6 Cycles, cycle duration 24 hours |

## Harmonized standards for CE compliance, according to the following directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility directive (EMC): 2004/108/EC

| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2006) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |

| Harmonized standards for CE compliance, according to the following directives<br>Low voltage directive (LVD): 2006/95/EC<br>Electromagnetic compatibility directive (EMC): 2004/108/EC | |
|---|---|
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>0.15 to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 10 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## Ordering information(1)

| Article | | Description | Order No. |
|---|---|---|---|
| Basic/<br>IEPE200k ISO |  | 8 channel, 18 bit, 200 kS/s, ± 10 mV to ± 50 V input range, 200 MB RAM, 33 V RMS isolated unbalanced differential input, single metal isolated BNC per channel. Basic voltage and IEPE sensor with TEDS class 1 support.<br>Real-time cycle and timer based calculations with triggering on calculated results<br><br>Supported by Perception V6.50 and higher | 1-GN816-2 |

(1) All GEN series systems are intended for exclusive professional and industrial use.

## A.14 B3244-1.0 en (GEN series GN410 and GN411)

| Capabilities Overview | | |
|---|---|---|
| **Component** | **Value** | |
| Model | **Bridge 200K ISO Digitizer** | **Bridge 1M ISO Digitizer** |
| Sample rate | 0.1 S/s to 200 kS/s | 0.1 S/s to 1 MS/s |
| Memory per card | 64 MS (128 MB) | 256 MS (512 MB) |
| Analog channels | 4 | |
| ADC resolution | 16 bit (0.0015 %) | |
| Isolation | Yes | |
| Input type | Fully isolated bridge or fully isolated differential, software selectable | |

| General Specifications | | | | |
|---|---|---|---|---|
| **Analog Input Section** | | | | |
| **Component** | | | **Unit Description** | **Value** |
| Channels | | | | 4 |
| Type | | | Fully isolated bridge or fully isolated differential, software selectable | |
| Connectors | | | Mating connector:FGG2B316CLAD52 | Lemo 16-pin |
| Ranges | | | Plus variable gain in 1000 steps (0.1 %) | ± 2 mV, ± 5 mV, ± 10 mV,<br>± 20mV, ± 50 mV, ± 100 mV,<br>± 200 mV, ± 500 mV, ± 1 V,<br>± 2 V, ± 5 V, ± 10 V |
| Offset | | | 1000 steps | 0.1 % |
| Coupling | | | AC<br>DC, GND | -3 dB @ 0.16 Hz |
| Impedance | | | | 2x 10 MΩ// 130 pF |
| Analog bandwidth | | | Overall bandwidth is always limited by digital filters | 20 kHz (**Bridge 200k** only) |
| Maximum Static Error | | | | |
| | Wideband | | | 0.2 % of FS ± 120 µV |
| | Bessel/Butterworth | | | 0.1 % of FS ± 40 µV |
| Noise | | | RMS | 0.02 % of FS ± 30 µV |
| Resolution | | | For each level | 16 bit (= 0.0015 %) |
| CMRR | | | | > 72 dB @ 100 Hz |
| CM voltage | | | To amplifier ground | ± 10 V |
| | | | To chassis (earth) | ± 50 V |
| Overload protection | | | | 35 V |
| Number of slots | | | Including signal conditioners | 1 |
| Isolation | | | | |
| | Channel - channel | | | 100 V |
| | Channel - chassis | | | 50 V |
| | Nondestructive | | To chassis (earth) | 100 V |
| Bridge amplifier | | | | |
| | Gain | | (± 10 V ÷ range) | 5000, 2000, 1000, 500, 200, 100, 50, 20, 10, 5, 2, 1 |
| | Fine gain | | | Variable gain in 1000 steps (0.1 %) within each range |
| | Balance voltage | | Unbalance voltage compensation | ± 250 mV max |
| Bridge support | | | | |
| | Excitation | | | |
| | | Voltage excitation | Off, in 1000 steps, up to 85 mA per channel | ± 1.0 V to ± 7.5 V |
| | | Current excitation | Off, 2 mA to 40 mA, 15 V compliance | |
| | Supported circuits | | Two to ten wire included, driven guard | |

## General Specifications

### Analog Input Section

| Component | | Unit Description | | Value |
|---|---|---|---|---|
| | Completion resistors | Half bridge | Completion resistors | 2x 100 kΩ (0.1%) |
| | | Quarter bridge[(1)] | | 350 Ω |
| | Shunt resistors | 2 pre-installed calibration resistors[(1)] one user-defined, plus external, shunt to + or – excitation | | 20 kΩ, 100 kΩ |
| | Sense | 2 separate sense wires or internal | | |

(1) These are metal-foil high-performance instrumentation resistors with a tolerance of 0.1% and a TCR of 0.6 ppm/˚C

### Analog to Digital Conversion

| Component | | Value | |
|---|---|---|---|
| Model | | **Bridge 200K XT ISO Digitizer** | **Bridge 1M XT ISO Digitizer** |
| Sample rate | | 0.1 S/s to 200 kS/s | 0.1 S/s to 1 MS/s |
| ADC resolution | | 16 bit (0.0015 %) | 16 bit (0.0015 %) |
| Time base accuracy | | 50 ppm | |
| Wideband bandwidth | | 20 kHz | > 120 kHz at maximum<br>Bandwidth gain (ranges ≤ ± 20 mV), 450 kHz at minimum gain |
| Bessel filter specifics | | | |
| | Analog anti-aliasing | Time, Frequency- domain optimized | Bypass, Time, Frequency- domain optimized |
| | Time Domain | 7-pole Bessel, optimal step response | |
| | | 20 kHz | 220 kHz |
| | Frequency Domain | 7-pole Butterworth, extended frequency response | |
| | | 20 kHz | 350 kHz |
| IIR or FIR filter specifics | | | |
| | Digital | | |
| | Time Domain | 6-pole Bessel style IIR, sample rate divided by: 10, 20, 40, 100 | |
| | Frequency Domain | 12-pole, FIR at sample-rate divided by: 4, 10, 20, 40 | |

### On-board Memory

| Component | Value | |
|---|---|---|
| Model | **Bridge 200K XT ISO Digitizer** | **Bridge 1M XT ISO Digitizer** |
| Per card<br>(shared by enabled channels) | 64 MS (128 MB) | 256 MS (512 MB) |
| Per Channel | 16 MS | 64 MS |

## Triggering

| Component | | Unit Description | Value |
|---|---|---|---|
| Channel trigger | | Fully independent, per channel | 1 |
| Pre- and post-trigger length | | | 0 to full memory |
| Trigger rate | | Up to 400 triggers per second, zero re-arm time | 1 per 2.5 ms |
| Trigger total | | Total number of triggers per recording | 10,000 |
| Resolution | | For each level | 16 bit (0.0015 %) |
| Hysteresis | | Defines the trigger insensitivity | 0.1 to 100 % of Full Scale |
| Cross channel triggering | | Analog triggers of all channels | Logical OR |
| | | Qualifiers of all channels | Logical AND |
| Analog trigger modes | | | |
| | Basic | Single level | Positive or negative crossing |
| | Dual Level | Two individual levels, OR-ed | One positive and one negative crossing |
| Analog qualifier modes | | | |
| | Basic | Arm the acquisition with a single level | Positive or negative crossing |
| | Dual (level) | Arm the acquisition with two individual levels, OR-ed | One positive and one negative crossing |

## Real-time Analysis

| Component | Description |
|---|---|
| StatStream © | Each channel includes real-time extraction of Max, Min, Mean, Peak-to- Peak, and RMS values |

## Acquisition Modes

| Component | Description |
|---|---|
| Sweeps | Triggered acquisition to RAM without sample rate limitations; for single or repetitive transients or intermittent phenomena. |
| Continuous | Direct storage to PC or mainframe hard disc without file size limitations; triggered or un-triggered; for long duration recorder type applications with up to 1 MS/s rate per channel; (maximum aggregate rate pending from mainframe configuration and PC). |
| Dual | Combination of Sweeps and Continuous; recorder type streaming to hard disc with simultaneously triggered sweeps in RAM. |
| Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. |

## Storage Modes

| Component | Description |
|---|---|
| Recorder | Spooled directly to hard-disk of control PC; unlimited file size or duration |
| Scope | Store in transient memory |
| Transient | Store in transient memory, single or A-B-A time base |

## Ordering Information

| Model | | Unit Description | Order number |
|---|---|---|---|
| Bridge 200k ISO XT |  | **200kS**, **128M** 4 Channel, 200 kS/s Bridge Card, 128 MB RAM (16 MS/ch), isolated | 1-GN410-2 |
| Bridge 1M ISO XT | | **1MS**, **512M** 4 Channel, 1 MS/s Bridge Card, 512 MB RAM (64 MS/ch), isolated | 1-GN411-2 |

## Accessories

| Model | Unit Description | Order number |
|---|---|---|
| G021 | GEN DAQ Bridge completion/shunt cal resistor cards, 4 additional pieces (4 pieces included in both GN410 as well as GN411) | 1-G021-2 |

## A.15 B3250-1.0 en (GEN series GN440 and GN441)

| Capabilities Overview | | |
|---|---|---|
| **Component** | **Value** | |
| Model | **Universal 200 iso CARD** | **Universal 1M iso CARD** |
| Sample rate (maximum) | 200 kS/s | 1 MS/s |
| Memory per card | 64 MS (128 MB) | 256 MS (512 MB) |
| Analog channels | 4 | |
| ADC resolution | 16 bit (0.0015 %) | |
| Isolation | Yes | |
| Input type | Differential; software selectable: voltage, current or IEPE; differential or single ended isolated | |

| General Specifications | | | |
|---|---|---|---|
| **Analog Input Section** | | | |
| **Component** | | **Unit Description** | **Value** |
| Channels | | | 4 |
| Type | | Differential; software selectable: voltage, current or IEPE; differential or single ended isolated | |
| Connectors | | 4 x 2 isolated BNC | |
| Ranges | | 13, programmable: | |
| | Course | ± 10 mV to ± 100 V<br>in 1, 2, 5 steps | ± 10 mV, ± 100 mV, ± 200 mV, ± 400 mV, ± 1 V, ± 2 V, ± 4 V, ± 10 V, ± 20mV, ± 40 V, ± 100 V, ± 200 V |
| | Fine | Variable gain in 1000 steps (0.1 %) of the selected range within each course range | |
| Offset (zero position) | | Software selectable in 1000 steps (0.1 %) of selected<br>Full Scale, with a maximum of ± 50 % in the ± 100 V range | 0.1%<br>50 %  Maximum |
| Coupling | | AC<br>DC, GND | (-3 dB @ 1.6 Hz) |
| Impedance | | | 2 x 1 MΩ// 100 pF |
| Maximum Static Error (2) | | | ± 0.1 % of Full Scale ± 100 μV |
| Gain Error (2) | | | ± 0.1 % of Full Scale ± 100 μV |
| Offset Error (2) | | | ± 0.02 % full scale ± 100 μV |
| Noise (RMS) | | | 0.02 % + 116 μV |
| Analog Bandwidth | | | 20 kHz (-3 dB) |
| CMRR | | Typical @ 80 Hz for all ranges | < -80 dB |
| CM voltage | | Ranges < ± 2 V<br>Ranges > = ± 20 V<br>Other ranges; all referred to amplifier ground | < 10 Vpeak<br>< 250 Vpeak<br>< 100 Vpeak |
| Measurement Overrange | | | 5 % above/below Full Scale |
| Recovery time | | to 0.03 % after a 200 % Full Scale overload | ≤ 10 μs |
| Isolation | | | |
| | Channel – channel | Peak isolation | 250 Vpeak |
| | Channel – chassis | Peak isolation | 250 Vpeak |
| | Maximum input voltage | Ranges < ± 2 V<br>Ranges ≥ ± 2 V | ± 100 V<br>± 250 V |
| | Maximum common mode voltage | 250 Volt peak with isolated common floating | + 250 Vpeak |

| General Specifications | | | |
|---|---|---|---|
| **Analog Input Section** | | | |
| **Component** | | **Unit Description** | **Value** |
| IEPE amplifier support (1) | | | |
| | Ranges | 7 ranges from in 1, 2, 5 steps | ± 0.2 V to ± 20 V |
| | Excitation current | Software selectable in 1 mA steps | 1 to 15 mA |
| | Excitation accuracy | Nominal | 24 V |
| | Coupling time constant | | 1 s |
| Current Shunt Support | | | |
| | Ranges | 5 ranges in 1, 2, 5 steps | ± 50 mA to ± 1 A |
| | Accuracy (2) | | ≤ 0.2 % of FS } ± 300 μA |
| | Measurement Shunt | | 0.2 Ω ± 1 % |
| | Maximum Current | | 1 A |
| | Overload Protection | Resettable fuse, 0.1 Ω ± 20 % | 1.6 A |

(1) IEPE refers to internally amplified sensors - low impedance, piezoelectric force, acceleration and pressure type sensors with built-in integrated circuits.

(2) Errors are listed for amplifier with filter (IIR or FIR)

| Analog to Digital Conversion | | | |
|---|---|---|---|
| **Component** | | **Value** | |
| Model | | **Universal 200 ISO CARD** | **Universal 1M ISO CARD** |
| Sample rate | | 200 kS/s to 0.1 S/s | 1 MS/s to 0.1 S/s |
| ADC resolution | | 16 bit (0.0015 %) | |
| Time base accuracy | | 50 ppm | |
| Bessel or Butterworth filter specifics | | | |
| | Analog anti-aliasing | Time- or Frequency domain optimized | Bypass, Time, Frequency-domain optimized |
| | Time Domain | 7-pole Bessel, optimal step response | |
| | | 20 kHz | < ± 0.2 V: 185 kHz (-3 dB)<br>≥ ± 0.2 V: 220 kHz (-3 dB) |
| | Frequency Domain | 7-pole Butterworth, extended frequency response | |
| | | 20 kHz | < ± 0.2 V: 300 kHz (-3 dB)<br>≥ ± 0.2 V: 350 kHz (-3 dB) |
| IIR or FIR filter specifics | | | |
| | Digital | IIR or FIR | |
| | Frequency domain | 12-pole FIR at sample rate divided by:<br>4, 10, 20, 40 | 12-pole FIR at sample-rate divided by:<br>4, 10, 20, 40 |
| | Time domain | 6-pole Bessel style IIR, sample rate divided by:<br>10, 20, 40, 100 | 6-pole Bessel style IIR, sample rate divided by:<br>10, 20, 40, 100 |

| On-board Memory | | |
|---|---|---|
| **Component** | **Value** | |
| Model | **Universal 200 ISO CARD** | **Universal 1M ISOCARD** |
| Per card (Mega Samples) | 64 MS shared by enabled channels | 256 MS shared by enabled channels |
| Per channel | 16 MS per channel | 64 MS |

## Triggering

| Component | Unit Description | Value |
|---|---|---|
| Channel trigger | Fully independent, per channel | 1 |
| Pre- and post-trigger length | | 0 to full memory |
| Trigger rate | Up to 400 triggers per second, zero re-arm time | 1 per 2.5 ms |
| Trigger total | Total number of triggers per recording | 10,000 |
| Resolution | For each level | 16 bit (0.0015 %) |
| Hysteresis | Defines the trigger insensitivity | 0.1 to 100 % of Full Scale |
| Cross channel triggering | Analog triggers of all channels | Logical OR |
| | Qualifiers of all channels | Logical AND |

## Real-time Analysis

| Component | Description |
|---|---|
| StatStream © | Each channel includes real-time extraction of Max, Min, Mean, Peak-to- Peak, and RMS values |

## Acquisition Modes

| Component | Description |
|---|---|
| Sweeps | Triggered acquisition to RAM without sample rate limitations; for single or repetitive transients or intermittent phenomena. |
| Continuous | Direct storage to PC or mainframe hard disc without file size limitations; triggered or un-triggered; for long duration recorder type applications with up to 1 MS/s rate per channel; (maximum aggregate rate pending from mainframe configuration and PC). |
| Dual | Combination of Sweeps and Continuous; recorder type streaming to hard disc with simultaneously triggered sweeps in RAM. |
| Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. |

## Storage Modes

| Component | Description |
|---|---|
| Recorder | Spooled directly to hard-disk of control PC; unlimited file size or duration |
| Scope | Store in transient memory |
| Transient | Store in transient memory, single or A-B-A time base |

## Ordering Information

| Model | | Unit Description | Order number |
|---|---|---|---|
| Uni 200kS, 128M |  | 4 Channel, 200 kS/s Universal Card, 128 MB RAM (16 MS/ch) | 1-GN440-2 |
| Uni 1MS, 512M | | 4 Channel, 1 MS/s Universal Card, 512 MB RAM (64 MS/ch) isolated | 1-GN441-2 |

## A.16 B3240-2.0 en (GEN series GN1610 and GN3210)

| Capabilities Overview | | | |
|---|---|---|---|
| **Component** | | **Value** | |
| Model | | **GN3210** | **GN1610** |
| Sample rate max | | 250 kS/s | 250 kS/s |
| Memory per card | | 1800 MB | 1800 MB |
| ADC resolution (1) | | 16/24 bits | 16/24 bits |
| Analog channels | | 32 | 16 |
| Digital event channels (2) | | 16 | 16 |
| Timer/Counter support (2)(3) | | yes | yes |
| Input type | | | |
| | Analog | yes | yes |
| | IEPE | yes | yes |
| | Charge | yes | yes |
| | TEDS support (4) | yes | yes |

(1) Software selectable
(2) When supported by mainframe
(3) When in 24-bit mode
(4) When IEPE selected

**Note** ***The listed specifications are valid for cards that are calibrated, and used in the same mainframe and slot as they were at the time of the calibration.***
***When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated: Offset error, gain error and MSE. Typically they can double.***

| General Specifications | | | |
|---|---|---|---|
| **Analog and Global** | | | |
| **Component** | **Unit Description** | **Value** | |
| Channels | | **GN3210** | **GN1610** |
| | | 32 | 16 |
| Input connectors | D-Sub (DD-50) connector | 2 | 1 |
| Input type | Differential (software switchable to single-ended positive or negative), symmetrical | DC, AC, GND | |
| Input ranges | Given voltage spans apply where offset = 0 | ± 10 mV, ± 20 mV, ± 50 mV, ± 100 mV, ± 200 mV, ± 500 mV, ± 1 V, ± 2V, ± 5 V, ± 10 V, ± 20 V | |
| Offset | Zero position (except for the 40 V range) | ± 50 % Full scale | |
| Offset error drift | | ± (10 ppm + 2 μV)/°C | |
| Input impedance | | 2 x 1 MΩ (± 0.5 %) // 2 x 75 pF (± 15 %) | |
| Max static error | Total | ± 0.015 % ± 25 μV | |
| Gain error | | ± 0.015 % ± 25 μV | |
| Gain error drift | | ± 10 ppm/°C | |
| Noise | Total | ± 0.01 % ± 25 μV | |
| CMRR | In range <4 V | < -80 dB | |
| | In range ≥4 V | < -60 dB | |
| CMV | In range <4 V | ± 3 Vpeak | |
| | In range ≥4 V | ± 50 Vpeak | |
| Input protection | Transient free | ± 50 Vpeak | |

| General Specifications | | | |
|---|---|---|---|
| **Analog and Global** | | | |
| **Component** | **Unit Description** | | **Value** |
| Sample rate | High rates | | 10 S/s to 250 kS/s |
| | Low rates (Low rate = High rate / n, where n is an integer ≥ 2) | | 1 S/s to 125 kS/s |
| Binary sample rate | Supported | | Yes |
| External time base | Supported | | Yes |
| Filter selection | | | |
| Bandwidth | 250 kS/s and 125 kS/s (Sigma Delta wideband selected) | | 100 to 105 kHz @ -3 dB |
| | Bandwidth @ All other sample rates | | 80 to 85 kHz @ -3 dB |
| | Flatness up to 100 kHz | In range < 4 V | +0 dB/-0.3 dB |
| | | In range ≥ 4 V | +0.2 dB/-0.4 dB |
| Digital Decimation Filters | | | |
| Time Domain | 12(1) -pole Bessel style IIR, sample rate divided by 10, 20, 40 and 100 | | |
| | Minimum filter frequency | | 40 Hz @ -3dB |
| Frequency Domain | 12-pole Butterworth style IIR, sample rate divided by 4, 10, 20 and 40 | | |
| | Minimum filter frequency | | 100 Hz @ -3dB |
| Measurement category | IEC 61010 | | CAT 1 |

(1) Bessel style IIR filter frequencies, 25 kHz and 20 kHz are 8-pole.

| Sigma Delta Wideband Characteristics |
|---|
| **Component** |

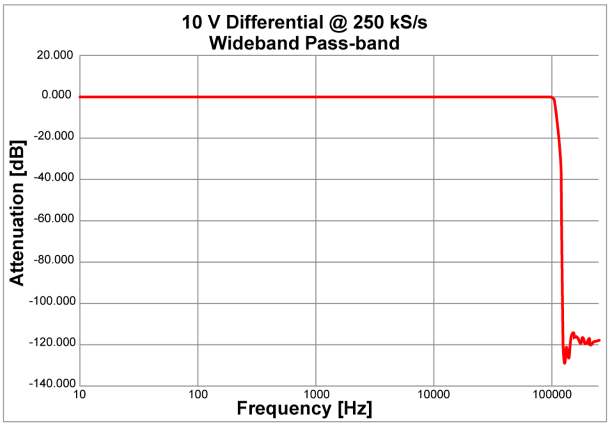



**Figure A.116:** 10 V Differential @250 kS/s

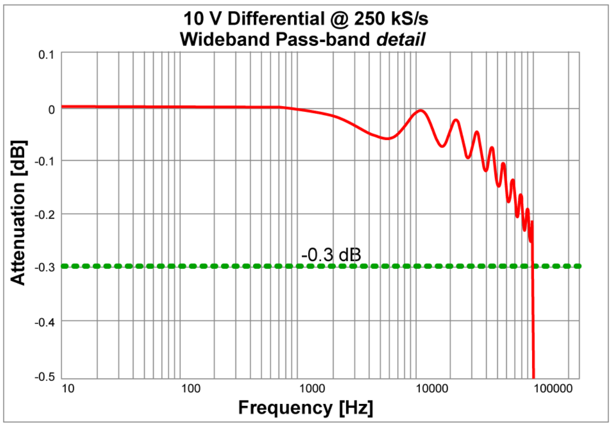



**Figure A.117:** 10 V Differential @250 kS/s - Detail

| Sigma Delta Wideband Characteristics |
|---|
| Component |

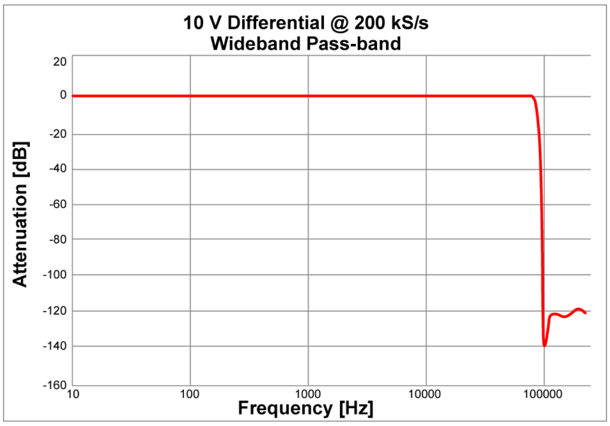



**Figure A.118:** 10 V Differential @200 kS/s

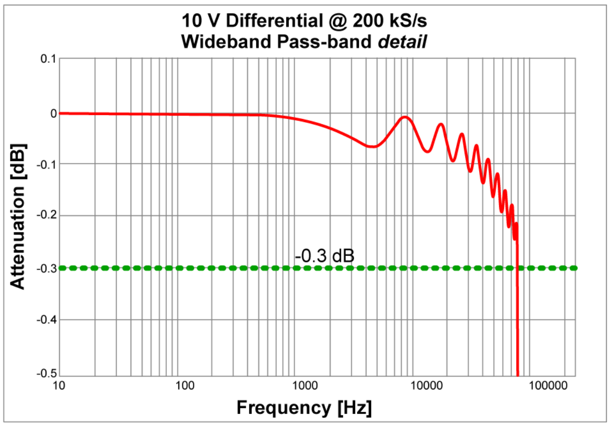



**Figure A.119:** 10 V Differential @200 kS/s - Detail

## IEPE Amplifier

| Component | | Unit Description | Value |
|---|---|---|---|
| Input ranges | | | ± 10 mV, ± 20 mV, ± 50 mV, ± 100 mV, ± 200 mV, ± 500 mV, ± 1 V, ± 2V, ± 5 V, ± 10 V, ± 20 V |
| Over voltage protection | | | -1 V to 22 V |
| IEPE gain error | | All ranges | ± 0.1 % ± 300 µV |
| IEPE gain error drift | | | ± 10 ppm/°C |
| Sensor compliance voltage | | | 22 V |
| Sensor excitation current | | Software selectable | 2 mA, 4 mA, 6 mA and 8 mA |
| | Excitation accuracy | | ± 5 % |
| | Coupling time constant | | 1.5 s |
| | Lower bandwidth | | -3 dB @ 0.11 Hz |
| | Sensor ID readout | | TEDS |
| | Maximum cable length | | 100 m (RG-58) |

## Charge Amplifier

| Component | Unit Description | Value |
|---|---|---|
| Input ranges | | ± 10 pC, ± 20 pC, ± 50 pC, ± 100 pC, ± 200 pC, ± 0.5 nC, ± 1 nC, ± 2 nC |
| Over voltage protection | | ± 30 Vpeak |
| Charge gain error | | ± 2 % |
| Charge gain error drift | | ± 30 ppm/°C |
| Lower bandwidth limit | | -3 dB @ 1 Hz |
| Upper bandwidth limit | 1 nF source capacity | -3 dB @ 10 kHz |

| Digital Functionality<br>*Only available when the mainframe provides a complementary connector* | | | |
|---|---|---|---|
| **Component** | | **Unit Description** | **Value** |
| Event inputs | | | |
| | Number of | | 16 |
| | Levels | User can invert value in software | High (1)/Low (0) |
| Event/Status outputs | | | |
| | Number of | | 2 |
| | Status output | Acquisition status | High when active |
| | Event output | Trigger or Alarm; user programmable | |
| Event out | | | |
| | Duration | | Pulse of 12.8 µs |
| | Delay | | 200 µs ± 1 µs ± 1 sample |
| Timer/counter functionality | | | |
| | | Uses three event input channels. You can use timer/counter functionality in parallel with the used event input channels | • Counter<br>• Frequency counter<br>• Quadrature decoder |
| Counter | | | |
| | Functionality | Up/down counter with reset | |
| | Inputs | • Count<br>• Up/down<br>• Reset | |
| | Range | Count up or down with a 32-bit counter | 0 - 4 294 967 295 (4 GB) |
| | Frequency | Maximum input frequency | 5 MHz |
| | Reset | One of four modes:<br>• Software controlled (manual)<br>• On Start of Acquisition<br>• On external trigger once<br>• Always on external trigger | |
| Frequency counter | | | |
| | Functionality | Frequency and RPM measurement with external direction input and reset | |
| | Inputs | • Measure<br>• Direction<br>• Reset | |
| | Frequency | Maximum input frequency | 5 MHz |
| | Accuracy | Measurement accuracy | 0.1 % |
| | Gate time | Measurement gate time, user selectable | 5 ms to 50 s |
| | Reset | One of four modes:<br>• Software controlled (manual)<br>• On Start of Acquisition<br>• On external trigger once<br>• Always on external trigger | |
| Quadrature decoder | | | |
| | Functionality | Quadrature decoding with reset | |
| | Inputs | • Signal A<br>• Signal B<br>• Reset | |
| | Frequency | Maximum input frequency | 5 MHz |
| | Accuracy | The number of edges in the input signals used per cycle to determine position. | 1: Single precision<br>2: Dual precision<br>4: Quadruple precision |
| | Count | Maximum count equals counter width divided by precision 'N' | 32 bit/N |
| | Reset | One of four modes:<br>• Software controlled (manual)<br>• On Start of Acquisition<br>• On external trigger once<br>• Always on external trigger | |

## Digital Functionality

*Only available when the mainframe provides a complementary connector*

| Component | | Unit Description | Value |
|---|---|---|---|
| Status output | | | |
| | Functionality | Outputs status. One event for "Acquisition active" and one for "Trigger" or "Alarm" under user control | |
| | Outputs | • Acquisition active<br>• Trigger/alarm | |
| | Acquisition active | Active high when recording. Low in idle and pause mode | Level |
| | Pulse width | Trigger output pulse | 12.8 µs |
| | Delay | Delay from actual event to output | 200 µs ± 1 µs ± 1 sample |

## Triggering

| Component | | Unit Description | Value |
|---|---|---|---|
| Triggered acquisition | | Pretriggered acquisitions, with user selectable pre- and post-trigger | |
| Trigger detector | | The trigger detector flags a user-defined situation on the input signal to start an acquisition sequence (trigger) or to arm the acquisition (qualifier). Digital functionality applies to event channels. | 1 per channel |
| | Functionality | Analog trigger modes | 2 |
| | | Digital trigger modes | 1 |
| | | Digital qualifier modes | 1 |
| | Levels | Analog: individual levels | 2 |
| | | Digital | 1 |
| | Resolution | Analog: for each level; covers the selected Full Scale | 16 bit (0.0015 %) |
| | | Digital | 1 bit |
| | Hysteresis | Defines the trigger levels insensitivity (analog only) | 0.1 % to 100 % of FS |
| Pre-trigger length | | Independent of storage medium used | 0 to 100 % of recording length |
| Post-trigger length | | With sweep acquisition | 0 to full on-board RAM |
| | | Continuous type acquisition | 0 to full HD capacity |
| Trigger rate | | Up to 400 triggers per second, with zero re-arm time | 1 per 2.5 ms |
| Trigger total | | Maximum number of triggers per recording | 10,000 |
| Cross-channel operation | | Triggers of all channels | Logical OR |
| | | Qualifiers of all event channels | Logical AND |
| Analog trigger modes | | | |
| | Basic | Single level | Positive or negative level crossing |
| | Dual level | Two individual levels, OR-ed | One positive and one negative level crossing |
| Digital (event) trigger modes | | | |
| | Basic | Single change of state | Rising or falling edge |
| Digital (event) qualifier modes | | | |
| | Basic | Arm the acquisition with a single change of state | Rising or falling edge |

| Acquisition and Storage Modes | | | |
|---|---|---|---|
| Component | | Unit Description | Value |
| Modes | | | |
| | Sweeps | Triggered acquisition to an on-board Random Access Memory (RAM) without sample rate limitations. | |
| | Continuous | Direct triggered acquisition to a PC or mainframe hard disk without file size limitations. Triggered or untriggered. | |
| | Dual | Combination of sweeps and continuous mode: continuous type streaming acquisition to disk with simultaneously triggered sweeps in RAM. | |
| | Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. | |
| | Sample width | When acquiring 16 bit data. | 16 bit/sample |
| | | When acquiring 24 bit data and/or using counter timer channels. | 32 bit/sample |
| Acquisition | | | |
| | Sample memory | | 1800 MB |

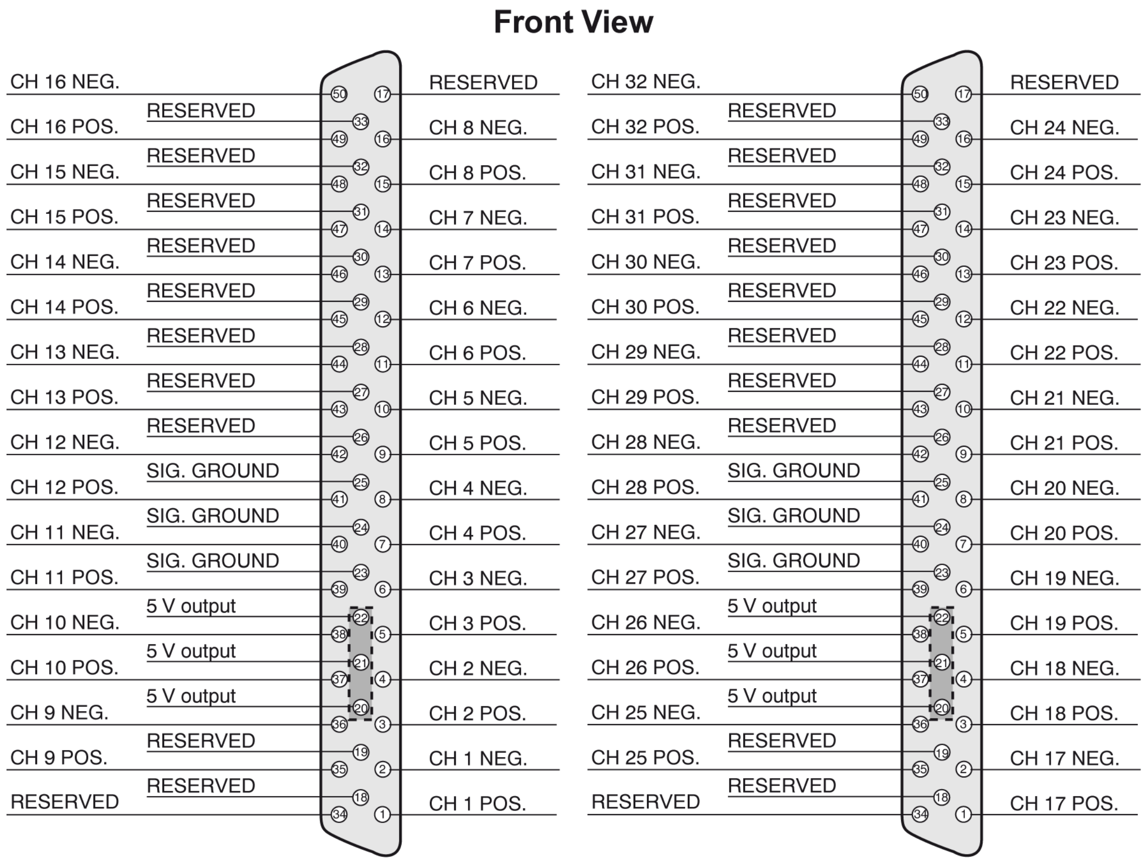



**Figure A.120:** Pin diagram for top 16 Ch Connector (left), Bottom 16 Ch connector (right, 32 Ch Card only)

**Note** *Both positive and negative pins must be connected to avoid erroneous measurement results with noise.*

**Note** *There are 3 output pins available on each connector giving 5 V at 0.3 A in total from an automatic resettable fuse.*

