

# User Manual

English



Portable, Integrated Data  
Acquisition System

**GEN5i**

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*References made to the Perception software are for version 6.40 or higher*

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# 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 not allowing it to (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.



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

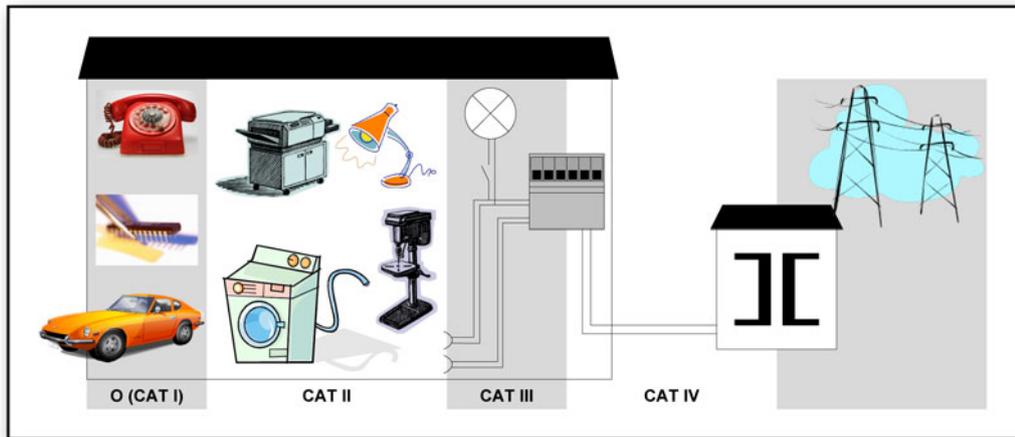
Electrical equipment, specifically measurement tools can according to IEC 61010-2-030:2010 be assigned into 4 categories. These measurement categories are indicated with the terms O (previously CAT I), CAT II, CAT III and CAT IV. Originally these categories are used to indicate the overvoltage or surge 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 deduce 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 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.**

**2.5.3 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.

**2.5.4 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 a space around the equipment for unrestricted ventilation, especially at the front and back of the unit.

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 damp (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.



### CAUTION

**The weight of the instrument may exceed 25 kg when fully loaded. Please take appropriate actions before lifting the instrument.**

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 GEN5i weights typically 20-25 kg:



## 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 er 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 deksel 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 suojohtimen 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 sähkötekniikan 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).

**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).

**AVVISO DI SICUREZZA**

Questo strumento deve essere 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).

**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. Tiltent brudd er tillatt. I tillegg må en signalgjord 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.)

**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 fränkopplingsenhet.

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).

**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 boards 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).

**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 위협할 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 VDC**를 초과하는 작동 전압의 모든 보드는 검증된 전문 기사 또는 전기공학 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 imply 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 boards 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 GEN5i 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 GEN5i 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.

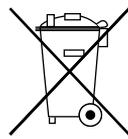
Supply cables, interface cables and probes should be kept as short as practical, preferably a maximum of 1 m. Interface cables should be screened and interface cables longer than 3 m are not acceptable in terms of interference port immunity.

## 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 EC Declaration refer to [www.hbm.com/highspeed](http://www.hbm.com/highspeed).

## 4 Batteries

### 4.1 General

The GEN5i has internal batteries.

#### Battery life time

A batteries life time depends on the 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 Remove and replace

The GEN5i PC motherboard includes a removable, Lithium battery. Replace only with same or equivalent type (CR2032).

The GEN5i controller/interface board 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 Recharge**

The GEN5i does not use rechargeable batteries. When batteries are depleted dispose of the batteries.

**4.4 Dispose**

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

Do not dispose of batteries in a fire.

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 57 for more details.

The GEN5i uses up to 500 VA and operates from line voltages from 90 V AC to 264 V AC at 47-63 Hz. The power connection of the GEN5i is via a standard IEC 320 EN 60320 C14 (male) appliance inlet, 2-pole, 3-wire designed for 250 V at 10 A. The GEN5i AC supply has no replaceable fuses installed. The power supply uses a build in resettable power shut down protection.