## Ordering Information

| Model | | Unit Description | Order Number |
|---|---|---|---|
| GN3210 |  | 32 Channel 250 kS/s per channel Differential digitizer, 1800 MB RAM per card, 16/24 bit, IEPE, TEDS and charge support | 1-GN3210-2 |
| GN1610 | | 16 Channel 250 kS/s per channel Differential digitizer, 1800 MB RAM per card, 16/24 bit, IEPE, TEDS and charge support | 1-GN1610-2 |

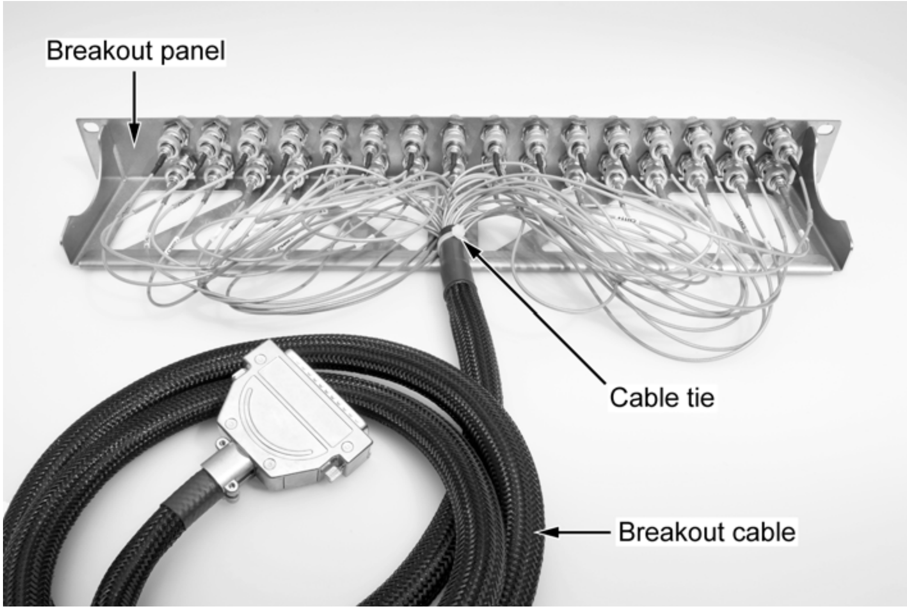



**Figure A.121:** Breakout panel and cable

## Accessories

| Model | | Unit Description | Order number |
|---|---|---|---|
| KAB171 |  | 16 ch single ended break out cable, HDSub to 16x BNC, 2 m; for use with GEN DAQ 16/32 ch input card | 1-KAB171-1-2 |
| KAB172 | | 16 ch differential break out cable, HDSub to 32x BNC, 2 m; for use with GEN DAQ 16/32 ch input card | 1-KAB172-1-2 |
| G055 |  | 16 ch single ended 19 inch or 1 U (44.45 mm) breakout panel; 16 BNC feed-through; to be used with 16 ch single ended break out cable | 1-G055-2 |
| G056 | | 16 ch differential 19 inch or 1 U (44.45 mm) breakout panel; 16 x 2 BNC feed-through; to be used with 16 ch differential break out cable | 1-G056-2 |
| G058 | | 32 ch single ended 19 inch or 1 U (44.45 mm) breakout panel; 32 BNC feed-through; to be used with two 16 ch single ended breakout cables | 1-G058-2 |

### A.17 B3264-2.0 en (GEN series GN1611 and GN3211)

| Capabilities Overview | | | |
|---|---|---|---|
| **Component** | | **Value** | |
| Model | | **GN3211** | **GN1611** |
| Sample rate max | | 20 kS/s | 20 kS/s |
| Memory per card | | 200 MB | 200 MB |
| ADC resolution | | 16 | 16 |
| Analog channels | | 32 | 16 |
| Digital event channels (1) | | 16 | 16 |
| Timer/Counter support | | no | no |
| Input type | | | |
| | Analog | yes | yes |

(1) When supported by mainframe

**Note** ***The listed specifications are valid for cards that are calibrated, and used in the same mainframe and slot as they were at the time of the calibration.***
***When the card is removed from its original location and placed in another slot and/or mainframe the following specifications are invalidated: Offset error, gain error and MSE. Typically they can double.***

| General Specifications | | | | |
|---|---|---|---|---|
| **Analog and Global** | | | | |
| **Component** | **Unit Description** | | **Value** | |
| Channels | | | **GN3211** | **GN1611** |
| | | | 32 | 16 |
| Input connectors | D-Sub (DD-50) connector | | 2 | 1 |
| Input type | Differential (software switchable to single ended positive or negative), symmetrical | | DC, AC, GND | |
| Input ranges | Given voltage spans apply where offset = 0 | | ± 10 mV, ± 20 mV, ± 50 mV, ± 100 mV, ± 200 mV, ± 500 mV, ±1 V, ±2 V, ± 5 V, ±10 V, ± 20 V | |
| Offset | Zero position (except for the range 40 V) | | ± 50 % | |
| Offset error drift | | | ± (10 ppm + 2μV)/°C | |
| Input impedance | In differential mode | | 2 x 1 MΩ (± 0.5 %) // 2 x 75 pF (± 15 %) | |
| Max static error | Total | | ± 0.015 % ± 25 μV | |
| Gain error | | | ± 0.015 % ± 25 μV | |
| Gain error drift | | | ± 10 ppm/°C | |
| Noise | Total | | ± 0.01 % ± 25 μV | |
| CMRR | In range <4 V | | < -80 dB | |
| | In range ≥4 V | | < -60dB | |
| CMV | In range <4 V | | ± 3 Vpeak | |
| | In range ≥4 V | | ± 50 Vpeak | |
| Input protection | Transient free | | ± 50 Vpeak | |
| Sample rate | High rates | | 10 S/s to 20 kS/s | |
| | Low rates (Low rate = High rate / n. Where n is an integer ≥ 2 | | 1 S/s to 10 kS/s | |
| Binary sample rate | Supported | | Yes | |
| External time base | Supported | | Yes | |
| Filter selection | | | | |
| Bandwidth | Wideband selected | | 20 kHz @ -3 dB | |
| | Flatness up to 5 kHz | All ranges | +0 dB/-0.4 dB | |

| General Specifications | | | |
|---|---|---|---|
| **Analog and Global** | | | |
| **Component** | | **Unit Description** | **Value** |
| Digital Decimation Filters | | | |
| | Time Domain | 12-pole Bessel style IIR, sample rate divided by 10, 20, 40 and 100 | |
| | | Minimum filter frequency | 40 Hz @ -3dB |
| | Frequency Domain | 12-pole Butterworth style IIR, sample rate divided by 4, 10, 20 and 40 | |
| | | Minimum filter frequency | 100 Hz @ -3dB |
| Measurement category | | IEC 61010 | CAT 1 |

## Wideband (20 kHz) Characteristics

**Component**

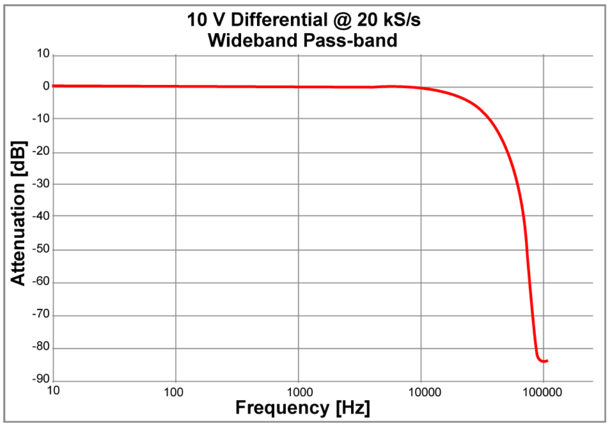



**Figure A.122:** 10 V Differential @ 20 kS/s

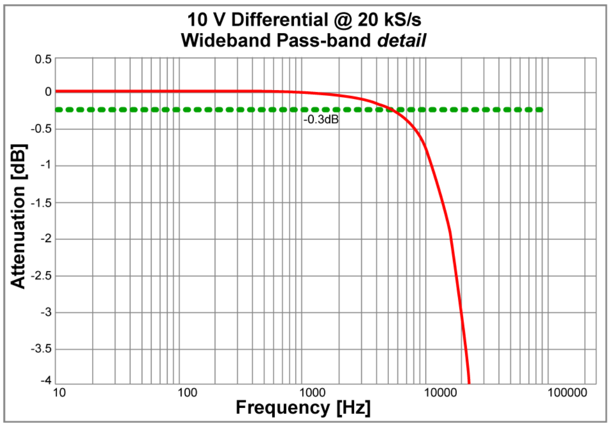



**Figure A.123:** 10 V Differential @ 20 kS/s - Detail

## Digital Functionality

*Only available when the mainframe provides a complementary connector*

| Component | | Unit Description | Value |
|---|---|---|---|
| Event inputs | | | |
| | Number of | | 16 |
| | Levels | User can invert value in software | High (1)/Low (0) |
| Event/Status outputs | | | |
| | Number of | | 2 |
| | Status output | Acquisition status | High when active |
| | Event output | Trigger or Alarm; user programmable | |
| Event out | | | |
| | Duration | | Pulse of 12.8 µs |
| | Delay | | 200 µs ± 1 µs ± 1 sample |

## Triggering

| Component | | Unit Description | Value |
|---|---|---|---|
| Triggered acquisition | | Pretriggered acquisitions, with user selectable pre- and post-trigger | |
| Trigger detector | | The trigger detector flags a user-defined situation on the input signal to start an acquisition sequence (trigger) or to arm the acquisition (qualifier). Digital functionality applies to event channels. | 1 per channel |
| | Functionality | Analog trigger modes | 2 |
| | | Digital trigger modes | 1 |
| | | Digital qualifier modes | 1 |
| | Levels | Analog: individual levels | 2 |
| | | Digital | 1 |
| | Resolution | Analog: for each level; covers the selected Full Scale | 16 bit (0.0015 %) |
| | | Digital | 1 bit |
| | Hysteresis | Defines the trigger levels insensitivity (analog only) | 0.1 % to 100 % of FS |
| Pre-trigger length | | Independent of storage medium used | 0 to 100 % of recording length |
| Post-trigger length | | With sweep acquisition | 0 to full on-board RAM |
| | | Continuous type acquisition | 0 to full HD capacity |
| Trigger rate | | Up to 400 triggers per second, with zero re-arm time | 1 per 2.5 ms |
| Trigger total | | Maximum number of triggers per recording | 10,000 |
| Cross-channel operation | | Triggers of all channels | Logical OR |
| | | Qualifiers of all event channels | Logical AND |
| Analog trigger modes | | | |
| | Basic | Single level | Positive or negative level crossing |
| | Dual level | Two individual levels, OR-ed | One positive and one negative level crossing |
| Digital (event) trigger modes | | | |
| | Basic | Single change of state | Rising or falling edge |
| Digital (event) qualifier modes | | | |
| | Basic | Arm the acquisition with a single change of state | Rising or falling edge |

## Acquisition and Storage Modes

| Component | | Unit Description | Value |
|---|---|---|---|
| Modes | | | |
| | Sweeps | Triggered acquisition to an on-board Random Access Memory (RAM) without sample rate limitations. | |
| | Continuous | Direct triggered acquisition to a PC or mainframe hard disk without file size limitations. Triggered or untriggered. | |
| | Dual | Combination of sweeps and continuous mode: continuous type streaming acquisition to disk with simultaneously triggered sweeps in RAM. | |
| | Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. | |
| | Sample width | | 16 bit/sample |
| Acquisition | | | |
| | Sample memory | | 200 MB |

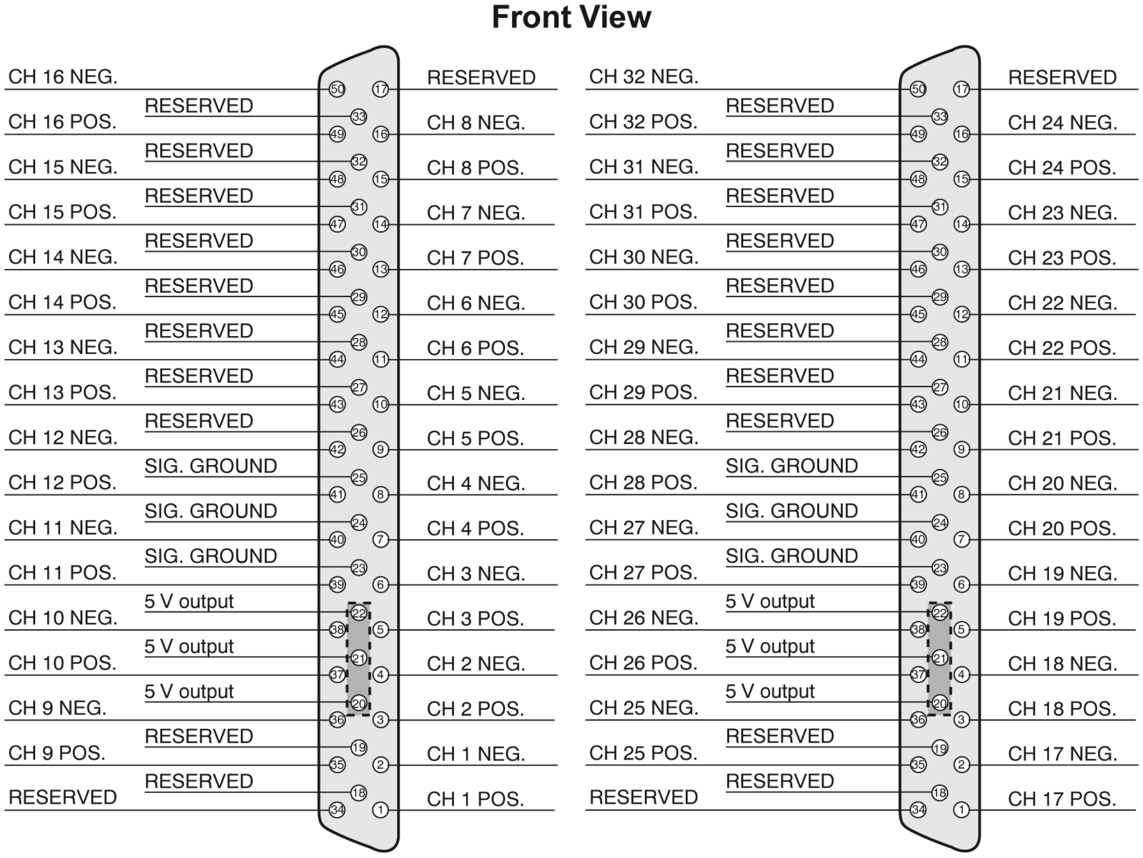



**Figure A.124:** Pin diagram for top 16 Ch Connector (left), Bottom 16 Ch connector (right, 32 Ch Card only)

**Note** *Both positive and negative pins must be connected to avoid erroneous measurement results with noise.*

**Note** *There are 3 output pins available on each connector giving 5 V at 0.3 A in total from an automatic resettable fuse.*

| Ordering Information | | | |
|---|---|---|---|
| **Model** | | **Unit Description** | **Order Number** |
| GN3211 |  | 32 Channel 20 kS/s per channel Differential digitizer, 200 MB RAM per card, 16 bit. | 1-GN3211-2 |
| GN1611 | | 16 Channel 20 kS/s per channel Differential digitizer, 200 MB RAM per card, 16 bit. | 1-GN1611-2 |

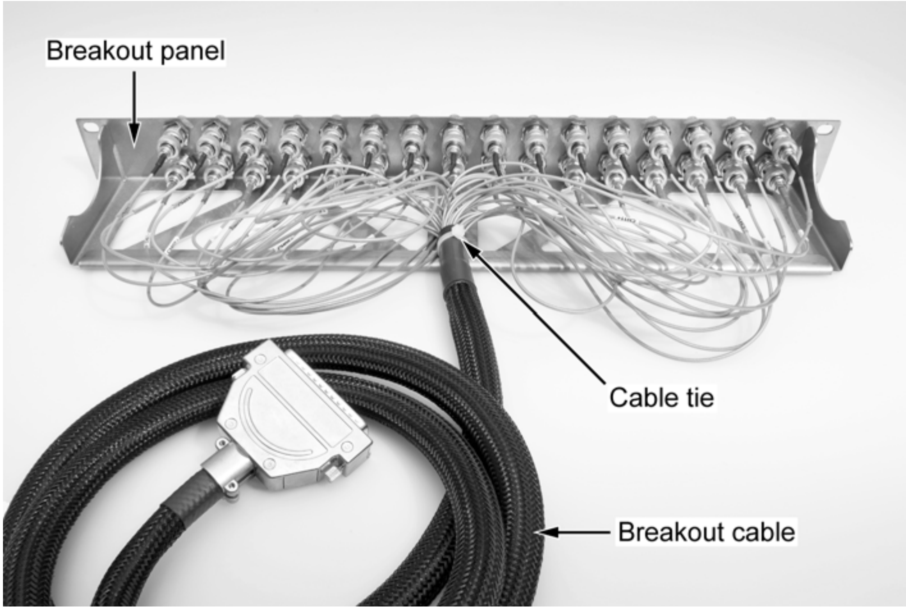



**Figure A.125:** Breakout panel and cable

| Accessories | | | |
|---|---|---|---|
| **Model** | | **Unit Description** | **Order number** |
| KAB171 |  | 16 ch single ended break out cable, HDSub to 16x BNC, 2 m; for use with GEN DAQ 16/32 ch input card | 1-KAB171-1-2 |
| KAB172 | | 16 ch differential break out cable, HDSub to 32x BNC, 2 m; for use with GEN DAQ 16/32 ch input card | 1-KAB172-1-2 |
| G055 |  | 16 ch single ended 19 inch or 1 U (44.45 mm) breakout panel; 16 BNC feed-through; to be used with 16 ch single ended break out cable | 1-G055-2 |
| G056 | | 16 ch differential 19 inch or 1 U (44.45 mm) breakout panel; 16 x 2 BNC feed-through; to be used with 16 ch differential break out cable | 1-G056-2 |
| G058 | | 32 ch single ended 19 inch or 1 U (44.45 mm) breakout panel; 32 BNC feed-through; to be used with two 16 ch single ended breakout cables | 1-G058-2 |

### A.18 B3246-1.0 en (GEN series GN4070)

## General Specifications

### Analog Input Section

| Component | Unit Description | Value |
|---|---|---|
| Channels | Fiber optic isolated marker (event) inputs | 8 |
| | Non-isolated marker(event) inputs | 32 |
| | Fiber optic isolated ARM output | 1 |
| Type | TTL, active low with pull-up resistor to enable activation by relays or short-circuit to ground | |
| Connectors | Two connectors with 16 events per connector | 2 x 26-pin SubD |
| Fiber optic connectors | | 8 in + 1 out |

### Analog to Digital Conversion

| Component | Unit Description | Value |
|---|---|---|
| Sample rate | Maximum | 1 MS/s |

### Digital Input Section

| Component | Unit Description | Value |
|---|---|---|
| Connectors | Fiber optic connectors | 8 in + 1 out |
| Type | | KF66-A26P-N |
| Pull-up | | 25.5 kΩ @ 5 Volt |
| Voltage range | TTL compatible, maximum | 30 V |
| Voltage levels | Logic threshold voltage level '0' | - 30 V to + 0.7 V |
| | Logic threshold voltage level '1' | + 2 V to + 30 V |

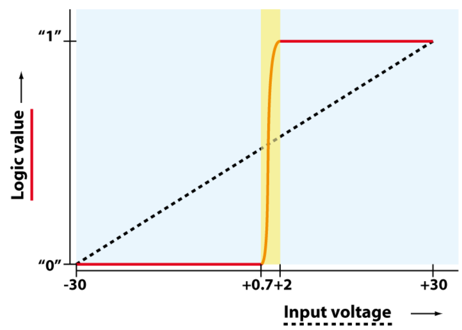
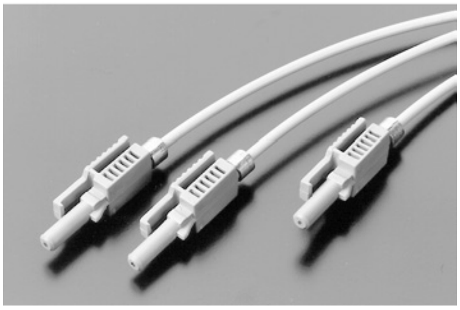



**Figure A.126:** Logic threshold voltage levels

| Component | Unit Description | Value |
|---|---|---|
| Protection | Continuous | ± 30 V |
| Fiber optic cable (recommended) | | |
| Type | Plastic, single step index, HP HFBR-RXXYYY series | HP HFBR-RXXYYY |
| Diameter | Core and cladding | 1.00 mm |
| Attenuation | | 0.22 dB/m |
| Delay | Propagation delay constant | 5.0 ns/m |
| Fiber optic I/O | | |
| Sockets | (660 nm LED) Input: | HP HFBR-2523 |
| | Output: | HP HFBR-1523 |
| Connectors | Simplex latching connector | HP HFBR-4503 |
| Output drive | Distance | 60 m to 100 m |
| Compatibility | Fully compatible with HBM BE3200 Test Sequencer | BE3200 |

| Digital Input Section | | | |
|---|---|---|---|
| Component | Unit Description | | Value |
| | <br>**Figure A.127:** Fiber optic cables | | |
| Conditional functionality | | | |
| Modes | Trigger, Qualifier, Alarm | | |
| Trigger | | | |
| | Modes<br>Off, rising edge active, falling edge active | | |
| | Combination<br>Logic condition: Event trigger OR any other trigger source | | |
| Qualifier | | | |
| | Modes | Off, active high/low | |
| | Combination | Logic condition: Event qualifier AND any other qualifier sources | |
| Alarm | | | |
| | Modes | Off, active high, active low | |
| Output functionality | | | |
| | ARM (status) | Active when continuous recording active, or named in triggered sweep mode | |
| Functionality | | | |
| General | | | |
| | Number of Channels | | 3 |
| | Pins per channel | | 3 |
| | Function | • Clock<br>• Direction<br>• Reset | |
| | Sample size | | 64 Bits (8 Bytes) |
| | Operation modes | • Counter<br>• Quadrature counter<br>• RPM<br>• Frequency | |
| Counter mode | | | |
| | Count size | | 64 bits |
| | Maximum frequency | | 10 MHz |
| | Direction | External | Up/down |
| | Reset to “0” | • Manual by user<br>• At start of recording<br>• By reset pin once after start of recording<br>• By reset pin always | |
| Quadrature mode | | | |
| | Count size | | 64 bits |
| | Maximum frequency | | 10 MHz |
| | Direction | External | Up/down |

| Digital Input Section | | | |
|---|---|---|---|
| **Component** | **Unit Description** | | **Value** |
| | Reset to "0" | • Manual by user<br>• At start of recording<br>• By reset pin once after start of recording<br>• By reset pin always | |
| RPM mode | | | |
| | Count size | | 64 bits |
| | Maximum frequency | | 10 MHz |
| | Direction | External | Up/down |
| | Gate time | User selectable in 1, 2, 5 steps | 1 ms to 10 sec |
| | Inaccuracy | Gate time | 10 ns |
| | Measurement | Counts and period | |
| | Pulse per rotation | User selectable | |
| | RPM | Counts/(period * pulse per rotation) | |
| Frequency mode | | | |
| | Count size | | 64 bits |
| | Maximum frequency | | 10 MHz |
| | Direction | External | Up/down |
| | Gate time | User selectable in 1, 2, 5 steps | 1 ms to 10 sec |
| | Inaccuracy | Gate time | 10 ns |
| | Measurement | Counts and period | |
| | Frequency | Counts/period | |

| On-board Memory | | | |
|---|---|---|---|
| **Component** | | **Unit Description** | **Value** |
| Per card | | The memory splits between marker inputs and counter/timers channels. | 512 MB |
| Per channel | | | |
| | Usable memory is: | Markers enabled only (1-64) | 64 MS |
| | | Markers plus 1 counter Ch enabled | 32 MS |
| | | Markers plus 2 counter Ch enabled | 20 MS |
| | | Markers plus 3 counter Ch enabled | 16 MS |

| Acquisition Modes | |
|---|---|
| **Component** | **Description** |
| Sweeps | Triggered acquisition to RAM without sample rate limitations; for single or repetitive transients or intermittent phenomena. |
| Continuous | Direct storage to PC or mainframe hard disc without file size limitations; triggered or un-triggered; for long duration recorder type applications with up to 1 MS/s rate per channel; (maximum aggregate rate pending from mainframe configuration and PC). |
| Dual | Combination of Sweeps and Continuous; recorder type streaming to hard disc with simultaneously triggered sweeps in RAM. |
| Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. |

| Storage Modes | |
|---|---|
| **Component** | **Description** |
| Recorder | Spooled directly to hard-disk of control PC; unlimited file size or duration |
| Scope | Store in transient memory |
| Transient | Store in transient memory, single or A-B-A time base |

| Miscellaneous | | |
|---|---|---|
| Component | Unit Description | Value |
| Output power | Typical @ 20 °C (ambient PCB)<br>Typical @ 60 °C (ambient PCB) | 5 V @ 0.5 A<br>5 V @ 0.35 A |

| Ordering Information | | | |
|---|---|---|---|
| Model | | Unit Description | Order number |
| Binary Marker HV 1 MS TTL/Fiber Optical Card |  | 32+8 binary channels, 1 MS/s Digital Input Card, 512 MB RAM, TTL level/light, SubD/LWL input connectors | 1-GN4070-2 |

### A.19 B3245-1.0 en (GEN series GN6470)

| Analog to Digital Conversion | | |
|---|---|---|
| **Component** | **Unit Description** | **Value** |
| Sample rate | Maximum | 1 MS/s |
| Type | TTL, active low with pull-up resistor to enable activation by relays or short-circuit to ground | |

| Digital Input Section | | | | |
|---|---|---|---|---|
| **Component** | | **Unit Description** | | **Value** |
| Connectors | | Four connectors with 16 events per connector | | 4 x 26-pin SubD |
| | Type | TTL | | KF66-A26P-N |
| Pull-up | | | | 25.5 kΩ @ 5 Volt |
| Voltage range | | TTL compatible, maximum | | 30 V |
| Voltage levels | | Logic threshold voltage level '0' | | - 30 V to + 0.7 V |
| | | Logic threshold voltage level '1' | | 30 V Maximum |

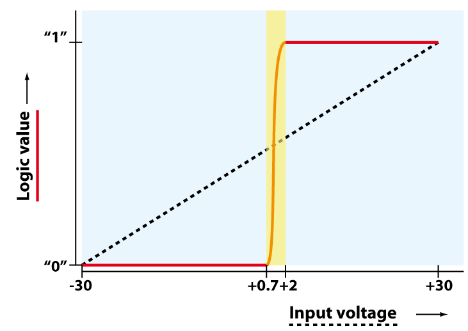



**Figure A.128:** Logic threshold voltage levels

| | | | | |
|---|---|---|---|---|
| Protection | | | | ± 30 V continuous |
| Reset modes | | | | |
| | External | Logical | | “1” or “0” |
| | Modes | Manual (software control), On Start of Acquisition, Use an External Trigger Once, Use an External Trigger Always. The reset functionality of the counter/ timer is under software control and can be set for each channel separately. | | |
| Conditional functionality | | | | |
| | Modes | Trigger, Qualifier, Alarm | | |
| | Trigger | | | |
| | | Modes | Off, rising edge active, falling edge active | |
| | | Combination | Each event trigger is OR-ed with all other trigger sources | |
| | Qualifier | | | |
| | | Modes | Off, active high/low | |
| | | Combination | Each event qualifier is AND-ed with all other qualifier sources | |
| | Alarm | | | |
| | | Modes | Off, active high, active low | |
| Functionality | | | | |
| | General | | | |
| | | Number of Channels | | 3 |
| | | Pins per channel | | 3 |
| | | Function | • Clock<br>• Direction<br>• Reset | |

## Digital Input Section

| Component | | Unit Description | | Value |
|---|---|---|---|---|
| | | Sample size | | 64 Bits (8 Bytes) |
| | | Operation modes | • Counter<br>• Quadrature counter<br>• RPM<br>• Frequency | |
| | Counter mode | | | |
| | | Count size | | 64 bits |
| | | Maximum frequency | | 10 MHz |
| | | Direction | External | Up/down |
| | | Reset to “0” | • Manual by user<br>• At start of recording<br>• By reset pin once after start of recording<br>• By reset pin always | |
| | Quadrature mode | | | |
| | | Count size | | 64 bits |
| | | Maximum frequency | | 10 MHz |
| | | Direction | External | Up/down |
| | | Reset to “0” | • Manual by user<br>• At start of recording<br>• By reset pin once after start of recording<br>• By reset pin always | |
| | RPM mode | | | |
| | | Count size | | 64 bits |
| | | Maximum frequency | | 10 MHz |
| | | Direction | External | Up/down |
| | | Gate time | User selectable in 1, 2, 5 steps | 1 ms to 10 sec |
| | | Inaccuracy | Gate time | 10 ns |
| | | Measurement | Counts and period | |
| | | Pulse per rotation | User selectable | |
| | | RPM | Counts/(period * pulse per rotation) | |
| | Frequency mode | | | |
| | | Count size | | 64 bits |
| | | Maximum frequency | | 10 MHz |
| | | Direction | External | Up/down |
| | | Gate time | User selectable in 1, 2, 5 steps | 1 ms to 10 sec |
| | | Inaccuracy | Gate time | 10 ns |
| | | Measurement | Counts and period | |
| | | Frequency | Counts/period | |

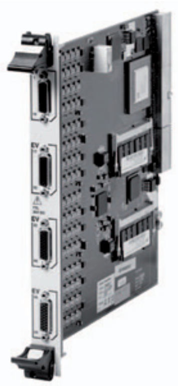
## On-board Memory

| Component | | Unit Description | Value |
|---|---|---|---|
| Per card | | The memory splits between marker inputs and counter/timers channels. | 512 MB |
| Per channel | | | |
| | Usable memory is: | Markers enabled only (1-64) | 64 MS |
| | | Markers plus 1 counter Ch enabled | 32 MS |
| | | Markers plus 2 counter Ch enabled | 20 MS |
| | | Markers plus 3 counter Ch enabled | 16 MS |

| Acquisition Modes | |
|---|---|
| **Component** | **Description** |
| Sweeps | Triggered acquisition to RAM without sample rate limitations; for single or repetitive transients or intermittent phenomena. |
| Continuous | Direct storage to PC or mainframe hard disc without file size limitations; triggered or un-triggered; for long duration recorder type applications with up to 1 MS/s rate per channel; (maximum aggregate rate pending from mainframe configuration and PC). |
| Dual | Combination of Sweeps and Continuous; recorder type streaming to hard disc with simultaneously triggered sweeps in RAM. |
| Slow fast sweep | A triggered acquisition in RAM which includes an acquisition phase with a higher sample rate, located at a point of interest. |

| Storage Modes | |
|---|---|
| **Component** | **Description** |
| Recorder | Spooled directly to hard-disk of control PC; unlimited file size or duration |
| Scope | Store in transient memory |
| Transient | Store in transient memory, single or A-B-A time base |

| Miscellaneous | | |
|---|---|---|
| **Component** | **Unit Description** | **Value** |
| Output power | Typical @ 20 °C (ambient PCB)<br>Typical @ 60 °C (ambient PCB) | 5 V @ 0.5 A<br>5 V @ 0.35 A |

| Ordering Information | | | |
|---|---|---|---|
| **Model** | | **Unit Description** | **Order number** |
| GN6470 |  | **1 MS TTL Card** 64 binary channels, 1 MS/s Digital Input Card, 512 MB RAM, TTL Level, 4 SubD input connectors. | 1-GN6470-2 |

# B Maintenance

## B.1 Preventive maintenance

Regularly scheduled HBM preventive maintenance services that include cleaning, adjusting, inspection and calibration will help to:

- Assure that the instrument is available whenever it is needed
- Maintain optimum performance
- Avoid expensive unplanned downtime and repair

Also, regularly scheduled maintenance is a predictable expenditure.

Except for the batteries, the instrument is a maintenance-free product, no preventive maintenance actions are required.

Inspect the instruments batteries at least two times per year and preferably every month. Damaged and/or lowered capacity batteries should be replaced to meet the battery's specified capacity and therefore the instrument's specified run-time using the battery. The main benefit of this inspection will result in reliable use of the instrument.

If the instrument was stored for 4 weeks or longer first inspect the battery before turning the instrument back to use.

Frequency of preventive maintenance depends on your application, workload, and regulatory requirements.

The GEN series system is factory calibrated as delivered to the customer. Swapping, replacing or removing of cards may result in minor deviations to the original calibration.

HBM recommends that every GEN series system should be tested and if necessary, calibrated, at one year intervals or after any major event that may affect calibration. When in doubt consult the local supplier.

### B.1.1 Hard Disk maintenance

When installed in the instrument, the hard disk drive is the "data center" of the instrument. It holds all of the programs and recorded data. The CPU may be the "brain" of the system, but if so, the hard drive is its memory and personality; it is what makes the instrument what it is.

The reliable service life of a typical hard disk drive is around three to five years. Some drives work for a decade or longer, but every year that passes after three years increases the chances of a failure.

Therefore HBM advises if the instrument uses a hard disk drive to replace it at least every two years to prevent loss of data or inactivity of the instrument.

Contact HBM service for more details.

### B.1.2 Solid State Disk maintenance

When installed in the instrument, the solid state disk is the "data center" of the instrument. It holds all of the programs and recorded data. The CPU may be the "brain" of the system, but if so, the solid state disk is its memory and personality; it is what makes the instrument what it is.

Solid state disks have no mechanical parts to fail, however each block of data on a solid state disk can only be erased and written a defined number of times before it fails. The solid state disk manage this limitation so that drives can last for many years under normal use. Very intensive use of the solid state disk to record and store new data will shorten the drives life expectation.

The reliable service life of a typical solid state disk drive is around three to five years. Some drives work for a decade or longer, but every year that passes after three or so increases the chances of a failure.

Therefore HBM advises if the instrument uses a solid state disk drive to replace it at least every two years to prevent loss of data or inactivity of the instrument.

Contact HBM service for more details.

## B.2 Cleaning

To clean the instrument, disconnect all power sources and wipe the surfaces lightly with a clean, soft cloth dampened with water.

The GEN DAQ does not require additional routine cleaning. If the cooling inlets on the side of the instrument become clogged with dust, use a small brush and/ or vacuum cleaner to remove the dust.

# C Service Information

## C.1 General - Service Information

HBM offers comprehensive factory servicing for all HBM Data Acquisition products. Extended warranties for calibration, repair or both are available. Installation, on-site or factory training are also available. Contact the factory or the local sales person for more information. For local contact information, visit www.hbm.com/support.

If servicing is ever needed on the equipment contact the factory with the model and serial numbers, a description of the problem, and your contact information. A Return Material Authorization (RMA) number will be issued. Attach this number to the unit and/or the accompanying paperwork.

During the warranty period, the customer pays for shipping to HBM. HBM will pay for the return of the equipment in the same fashion as it was received. Outside the warranty period, a quote will be given. A purchase order must be received before work can be performed.

It is recommended that the unit always be shipped in the original shipping container.

For frequent shipping of some products, HBM offers hard shipping containers specifically designed for frequent transportation.

## C.2 Calibration/verification

The GEN series Data Acquisition System is factory calibrated as delivered to the customer. Swapping, replacing or removing of cards may result in minor deviations to the original calibration. The GEN series system should be tested and if necessary, calibrated, at one year intervals or after any major event that may affect calibration. When in doubt consult your local supplier.

# D Understanding Inputs and Usage of Probes

## D.1 Overview of inputs

**Balanced Vs Unbalanced**
A balanced input describes an amplifier input stage where both input terminals exhibit the same electrical behaviour – like resistance and capacitance. Unbalanced electrical input properties are different.

**Symmetrical Vs Unsymmetrical**
Symmetrical (similar to **balanced**) describes the input properties; if both input terminals are built up using the same component in a mirrored way, they are **symmetrical**; (this will result in a **balanced input**)

**Differential**
A differential amplifier is a type of electronic amplifier that multiplies the difference between two inputs by a constant factor.
Very often a differential amplifier is treated as isolated – which is wrong.

**Single ended**
An amplifier where one input is fixed to (measurement) ground.

**Note** *A differential amp can be turned into a single ended one by connecting the **-Ve** input to ground.*

**Isolated**
An amplifier where both inputs are isolated from (earth) ground or has infinite resistance to ground.

**Note** *Isolation can be combined with any of the above mentioned amplifier variants.*

### D.1.1 Single ended input

A single ended input is not isolated and uses unbalanced inputs.

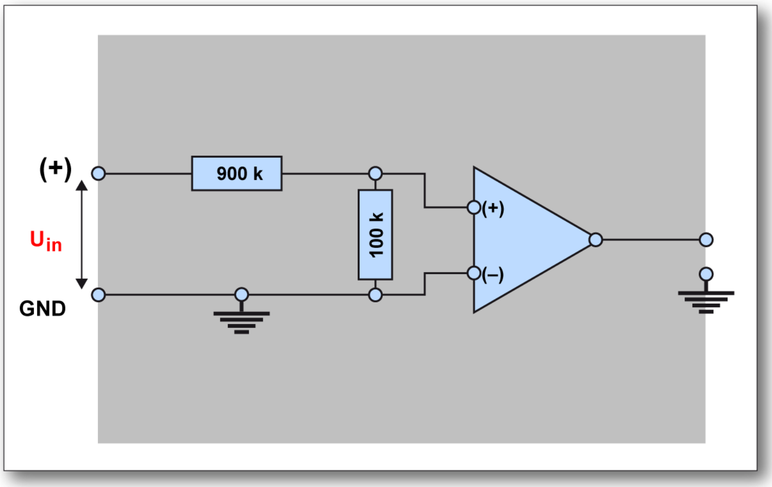



**Figure D.1:** Single ended amplifier

- One input is connected to ground
- Resistance / Capacitance from each terminal to ground is different
- Amplifier is typically found in oscilloscopes
  - Also used in GEN DAQ Basic amp, Liberty 8ch DC amp
  - Often identified by the use of a single METAL BNC connector per channel
- Can be used with standard passive probes (as with oscilloscopes)

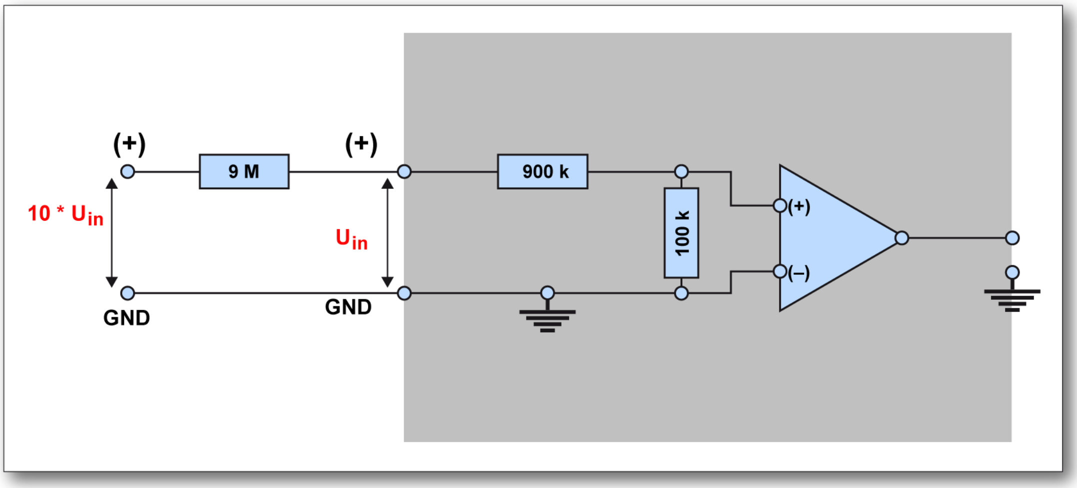



**Figure D.2:** Single ended amplifier with passive probe

- An inline resistor acts as a voltage divider with the input resistance of the amplifier
- The amplifier itself sees only $\mathbf{U_{in}}$; the **total** input range is $\mathbf{10 * U_{in}}$
- This can be done if the resistors (and capacitors) between probe and amp match
- This can be done with any oscilloscope or the GEN DAQ Basic Amp
  - But oscilloscope probes are typically only +/- 2 % to +/- 5 % accurate
- Probes used need compensation. The compensation range needs to match input amplifiers capacitance range.

### D.1.2 Balanced differential input

A balanced differential input is not isolated and uses balanced inputs.

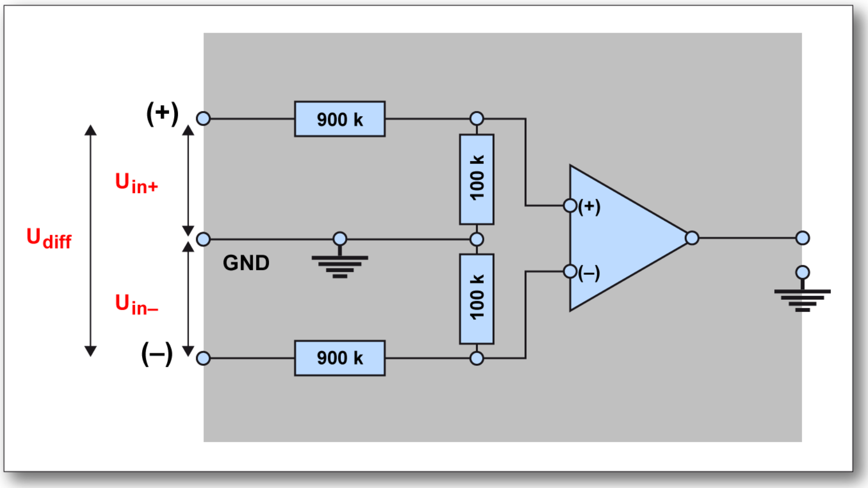



**Figure D.3:** Balanced differential amplifier

- Resistance / Capacitance from each terminal to ground is identical
- There is NO ISOLATION
  - Used in some of the GEN DAQ acquisition cards
  - Often identified by the use of two METAL BNC connectors per channel
- Can be used with matched pair of probes only
  - Work with the same limitations as single probes but is more tricky due to the needed **balance** between probes
- Probes used need compensation. The compensation range needs to match input amplifiers capacitance range

### D.1.3 Isolated single ended or Isolated unbalanced differential input

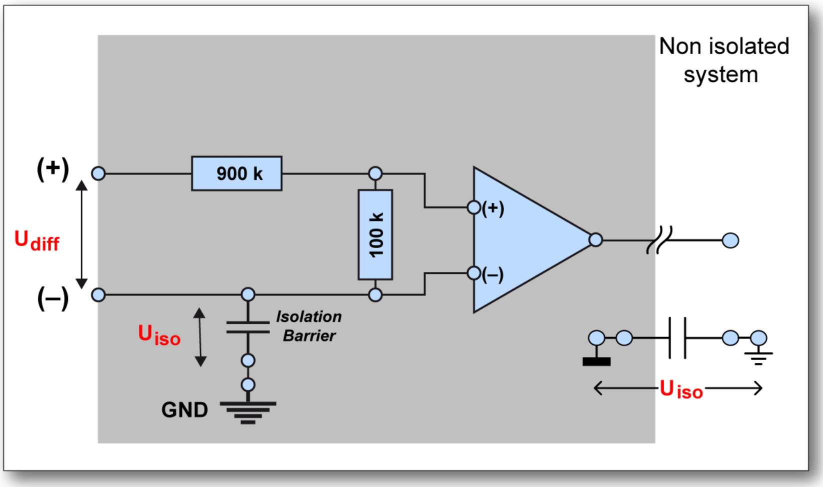



**Figure D.4:** Isolated single ended or Isolated unbalanced differential amplifier

- Also termed **unbalanced**, **isolated** or **unbalanced differential** amplifier
- None of the inputs are connected to ground for safety and to avoid ground loops
- Typically used in isolated DAQ systems
  - Often identified by the use of a single PLASTIC (isolated) BNC connector
  - Used in GEN DAQ ISOLATED Basic amp
- Can do *DIFFERENTIAL MEASUREMENTS with different limitations and options compared to a differential grounded amplifier*.

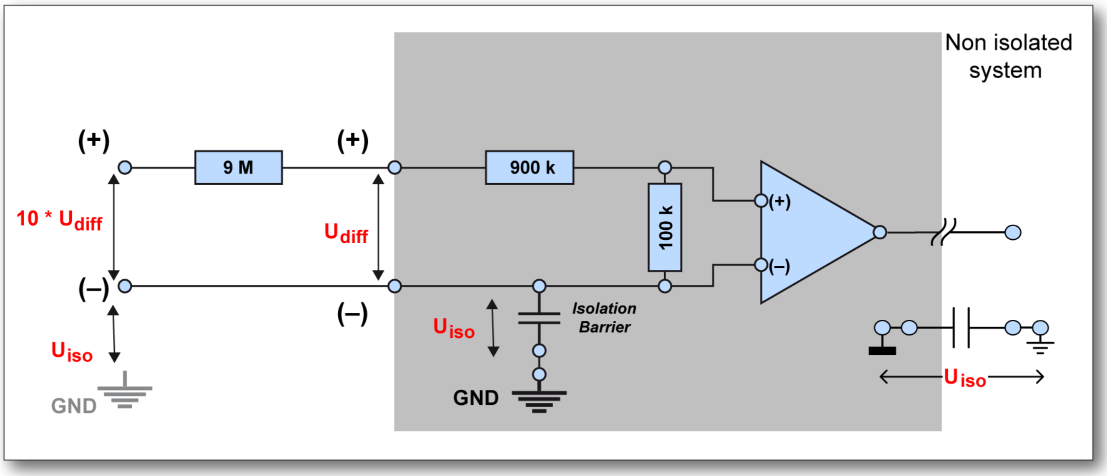



**Figure D.5:** Isolated single ended or Isolated unbalanced differential amplifier with passive probe

- Also termed **unbalanced**, **isolated** or **unbalanced differential** amplifier with probe
- Still none of the inputs are connected to ground
- The positive (system) input accepts ten times the input voltage of the amp
- The negative input has NOT CHANGED AT ALL
- So the measurement range is increased from + to - inputs,
  BUT the isolation voltage from (-) to ground remains unchanged
  - Example is the GEN DAQ Basic XT Iso card with external Isolated passive probe
- Probes used need compensation. The compensation range needs to match input amplifiers capacitance range

### D.1.4 Isolated balanced differential input

An isolated balanced differential input is isolated and uses balanced inputs. Isolated measurement ground is often not available.

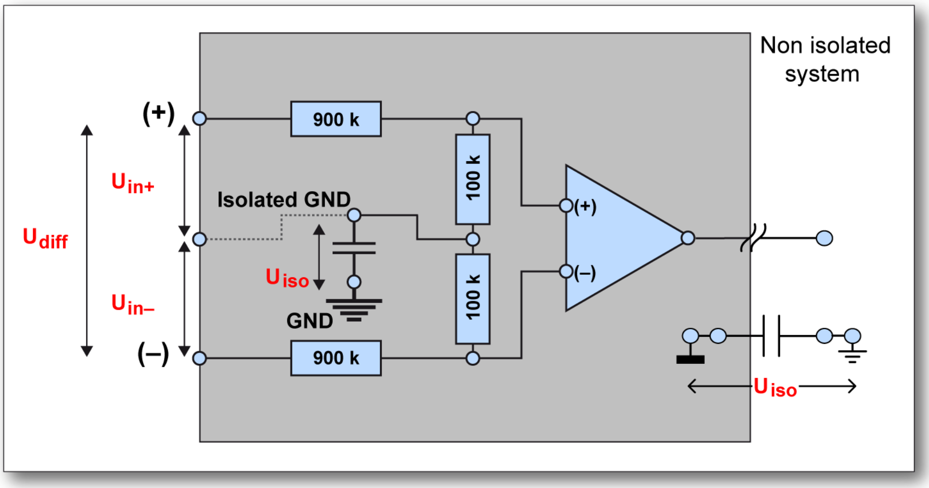



**Figure D.6:** Isolated balanced differential amplifier

- Resistance / Capacitance from each terminal to isolated measurement ground is identical
- There is an ISOLATED MEASUREMENT GROUND
  - Used in GEN DAQ Universal amplifier
  - Typically identified by using 2 or 3 (isolated) connectors per channel

**Note** *The isolated ground is not accessible in some designs*

- Cannot be used with probes as there is no ground reference for probes to divide the voltage down

### D.1.5 Probes versus external voltage dividers

Using probes the inaccuracy of the measurement typically changes to 2 to 5 %. One technique to improve the accuracy is to use external resistive voltage dividers.

HBM's 1 kV DC probe (1-G041-2) uses this technique.

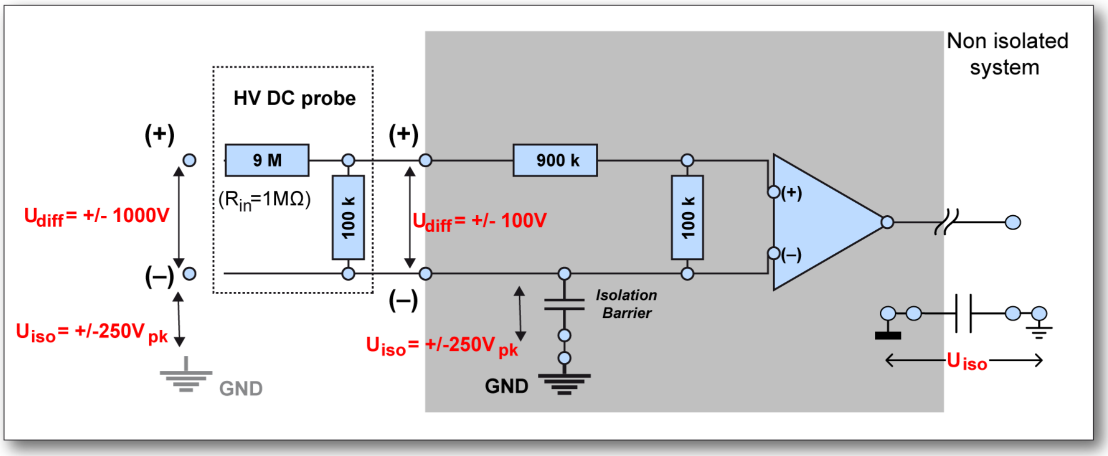



**Figure D.7:** GEN DAQ Basic ISO XT amp with HV DC probe

- The voltage division is done externally in the probe to maintain accuracy
- Input range is +/-1 kV from (+) to (-), NOT from (-) to (+)
- Isolation voltage is +/-250 $V_{pk}$
- The negative input has NOT CHANGED AT ALL
- In theory, if only the (+) input would be connected to 1 kV, the (-) input would float up to 1 kV as well as there is no reference for the divider. In practice, leakage currents are there which in many cases prevent this.
- Voltage dividers need compensation. The compensation range needs to match input amplifiers capacitance range

**Different amplifiers – Pros and Cons**
**Single ended (to ground) amplifiers**

- Cost effective and small
- High bandwidth
- Easy to use with probes
- Ground problems, no safety, no CMR, no CMV

**Single ended isolated amplifier – unbalanced differential**

- Can do differential measurements
- Expensive and large
- Difficult to use with probes
- Limited CMRR, best CMV
- Avoids ground loops, high safety

**Differential amplifier (with common ground)**

- Widely used in DAQ
- Good CMRR, limited CMV
- No (safety) isolation, potential ground loops will remain present

**Differential amplifier with isolated common**

- Safe
- Expensive and large
- Good CMRR, best CMV
- VERY difficult to use with probes

## D.2 Overview of probes

HBM offers a variety of probes for use with the Genesis Highspeed, ISOBE5600 and Isolated Digitizers systems. Which probe is needed depends on the application and which instrument is being used. It is important to match the compensation of the probe to the instrument.

- **Voltage probes for single ended amplifiers**
  These probes increase the input range of a single ended amplifier, they typically decrease the overall accuracy of the amplifier.
- **Voltage probes for isolated amplifiers**
  These probes increase the input range of an isolated unbalanced amplifier, they typically decrease the overall accuracy of the amplifier.
  It is also important to understand that they increase the range only, not the isolation voltage.
- **Voltage probes for isolated amplifiers (high accuracy)**
  These probes increase the input range of an isolated unbalanced amplifier, while they maintain a good accuracy.
  It is also important to understand that they increase the range only, not the isolation voltage.
- **Matched differential, passive voltage probes**
  These probes increase the input range of a differential amplifier, they typically decrease the overall accuracy and the CMRR of the amplifier.
  They work with isolated as well as with non-isolated variants of differential amplifiers.
  If used with isolated amplifiers, they increase the range only, not the isolation voltage.
- **Active differential voltage probes**
  These probes are self-contained, differential amplifiers to be used in front of an instrument.
  The input range and accuracy depend on the type of active differential probe used.
  Active differential probes can be used in front of virtually any amplifier, their performance typically is limited. Also, as they usually operate from batteries, this causes some inconvenience.
- **Current clamps**
  Current clamps are more transducers rather than probes, as they convert one physical quantity (current) into another one (usually voltage). They are used to make non-invasive current measurements. That is, the current in a circuit can be measured without disturbing the circuit.

**Note** *There are other possibilities to measure current as well (current shunts, or Rogowski coils).*

### D.2.1 Voltage probes for single-ended amplifiers

Voltage probes divide down a single-ended input signal by a specific factor.

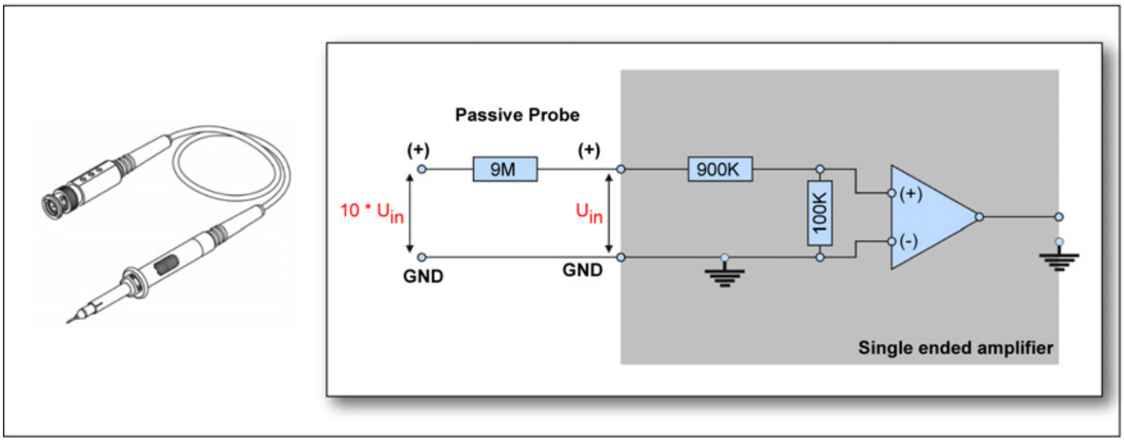



**Figure D.8:** Typical example of a voltage probe

Voltage probes are – in theory – just passive in-line resistors in front of the positive input of a single-ended amplifier. Together with the input resistor of the amplifier they form a voltage divider, so that the voltage in front of the amplifier itself gets divided down. As there is also a capacitive component in this divider, the input capacitance of the amplifier and the so called “compensation range” of the probe need to match, otherwise signal distortion might occur.

By selecting a higher resistance probe the divider ratio gets bigger, so that pretty large input ranges can be achieved. Voltage probes do not provide/add either isolation or common mode voltage rejection. These probes can only be used in front of single-ended amplifiers.

Voltage probes typically decrease the overall accuracy of the system (caused by the inaccuracy of the input divider ratio formed by the external probe resistance and the internal amplifier resistance).

*Table C.1: Voltage probes overview table (Part 1)*

| Part number | Divider factor | Maximum input voltage |
|---|---|---|
| **1-G901-2**(1) | x1/x10<br>switchable | 1X: 55 V AC rms<br>10X: 300 V AC rms |
| **1-G902-2**(1) | x1/x10<br>switchable | 1X: 55 V AC rms<br>10X: 300 V AC rms |
| **1-G903-2**(1) | x100 | 1000 V AC rms |
| **1-G904-2**(1) | x100 | 2 kV AC rms<br>3 kV DC incl. AC pk |
| **1-G906-2**(1) | x1000 | 20 kV DC<br>14 kV AC rms 50/60 Hz)<br>40 kV  pulse (derating) |
| **1-G027-2**(2) | 1X/10X<br>switchable | 1X: 55 V AC rms<br>10X: 300 V AC rms |

*Table C.2: Voltage probes overview table (Part 2)*

| Part number | Compensation range | Cable length | Bandwidth |
|---|---|---|---|
| **1-G901-2**(1) | 7 - 75 pF | 1.2 m | 1X: 12 MHz<br>10X: 200 MHz |
| **1-G902-2**(1) | 7 - 75 pF | 3 m | 1X: 6 MHz<br>10X: 100 MHz |
| **1-G903-2**(1) | 7 - 45 pF | 1.2 m | 400 MHz |
| **1-G904-2**(1) | 10 - 50 pF | 2 m | 300 MHz |
| **1-G906-2**(1) | 10 - 50 pF | 3 m | 100 MHz |
| **1-G027-2**(2) | 100 – 140 pF | 3 m | 1X: 2 MHz<br>10X: 50 MHz |

(1) Suitable instruments and input amplifiers:
GEN DAQ Basic cards **GN810 & GN811**
GEN DAQ High speed cards (in single ended mode only) **GN412 & GN413**
GEN DAQ 6600 & 7600 isolated digitizers **GN110 & GN111 & GN112 & GN113 & GN114**
ISOBE5600 transmitters **GENIS-1T & GENIS-1TM**

(2) Suitable instruments and input amplifiers:
GEN DAQ Universal cards (single ended mode) **GN440 & GN441**

**Note** *GN440 and GN441 cards are no longer available.*

### D.2.2 Voltage probes for ISOLATED amplifiers

Voltage probes for isolated digitizers divide down an isolated input signal by a specific factor. They are designed in an “isolated way” (like plastic BNC´s to prevent users touching the connection), so they can be used in front of an isolated unbalanced amplifier. So they are also called “isolated voltage probes”, though they do not add isolation; this comes from the amplifier.

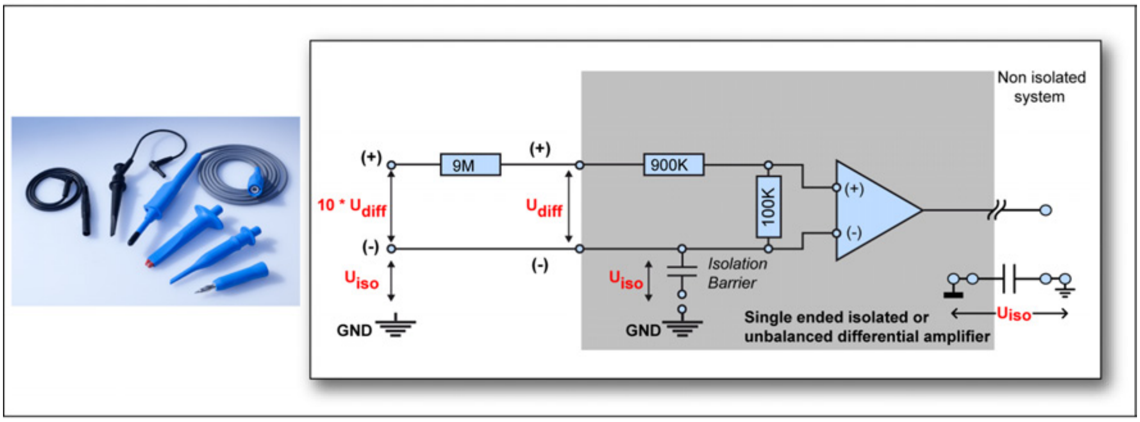



**Figure D.9:** Typical example of an isolated voltage probe

Voltage probes for isolated amplifiers are also – in theory – just passive in-line resistors in front of the positive input of an isolated unbalanced amplifier.

Together with the input resistor of the amplifier they form a voltage divider, so that the voltage in front of the amplifier itself gets divided down. As there is also a capacitive component in this divider, the input capacitance of the amplifier and the so called “compensation range” of the probe need to match, otherwise signal distortion might occur.

As the dividing down, however, only applies to the positive side of the amplifier input, the input range gets increased, while the isolation voltage remains the same as without probe.

These probes can only be used in front of isolated unbalanced amplifiers.

Isolated voltage probes typically decrease the overall accuracy of the system (caused by the inaccuracy of the input divider ratio formed by the external probe resistance and the internal amplifier resistance).

*Table C.3: Voltage probes for ISOLATED amplifiers overview table (Part 1)*

| Part number | Divider factor | Maximum input voltage |
|---|---|---|
| **1-G057-2**(1) | x100 | 3540 V<br>1000 V CAT II<br>600 V CAT III |

*Table C.4: Voltage probes for ISOLATED amplifiers overview table (Part 2)*

| Part number | Compensation range | Cable length | Bandwidth |
|---|---|---|---|
| **1-G057-2**(1) | 30 - 70 pF | 1.2 m | 50 MHz |

(1) Suitable instruments and input amplifiers:
GEN DAQ Basic Iso card **GN812**
GEN DAQ Basic XT cards **GN813 & GN814**

### D.2.3 Voltage probes for isolated amplifiers (high accuracy)

Voltage probes for isolated amplifiers divide down an isolated input signal by a specific factor. They are designed in an “isolated way”, so they can be used in front of an isolated unbalanced amplifier. So they are also called “isolated voltage probes”, though they do not add isolation; this comes from the amplifier.

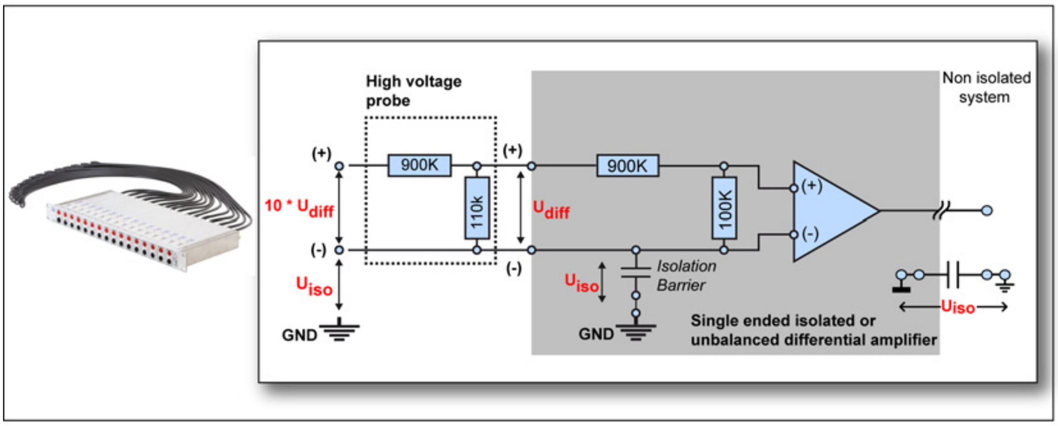



**Figure D.10:** Typical example of a high accuracy voltage probe for isolated amplifiers – done as external divider

Isolated voltage probes are usually just passive in-line resistors in front of the positive input of an isolated amplifier. Unfortunately this decreases the accuracy of the overall system.

However, isolated voltage probes can also be designed to overcome these drawbacks.

To achieve this, they are not only in-line resistors, they form a complete, high accuracy voltage divider in front (and in parallel) of the amplifier input. So the accuracy is determined mainly by the probe itself and maintained at high level.

There is still a capacitive component in this divider, so the amplifier and the probe need to match each other. Only a specific combination of probe and amplifier then can maintain high overall accuracy.

As the dividing down, however, only applies to the positive side of the amplifier input, the input range gets increased, while the isolation voltage remains the same as without probe.

These probes can only be used in front of isolated unbalanced amplifiers.

So these probes overcome the problems of "standard" passive probes and offer increased input ranges AND high accuracy.

*Table C.5: High accuracy voltage probes for isolated amplifiers overview table (Part 1)*

| Part number | Divider factor | Maximum input voltage |
|---|---|---|
| **1-G041-2(1)**<br>Must use suitable rack 1-G019-2 | x10 | 1 kV |
| **1-G042-2(1)**<br>Must use suitable rack 1-G020-2 | x1<br>AC coupled | 100 V AC<br>CMV: 1 kV DC |

*Table C.6: High accuracy voltage probes for isolated amplifiers overview table (Part 2)*

| Part number | Accuracy | Cable length | Bandwidth |
|---|---|---|---|
| **1-G041-2(1)**<br>Must use suitable rack 1-G019-2 | 0.2 %,<br>0.1 % typical | 1.2 m | 250 kHz |
| **1-G042-2(1)**<br>Must use suitable rack 1-G020-2 | 0.2 %,<br>0.1 % typical | 1.2 m | 250 kHz |

(1) Suitable instruments and input amplifiers:
GEN DAQ Basic XT cards **GN813 & GN814**

**Note** *These probes can only be used in the suitable probe racks, which itself must be mounted in a 19" rack or in a similar protective housing. Each probe rack holds up to 16 probes.*

### D.2.4 Passive differential voltage probes

Passive differential voltage probes are used in front of differential amplifiers and divide down a differential input signal by a specific factor.

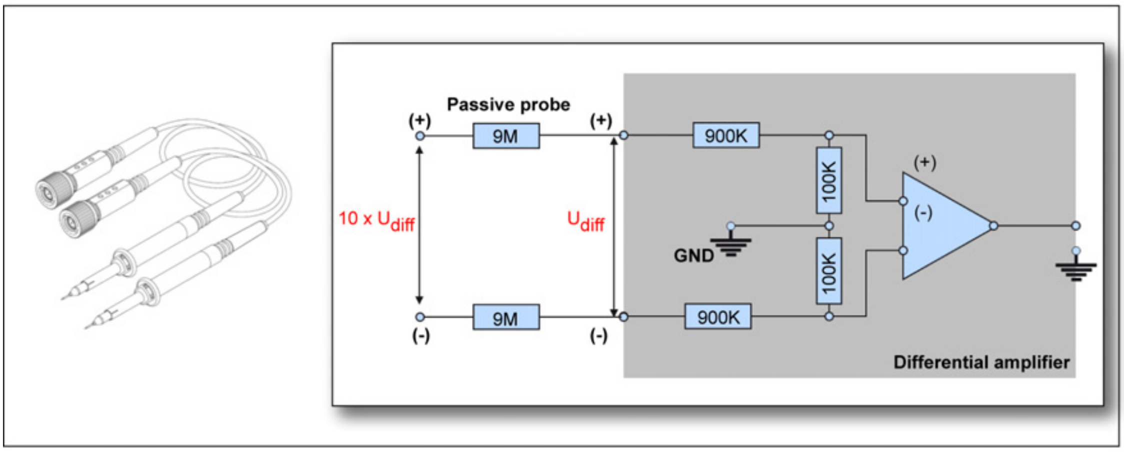



**Figure D.11:** Typical example of a passive differential voltage probe

Passive differential voltage probes are – in theory – just a pair of “normal” voltage probes.

They add passive in-line resistors in front of both the positive as well as the negative inputs of a differential amplifier. Together with the input resistor of the amplifier they form a voltage divider on each input side, so that the voltage in front of the amplifier itself gets divided down. As there is also a capacitive component in this divider, the input capacitance of the amplifier and the so called “compensation range” of the probe need to match.

As two of these probes are used, one with each input terminal, the probes itself needs to “match” as closely as possible, as otherwise the two input terminals are divided down differently.

Therefore the probes are typically manufactured (and sold) in pairs and called “matched”.

By selecting higher resistance probes the divider ratio gets bigger, so that pretty large input ranges are possible.

Passive differential voltage probes typically decrease the overall accuracy and the CMRR of the system.

*Table C.7: Passive differential voltage probes overview table (Part 1)*

| Part number | Divider factor | Maximum input voltage |
|---|---|---|
| **1-G025-2**(1) One pair | x200 | 2.8 kV AC rms<br>4 kV DC incl. AC pk |
| **1-G026-2**(1) One pair | x10 | 400 V rms CAT I<br>300 V rms CAT II |
| **1-G907-2**(2) One pair | x10 | 300 V rms CAT II |

*Table C.8: Passive differential voltage probes overview table (Part 2)*

| Part number | Compensation range | Cable length | Bandwidth |
|---|---|---|---|
| **1-G025-2**(1) One pair | 100 – 140 pF | 3 m | 20 MHz |
| **1-G026-2**(1) One pair | 105 – 140 pF | 3 m | 100 MHz |
| **1-G907-2**(2) One pair | 35 – 70 pF | 3 m | 100 MHz |

(1) Suitable instruments and input amplifiers:
GEN DAQ Universal cards **GN440 & GN441**

(2) Suitable instruments and input amplifiers:
First generation GEN DAQ High speed cards

**Note** *GN440 and GN441 cards are no longer available.*

### D.2.5 Active differential voltage probes

Active differential probes are battery powered, differential amplifiers in front of the input amplifier.