#### CAUTION

**Do not position the GEN5i so that it is difficult to remove the power input cable.**

The GEN5i 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

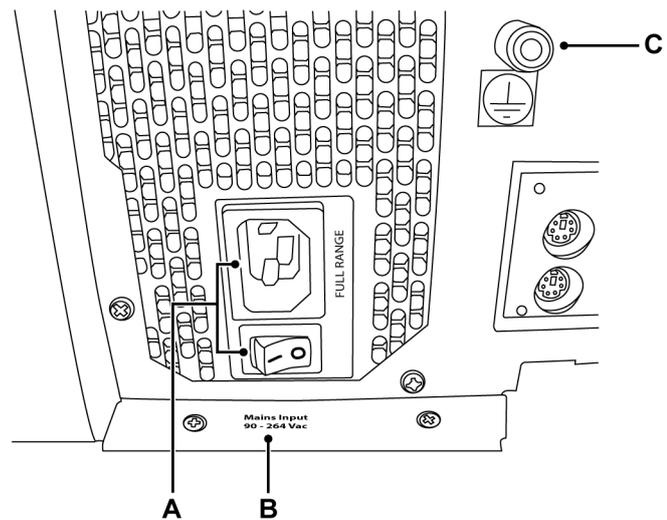
The power inlet and the protective ground lug are located on the rear of the GEN5i system. A main power cord according to the country is shipped with the unit.



### WARNING

**Connect a protective ground wire to prevent electric shock or damage to the GEN5i.**

The On/Off switch located just below the power inlet connects/disconnects the main power from the GEN5i system. To disconnect the GEN5i completely from the AC supply, unplug the IEC connector on the rear of the instrument. This switch isn't used to switch on the GEN5i instrument. Use the power button on the front panel for this purpose, see "Front panel control" on page 100.



**Figure 5.1:** Connecting Power

- A Power inlet and switch
- B Voltage rating
- C Protective ground

### 5.3 Fuse requirements and protection

The GEN5i AC supply has no replaceable fuses installed. The power supply uses a build in resettable power shut down protection.



#### **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 GEN5i has no replaceable fuses.

## 6 Introduction

### 6.1 Introducing the GEN5i

Welcome. You have made the right choice: your GEN5i Portable, Integrated Data Acquisition System is one of the most sophisticated and powerful systems in the marketplace and demonstrates the quality HBM has to offer. The GEN5i is all-in-one, 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 off-the-shelf and at the same time unique and tailored to your requirements. Some of the main features include:

- Combines a transient recorder and data acquisition system
- Combines time domain and frequency domain performance and analysis
- Provides sample rates ranging from 200 kS/s to 100 MS/s
- Transient RAM typically provides 8 to 64 MS per channel and goes up to 200 MS in parallel (equals 800 MS transient storage on a single channel)
- Isolated and non-isolated channels with high-fidelity signal conditioning
- Unlimited recording size and duration
- Built-in PC with sophisticated Perception control and analysis software
- A variety of data storage capabilities
- High-resolution 17 inch TFT display
- Front-panel buttons for quick access of acquisition control
- Portable and rugged

Especially in the field, data archiving is a challenging task when doing data acquisition. The GEN5i offers a wealth of storage and archiving options. Internal the GEN5i is equipped with a RAID0 HD configuration of 1200 GB. The instrument can be networked using built-in wired and wireless interfaces. The built-in DVD±R/W DL drive can be used to store large files. Standard USB interfaces can be used for any kind of data storage device. A built-in bay can be used to hold a removable (solid-state) hard disk drive.

And when it comes to usability: the Perception 64-bit Enterprise edition gives you a working environment that allows you to achieve your goals with effectiveness, efficiency and satisfaction.