**Figure D.12:** Typical example of an active differential voltage probe

Active differential voltage probes are independent differential amplifiers in front of the system input amplifier.

The achievable input range and accuracy depends on the active differential probe used. Active differential probes can be used in front of virtually any amplifier, their performance typically is limited. Also, as they usually operate from batteries, this causes some inconveniency as battery maintenance is needed.

Active differential voltage probes typically decrease the overall accuracy and the CMRR of the system.

*Table C.9: Active differential voltage probes overview table (Part 1)*

| Part number | Divider factor | Maximum input voltage |
|---|---|---|
| **1-G909-2(1)** | 20X/200X switchable | +/- 1.4 kV DC or +/- 1000 V rms |

*Table C.10: Passive differential voltage probes overview table (Part 2)*

| Part number | Accuracy | Cable length | Bandwidth |
|---|---|---|---|
| **1-G909-2(1)** | +/- 2 % | 0.9 m | 25 MHz |

(1) Suitable instruments and input amplifiers:
All GEN DAQ Basic cards **GN810 & GN811 & GN812 & GN 814**
GEN DAQ High speed cards **GN412 & GN413**

### D.2.6 Reference tables

**Amplifiers and probes match overview table**

| Amplifier type | Part number | Input type | Input cap.(1) |
|---|---|---|---|
| **Basic200k(1)**<br>**Basic1M(1)** | **1-GN810-2**<br>**1-GN811-2** | Single ended | 32 pF |
| **Basic1M iso(2)** | **1-GN812-2** | Isolated unbalanced | 65 pF |
| **BasicXT200k iso(3)**<br>**BasicXT1M iso(3)** | **1-GN814-2**<br>**1-GN813-2** | Isolated unbalanced | 55 pF |
| **Uni200k iso(4)**<br>**Uni1M iso(4)** | **1-GN410-2**<br>**1-GN411-2** | Differential isolated | 100 pF |
| **HighSpeed25M(5)**<br>**HighSpeed100M(5)** | **1-GN412-2**<br>**1-GN413-2** | Differential | 21/25 pF; pending from range |
| **6600 HV 100M(6)**<br>**6600 HV 25M(6)**<br>**6600 MV 100M(6)**<br>**6600 MV 25M(6)**<br>**7600(6)** | **1-GN110-2**<br>**1-GN111-2**<br>**1-GN112-2**<br>**1-GN113-2**<br>**1-GN114-2** | Isolated unbalanced | 38 pF |
| **ISOBE5600 HV(7)**<br>**ISOBE5600 MV(7)** | **1-GENIS-1T**<br>**1-GENIS-1TM** | Isolated unbalanced | 38 pF |

(1) Suitable probes:
1-G901-2, x1/x10 (7-75 pF)
1-G902-2, x1/x10 (7-75 pF)
1-G903-2, x100 (7-45 pF)
1-G904-2, x100 (10-50 pF)
1-G906-2, x1000 (10-50 pF)
1-G909-2, active differential 1.4 kV
1-G912-2 & 1-G913-2 & 1-G914-2 current clamps

(2) Suitable probes:
1-G057-2, isolated, x100, 1 kV (30-70 pF)
1-G909-2, active differential 1.4 kV
all current clamps

(3) Suitable probes:
1-G057-2, isolated, x100, 1 kV (30-70 pF)
1-G041-2, isolated, x10, 1 kV, matched to amp
1-G042-2, AC isolated, x10, 100 V, matched to amp
1-G909-2, active differential 1.4 kV
1-G912-2 & 1-G913-2 & 1-G914-2 current clamps

(4) Suitable probes:
1-G025-2, passive differential, x200, 2.8 kV (100-140 pF)
1-G026-2, passive differential, x10, 400 V (100-140 pF)
1-G027-2, x1/x10, 400 V (100-140 pF)
(in single ended mode of the amplifier only)
1-G912-2 & 1-G913-2 & 1-G914-2 current clamps

(5) Suitable probes:
1-G909-2, active differential 1.4 kV
1-G912-2 & 1-G913-2 & 1-G914-2 current clamps

(6) Suitable probes:
1-G901-2, x1/x10 (7-75 pF)
1-G902-2, x1/x10 (7-75 pF)
1-G903-2, x100 (7-45 pF)
1-G904-2, x100 (10-50 pF)
1-G906-2, x1000 (10-50 pF)
1-G912-2 & 1-G913-2 & 1-G914-2 current clamps

(7) Suitable probes:
1-G901-2, x1/x10 (7-75 pF)
1-G902-2, x1/x10 (7-75 pF)
1-G903-2, x100 (7-45 pF)
1-G904-2, x100 (10-50 pF)
1-G906-2, x1000 (10-50 pF)
1-G912-2 & 1-G913-2 & 1-G914-2 current clamps

**Note** *For amplifiers not listed HBM currently does not offer any probes.*

## Amplifier/probe matrix

| Probe type / Input module | GN810, 200K | GN811, 1M | GN812, 1M iso | GN813, 1M iso XT | GN814, 200K iso XT | GN412, 100M | GN413, 25M | GN440, 200K Uni | GN441, 1M Uni | GN110, 100M 6600HV | GN111, 25M 6600HV | GN112, 100M 6600MV | GN113, 25M 660MV | GN114, 100M 7600 | GENIS-1T, 5600HV | GENIS-1TM, 5600MHV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **passive, single ended** | | | | | | | | | | | | | | | | |
| **1-G901-2, x1/x10** | ✓ | ✓ | | | | ✓* | ✓* | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **1-G902-2, x1/x10** | ✓ | ✓ | | | | ✓* | ✓* | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **1-G903-2, x100** | ✓ | ✓ | | | | ✓* | ✓* | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **1-G904-2, x100** | ✓ | ✓ | | | | ✓* | ✓* | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **1-G906-2, x1000** | ✓ | ✓ | | | | ✓* | ✓* | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **1-G027-2, x1/x10** | | | | | | | | ✓* | ✓* | | | | | | | |
| **passive, for isolated amplifiers** | | | | | | | | | | | | | | | | |
| **1-G057-2, x100, iso** | | | ✓ | ✓ | ✓ | | | | | | | | | | | |
| **1-G041-2, x10, iso** | | | | ✓ | ✓ | | | | | | | | | | | |
| **1-G042-2, x10, iso AC** | | | | ✓ | ✓ | | | | | | | | | | | |
| **passive differential, matched** | | | | | | | | | | | | | | | | |
| **1-G025-2, x200** | | | | | | | | ✓ | ✓ | | | | | | | |
| **1-G026-2, x10** | | | | | | | | ✓ | ✓ | | | | | | | |
| **1-G907-2, x10 ** ** | | | | | | | | | | | | | | | | |
| **active differential** | | | | | | | | | | | | | | | | |
| **1-G909-2, x20/x200** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | |
| **current clamps** | | | | | | | | | | | | | | | | |
| **1-G912-2** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | |
| **1-G913-2** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | |
| **1-G914-2** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | |

* Probe can be used in single ended mode of the amplifier only

** Probe fits only obsolete first generation fast digitizers

## HBM/LDS part number reference table

| HBM Part number | Type | Probe factor | Old LDS Part number |
|---|---|---|---|
| 1-G901-2 | Passive voltage | x1/x10 | 869-923900 |
| 1-G902-2 | Passive voltage | x1/x10 | 869-924900 |
| 1-G903-2 | Passive voltage | x100 | 869-925000 |
| 1-G904-2 | Passive voltage | x100 | 117-901600 |
| 1-G906-2 | Passive voltage | x1000 | 085-953700 |
| 1-G057-2 | Isolated | x100, iso | n/a |

| HBM<br>Part number | Type | Probe factor | Old LDS<br>Part number |
|---|---|---|---|
| 1-G041-2 | Isolated | x10, iso | 846-948000 |
| 1-G042-2 | Isolated, AC only | x10, iso AC | 846-948100 |
| 1-G025-2 | Differential, match-ed | x200 | 869-929500 |
| 1-G026-2 | Differential, match-ed | x10 | 869-929600 |
| 1-G027-2 | Passive voltage | x1/x10 | 869-929700 |
| 1-G907-2 | Differential, match-ed | x10 | 869-925100 |
| 1-G909-2 | Active differential | x20/x200 | 869-926500 |
| 1-G912-2 | Current clamp | | 085-963200 |
| 1-G913-2 | Current clamp | | 222-146100 |
| 1-G914-2 | Current clamp | | 085-940900 |

### Probe accessories

**Probe accessories**
**Part number: 1-G910-2 (ex 040-747900)**
Probe tip adapters with 4 mm safety-shrouded banana plugs. Includes tip and ground lead adapters and two alligator clips with 1" jaw opening.
Use on probes G901 and G902 only.

**G911 Probe Accessory Kit**
**Part number: 1-G911-2 (ex 869-925200)**
Includes rigid probe tip, spring-loaded probe tip, insulating cap, ground lead, sprung hook, trimmer tool, and BNC adapter.
Use on probes G901 and G902 only.

Genesis Highspeed Probes MASTER list with part number and vendor list:

| HBM Part number | Type | Vendor | Vendor type name | Probe factor | Compensation range | Cable length | Max voltage | Bandwidth | Accuracy |
|---|---|---|---|---|---|---|---|---|---|
| 1-G901-2 | passive, single ended, switchable | PMK | PMK 869-923900 | x1 / x10 | 7….75 pf | 1.2 m | x1: 55 V rms CAT II<br>x10: 400 V rms CAT I<br>x10: 300 V rms CAT II | x1: 12 MHz<br>x10: 200 MHz | x10: +/- 2 % at DC |
| 1-G902-2 | passive, single ended, switchable | PMK | PMK 869-924900 | x1 / x10 | 7….75 pf | 3 m | x1: 55 V rms CAT II<br>x10: 400 V rms CAT I<br>x10: 300 V rms CAT II | x1: 6 MHz<br>x10: 100 MHz | x10: +/- 2 % at DC |
| 1-G903-2 | passive, single ended | PMK | PHV1000-1-45 | x100 | 7….45 pf | 1.2 m | 1000 V rms CAT I<br>1000 V rms CAT II | 400 MHz | +/- 2 % at DC |
| 1-G904-2 | passive, single ended | PMK | PHV642-L | x100 | 10…50 pF | 2 m | 2 kV AC rms<br>3 kV DC incl AC pk | 300 MHz | |
| 1-G906-2 | passive, single ended | PMK | PHV4002-3 | x1000 | 10…50 pF | 3 m | 20 kV DC<br>14 kV AC rms (50/60 Hz)<br>40 kV pulse (derating) | 100 MHz | |
| 1-G057-2 | passive, single ended, isolated | Multi-Contact | Isoprobe II 100:1 55pF | x100 | 30….70 pF | 1.2 m | 3540 V CAT I<br>1000 V CAT II<br>600 V CAT III | 50 MHz | |
| 1-G041-2 | passive, single ended, isolated | HBM product | | | n/a | | | | |
| 1-G042-2 | passive, single ended, isolated, AC only | HBM product | | | n/a | | | | |
| 1-G025-2 | passive differential, matched | PMK | PDD 4263-L-140 | x200 | 100….140 pF | 3 m | 2.8 kV AC rms<br>4 kV DC incl AC pk | 20 MHz | |
| 1-G026-2 | passive differential, matched | PMK | PDD 4013A-140 | x10 | 105…140 pF | 3 m | 400 V rms CAT I<br>300 V rms CAT II | 100 MHz | |
| 1-G027-2 | passive, single ended, switchable | PMK | PMTG 323A-140 | x1 / x10 | 100…140 pF | 3 m | x1: 55 V rms CAT II<br>x10: 400 V rms CAT I<br>x10: 300 V rms CAT II | x1: 2 MHz<br>x10: 50 MHz | x10: +/- 2 % at DC |
| 1-G907-2 | passive differential, matched | PMK | PDD4013A-70 | x10 | 35...70 pF | 3 m | 400 V rms CAT I<br>300 V rms CAT II | 100 MHz | +/- 2 % at DC |
| 1-G909-2 | active differential | ProbeMaster | Model 4231 | x20 / x200 | n/a | 0.9 m | x20: +/-140 V DC or 140 V rms<br>x200: +/-1.4 kV DC or 1 kV rms | 25 MHz | +/- 2 % |

## D.3 General note on probes

Due to the high capacitive load of the input of the universal amplifier, special care must be taken when selecting a probe for measurements. This section describes some related issues.

A probe makes a physical and electrical connection between a test point or signal source and the instrument. Depending on the measurement needs, this connection can be made with something as simple as a length of wire or with something as sophisticated as an active differential probe.

For the purpose of this document we only describe attenuating probes within two categories: 1X Probes and 10X Probes.

## D.4 1X Probes

1X probes, also known as 1:1 (one-to-one) probes, simply connect the input of the instrument to the circuit being measured. They are designed for minimum loss and easy connection, otherwise they are equivalent to using a cable to connect the instrument.Figure D.13 shows the circuit diagram for an instrument input connected to a circuit under test. The circuit under test is modeled as a voltage source with a series resistor. The 1X probe (or cable) will introduce a significant amount of capacitance that appears in parallel with the input of the instrument. A 1X probe may have around 40 to 60 pF of capacitance.

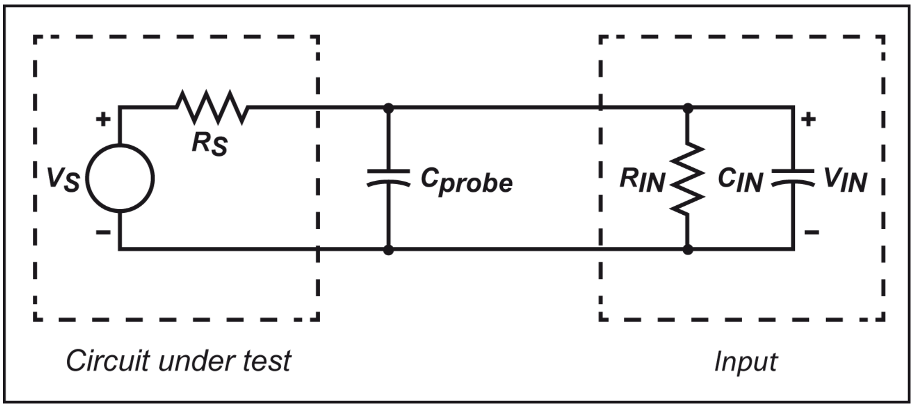



**Figure D.13:** Input connected using a 1X probe

The impedance of the circuit and the input impedance of the instrument together produce a lowpass filter. For very low frequencies, the capacitor acts as an open circuit and has little or no effect on the measurement. For high frequencies, the capacitor's impedance becomes significant and loads down the voltage seen by the instrument. Figure D.14 shows this effect in the frequency domain. If the input is a sine wave, the amplitude tends to decrease with increasing frequency and the phase is shifted.

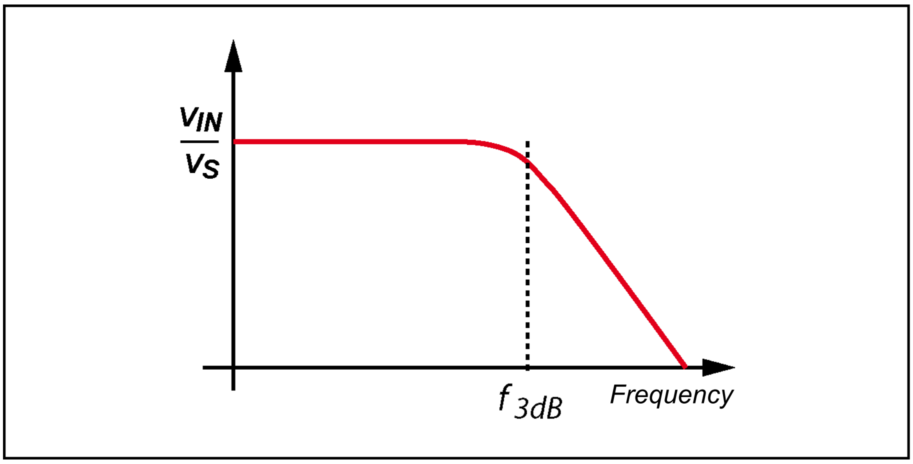



**Figure D.14:** Frequency response with 1X probe

Example: assume a voltage source with a 1 MΩ resistance and a 1X probe with 50 pF capacitance (a 1X probe by itself has no resistance). The universal amplifier input has a 1 MΩ resistance and a 100 pF capacitance.

This yields a – 3dB point at:

**(EQ1)**

$$f(\text{-}3db) = \frac{1}{2\pi(R_s \| R_{IN})\ (C_{IN} + C_{probe})}$$

= 1 / (6.28 x 500 E+3 x 150 E-12) ≈ 2 kHz

The loading due to the input impedance of the instrument and the probe capacitance is twofold: resistive loading and capacitive loading.

The resistive loading actually reduces the voltage delivered to the instrument:

**(EQ2)**

$$V_{IN} = V_S\left(\frac{R_{IN}}{R_{IN} + R_S}\right)$$

The effect of the capacitive loading is more complex and results in an exponential response in the voltage:

**(EQ3)**

$$V_{IN}(t) = V_{MAX}\left[1 - e^{-t/(R_S C_{in} + probe)}\right]$$

## D.5 10X Probes

10X probes (also called 10:1 probes, divider probes, or attenuating probes) have a resistor and capacitor (in parallel) inserted into the probe. Figure D.15 shows the circuit for the 10X probe connected to a high-impedance input of an instrument.

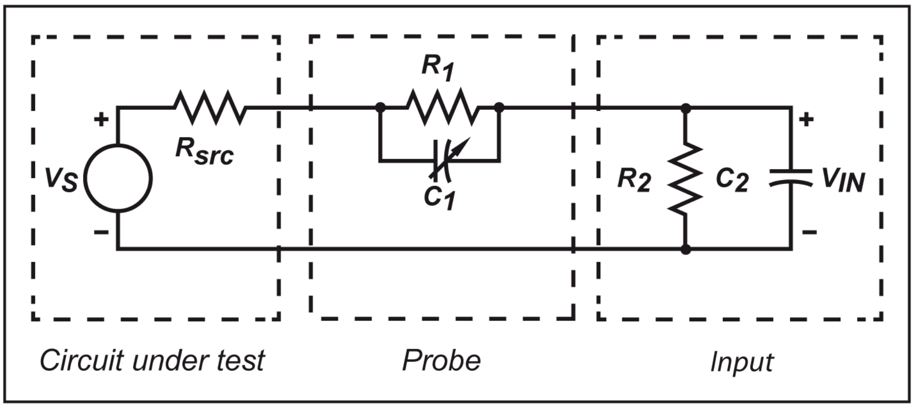



**Figure D.15:** Input connected using a 10X probe

Supposing that Rsrc is low compared to R1, and if R1C1 = R2C2, then this circuit has the result that the effect of both capacitors exactly cancel. The capacitor is usually made adjustable and can be tweaked for a near perfect match. Under these conditions, the relationship of VS to VIN is:

**(EQ 4)**

$$V_{IN} = V_S\left(\frac{R_2}{R_1 + R_2}\right)$$

R2 is the input resistance of the instrument's high input impedance (1 MΩ) and R1 = 9R2. From the previous equation, this results in:

**(EQ 5)**

$$V_{IN} = \left(\frac{1}{10}\right)V_S$$

So the final result is a probe / instrument input combination that has a much wider bandwidth than the 1X probe, due to the effective cancellation of the two capacitors. However, the instrument now sees only one-tenth of the original voltage (hence the name 10X probe). Also notice that the circuit being measured sees a load impedance of R1 + R2 = 10 MΩ, which is much higher than with the 1X probe.

**IMPORTANT**

**For a correct compensation it is necessary that both impedances have the same value, i.e. R1C1 = R2C2. In practice, this condition may not be met exactly but can be approximated. The probe's compensation capacitor is usually made adjustable somewhere between 10 pF and 50 pF to compensate for the instrument's input capacitance. Since the Universal Amplifier has a 100 pF capacitance there is no way to compensate correctly with standard probes. Therefore the probe capacitance must be adapted to this situation. Various probe manufacturers offer the possibility to purchase probes with other compensation ranges on request.**

### D.5.1 Probes and differential measurements

Connecting the differential amplifier or probe to the signal source is generally a great source of error. To maintain the input match, both paths should be as identical as possible. Any cabling should be of the same length for both inputs. If individual probes are used for each signal line, they should be the same model and cable length. When measuring low-frequency signals with large common-mode voltages, avoid the use of attenuating probes. At high gains, they simply cannot be used as it's impossible to precisely balance their attenuation. When attenuation is needed for high-voltage or high-frequency applications, special passive probes designed specifically for differential applications should be used. These probes have provisions for precisely trimming DC attenuation and AC compensation. To get the best performance, a set of probes should be dedicated to each specific amplifier and calibrated with that amplifier using the procedure included with the probes.

## D.6 Shunt measurements

Special care must be taken with shunt measurements. Typical shunt measurements generate signals with an amplitude of only a few volts or even mV. To prevent interference from higher voltage signals (up to 100 V) the following guidelines apply:

- Use only coaxial cables for all measurements.
- If possible place the instrument as close as possible to the test object to reduce the length of the coax cable.
- Physically separate low voltage signal lines and high voltage signal lines as much as possible. Do not combine them. When the high voltage signals include high frequency transients these will easily cross over to the low voltage signals.

**HINT/TIP**

The GEN DAQ series instruments typically have a very high bandwidth. As a result of this high bandwidth, high frequency transients might show that have never shown before while using other (low-bandwidth) equipment. Use the filter to reduce the bandwidth to a physically relevant value.

# E Trouble Shooting

## E.1 Embedded Software upgrades

When a new version of Perception is installed, the embedded software of the mainframes is updated automatically when Perception connects to the mainframe.

**Note** *Some upgrades may take more than 10 minutes.*

**IMPORTANT**

**Do not power-off the mainframe, do not disconnect network cables and do not shut down Perception during an embedded software upgrade.**

When the software upgrade process does not complete within 30 minutes, turn-off the mainframe by keeping the Power-On button pressed for 5 seconds. Wait for 30 seconds and turn the unit back-on.

Wait until the unit completed is boot process. If the new software version is booted, Perception will connect and start using the mainframe as normal. In rare conditions the upgrade might have failed. This could result in:

- The mainframe uses the old software.
- The mainframe uses the “minimum mode” software.

In both cases Perception software will automatically detect old software version during connection attempt and restarts the upgrade procedure.

In the very unlikely event your mainframe will not reboot, turn the unit off again and retry the boot process. If your mainframe keeps failing to boot, contact your HBM service agent for enhanced support.

## E.2 Unexpected mainframe shutdown

If the mainframe has shut down unexpectedly, this can have several causes:

- **Power interruption**
  - Check if the mains cable is still firmly connected.
  - Find out if other devices on the same mains group have experienced a power interruption
- **Over-temperature or over-voltage:**
  - If this happens while Perception is connected, a message is shown that tells the reason for the shutdown. Apart from that, a message is shown when connecting the next time, even if Perception was not connected at the time of the shutdown.
  - If the cause was an over-temperature, please check the airflow around the mainframe: the mainframe must be able to attract cool air to avoid over-heating.
  - In case of an over-voltage, please contact HBM service.

## E.3 The Master/Slave connection doesn't get synchronized

If this happens, check the following:

- Check if the Master/Slave mode setting for each mainframe matches the role of that mainframe. There should be one (and only one) master and one or more slave(s).
- Check the optical Master/Slave cables. Both LEDs at the connector should be lit
- Verify the cable type: the Master/Slave cables should be multi-mode, 850 nm optical cables.
- Very long cables and optical couplers in the cable degrade the optical signal. Check chapter "Calculating maximum fiber cable length" on page 691 for calculation of optical losses.
- The optical connections should not be damaged and should be free of dust and lint.

## E.4 The IRIG/GPS doesn’t get synchronized

- Verify the settings: Is the correct synchronization source selected?
- In case of IRIG, does the IRIG mode (like “IRIG B AM”) match the IRIG signal?
- Check if the correct connections are made: refer to the corresponding chapter.
- GPS synchronization can take a long time. Be patient. You may try to switch back to RTC and start all over again.
- Check if the signal (IRIG) is free of distortions (e.g. record the IRIG signal and check if the amplitude-modulated sine wave is clean).
- Check the positioning of the GPS antenna. The GPS synchronization needs signals from at least three satellites for correct operation. Walls can distort the signals from the satellites by blocking or reflecting them.

## E.5 Optical Network (SFP)

If no connection is present on the fiber optic channel, first check the following:

1. That the **cable type** matches the **SFP module type** (Single Mode or Multi Mode).
   *For this you will need to check with the cable manufacturer specifications and the wavelength printed on the label of the SFP module to compare (1310 nm for Single Mode, 850 nm for Multi Mode).*
2. Check that the **cable wavelength** and **SFP module wavelength** are the same.
   *For this you will need to check with the cable manufacturer specifications and check the print on the label of the SFP module to compare.*
3. Check that the communication speed at either end of the fiber optic connection is the same.
4. Inspect cable and connectors for any possible faults and breaks that could impede communication.
5. The optical connections should not be damaged and should be free of dust and lint.

## E.6 Legacy firmware upgrade process

**Note** *If you are using Perception 6.14 or higher, firmware is automatically upgraded.*

Your instrument stores its operating instructions in internal non-volatile flash memory which you can easily upgrade as HBM adds new features and functions. The process is comparable to upgrading the BIOS in your PC. You may check HBM's web site www.hbm.com/highspeed for the latest versions, or you may subscribe to an automatic maintenance service that will assure you always receive applicable upgrades. Please contact your HBM representative for details on available subscriptions.

Upgrading the GEN series firmware requires an application that either came on a CD supplied with your hardware or you downloaded through the Internet update service. Run Setup to install this software.

**To update the firmware proceed as follows:**

1. Turn the instrument on and wait for it to display "Ready" or “Fast Streaming” on its local display.
2. Ensure your PC is connected correctly to the instrument by a network cable or via a network switch or hub *(if you have been successfully using the instrument with Perception, your connection is correct).*
3. Make sure no other software is active on your PC and close the Perception application before using the upgrade software.
4. To start the upgrader on your PC click **Start**, point to **All Programs**, point to **HBM**, point to **GEN series**, point to **Firmware Upgrader** and click **GEN series Firmware Upgrader**. This will launch the application.
5. Read pop-up messages carefully before continuing. They may contain important information with respect to the upgrade process.

6 Depending on your security settings the following dialog may come up:


**Figure E.1:** Windows Security Alert dialog

Select **Unblock** to continue.

**7** A dialog appears:

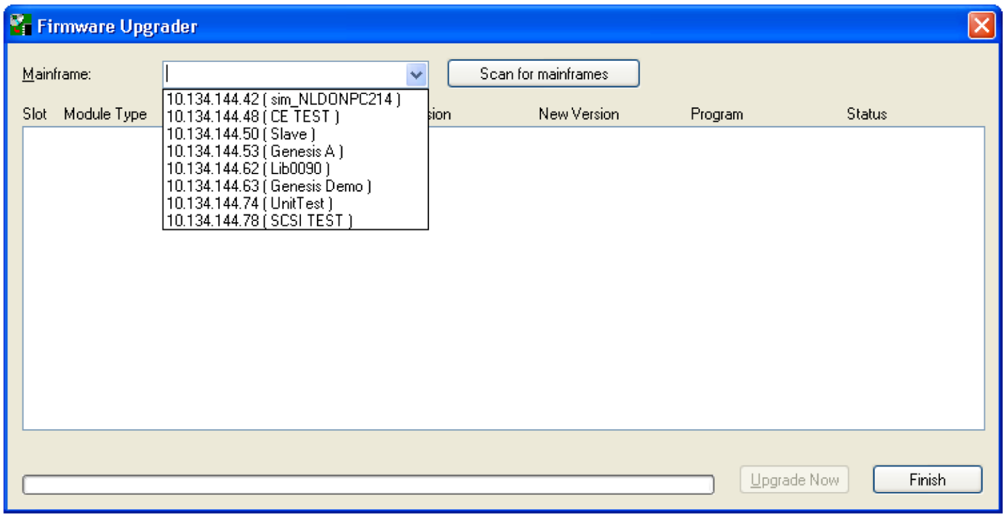



**Figure E.2:** Firmware Upgrader dialog (1)

Click the down arrow of the Select mainframe list. This will give you a list of available mainframes, identified by both the IP address and network name. You may need to click the Scan network button to update/refresh the list.

**8** Select the system you need to upgrade. You will be prompted for a password when the system is password protected. The default password for the GEN series is "genesis", all in lower case and without the quote marks. If you have changed your password, you will be prompted here, otherwise the program will continue automatically.

9 When connected the FirmwareUpgrader utility checks your mainframe's current versions and compares them to the upgrade versions to see if an upgrade is necessary:

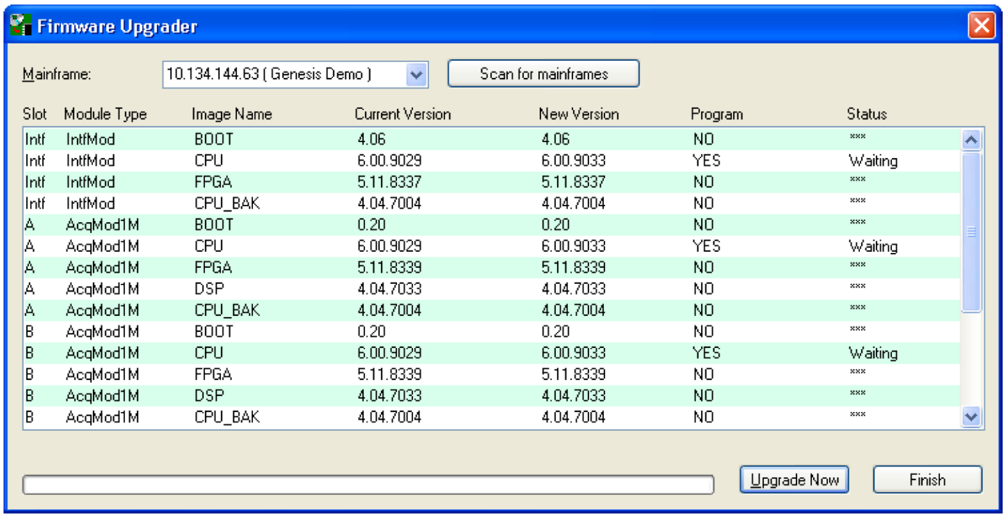



**Figure E.3:** Firmware Upgrader dialog (2)

The Upgrade column shows which firmware parts will be upgraded. The Status column shows the status of the upgrade process.

10 Click **Upgrade Now** to start the upgrade process. Allow up to 15 minutes for the upgrade to complete. A progress indicator is shown in the bottom status bar.

**WARNING**

**DO NOT for any reason switch off your computer, your instrument, or close the upgrade program while an update is in process. Your instrument could be DAMAGED PERMANENTLY and require factory repair if the upgrade is interrupted.**

When finished, the message **Ready** appears at the bottom of the screen. Click the **Close** button to exit.

11 Your instrument must be powered down and restarted for the new firmware to take effect. After rebooting, the startup screen will display your new CPU version and the instrument is ready for use. The upgrade is now completed.

When major new features have been added since the prior version, it is possible an upgrade to the Perception control software may also be necessary. If so, you will be advised the next time you start Perception and attempt to connect. If no message appears your versions are compatible.

## E.7 Formatting a SCSI for use with the GEN series

The volume to be created and formatted has to be a FAT32 file system with a cluster-size of 32768 bytes. All windows versions are capable of detecting and working with FAT32 volumes up to 2 TB. However, every Windows version has the limitation that it can only create and format FAT32 volumes up to only 32 GB. Most SCSI disks are capable of holding much larger volumes and GEN series mainframes support volumes up to 1 TB. A third party windows format tool is required to create the volume using a windows PC that is supported by GEN series mainframes.

To prepare a SCSI disk to be uses on a GEN series mainframe the following steps have to be performed on a windows PC:

**1** Connect a Windows 2000 PC or higher to the SCSI disk and reboot the PC.

**2** Open the control panel and choose “administrative tools”.

**3** Open “Computer Management”.

**4** Open “Disk Management”.

**5A** The SCSI disk should be visible as a disk that only has **Unallocated Space** like in the screen-shot Figure E.4.

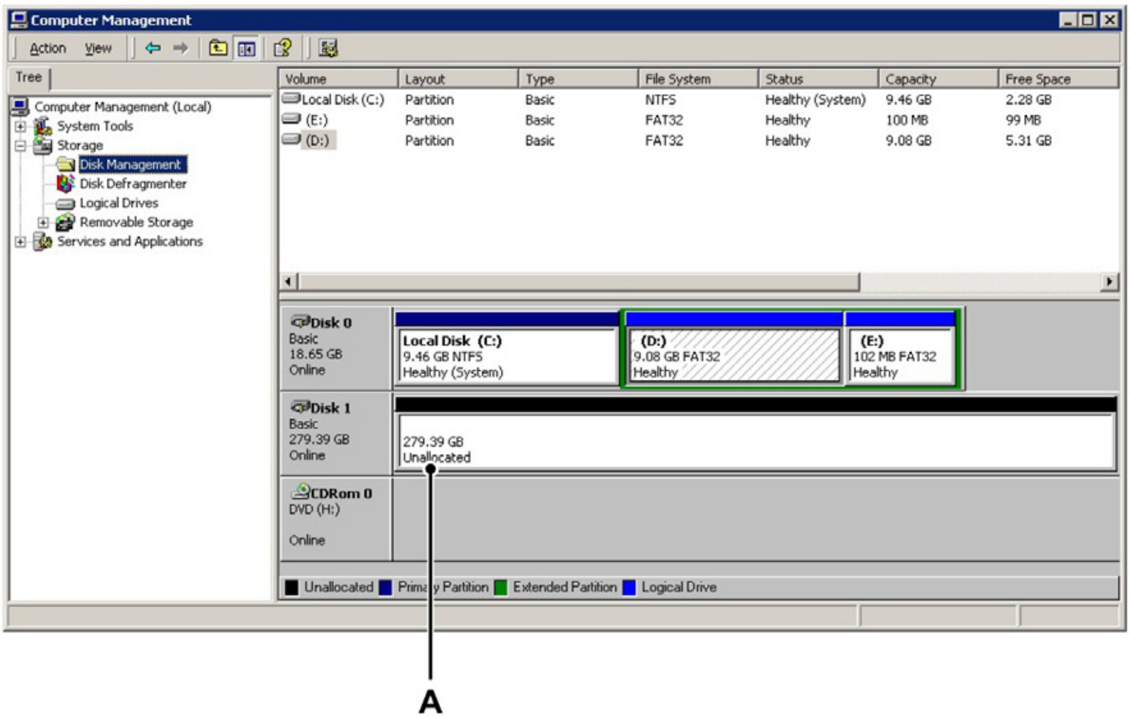



**Figure E.4:** Computer Management - Unallocated Space

**A** Unallocated Space

**5B** In case the disk is detected as “Dynamic”, change it to “Basic” ...
Right click on the grey box where “Disk 1” is written and select the option “Revert to basic disk”.

**6** Right click on the long white box containing **GB Unallocated**, select **Create Partition** and click next.

**7** Select **Primary Partition** and click **next**.

**8** Confirm the partition size with the maximum possible size and click **next**.

**9** Choose **Assign a drive letter** and click next.

**10** Choose **Do not format this partition** and click next.

**11** Click **Finish** and close the **Computer Management** window.

**12** Start a command prompt and use the utility “fat32format.exe” from there, using the drive letter assigned to the newly created partition (e.g. “fat32format f:”).

**13** Confirm the format with Y and Enter.

After the format has been completed, the SCSI disk should be accessible using the windows explorer. The SCSI disk has to be connected with the GEN series mainframe again. The GEN series mainframe has to be rebooted. The SCSI disk is now ready to be used.

## E.8 Installation of the SSD disk on a IM2 Module

**CAUTION**

**HBM uses state-of-the-art electronic components in its equipment. These electronic components can be damaged by discharge of static electricity (ESD). ESD damage is quite easy to induce, often hard to detect, and always costly. Therefore we must emphasize on the importance of ESD preventions when handling a GEN series system, its connections or a plug-in card.**

**WARNING**

**Installation of the SSD disk requires trained production or service people.**

**WARNING**

**Engineer must have basic knowledge of the Perception Software.**

**Required parts**

| Number | Description | Order No. |
|---|---|---|
| 1 | Solid State disk | LD-222-943700 |
| 4 | Screw M3x5 Torx SS | LD-227-M03000500 |
| 4 | Spring washer M3 wave SS | LD-244-M03000 |

**Required tooling**

| Number | Description | Order No. |
|---|---|---|
| 1 | GEN7t or GEN16t mainframe | 1-GEN7T-2 |
| - | Torque screwdriver with T10-bit | - |
| - | Perception software | - |

### E.8.1 How to Install the SSD disk on a IM2 Module

**HINT/TIP**

Take anti static precautions, before installation

1 Check if there is a insulation sheet on the IM2 module. This must be installed.

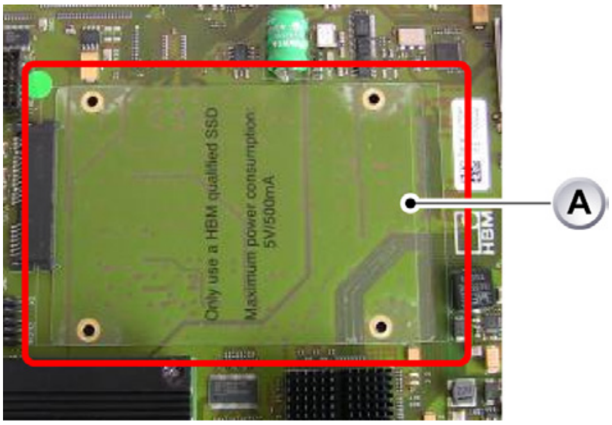



**Figure E.5:** Insulation sheet

**A** Installed insulation sheet on the IM2 module.

2 Slide the SSD disk in the SATA connector.

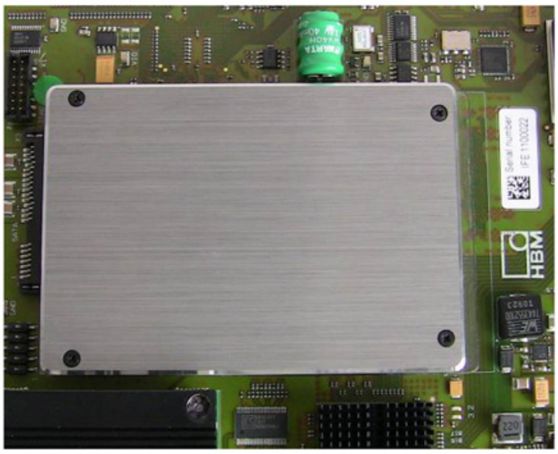


**Figure E.6:** SSD disk on the IM2 module

**3** Turn around the IM2 module carefully (press the SSD disk against the module).
Fix the disk using four screws and washer.
(Torque value: 0.70 Nm (= 6.2 Lb-In)

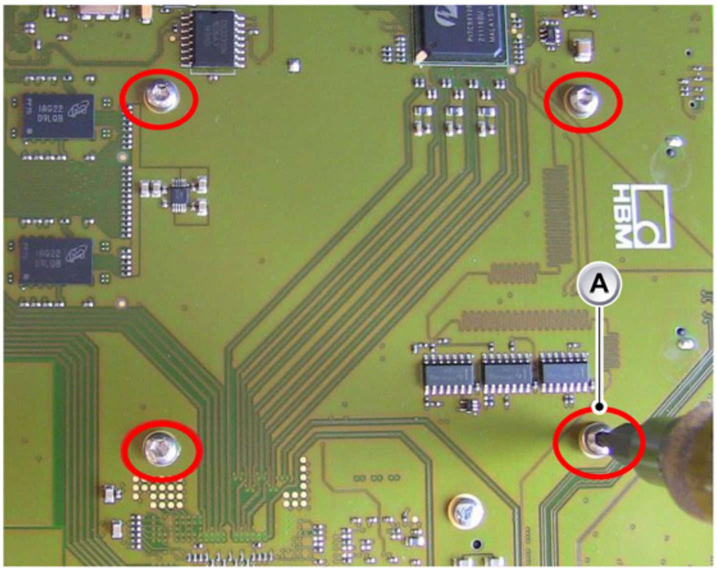



**Figure E.7:** Installation of the SSD disk

**A** Screw for fixing the SSD disk

**4** Now the SSD disk is installed on the IM2 module.
Before usage, the disk must be checked and formatted. See next chapters how to do this.

### E.8.2 Disk status check

**How to check the disk status:**

**1** Install the IM2 module in a GEN7t mainframe (no acquisition cards required).

**Note** *Installation in a GEN16t is also possible. Process is exactly the same. Pictures in this document only show the GEN7t.*

**Note** *For the option on a IM2 module in a GEN5i or GEN2i the IM2 module must be removed from the system and must be installed in a GEN7t or GEN16t*

**2** Connect power and switch on the unit.

**Note** *Network connection is not required, but is preferred because it reduces startup time.*

**Figure E.8:** GEN7t with IM2 module

**3** During start up the **Name / DHCP BUSY / Time** are shown.


**Note** *Name and time can be different.*

**4** After the unit is booted the **Name / Version / Time** are shown.


**Note** *Name, version and time can be different.*

5 Press the **Menu** key. The **Menu / Settings** comes up.


6 Press the **Down** key until the **Menu / Status** comes up.


7 Press the **Select** key. Now the **Status / Version** option will come up.


8 Press the **Down** key until the **Status / LocDisk** comes up.

*Table D.1: Disk status check summary*

| MENU | FUNCTION |
|---|---|
| **Disk Available** | This means there is a formatted disk installed and there are no additional actions required.<br><br>**Note**<br>*If you want to be sure that the disk is clean, you can still perform the Disk-Format process.* |
| **NotFormatted** | This tells you that the disk is recognized by the hardware, but still needs to be formatted. To do so the Format Process has to be executed (See next chapter "Disk formatting process" on page 669). |

### E.8.3 Disk formatting process

**Menu > Status**

**How to perform a disk formatting process**

1 Press the **Down** key until the **Status / Format** option comes up.

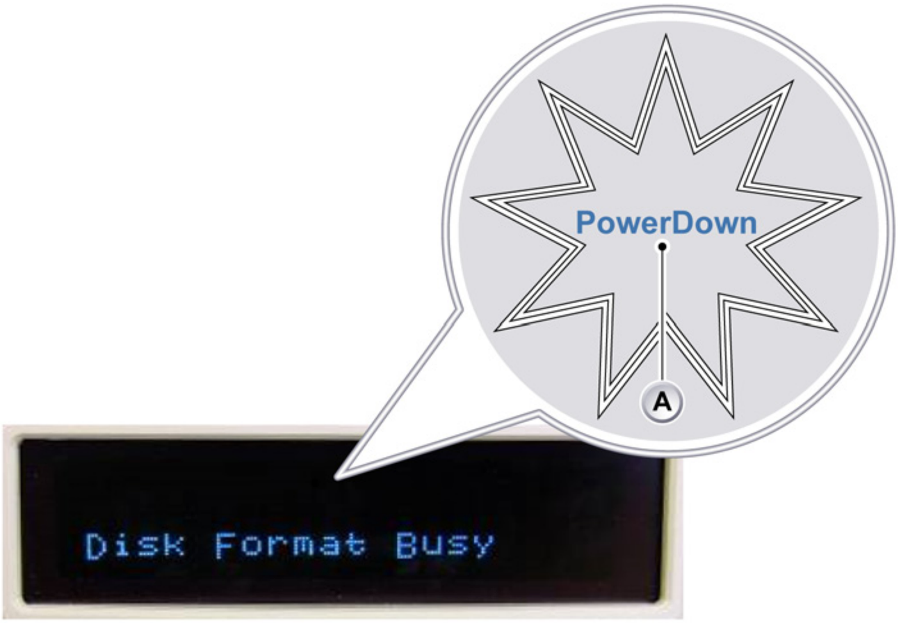

2 Press the **Select** key until the **QuickFormat & Reboot** option comes up.


3 Press the **Select** key to start the format and reboot process.

**WARNING**

**Do not switch off the unit during this process !!**

During the **QuickFormat & Reboot** process the following message comes up:




**A** **PowerDown** blinks

**Note** *This process takes several minutes !!*

4 When **Disk Format Busy** process has finished the **Rebooting** process starts.

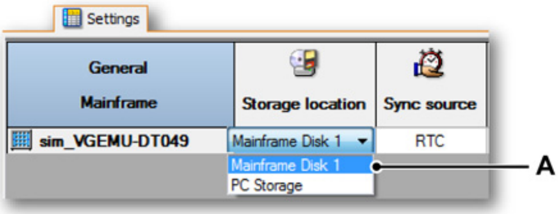

**Note** *System reboots automatically.*

After the disk is formatted, check if the disk is visible by the Perception software (See next chapter "Disk check with Perception" on page 670).

### E.8.4 Disk check with Perception

1 Make sure an acquisition card is installed to run Perception.

2 Startup Perception and connect to the mainframe.
3 The **Storage Location** options contains now a new storage location **Mainframe Disk 1**.




**A** Mainframe Disk 1 storage location

Select **Mainframe Disk 1** option.

4 Set sample frequency to 10 kHz.
5 Put a 80 % full scale, 100 Hz sine wave on the input.
6 Make a recording for 3 seconds (settings are not critical).
7 When the recording is OK the Solid State disk option is properly installed.

## E.9 Removal of the SSD disk from an IM2 module

**CAUTION**

**HBM uses state-of-the-art electronic components in its equipment. These electronic components can be damaged by discharge of static electricity (ESD). ESD damage is quite easy to induce, often hard to detect, and always costly. Therefore we must emphasize on the importance of ESD preventions when handling a GEN series system, its connections or a plug-in card.**

**WARNING**

**Removing the SSD disk requires trained production or service people.**

**Required tooling**

Torque screwdriver with T10-bit.

**Remove IM2 from mainframe**

For detailed instructions how to remove a board see Figure 11.43 "IM2 Module - Remove device" on page 227.

**Removal of the disk**

**1** Turn the IM2 module over so you are looking at the backside as show in Figure E.9.

2 Disconnect the SSD disk from the IM2 module by removing the four screws and washers marked with red circles below.

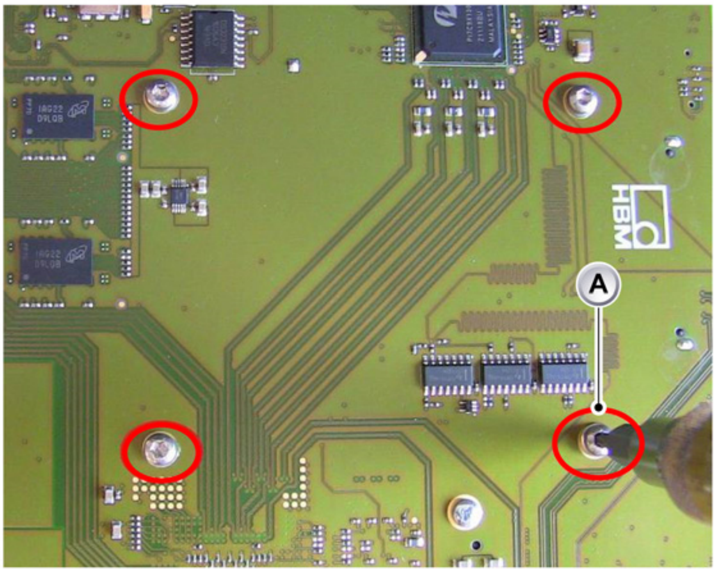



**Figure E.9:** Removal of the SSD disk (Part 1)

**A** Screw for fixing the SSD disk

3 Turn the IM2 module over while supporting the SSD disk
4 Slide the SSD disk out of the SATA connector by carefully moving the disk to the right as shown in Figure E.10

**WARNING**

| **Do not lift the disk until it is disconnected from the connectors.** |
| --- |

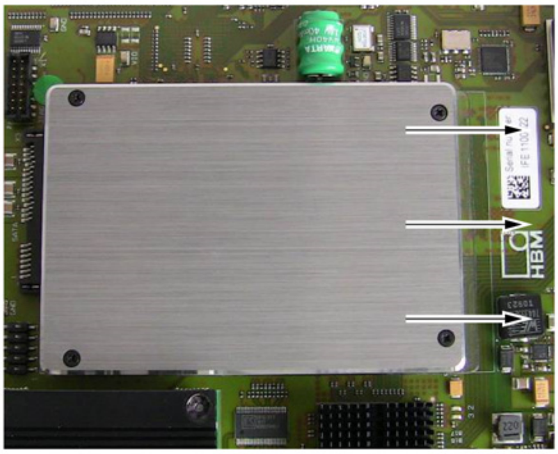


**Figure E.10:** Removal of the disk (Part 2)

**5** The SSD disk is now removed. The IM2 can be re-inserted into the mainframe.

## E.10 Master/Slave synchronization verification procedure

To verify the correct operation of the Master/Slave configuration, proceed as follows:

**Hardware set-up**

1. Set-up two GEN series mainframes each with at least one recorder card installed.
2. For GEN5i/GEN7t/GEN16t make sure each mainframes has a Master/ Slave card installed.
   For GEN2i/GEN3i/GEN3t/GEN7i and GEN7tA the system synchronization connector can be used.
3. Connect a TTL level, 1 Hertz signal to the top input of the first recorder card of the master mainframe and to the top input of the first recorder card of the slave mainframe.
4. Switch on both GEN series mainframes and wait until they have completed the booting process.
5. With the fiber optic cable, connect to any connector of the Master/Slave card of the master mainframe to the top connector labelled **M/S IN** of the Master/Slave card of the slave mainframes (For GEN2i/GEN3i/GEN3t/ GEN7i and GEN7tA use the Master/Slave synchronisation connector).
6. Check if both LEDs on both Master/Slave cards are illuminated green (For GEN2i/GEN3i/GEN3t/GEN7i and GEN7tA check the LEDs near the Master/Slave synchronisation connector).

**Software set-up**

1. If it is not already active, start Perception.
2. In the start dialog, select **New blank experiment**.
3. Make sure that you are connected to the required mainframes. Use the *Hardware Navigator* to do this.
4. In the **Settings** sheet, go to the **General** group in the task pane and select **Mainframe**. A list of available mainframes is displayed in the settings area.
5. Set the master mainframe operating mode to Master in the **Master/ Slave mode** column.
6. Set the slave mainframe operating mode to Slave in the **Master/ Slave mode** column.
7. The slave mainframe will now be synchronized to the master mainframe. The status palette will now show a box with the synchronization status of the Master/Slave system. This box is labelled **MASTER SLAVE**.

8 The synchronization status will first be **Synchronizing** for up to three minutes before becoming **Synchronized**.


**Figure E.11:** MASTER SLAVE Synchronizing


**Figure E.12:** MASTER SLAVE Synchronized

9 In the **Settings** sheet, go to the **Trigger** group in the task pane and select **Channel**.
10 In the **Trigger mode** column, set all triggers to **Off**.

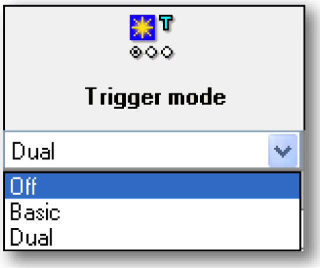



**Figure E.13:** Trigger mode list

11 Select the input with the connected TTL level, 1 Hertz signal on the master mainframe and set the trigger of this channel to **Basic**.
12 In the **Trigger** group, select **Recorder**.
13 Double-click on the **Master/Slave trigger** cell to open it for modification.

**14** In the drop-down list that comes up, select **Transceive** for all recorders.

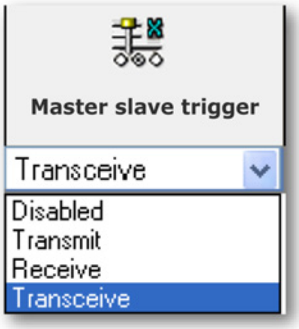



**Figure E.14:** Master/Slave trigger list

**15** Set the filter mode of both channels to "Wideband".

**16** Set-up a display with the first channel of the first recorder card in the master mainframe and the first channel of the first recorder card in the slave mainframe.

**Making a multi-mainframe recording**

**1** Wait for the “MASTER SLAVE” status to display **Synchronized** before proceeding to the next step.


**Figure E.15:** MASTER SLAVE Synchronized

**2** Press **Run** in the acquisition control panel to start a recording.

**3** The signal on the master mainframe will now generate a trigger event. This trigger event will be relayed to the slave mainframe.

**4** The recording will now show the rising edge of the TTL level 1 Hertz signal recorded by the master mainframe and the slave mainframe.

**5** The recordings in both mainframes are started at the same time.

**6** All recorded signals will match in time to within ± 150 ns.

If all signals match in time, the recordings were completed successfully.

# F Application Specific Usage

## F.1 Rotational External Clock

GEN DAQ systems allow extensive setups for rotating external clock measurements. This document explains how to use the settings to get the job done.

### F.1.1 GEN DAQ settings explained

All settings shown in this document can be found in the Perception software.

In Perception activate the settings sheet as shown in Figure F.1.

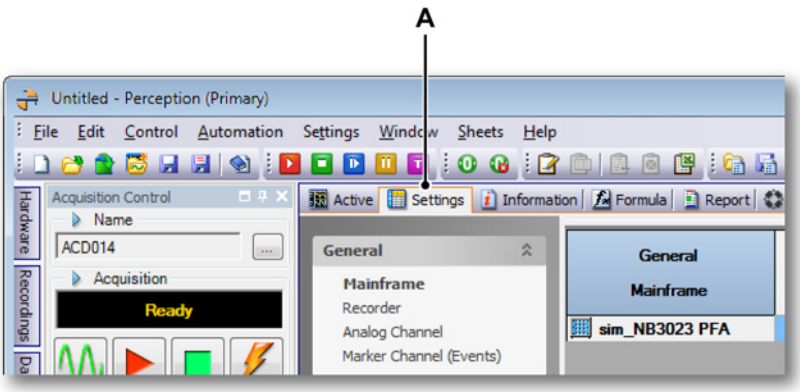



**Figure F.1:** Perception with activated settings sheet tab

**A** Settings sheet

Switch the settings sheet to show the advanced (Dark Gray) settings by using the Settings menu item **Settings ► Show Settings ► Advanced (All settings)**

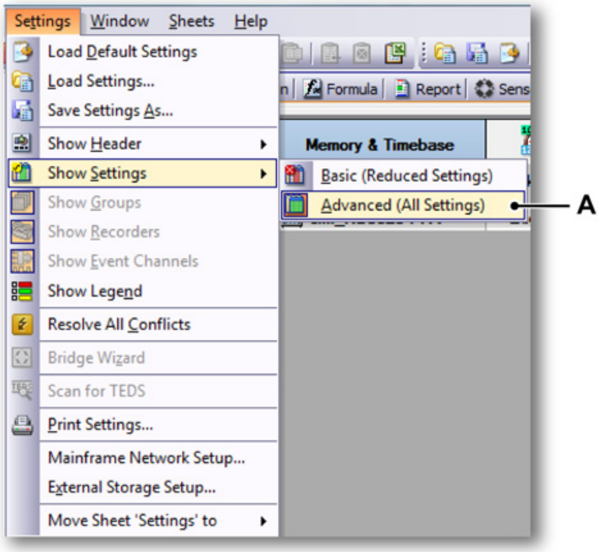



**Figure F.2:** Settings menu

**A** Advanced (All Settings)

### F.1.2 Memory and Time base

**Mainframe**

Within the settings sheet select **Memory & Time base ▸ Mainframe**. The Mainframe setting sheet should look like Figure F.3.

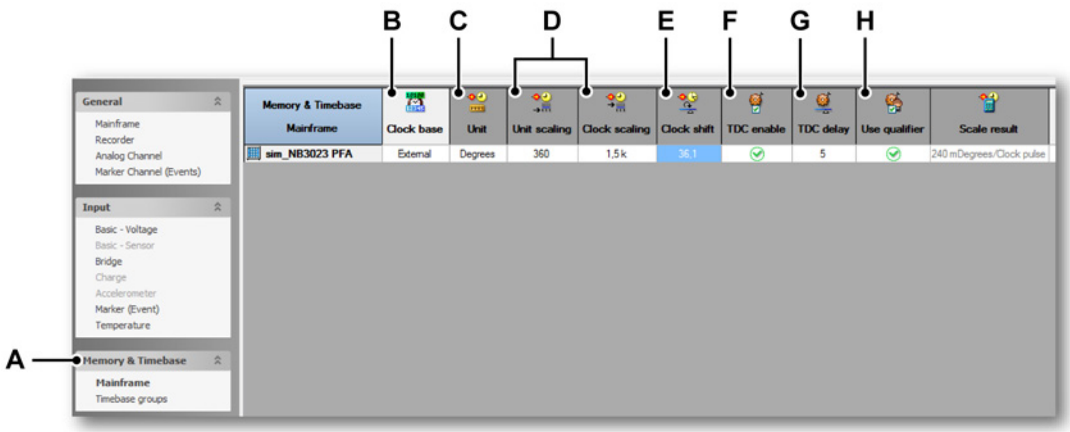



**Figure F.3:** Memory and Time base

**A** Memory and time base settings

**B** Clock base

**C** Unit

**D** Unit scaling/Clock scaling

**E** Clock shift

**F** TDC enable

**G** TDC delay

**H** Use qualifier

**A Memory and time base settings**

**B Clock base**

This setting must be set to “External”.

**C Unit**

Normally during rotating measurements this would be “Degrees”.

**D Unit scaling and Clock scaling (Scale result)**

These two settings define the relation between the external clock pulses and the units. The final setting is the division of these two settings. The setup uses two settings to ease the setup process and avoid rounding errors whenever possible.

For example using a 1500 clock pulses per 360 degrees cycle then:

**Unit scaling** = 360
**Clock Scaling** = 1500

The result is shown in the read only “Scale result”: 240 mDegrees/Clock pulse

**E Clock shift: (TDC position)**
This setting can be used to shift the position of the 0 degrees indication on screen automatically. If for example the TDC signal is not exactly the 0 degrees position but comes in at 36.1 degree, set the “Clock shift” to 36.1.

**Note** *Once the TDC point has been established all samples recorded prior to TDC detection will be scaled backward from this point.*

**F TDC enable**
When this setting is enabled, GEN DAQ systems will use the External Trigger input signal to automatically establish the 0 Degree reference (TDC: Top Dead Center) for rotational measurements.

**G TDC delay**
The TDC delay parameter can be used to skip some of the beginning TDC signals, e.g. to avoid jitter TDC problems while starting engines. Example: If this setting is set to 5 then the 0 degree position is linked to the $5^{th}$ occurrence of the TDC signal after start of recording in the GEN DAQ system.

**H Use qualifier**
This setting can be used to separate the ignition cycle from the exhaust cycle. Typically the ignition and exhaust cycle together are treated as a 720 degree rotation cycle. For every 360 degree rotation a TDC pulse will be generated by the engine. For the GEN DAQ system to separate the 0 degree TDC pulse from the pulse appearing at 360 degrees we need a second signal: TDC qualifier.

The TDC qualifier is implemented by using the alarm function of the GEN DAQ analog channels driving the alarm output of the GEN DAQ mainframe. The alarm status will be AND-ed with the external trigger input to produce the proper TDC signal selection. No additional wiring is required other then measuring the qualification signal by one of the analog channels.

To separate the ignition from exhaust cycle, we could measure the cylinder pressure on e.g. Channel 1. Set the Alarm level of Channel 1 to be active above 10 PSI. Disable all other alarm settings for all other channels in the system. Enable the use Qualifier setting. If channel 1 measures less than 10 PSI, the alarm output signal will disable the TDC detection. As soon as the pressure exceeds 10 PSI the detection of the TDC is enabled. If no TDC is detected before the pressure drops below 10 PSI again, the TDC detection is disabled again.

**Recorder/Time base groups**

**Note** *Perception V6.20 and earlier use recorder settings for the next setting. In later version of Perception these recorder settings have been replaced by Time base group settings. The basic behavior of the “External Clock Divider” is identical.*

**External Clock Divider**
This setting can be found at the Recorder Memory & Time base settings. The default value for this setting is 1, which means that samples are stored at each external clock pulse. If it is required that GEN DAQ only samples every third external clock pulse, setting the “External Clock Divider” to 3 will create the required sampling rate.

**Note** *GEN DAQ systems cannot sample at higher speeds than the external clock signal supplied.*

### F.1.3 Calculating sample limits for external time base use

External sample rates are limited per card type. See the individual specification sheets of the different acquisition cards for details. Make sure and check not to exceed the maximum external sample rate. Exceeding the sample rate will results in missing samples at one or more external clock signal events.

**Calculation example**
Engine runs at 10 000 RPM maximum.

6 000 RPM equals 100 rotations per second.

With a maximum external clock speed of e.g. 500 kS/s (all acquisition cards having a maximum sample rate of 1 MS/s) the maximum pulses per rotation are:

500 000 / 100 = 5 000 pulses per rotation maximum

However it is advisable not to exceed 10 % of the maximum sample rate of the acquisition card used. As in external clock mode GEN DAQ systems internally operate on the maximum sample rate storing the next sample after external clock is detected.

Using a 1 MS/s acquisition cards an external clock at 500 kS/s would appear to contain jitter of up to 1 us. The jitter then is 50 % of the external clock time period (1/500 kS/s = 2 µs).

**Note** *One way to overcome exceeding the maximum external sample rate of the card of choice might be to use the “External Clock Divider”. The maximum external clock rate of the GEN DAQ mainframe is 2 MS/s. Using an “External Clock Divider” of 4 would allows the 1 MS/s card to run an external clock rate of 2 MS/s. It does not increase the measurement resolution, but it does allow a measurement at higher external clock rates.*

### F.1.4 Perception Display settings explained

The Perception displays are capable of handling external time base recordings in different ways. The setup is controlled using the display’s X-Annotation Scaling settings.

These settings can be found by using a right mouse click in the display of choice and selecting “Display Setup” at the bottom of the menu.

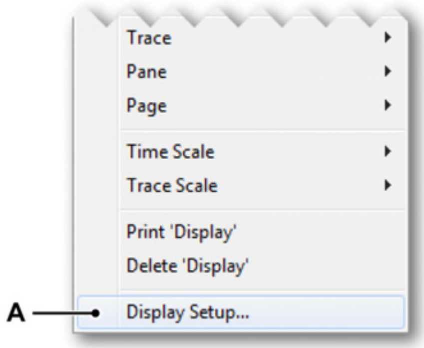



**Figure F.4:** Perception - Display setup

**A** Display setup

In the **Setup of Display** dialog select the **Annotation & Grid** tab.
For external time base recordings select the X-Annotation scaling to **Position**. Within this mode there are three ways to show the X-axis.

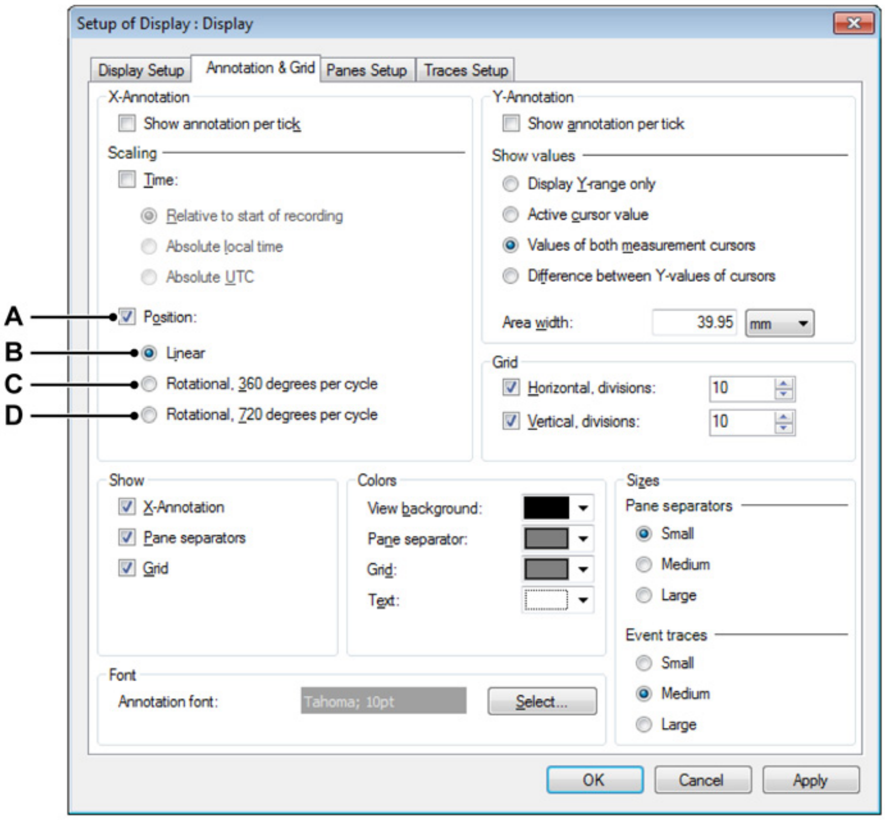



**Figure F.5:** Display Setup dialog - Annotation & Grid

**A** X-Annotation/Position check box

**B** Linear

**C** Rotational, 360 degrees per cycle

**D** Rotational, 720 degrees per cycle

**A Linear**
The X position is expressed in units as selected at the Mainframe – “Memory & Time base” settings dialog.
E.g. 1000 degrees will show as 1000 degrees on the X-axis.

**B Rotational, 360 degrees per cycle**
The X position is expressed by 360 degrees cycles and the number of remaining degrees.
E.g. 1200 degrees will show as 3:120 3 Cycles and 120 degrees.

**C Rotational, 720 degrees per cycle**
The X position is expressed by, means 720 degrees cycles and the number of remaining degrees.
E.g. 1200 degrees will show as 1:480, means 1 Cycle and 480 Degrees.

Perception will use the TDC setup process to determine the proper 0 degree point. (See “TDC Enable” and “TDC qualifier” (Figure F.3 "Memory and Time base" on page 680) how to use these settings).

### F.1.5 Cylinder Pressure Analysis option package

HBM offers a special custom software package for Perception to analyze some parameters of combustion engines.

The basic purpose of the current version of program is to get the following information from a cylinder pressure measurement:

- Get the cycle with the absolute maximum pressure peak of the full recording
- Get the cycle with the absolute minimum pressure peak of the full recording
- Calculate the mean pressure cycle of all cycles of the full recording

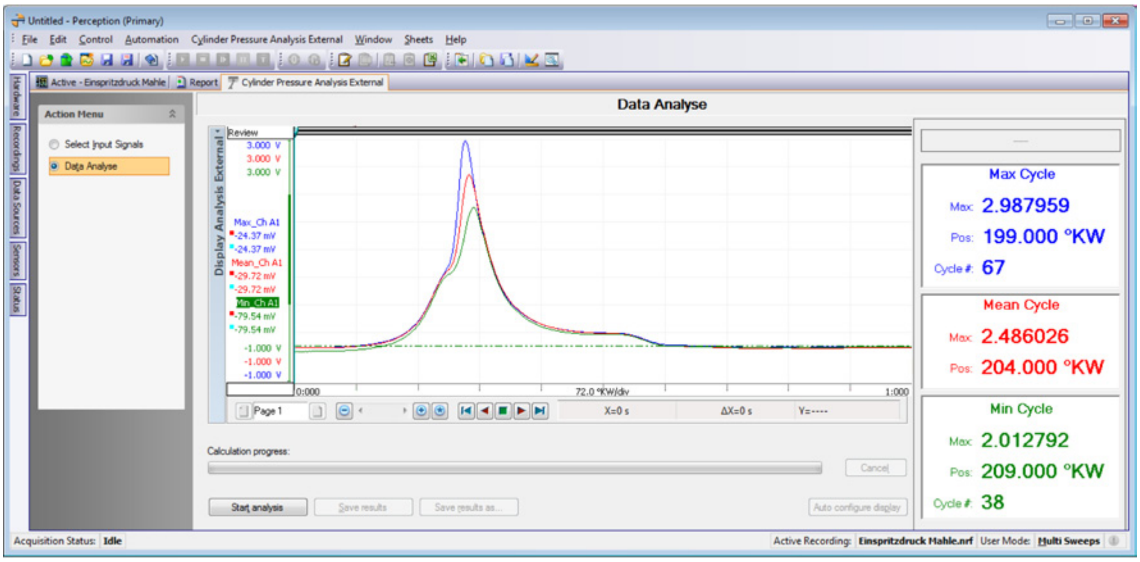



**Figure F.6:** Cylinder Pressure Analysis dialog

### F.1.6 Cylinder Pressure Analysis customer evaluation

HBM offers a 30 day evaluation version of this special software to see if this meets the requirements.