## 6.2 Mainframe overview

There are five different GEN series mainframes available:

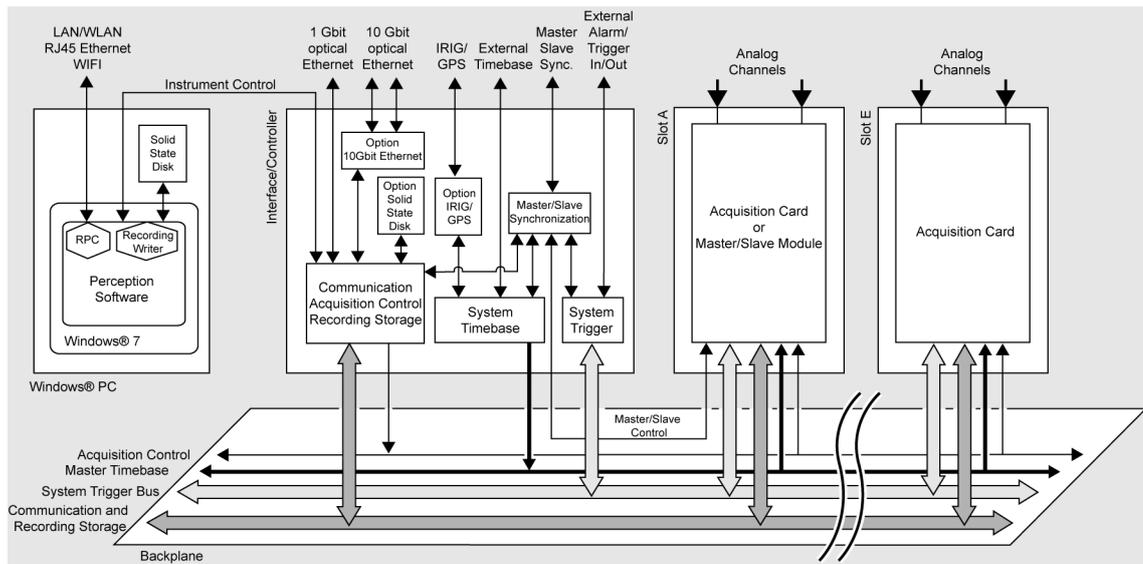
Model	Slots	Design	Comments
GEN 7t	7	Tower	Best for smaller count channel applications and easy to be transported
GEN 16t	16	Rack	Offers higher channel counts and be mounted in a rack or used stand alone
GEN 2i	2	Portable	Replaced by GEN3i end of 2013
GEN 3i	3	Portable	An integrated all in one portable 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	A larger transportable unit intended for lab use

All mainframes have identical technical specification. Main differentiating specifications are mechanics, power consumption and number of card slots.

### 6.3 Hardware

The acquisition section of the GEN5i is based on the successful and proven stand-alone GEN series Data Acquisition System, available in a Tower model and a Rack model.

In the GEN5i the same concepts are used.



**Figure 6.1:** Block Diagram GEN5i Portable Integrated Data Acquisition Systems

#### 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 local hard disk or Solid State Disk (SSD), or stream directly to the GEN5i internal PC. For more information see "Interface Module/System Controller" on page 144.

#### 6.3.3 Input cards

The GEN5i can accept up to five input cards. Each input card includes one or more digitizers, powerful filtering and intelligent triggering, and acquisition management. For the analog input section the GEN5i 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 239.

**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" on page 312.*

#### **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:

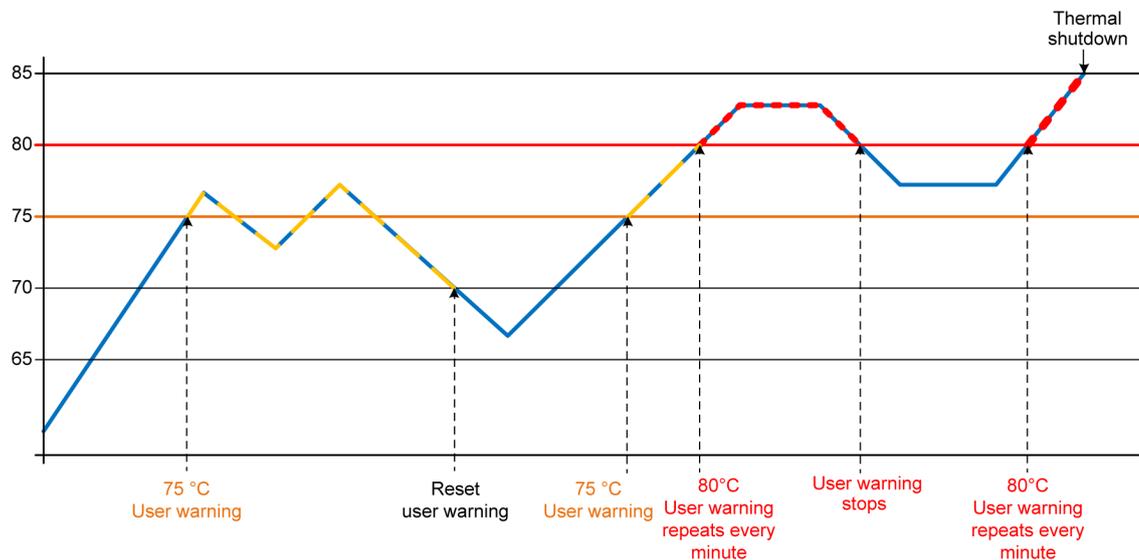
- the sampling clock, absolute time info, trigger and start/stop signals between the mainframes, creating a real high channel synchronized system out of the nine mainframes
- a timing accuracy between the mainframes better than 100 ns
- an automatic cable length detection and compensation

For information on the usage of the master/slave card, see "Master/Slave Card" on page 212.

#### **6.3.5 Thermal protection**

Every GEN series mainframe supports a feature called Thermal Shutdown. For this the mainframe and acquisition cards have build-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 6.2).



**Figure 6.2:** Thermal protection - Automatic user warnings

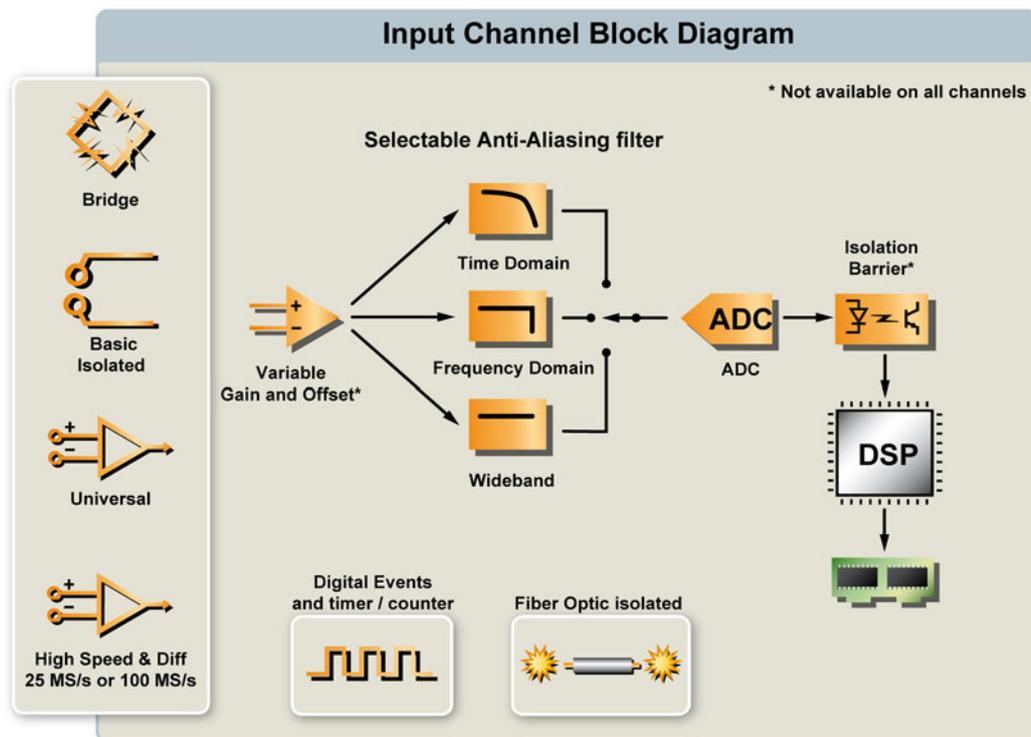
- As soon as one of the internal thermocouples measures a temperature above +75 °C for the first time, a single user warning is initiated. As long as the highest measured temperature measured is above +70 °C and below 80 °C no additional user warnings are initiated.
- If the internal temperature after 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.