Special wishes can be adapted as cost option after consulting our CSI programmer.

### F.1.7 Cylinder Pressure Analysis and TDC settings

The Cylinder Pressure Analysis application is able to use all of the available TDC settings. When properly used during the recording process, the defined **Offset**, **Analysis interval** and **Cycle size** of the Cylinder pressure analysis CSI will automatically process every new recording without user interaction.

Defining the **Cycle Size**, the **Analysis Interval** and analysis **Offset** relative to the **TDC** signal is done using the configuration dialog of the Cylinder Pressure Analysis application as shown in Figure F.7.

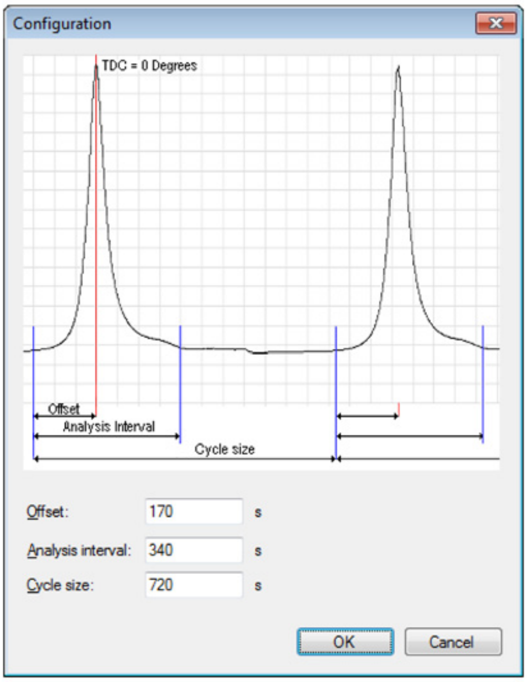



**Figure F.7:** Cylinder Pressure Analysis Configuration

## F.2 dY/dT Triggering

**Basic setting definitions:**

**dY:** The result of subtracting two ADC values

**dT:** Specifies the time between the two samples subtracted

These two setting values are independent from each other. So the user needs to specify both explicitly for the trigger unit to do a correct job. Perception, nor the GEN series can recalculate the 2 settings to extract a useable setting. It is the user that needs to specify both settings within limits that the GEN series can use.

**Notes on setting definitions:**

**dY:** Specified in technical user units so the value scales with changes of technical units. Maximum dY depends on your amplifier range and technical unit scaling. Perception might turn the background yellow to inform a change in the amplifier settings is required to be able to actually generate a trigger for you. Assume the amplifier is set to 100 V range and dY of 110 V can never be measured with this sensitivity. Applying a technical unit multiplier of 10 or decreasing the amplifier sensitivity to 200 V range both would make this setting valid. Do not expect Perception to re-calculate the dY/dT of 110 V/10 ms to 55 V/5 ms. Recalculation would lead to completely different trigger behavior as the noise sensitivity goes down from 110 V to 55 V and this might not be what is expected.

**dT:** Specified in seconds, used in samples. Setting is sample rate dependent. Maximum dT in samples is 1023. For user convenience entry in time is offered. But the hardware works in samples. Therefore changing sample rates might make your setting unusable. E.g. 1023 ms is OK as long as the sample rate is 1 kS/s. At 1 MS/s the maximum dT time is 1.023 ms.
Whenever a dT is not useable with the selected sample rate the background of this setting will turn yellow within Perception (Perception indicates this setting is not valid with the current time base settings that are dependent on this setting).

**Remember:**
Always specify your requested dY and dT values the way you expect GEN series to look at your signals.

**Example:**

- dY set to -4 V
- dT set to 2 ms
- Basic trigger
- Falling Edge

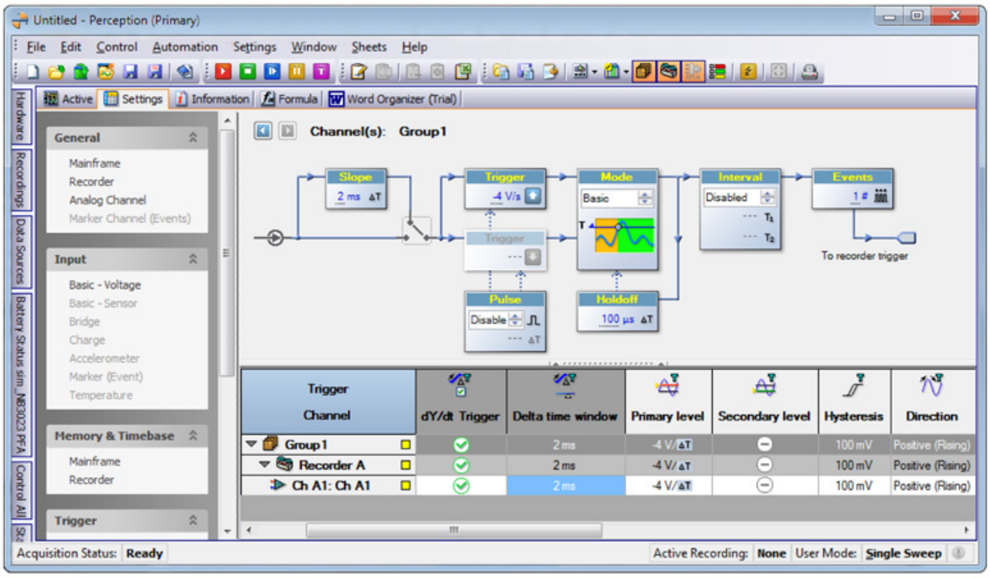


**Figure F.8:** Example of a dY/dT triggering

With the next pictures the two cursors are set to 2 ms. This means the difference between the blue and the red cursor will be the value sent to the trigger unit.

- Next sample recorded (sample of blue cursors, see Figure F.9)
- Difference is -2.451 V
- dY not met, no trigger

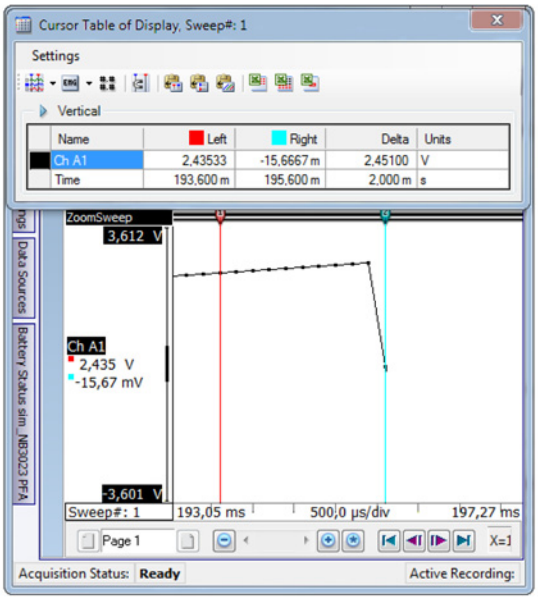



**Figure F.9:** Sample recording 1

- Next sample recorded (sample of blue cursors, see Figure F.10)
- Difference now is -3.81633 V
- dY not met, no trigger

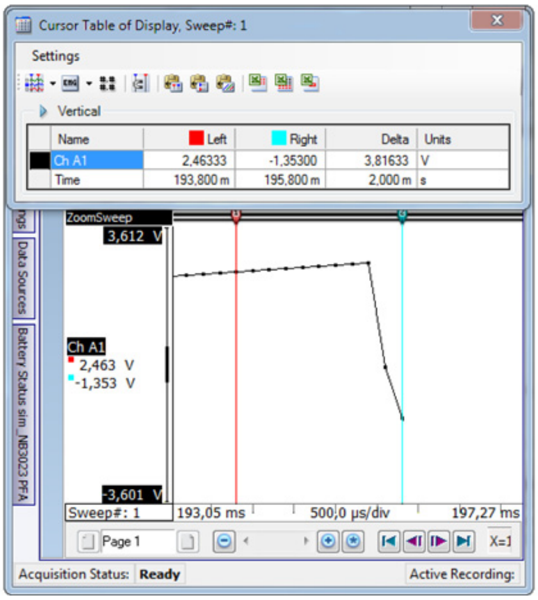



**Figure F.10:** Sample recording 2

- Next sample recorded (sample of blue cursors, see Figure F.11)
- Difference now is -4.49867 V
- dY met
- As previous dY was higher value, this is a falling edge: trigger

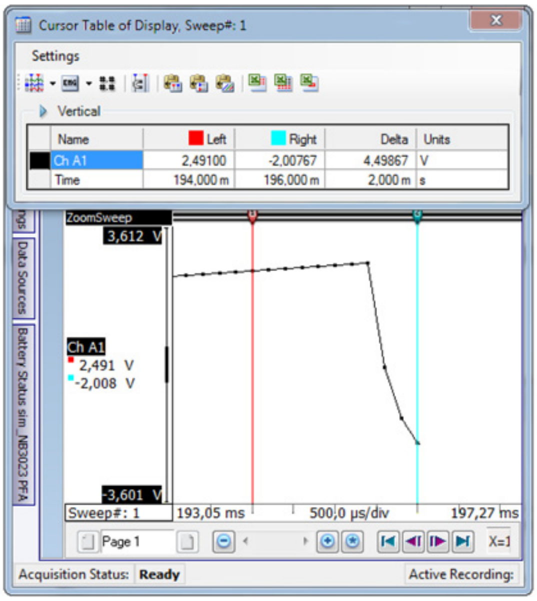



**Figure F.11:** Sample recording 3

**Note** *Trigger edge in this case is the edge of the differentiated signal. Not the signal itself.*

## F.3 Calculating maximum fiber cable length

Maximum optical fiber length is determined by two major factors; optical loss and bandwidth limit. These type of optical fiber performance and quality are defined in ISO standard ISO/IEC 11801.

| OMx/OCx = ISO/IEC 11801 standard (optical fiber type) | For wave-length | Optical power budget | Cable loss | Coupler loss. ANSI/TIA/EIA-568-A | BW Length limit |
|---|---|---|---|---|---|
| OM1 = Multi Mode 62.5/125 µm | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 200 MHz*km |
| OM2 = Multi Mode 50/125 µm | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 500 MHz*km |
| OM3 = Multi Mode 50/125 µm laser optimized fiber | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 2000 MHz*km |
| OM4 = Multi Mode 50/125 µm laser optimized fiber | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 4700 MHz*km |
| OS1 = Single Mode 9/125 µm | 1310 nm | 10 dB | -1 dB/km | -0.75 dB | N/A |
| OS2 = Single Mode 9/125 µm | 1310 nm | 10 dB | -0.4 dB/km | -0.75 dB | N/A |

**Note** *Table shows worst case specifications.*

Standard GHS systems use VCSEL 850 nm optical transmitters/receivers, they have an optical power budget of 8 dB. Calculating maximum length of optical cable can be done in the following manner:

| | | |
|---|---|---|
| Optical budget GHS system 850 nm | : | 8 dB |
| Maximum fiber cable length | : | $L_{optical}$ (km) |
| Fiber cable loss | : | -3.5 dB/km |
| Number of couplers | : | c |
| Coupler loss | : | -0.75 dB |
| Safety margin for aging and repair | : | -3 dB |

$$L_{optical} = -\frac{8dB + (c * -0.75dB) + (-3\ dB)}{-3.5dB}\ (km)$$

This formula also applies to Single Mode systems

If for example two couplers are used in cable, c = 2, maximum length would be $L_{optical}$ = 1 km

The second limiting factor for cable length is fiber cable bandwidth.
Bandwidth limit is caused by light pulse dispersion in the optical fiber; this only affects Multi Mode fiber systems.
This limit is the product of GHS system maximum signaling speed and fiber cable defined bandwidth.

| | | |
|---|---|---|
| GHS signaling speed over optical fiber | : | 1000 MHz |
| OM class defined bandwidth | : | BW |
| Maximum fiber cable length | : | $L_{BW}$ (km) |

$$L_{BW} = \frac{BW}{1000\,MHz}\ (km)$$

If for example OM2 type cable is used maximum length would be $L_{BW}$ = 0.5 km

**Maximum optical fiber length that can be used in a setup is the shortest outcome of $L_{optical}$ or $L_{BW}$**

If the two examples above are observed the optical fiber length must be limited to $L_{BW}$ = 0.5 km

## F.4 Using PTP to synchronize with QuantumX

### F.4.1 Mainframes supporting PTP

Within the GEN series mainframes the GEN2i and GEN5i have no support for PTP time synchronization.

The GEN7t and GEN16t only support PTP time synchronization when using an Interface/Controller module IM2.

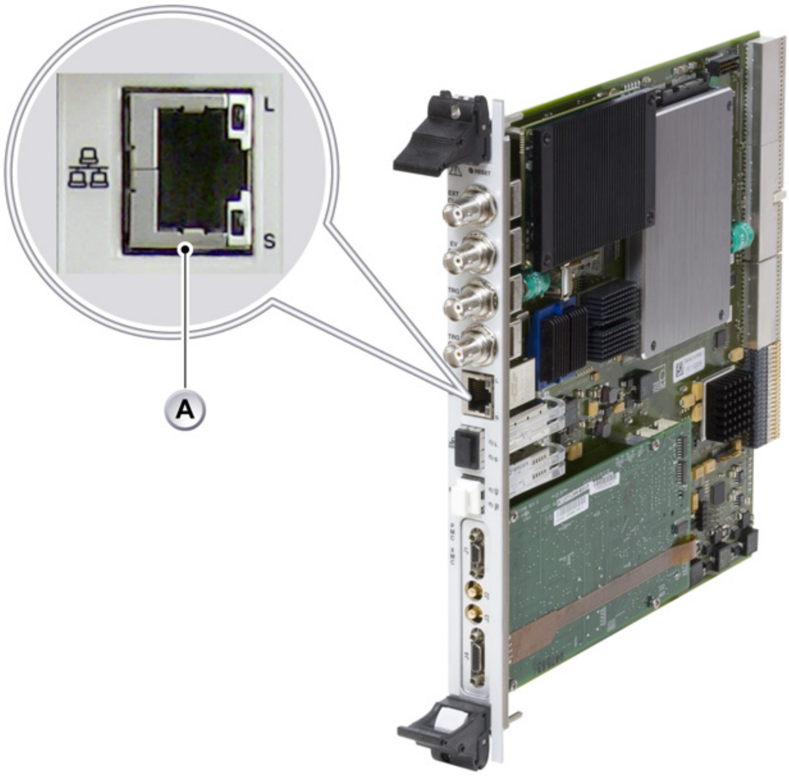



**Figure F.12:** GEN DAQ PTP enabled port (IM2 Module)

**A** PTP enabled network RJ45


**Figure F.13:** GEN7i PTP enabled ports

**A** PTP enabled network RJ45

**B** PTP enabled network optical SFP slot (SFP module is optional)


**Figure F.14:** GEN3i/GEN3t PTP enabled ports

**A** PTP enabled network RJ45

**B** PTP enabled network optical SFP slot (SFP module is optional)

**Note** *GEN3i and GEN3t are identical for PTP ports.*

### F.4.2 PTP support at GEN7t/GEN16t - Perception settings

As the GEN7t and GEN16t only have 1 PTP port, set “Sync Source“ to PTP1:

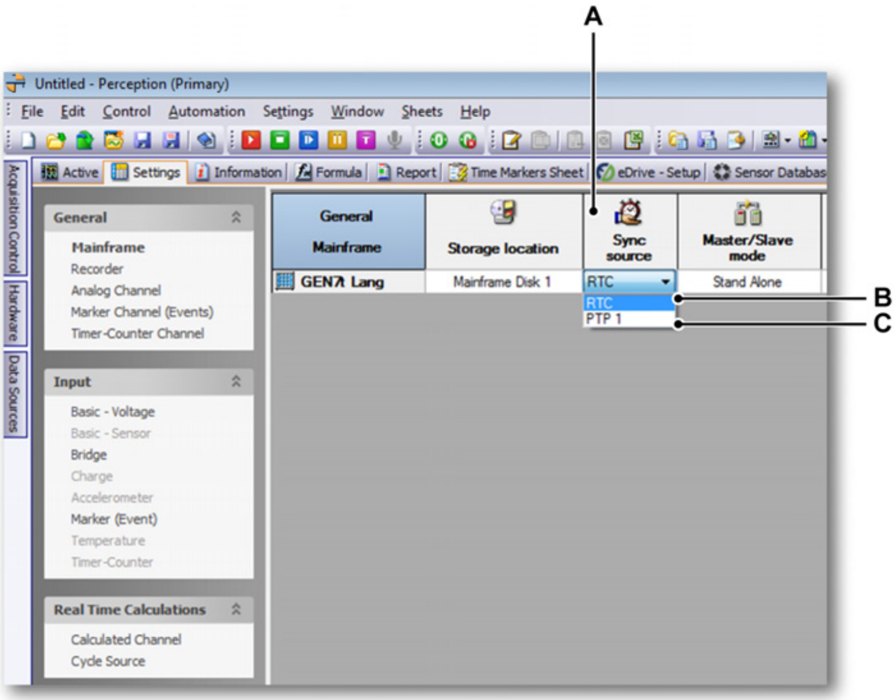


**Figure F.15:** Perception - Sync source option (PTP 1)

**A** Sync source option

**B** RTC

**C** PTP 1

### F.4.3 PTP support at GEN3i, GEN3t and GEN7i - Perception settings

Set "Sync Source“ to PTP1 (RJ45) **or** to PTP2 (optical):