## 6.5 Acquisition

The GEN5i is a multi-channel modular Data Acquisition System. It provides real-time data for waveform and meter displays. At a high streaming rate 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 6.4:** Input channel block diagram

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, the GEN5i 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

GEN5i 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:

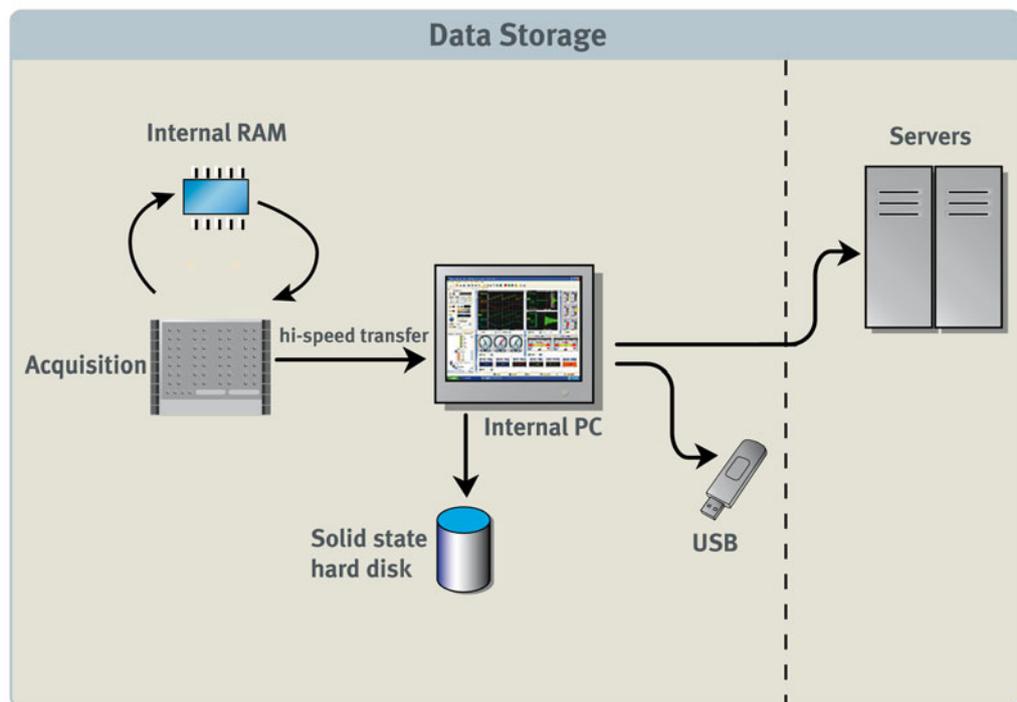
- Voltage (single-ended and differential)
- Current
- Strain gages in any configuration
- IEPE (Integrated Electronics Piezo Electric, for example ICP®, CCLD, Isotron®, Deltatron®, Piezotron® and others)
- Resistive sensors (e.g. displacement, temperature)
- Binary and frequency (counter/timer)
- And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

## 6.7 Data Storage

In addition to mega samples of on-board RAM, you can record directly to the GEN5i hard drive, removable disk, or USB device. In addition you can archive your data on a DVD, USB stick, removable disk; or to a network server over the Gigabit Ethernet. The GEN5i always stores to on-board high-speed RAM. Recorded data is then automatically stored on the GEN5i defined storage location at maximum speed. At rates up to megabytes per second storage is continuous, and unlimited duration recordings can be made.

The GEN5i control module can be factory-equipped with an optional SCSI controller. The SCSI option provides expansion and flexibility, allowing GEN5i users to add a wide range of external hard drives for additional storage of recordings. For details on the SCSI controller see "Option - SCSI interface board" on page 206.

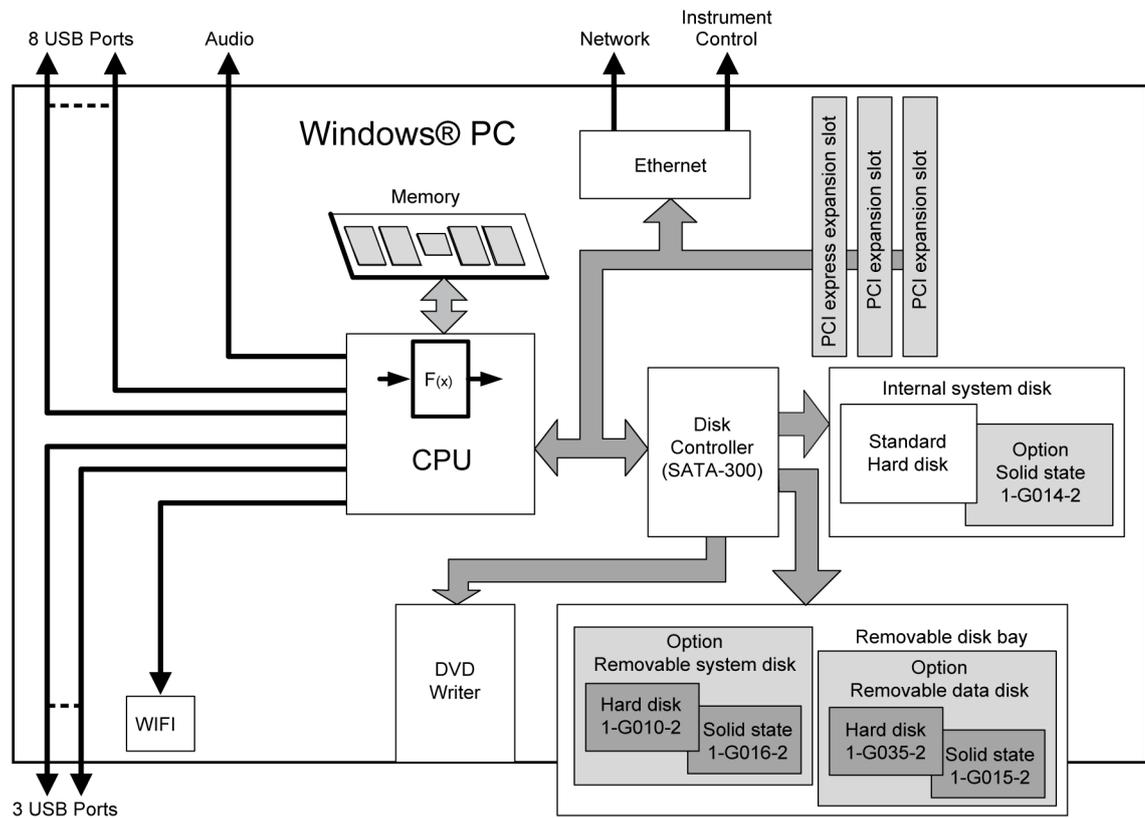
Recorded files are standard Windows files with extension PNRF (Perception Native Recording File).



**Figure 6.5:** Data storage options

### 6.8 PC Section

The GEN5i has a built-in industrial PC. This PC provides all the standard features that you may expect at an industrial grade quality.