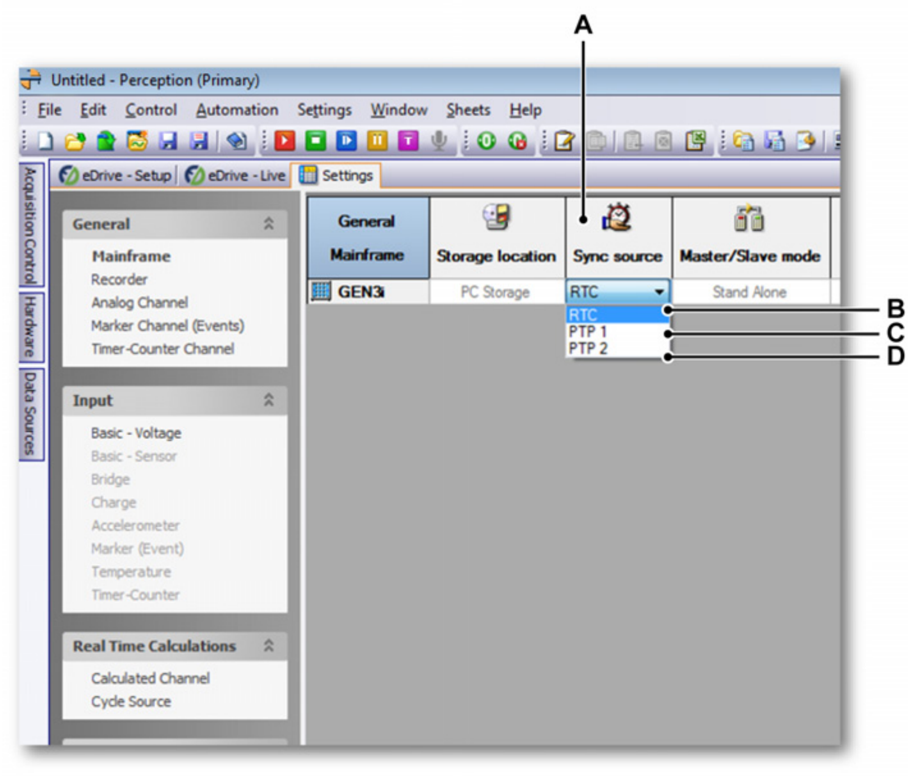



**Figure F.16:** Perception - Sync source option (PTP 1) or (PTP 2)

**A** Sync source option

**B** RTC

**C** PTP 1

**D** PTP 2

#### F.4.4 GEN3i/GEN7i with single QuantumX MX1609KB

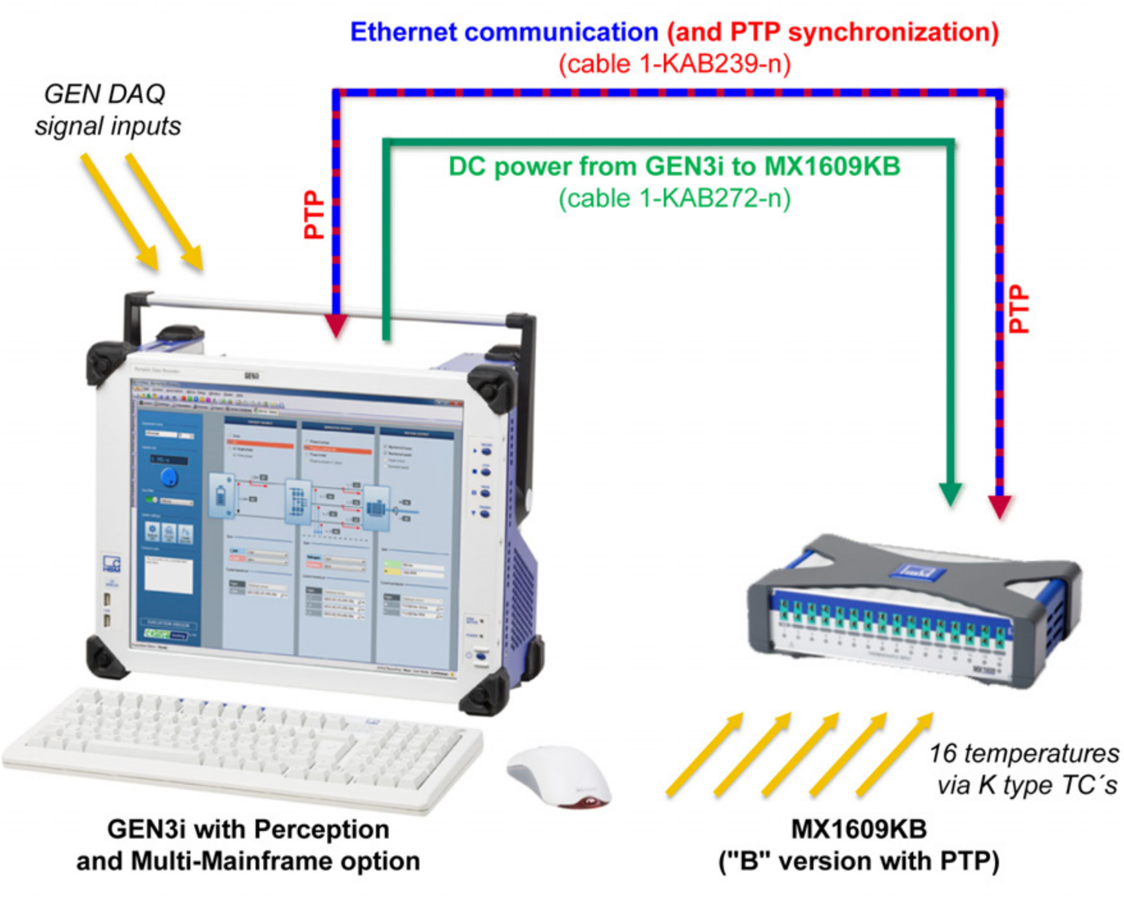



**Figure F.17:** GEN3i with single MX1609KB/MX1609TB - Overview

**Note** *Setup only shows GEN3i. GEN7i could be used instead.*

### F.4.5 GEN3i/GEN7i with single Somat$^{XR}$ MX1609KB-R

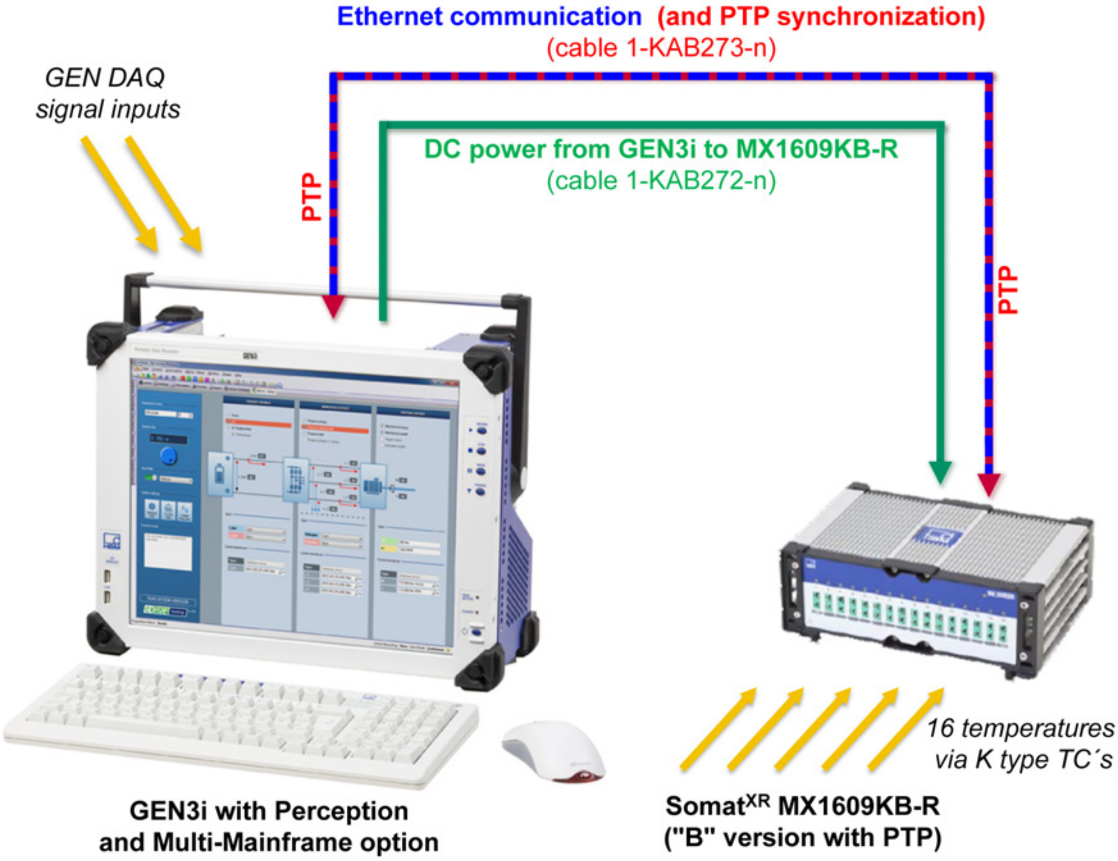



**Figure F.18:** GEN3i with single Somat$^{XR}$ MX1609KB-R - Overview

**Note** *Setup only shows GEN3i. GEN7i could be used instead.*

### F.4.6 GEN3i/GEN7i with up to three QuantumX MX1609KB

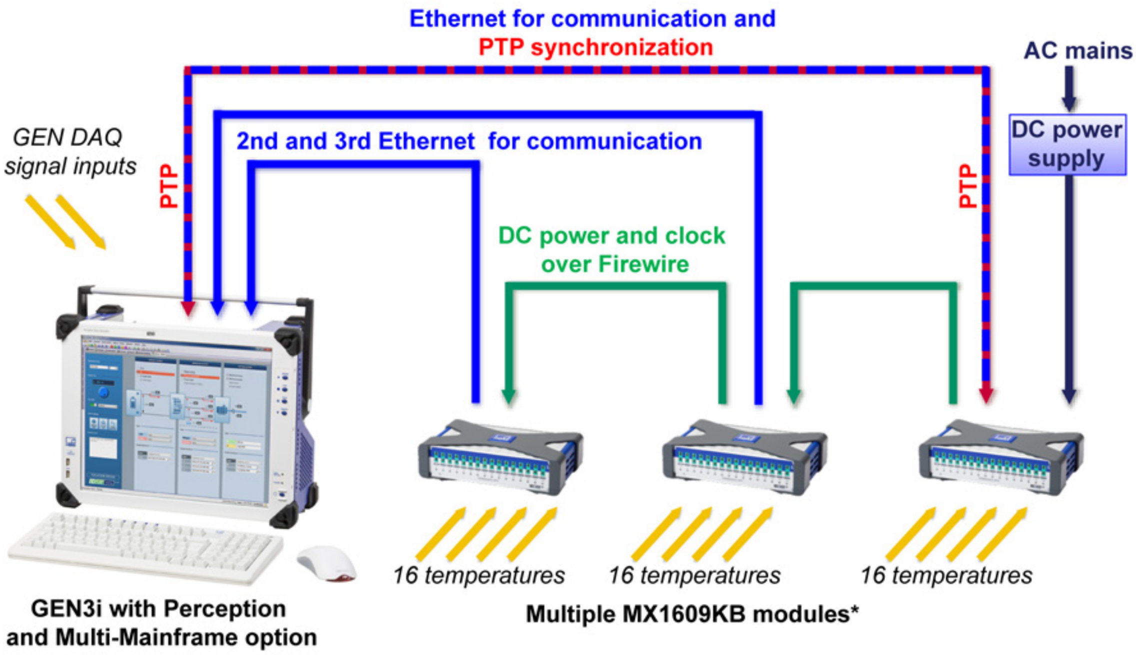



**Figure F.19:** GEN3i with some QuantumX MX1609KB - Overview

**Note** *Setup only shows GEN3i. GEN7i could be used instead.*

**Note** ** **All** must be “B“ versions, one set to “clock master“ and connected to the PTP Ethernet of GEN3i.*

### F.4.7 GEN3i/GEN7i with four or more of QuantumX MX1609KB (Standard switch)

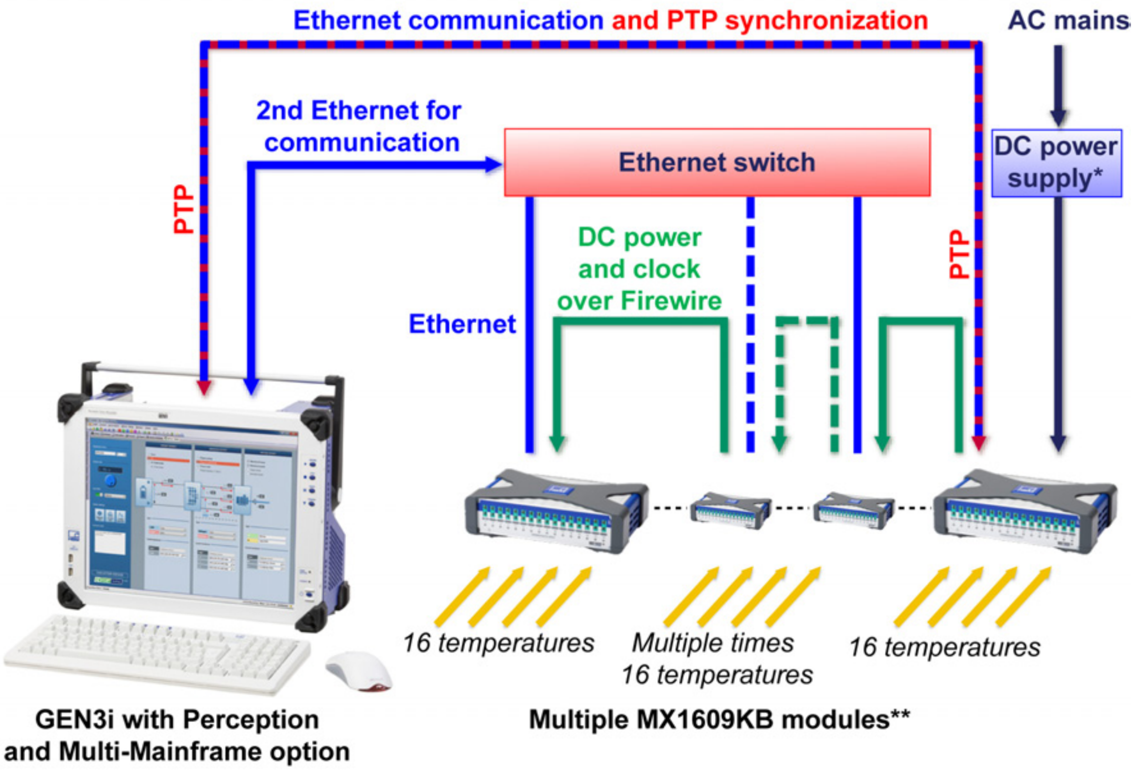



**Figure F.20:** GEN3i with multiple QuantumX MX1609KB - Using standard swich

**Note** *Setup only shows GEN3i. GEN7i could be used instead.*

**Note** ** Multiple QuantumX modules requires more than one power supply; see QuantumX documentation.*

**Note** *** **All** must be “B“ versions, one set to “clock master“ and connected to the PTP Ethernet of GEN3i.*

### F.4.8 GEN3i/GEN7i with four or more QuantumX MX1609KB (PTP switch)

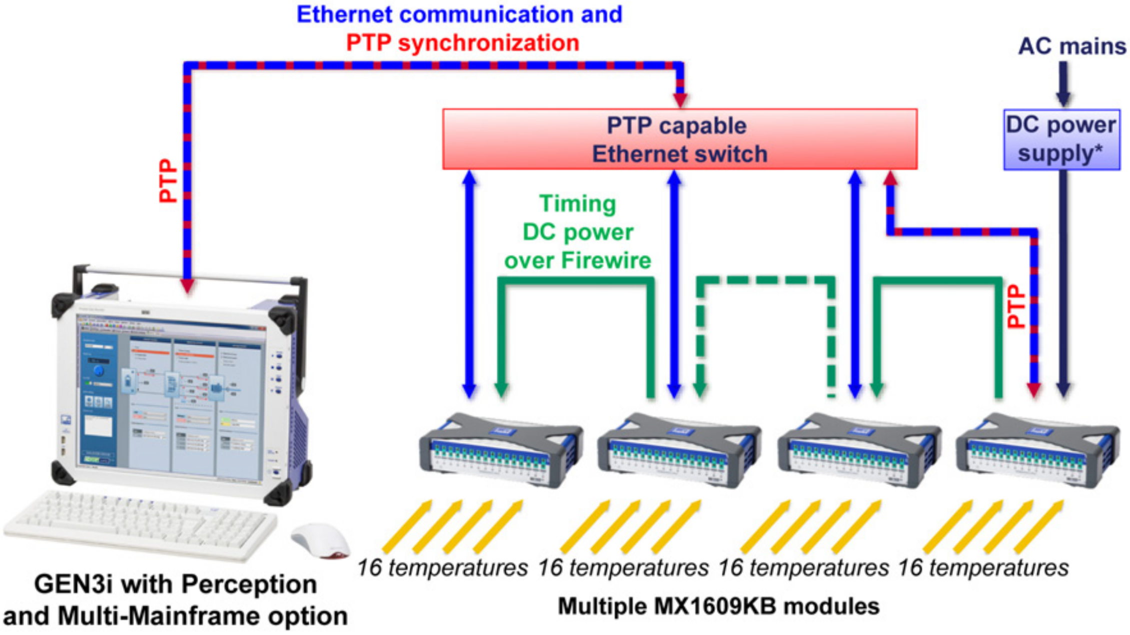



**Figure F.21:** GEN3i with multiple MX1609KB/MX1609TB - Using PTP switch

**Note** *Setup only shows GEN3i. GEN7i could be used instead.*

**Note** ** Multiple QuantumX modules requires more than one power supply; see QuantumX documentation.*

### F.4.9 GEN7t/GEN16t with single QuantumX MX1609KB

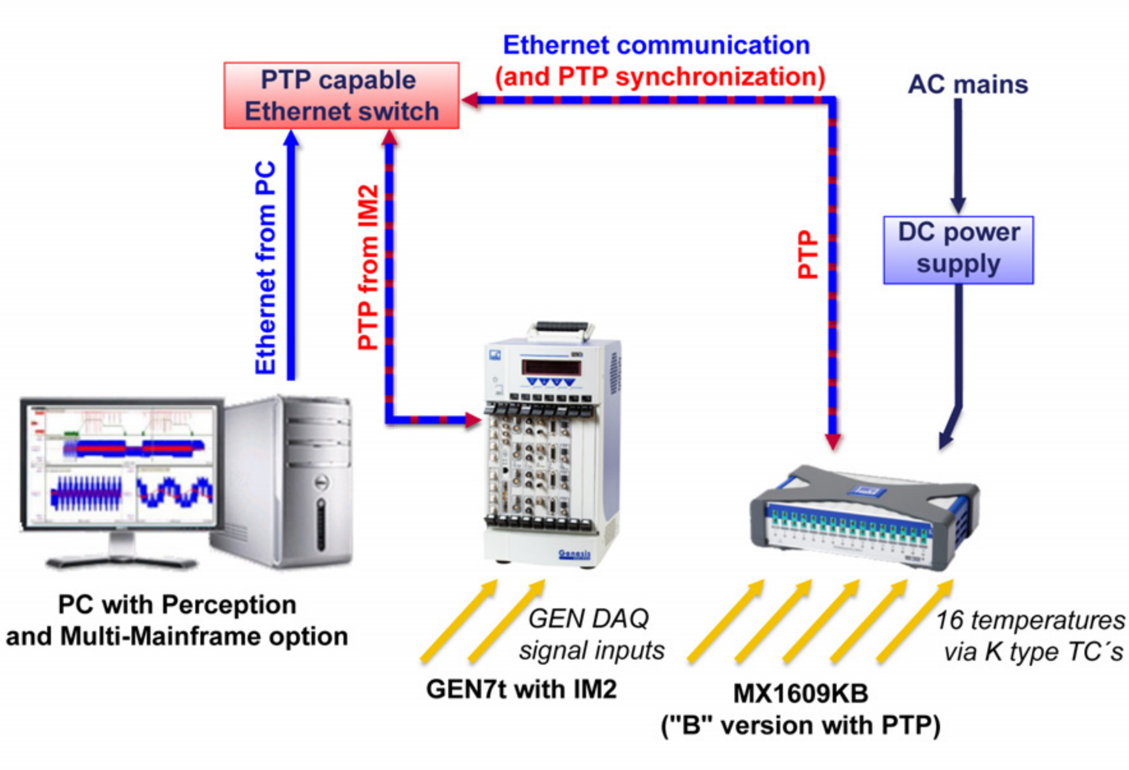



**Figure F.22:** GEN7t with single QuantumX MX1609KB/MX1609TB - Overview

**Note** *Setup only shows GEN7t. GEN16t could be used instead.*

### F.4.10 GEN7t with multiple QuantumX MX1609KB

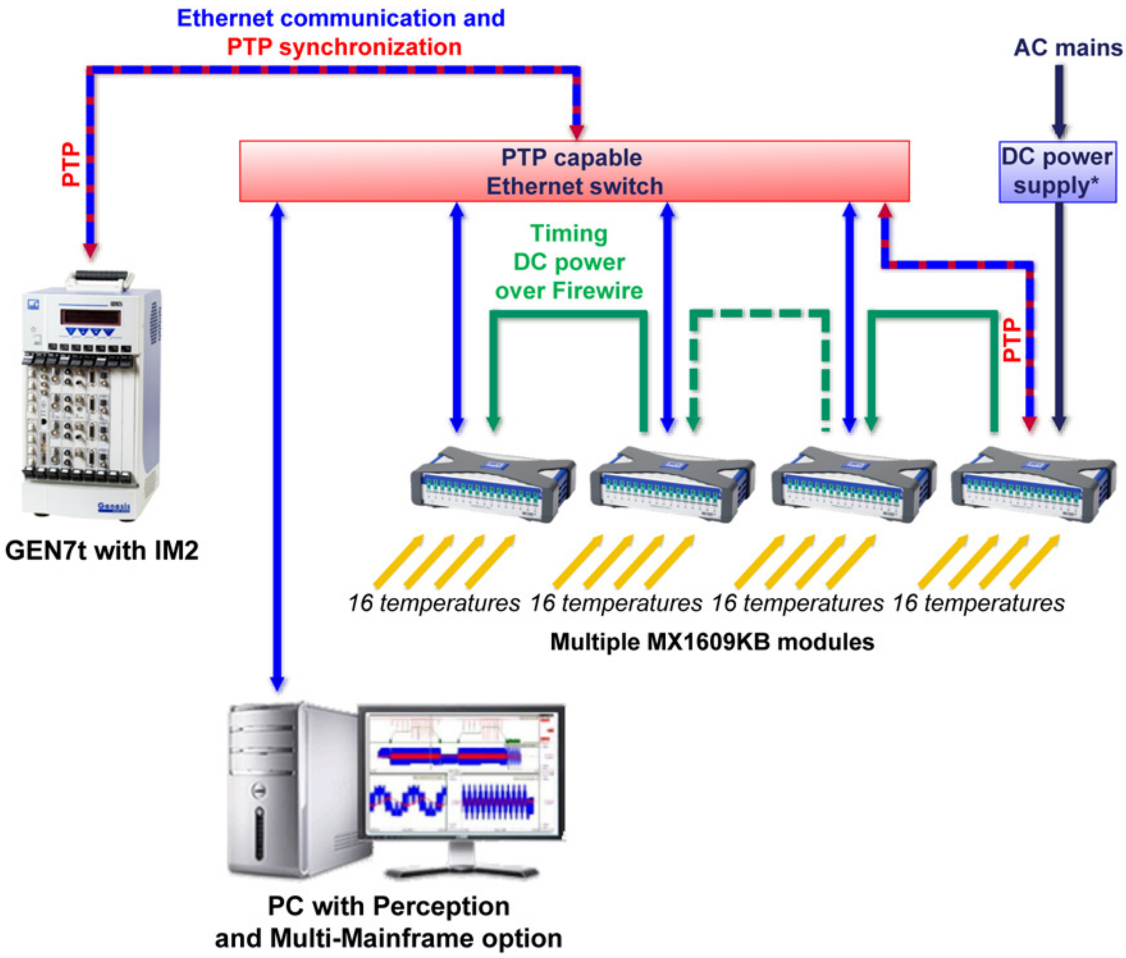



**Figure F.23:** GEN7t with multiple MX1609KB/MX1609TB - Using PTP switch

**Note** *Setup only shows GEN7t. GEN16t could be used instead.*

**Note** ** Multiple QuantumX modules requires more than one power supply; see QuantumX documentation.*

### F.4.11 Genesis and QuantumX Setup using IRIG-to-PTP Bridge

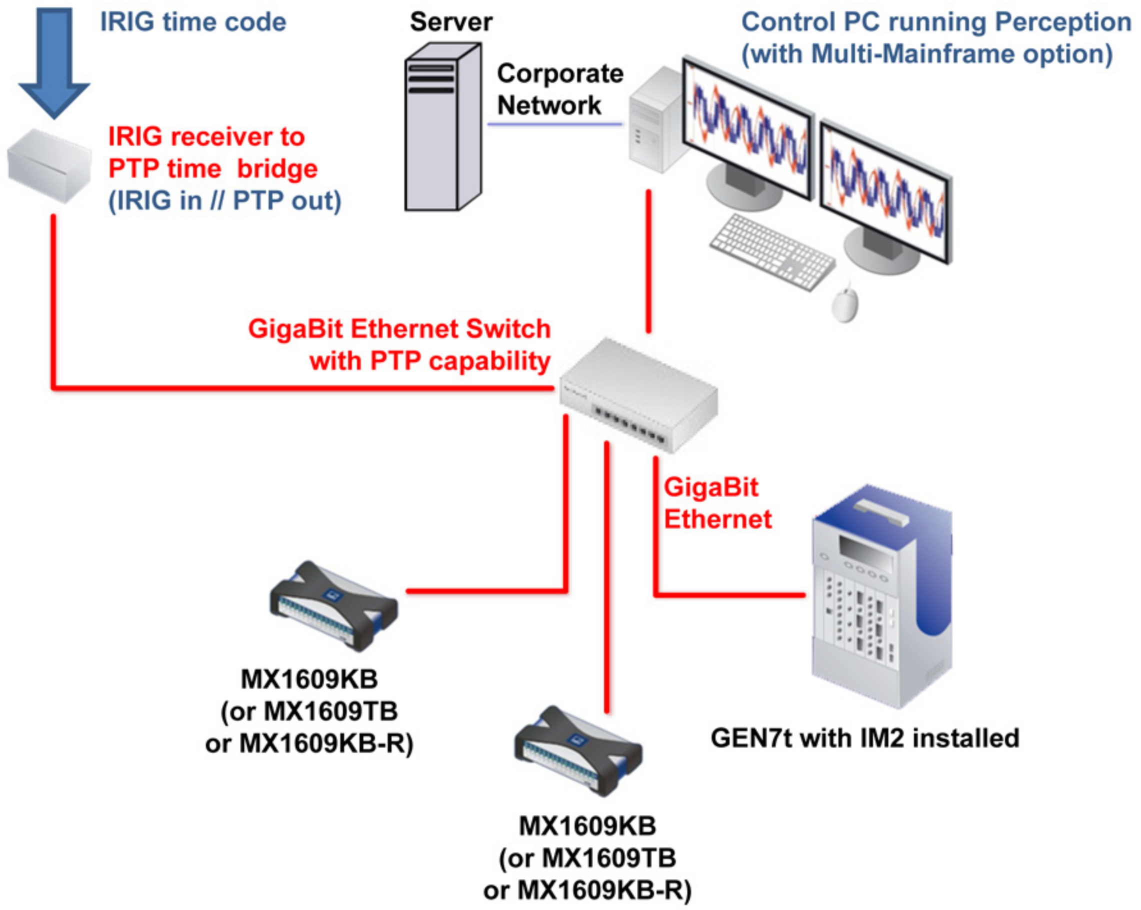



**Figure F.24:** Setup of IRIG-to-PTP Bridge

**Note** *GEN7t can be replaced by GEN3t/GEN16t/GEN3i/GEN7i*

**Settings in Perception**

- Use RJ45 connector for PTP support **(PTP 1)**.

### F.4.12 IRIG-to-PTP Bridge

- Successfully tested Symmetricom SyncServer® S350
- Equivalent model Symmetricom Xli GPS receiver (Model 1510-713)


**Figure F.25:** Symmetricom Xli GPS receiver

For more information please refer to: [www.symmetricom.com/](www.symmetricom.com/)

### F.4.13 PTP capable switch

- Successfully tested Siemens scalance xr324-12m

**Figure F.26:** Siemens scalance xr324-12m

For more information please refer to:
support.automation.siemens.com/CN/

### F.4.14 Using PTP and Master/Slave in combined setup

**This is possible**

- Master/Slave setup and PTP Synchronization.
- Set GEN3i as Master and GEN3t as Slave

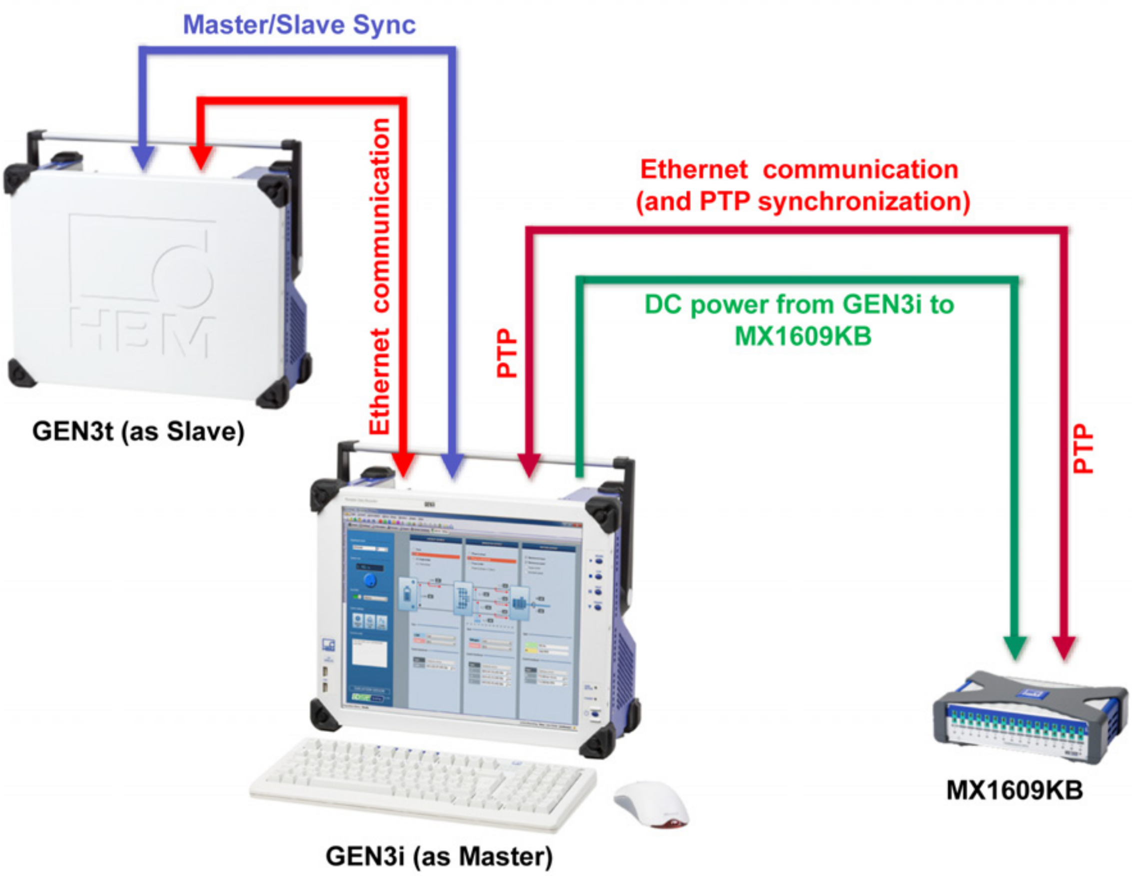



**Figure F.27:** Example of a correct PTP usage

**Note** *GEN3i can be replaced by GEN7i.The GEN3t can be replaced by GEN7t/GEN16t as slave.*

### F.4.15 PTP configuration errors

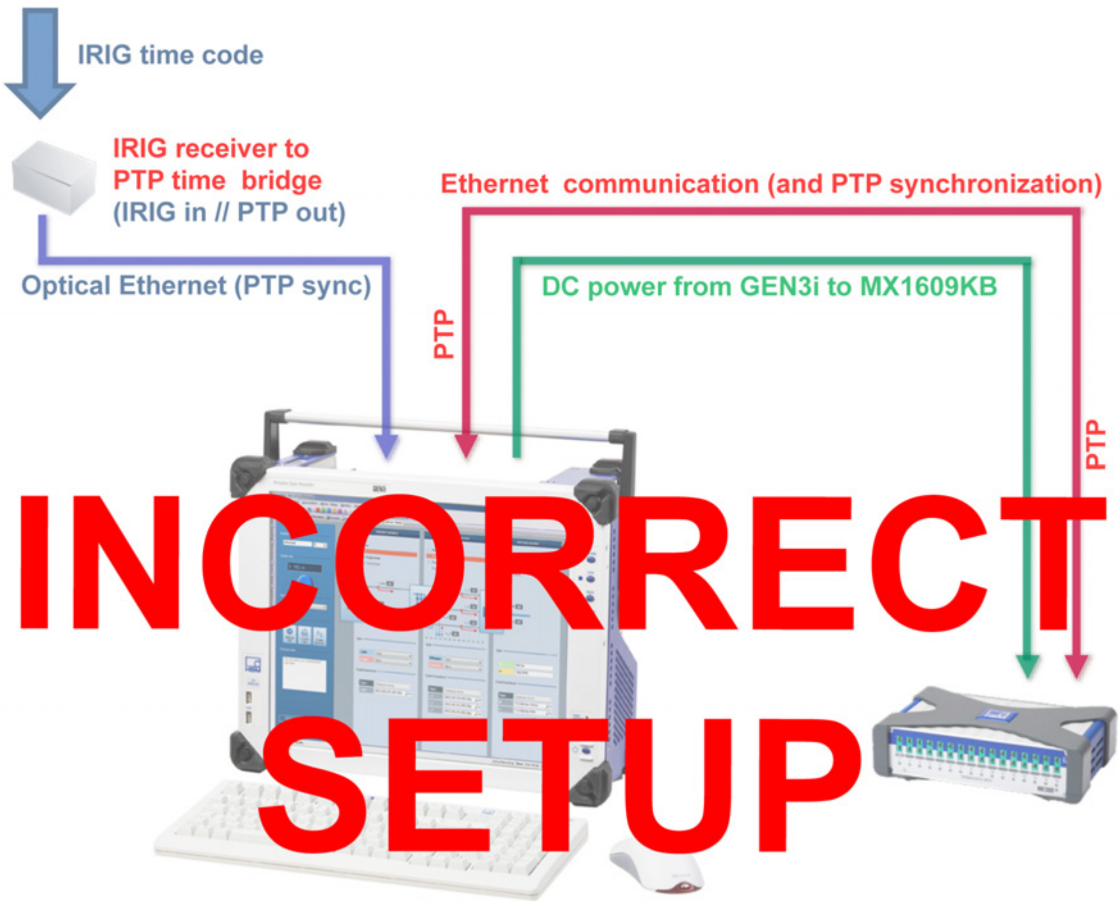



**Figure F.28:** Example of an incorrect PTP usage

**This is not possible!**

- Set "Sync Source“ to PTP1 (RJ45) **or** to PTP2 (optical)
- Both at the same time is not possible: we don’t “bridge” PTP1 to PTP2

# G 10 GB Ethernet Windows settings

## G.1 Introduction

To help achieve the highest possible speed rating for the 10 Gbit Ethernet card the following settings can be made to the network adaptor in Windows® 7.

Windows 10G network adapter settings:

- Interrupt moderation rate: **high**
- Receive side scaling queues: **8**
- Receive buffers: **2048**

**Note** *The above Windows settings were tested and chosen using a specific setup of equipment (including the Ethernet Server adaptor x520). These settings may not be the optimal settings for your specific system.*

**1** Firstly, on the Windows® 7 desktop navigate to the **Network and Sharing Centre**.

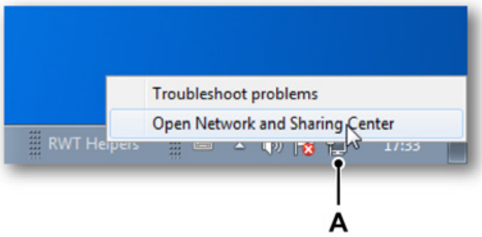



**Figure G.1:** Windows® 7 Network and Sharing Centre tooltip

**A** Network icon

Right click the **network icon** in the Windows® system tray and click **Open Network and Sharing Centre**.
Note: This dialog is also available by clicking **Start (Windows orb) > Control Panel > Network and Sharing Centre.**

**2** The following dialog will open.

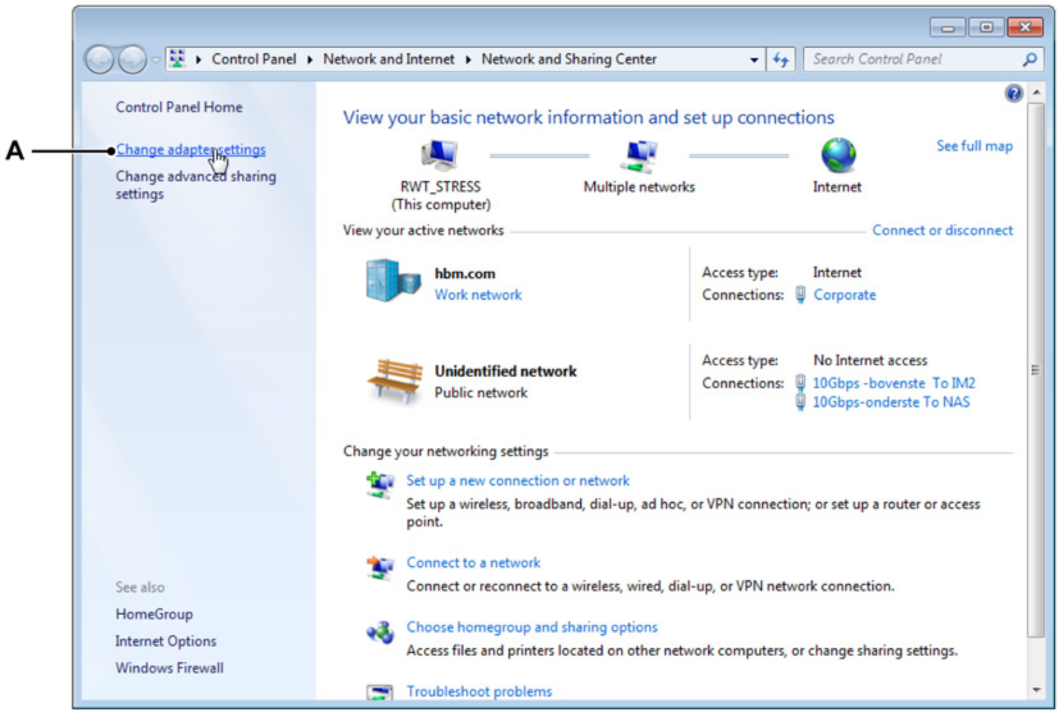



**Figure G.2:** Windows® 7 Network and Sharing Center

**A** Change adapter settings

Click **Change adaptor settings**

**3** The available adaptors in **Network Connections** should be shown as in the following Figure G.3.

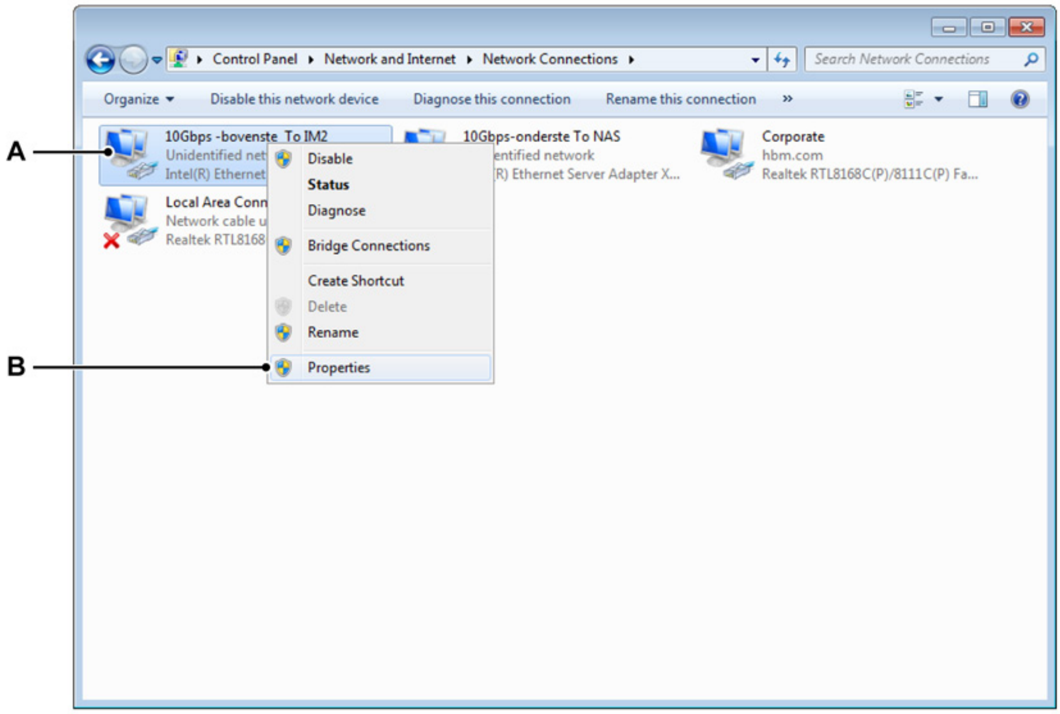



**Figure G.3:** Network Connections

**A** Adaptor

**B** Properties

Right click the 10 Gbit Ethernet adaptor connected to the IM2 module, In the pop-up menu select **Properties.**

**4** The following properties dialog will appear.

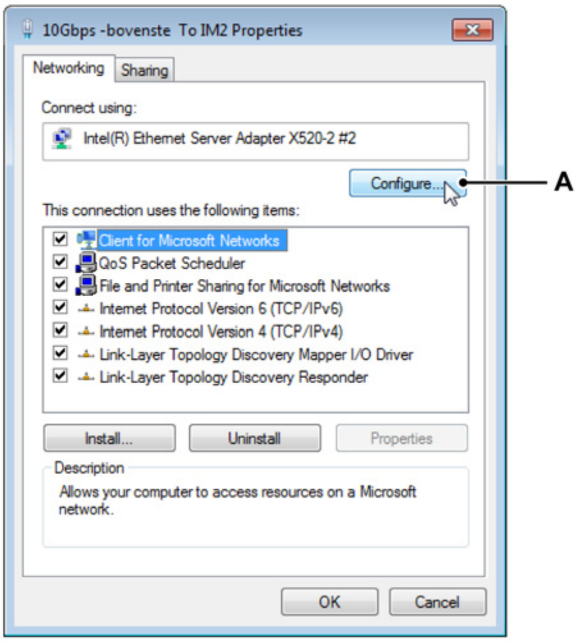



**Figure G.4:** Networking properties dialog

**A** Configure

Click **Configure…**

**5** The Ethernet Server Adaptor properties dialog for your specific adaptor will appear.

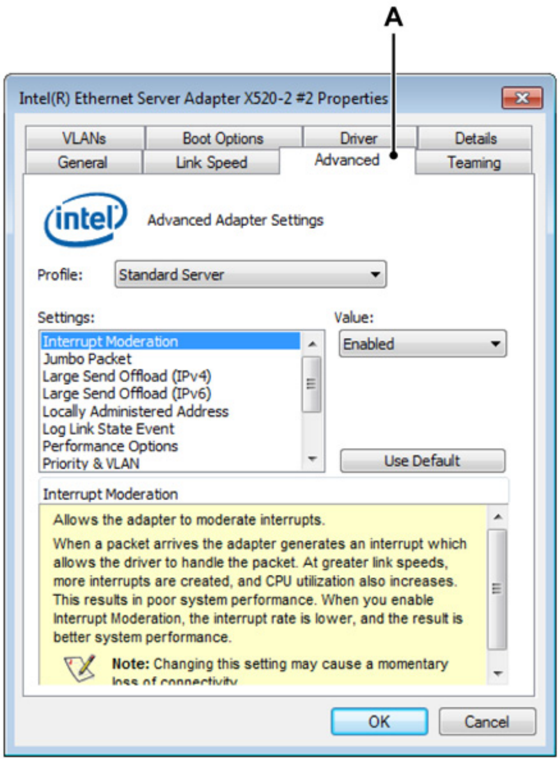



**Figure G.5:** Ethernet Server Adaptor properties dialog (Part 1)

**A** Advanced tab

Click the **Advanced** tab.

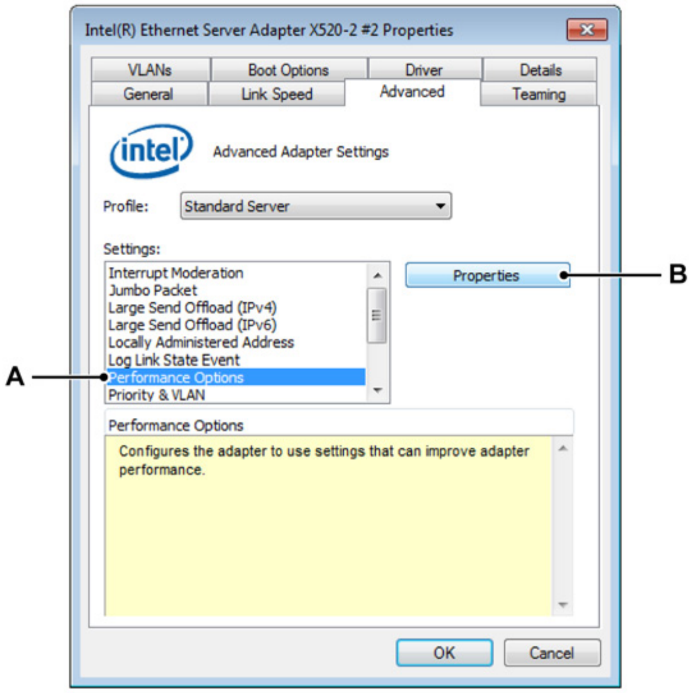



**Figure G.6:** Ethernet Server Adaptor properties dialog (Part 2)

**A** Settings/Performance Option

**B** Properties

Scroll down in the settings menu to **Performance Options** and then click **Properties** on the right hand side.

**6** The **Performance Options** properties dialog will appear

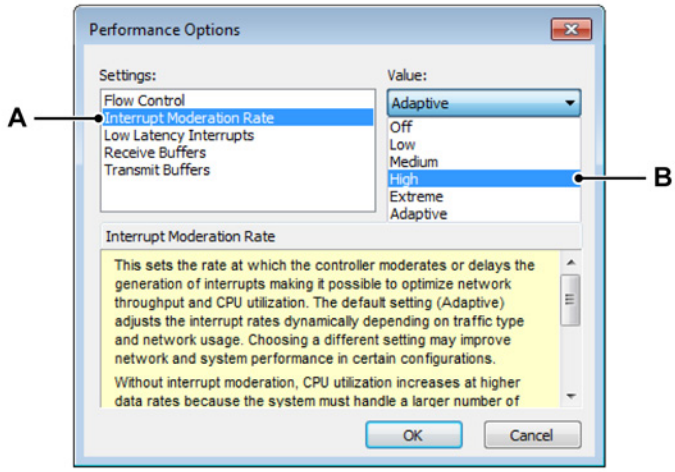



**Figure G.7:** Performance Options (Part 1)

**A** Settings/Interrupt Moderation Rate

**B** Value/High

Select **Interrupt Moderation Rate** and then click **High** in the Value drop down selection box.

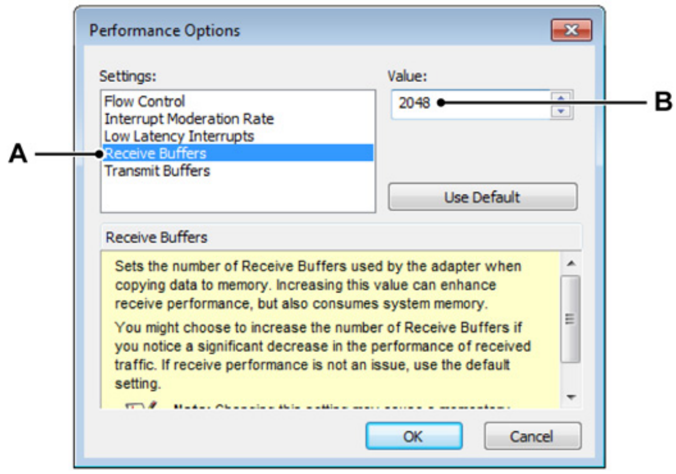



**Figure G.8:** Performance Options (Part 2)

**A** Settings/Receive Buffers

**B** Value/2048

Now click **Receive Buffers** in the settings pane, this should be set to **2048** in the **Value** box.

Click **OK** to return to the previous dialog

**7** The Ethernet Server Adaptor properties dialog appears

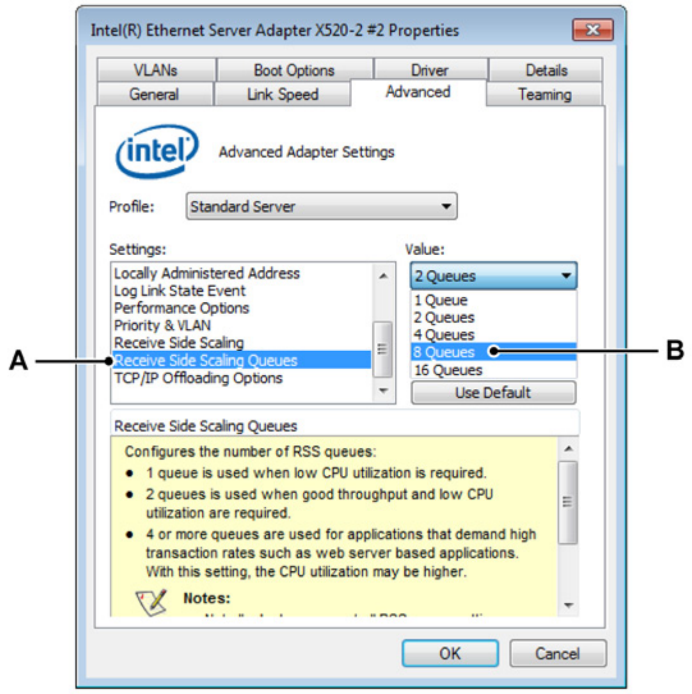



**Figure G.9:** Ethernet Server Adaptor properties dialog (Part 3)

**A** Settings/Receive side scaling queues

**B** Value/8 queues

In the drop down **Value** list select **8 queues** and then click **OK.**

The procedure is now complete.