**Figure 6.6:** Windows® PC Block Diagram

Features include, but are not limited to:

- High-Speed Multi-Core CPU
- Microsoft® 64 bit Windows® 7 Operating System (1)
- 4 GigaByte of RAM
- 1200 GB Hard Disk in a RAID0 configuration
- On-board graphics engine with video out
- Full audio
- PS/2 keyboard and mouse ports
- Serial port
- Multiple USB 2.0 ports
- 1 Gigabit Ethernet
- Wireless LAN support at 54 Mbps
- PCI expansion slots

- (1) Microsoft, Encarta, MSN, and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Refer to the specification section of this manual for full details.

## 6.9 Disk option

The GEN5i support several disk options each having a unique application benefit.

Disk Option Overview							
Disk option	System/data disk	Hard disk/solid state	Removable	Factory installed	RAID 0 striping	Size unformatted	Continuous write speed
Standard	System	HDD	No	Yes	Yes	1.5 TB	50 MB/s
1-G014-2	System	SSD	No	Yes	Yes	600 GB	100 MB/s <sup>(1)</sup>
1-G010-2	System	HDD	Yes	Yes	Yes	640 GB	40 MB/s <sup>(2)</sup>
1-G016-2	System	SSD	Yes	Yes	Yes	600 GB	100 MB/s <sup>(1)</sup>
1-G035-2	Data	HDD	Yes	No	No	320 GB	25 MB/s <sup>(3)</sup>
1-G015-2	Data	SSD	Yes	No	No	300 GB	100 MB/s <sup>(1)</sup>
Combination Overview							
Disk option	Standard system disk	1-G014-2	1-G010-2	1-G016-2	1-G035-2	1-G015-2	
1-G014-2	✗	✗	✗	✗	✓	✓	
1-G010-2	✗	✗	✗	✗	✗	✗	
1-G016-2	✗	✗	✗	✗	✗	✗	
1-G035-2 <sup>(4)</sup>	✓	✓	✗	✗	✓	✓	
1-G015-2 <sup>(4)</sup>	✓	✓	✗	✗	✓	✓	

- (1) Speed limited by Instrument Control transfer speed; Max 50 MB/s for systems shipped before January 2012.
- (2) Speed limited by removable 2.5" RAID 0 hard disk.
- (3) Speed limited by removable 2.5" single hard disk.
- (4) Multiple data disks can be ordered, but only used one at the time.

### 6.9.1 RAID 0 technology

Most of the GEN5i disk options support RAID functionality. RAID is an abbreviation for **Redundant Array of Independent Disks**. RAID technology exists in many different form each with their own specific usecase. Within this manual only the GEN5i used RAID mode will be explained. More RAID knowledge can be found on Wikipedia.

The GEN5i uses a 2 disk RAID 0 setup to increase the overall continuous storage speed. RAID 0 does not offer any enhanced data security. If one of the disks has a read error, the entire recorded data is lost.