# H Setting up the iSCSI target device

## H.1 Setting up the iSCSI target using Synology® NAS

For further tutorials please see:
www.synology.com/tutorials/tutorials.php

Equipment needed:

- Synology® assistant
- iSCSI NAS
- GEN DAQ system with Ethernet

1. Make sure network is setup and connected correctly with a network connection to the NAS storage device.
2. If the Synology® software is not yet installed please follow the Synology® installation instructions to install the iSCSI setup software.
   Available here: www.synology.com/support/download.php?lang=us
3. Start **Synology® assistant** from the program menu.

**Note** ***Synology®*** *assistant auto lists connected* ***Synology®*** *devices only.*

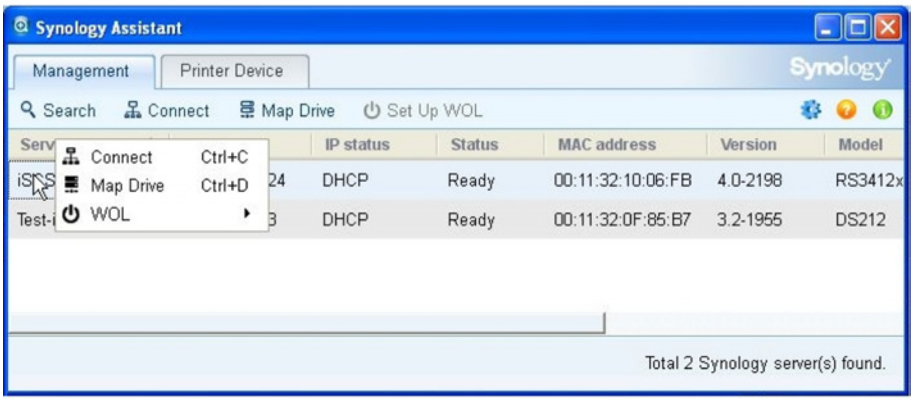



**Figure H.1:** Synology Assistant

Select or right click an iSCSI device and then click **Connect**.
Your web browser should open to **DSM Synology® RackStation** or **FileStation**. The **IP address** and **Port number** of the Synology® NAS server should now be displayed in your internet browser address bar.

4 A Log in screen may appear depending on whether or not the NAS has been setup before. You should not need to log in for the first time setting up a NAS.

If you see a log in screen you need to log in with the details that were used to setup the NAS the first time it was used. Please refer to the manufacturers guide if you need more information.

Please see the Synology® manual for the start up procedure and how to create log-in details.

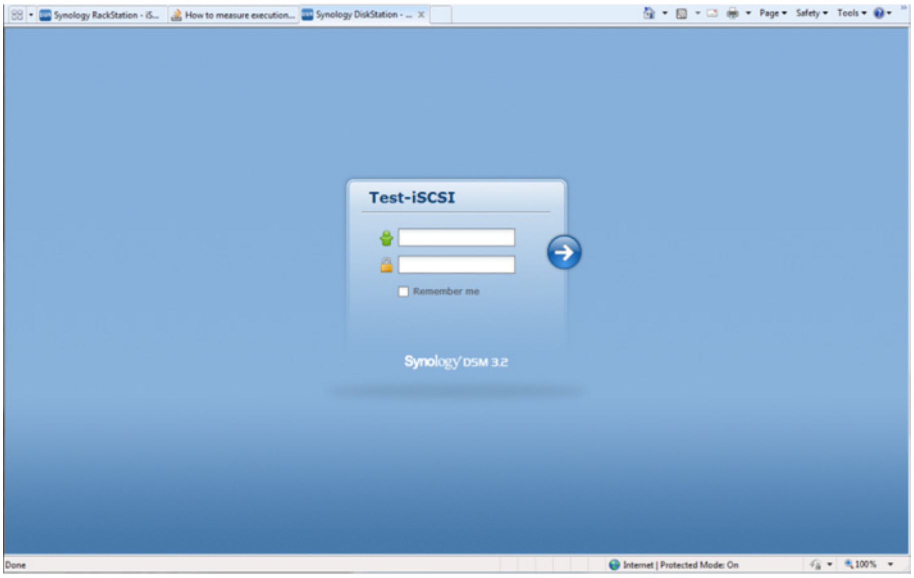



**Figure H.2:** Log-in dialog

5 When logged in and on the home screen, click the main-menu icon (A) as shown in the following Figure H.3.


**Figure H.3:** Home screen

**A** Main-menu icon

6 A quick launch window will open.


**Figure H.4:** Quick launch window

**A** Storage Manager

Click the **Storage Manager** icon.

**7** The **Storage Manager** dialog opens.

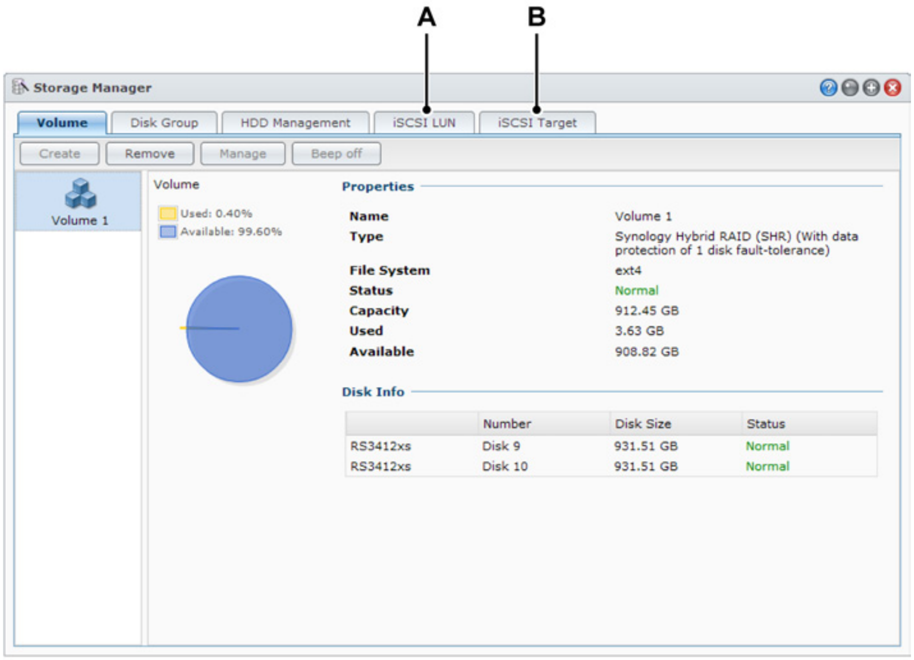



**Figure H.5:** Storage Manager dialog

**A** iSCSI LUN

**B** iSCSI Target

First, setup an **iSCSI Target** or **iSCSI LUN**.
In Perception, this information will be used in the **External Storage Setup: iSCSI Target** dialog box.

The same procedure can be done from the **iSCSI LUN** tab, **Create** button. If you want to create an iSCSI LUN first, please refer to Figure H.8 "Create a new iSCSI LUN target dialog" on page 726.

**8** Click the tab **iSCSI Target:**

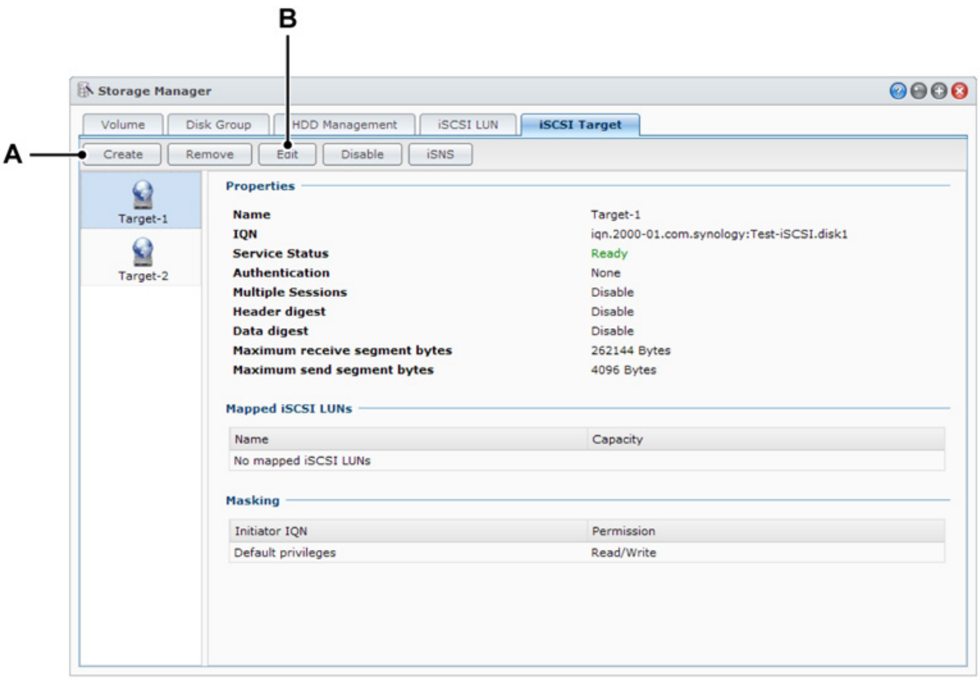



**Figure H.6:** iSCSI Target window dialog

**A** Create tab

**B** Edit tab

This tab shows the available iSCSI Target disks and their details. To create a new iSCSI target, click **Create**.

**9** The following **iSCSI** Creation Wizard dialog will appear:

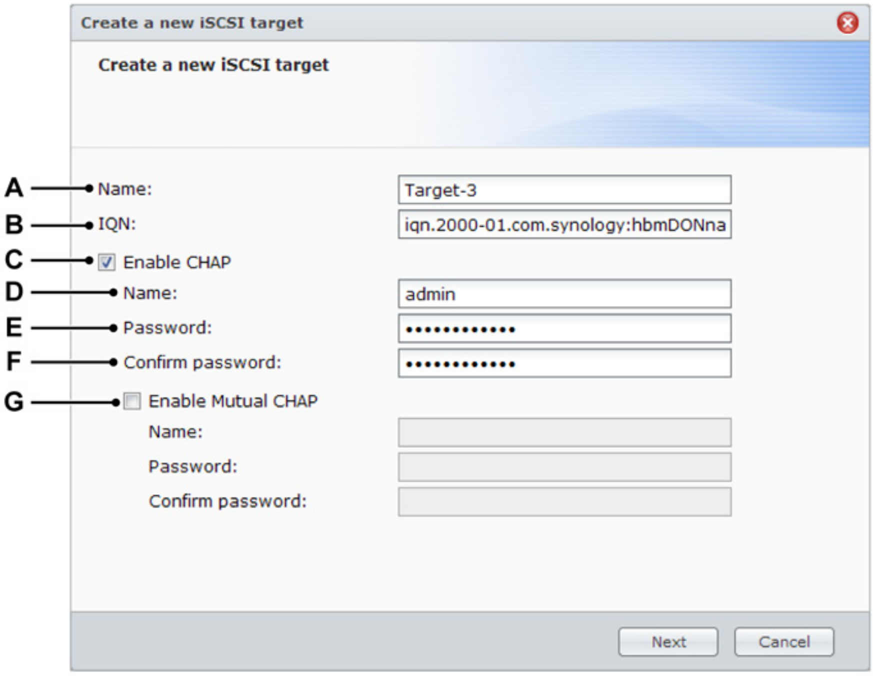



**Figure H.7:** Create a new iSCSI target dialog

**A** Name

**B** IQN number

**C** Enable CHAP

**D** CHAP Name:

**E** CHAP Password:

**F** CHAP Confirm Password:

**G** Enable Mutual CHAP

Figure H.7 dialog asks for your **IQN (B)** number and a Target **Name (A)**. **CHAP (C)** password protection can also be setup, this is the same password that will be used in the Perception setup dialog; **External Storage Setup > iSCSI Logon: User name and Password**.

If you need to check the user name of an existing iSCSI Target click the correct target in the **iSCSI Target tab** (see Figure H.6 **(B)**) and then click **Edit**.

**A** **Name:** Enter a name for target mapping.
Recommended Format: iqn.yyyy-mm.domain:device.ID

**B** **IQN:** Enter the actual iSCSI IQN name here.
Recommended Format: iqn.yyyy-mm.domain:device.ID
This IQN name is the same name used in Perception dialog **External storage setup: iSCSI Target - Target name** (see Figure 11.8 "External Storage Setup dialog" on page 186 **(C1)** for an example).

**C** **Enable CHAP** If logon Password protection is needed select this check box.

**Note** *CHAP is used to authenticate iSCSI Initiators before using the iSCSI Target.*

**D** **CHAP Name:** Enter a name to be used on login to the iSCSI.

**E** **CHAP Password:** Enter a password; minimum 12 characters.

**F** **CHAP Confirm Password:** Re-type the password.

**G** **Enable Mutual CHAP** will require both initiator and target to authenticate each other before communicating.

When done click **Next**.

**10** When setting up an iSCSI target you also need to setup an iSCSI LUN as follows.

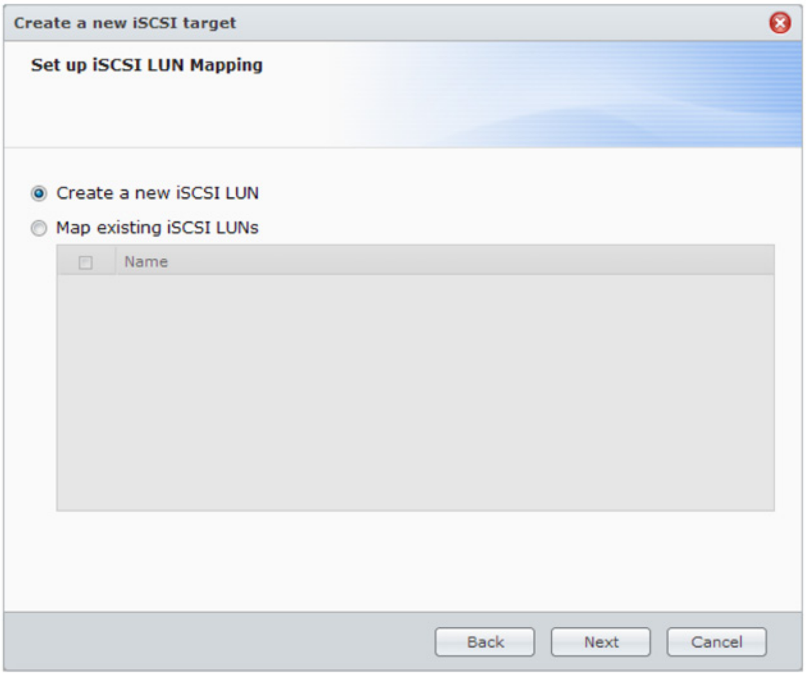



**Figure H.8:** Create a new iSCSI LUN target dialog

From the **Storage Manager** window select **Create new iSCSI LUN** when no LUNs are yet available, if LUNs are available then you may select **Map existing iSCSI LUNs.**

Click the **Next** button.

**11** Create a new iSCSI LUN

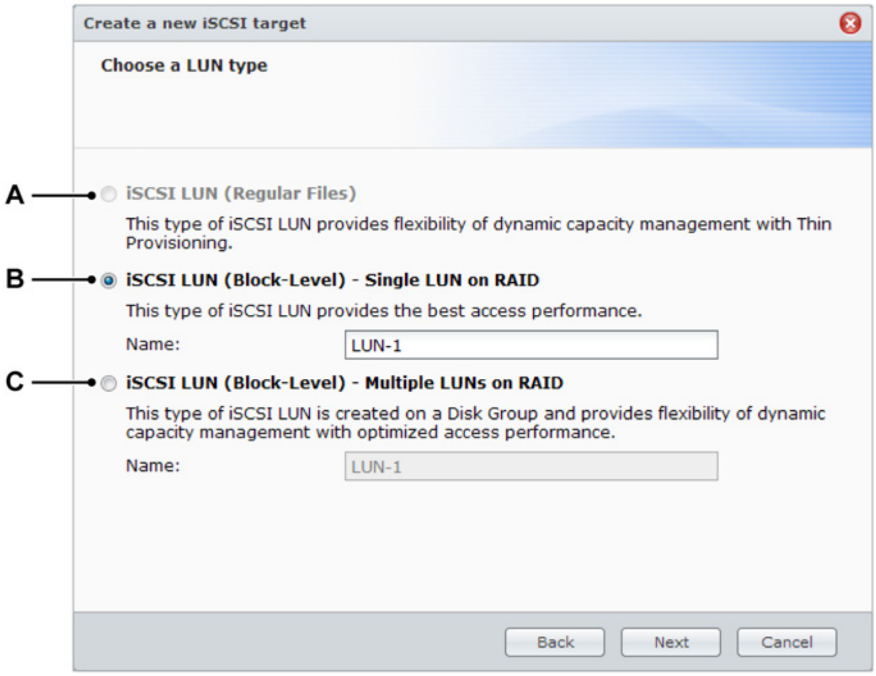



**Figure H.9:** Create a new iSCSI LUN target - Choose a LUN type dialog

**A** iSCSI LUN (Regular Files)

**B** iSCSI LUN (Block-Level) - Single LUN on RAID

**C** iSCSI (Block-Level) - Multiple LUNs on RAID

Select **iSCSI LUN (Block-level) - Single LUN on RAID (B)** this mode copies blocks of data exactly as they are and therefore offers best performance.

For the following options:

- **iSCSI LUN (Regular files) (A)**
- **iSCSI LUN (Block-level) - Multiple LUN on RAID (C)**

Please see manufacturers description online:
www.synology.com/tutorials

Click the **Next** button.

12 The **Create a new iSCI target - Choose disks** dialog appears.

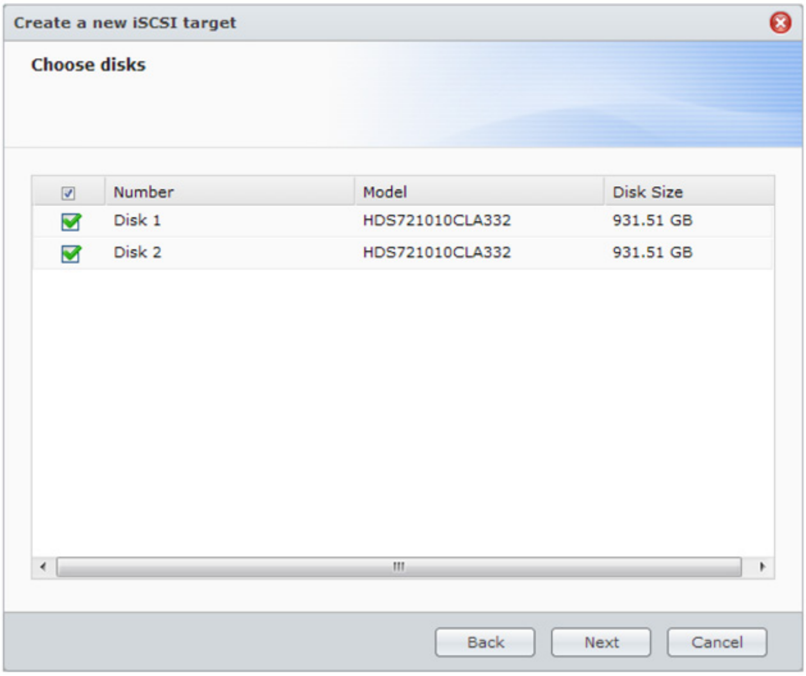



**Figure H.10:** Create a new iSCSI LUN target - Choose disks dialog

Choose the physical discs to use as a LUN target, one or many and click **Next**.

13 The **Create a new iSCI target - Choose RAID type** dialog appears.

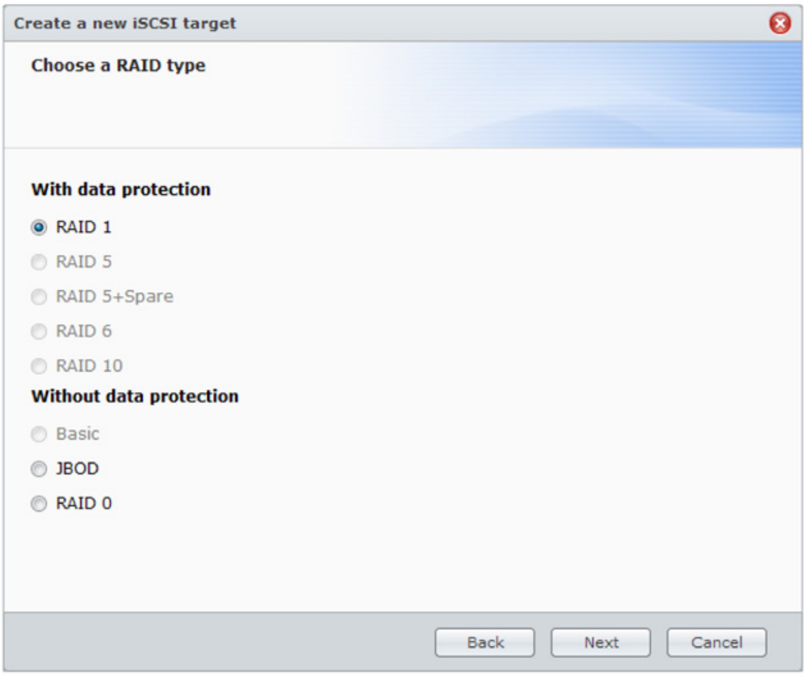



**Figure H.11:** Create a new iSCSI LUN target - Choose a RAID type

Select the RAID configuration you require.

A number of configurations are possible depending on the available setup, the user must decide what is best here. Some information is available on the **Synology®** website:
forum.synology.com/wiki/index.php

Click the **Next** button.

**14** The **Create a new iSCI target - Perform disk check** dialog appears.

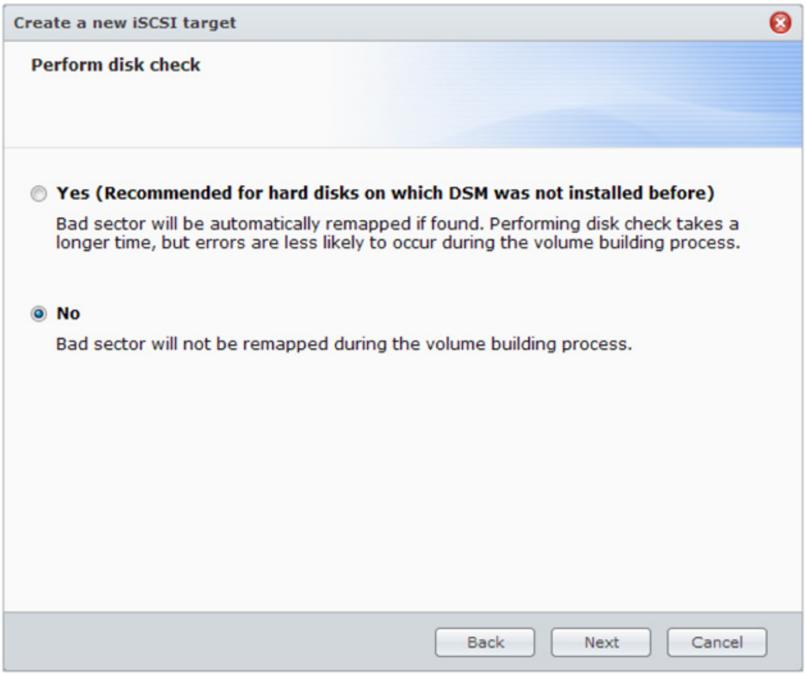



**Figure H.12:** Create a new iSCSI LUN target - Perform disk check dialog

Follow the on screen dialog and select your preference.
Disk checking will take a long time and depends on the size of the disk being checked.

Click the **Next** button.

**15** The **Create a new iSCI target - Confirm Settings** dialog appears.

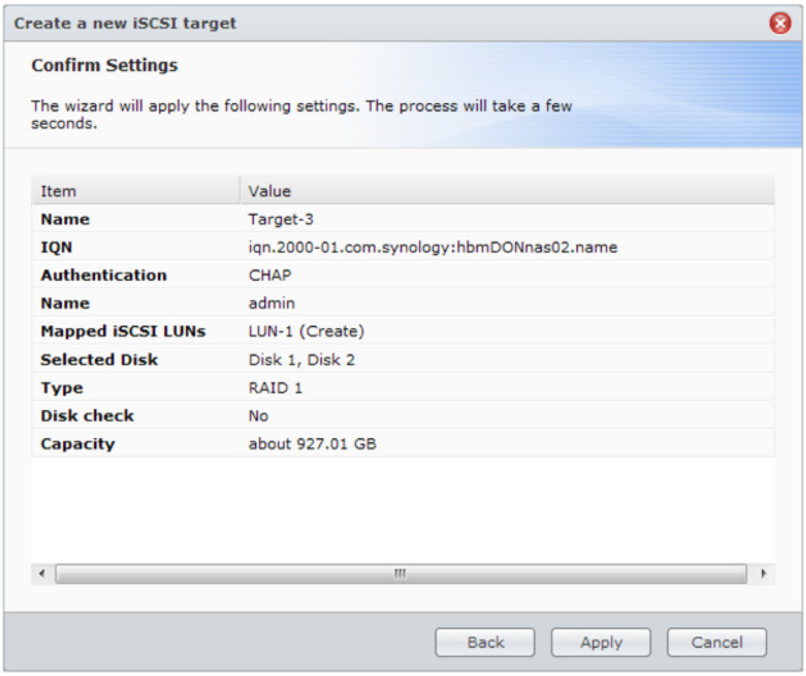



**Figure H.13:** Create a new iSCSI LUN target - Confirm Settings dialog

A summary of the information used to create the new iSCSI LUN/Target is presented, check the information is correct and then click **Apply**.

When the dialog box closes a new iSCSI Target/LUN will appear in the iSCSI Target and/or LUN tab of the Sinology® software.

**Note** *This disk is not formatted and requires formatting using Perception, when connecting to this disk for the first time, Perception will inform you of the format requirements.*

# I BE3200 USB to Optical RS232 convertor

## I.1 Re-programming of the USB-RS232 (opt. 650nm) converter to work with BE3200

**1** Download the “FT-Prog“ from:
[www.ftdichip.com/Support/Utilities.htm“](www.ftdichip.com/Support/Utilities.htm)
This is required to re-program the internal EEPROM in the converter to support inverted TX/RX lines (required to work with BE3200).

**2** Unzip downloaded ZIP-Archive and run “FT_Prog“ program. Connect converter to a free USB connector on your PC.

**3** Press **F5** or go to the menu **Devices** ▸ **Scan and Pharse**. As soon as the USB converter is found, the display should look like this:

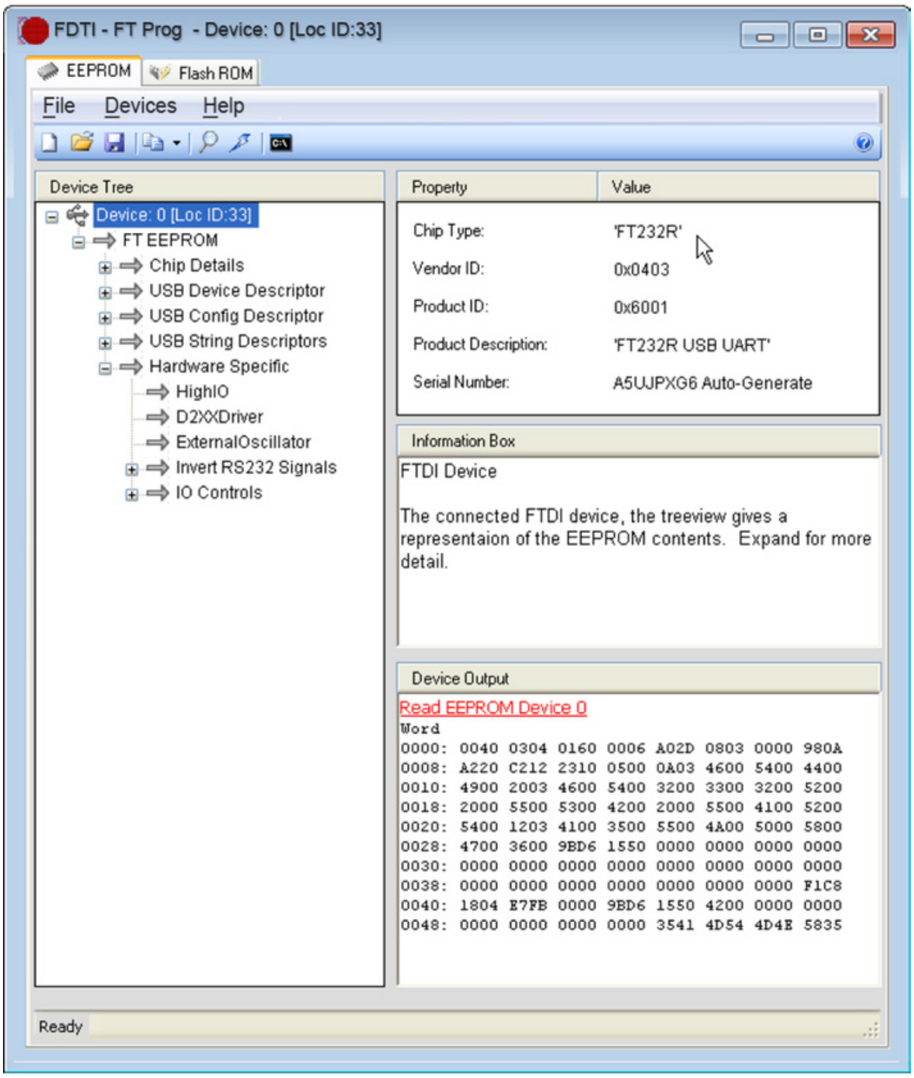



**Figure I.1:** FTDI - FT Prog (Part1)

4 In **Device Tree** on the left column expand the **Hardware Specific** node and select the **Invert RS232 Signals** (see Figure I.2).

5 In the **Property** column select **Invert TXD** and **Invert RXD** check boxes (see Figure I.2):

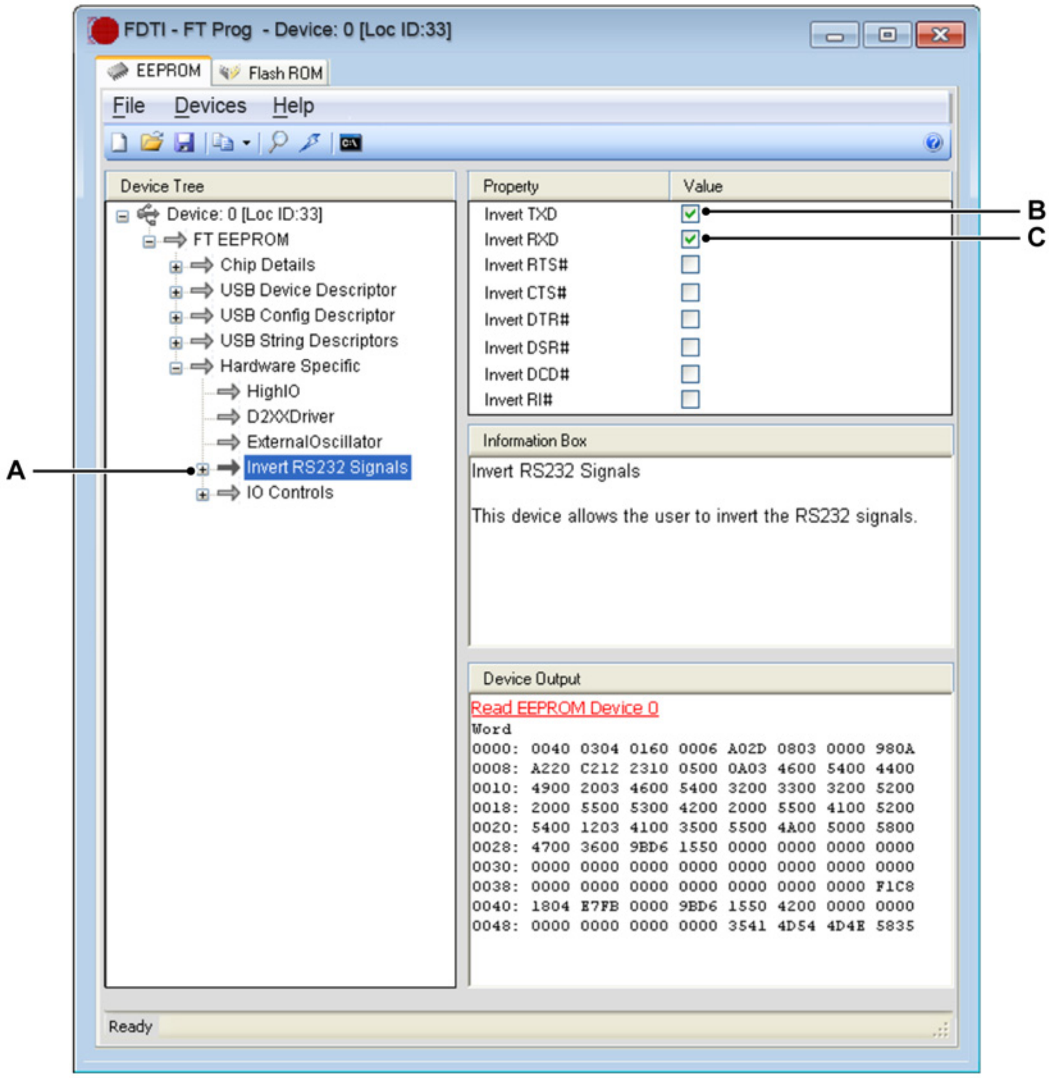



**Figure I.2:** FTDI - FT Prog (Part2)

**A** RS232 Signals

**B** Invert TXD

**C** Invert RXD

6 Finally: Select from the menu **Devices** ► **Program** to re-program the **EEPROM** on the converter.

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## *

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