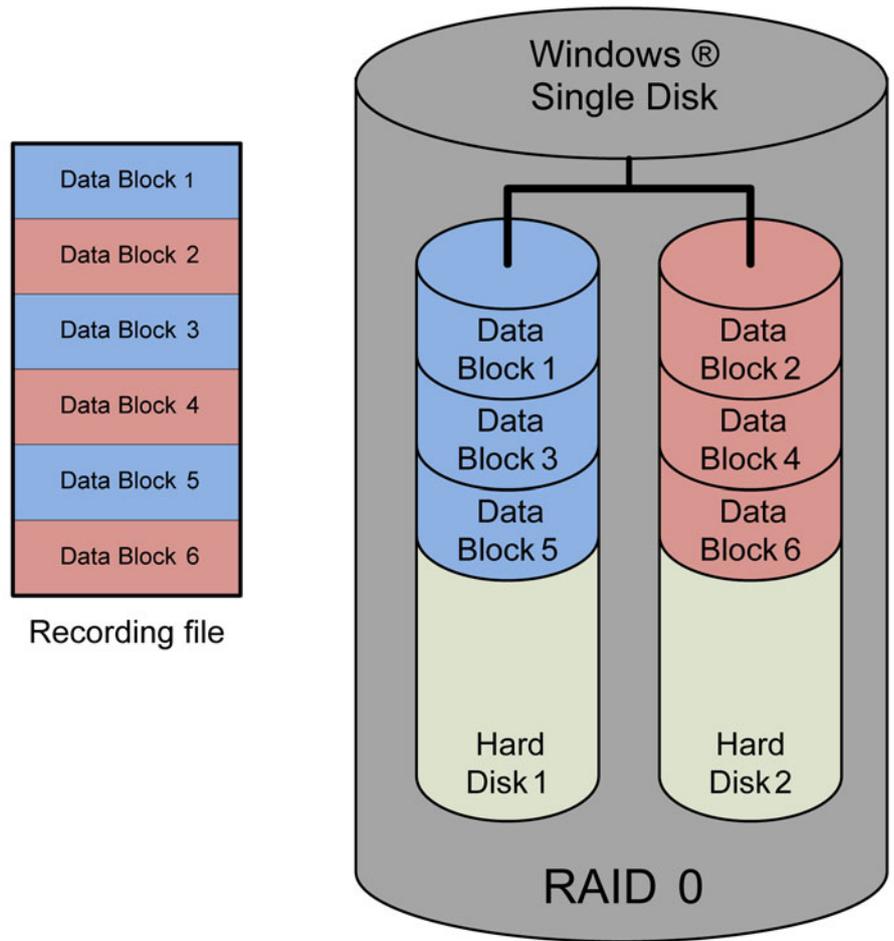
#### WARNING

**Make backup copies of your recorded data to prevent data loss due to disk errors.**



**HINT/TIP**

Regular predictive replacement of your GEN5i disk is recommended to minimize the risk of losing data. See appendix "Preventive maintenance" on page 499 for more details.



**Figure 6.7:** RAID 0 data storage

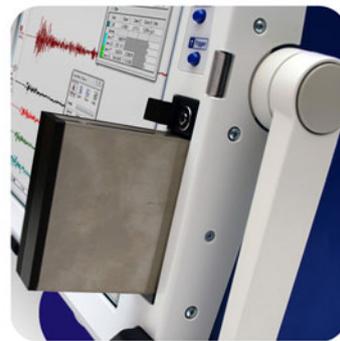
When two hard disks are setup in a RAID 0 mode, the Windows operating system will only show one single disk. Only the RAID controller has the know-how of the two hard disks.

Any (recording) file written to a disk is always stored using multiple smaller blocks of data. Each block of data is written sequentially to the windows disk. As the data is written to the RAID controller, it spreads the sequential written data blocks across the disks of the RAID array. As the GEN5i uses two disks all odd data blocks are written to hard disk 1 all even data blocks are written to hard disk 2.

The net effect is almost a doubled data read and write speed compared to the use a of single hard disk. If however one of the disk experiences data read errors the entire recording is lost as no redundancy is available.

### 6.9.2 GEN5i Removable disk

The GEN5i mainframe has an removable disk bay. It is conveniently located on the front side of the GEN5i for quick an easy removal of the disks.



**Figure 6.8:** GEN5i removable disk bay

All removable disk options use this disk bay; only one removable disk option can be used at the same time. Ordering multiple disk options is possible to be used one after the other.



#### **WARNING**

**Windows® will not recognize the removable disk option as a removable disk. To prevent loss of data and disk integrity shutdown the GEN5i before removing or replacing your disk.**

### 6.9.3 GEN5i system and data disk

Data disk are pre-formatted and have no Windows® operating system installed. When using a removable data disk an internal (Not removable) system disk must be installed to run the Windows® 7 operating system. Removable data disks shipped up to 2012 can have different continuous write speeds and unformatted disk sizes.



#### HINT/TIP

HBM supplies USB attached removable disk bays to be used with your desktop or laptop PC. When removing the removable data disks from the GEN5i it can be directly plugged into the USB disk bay and attached to any Windows based PC. All recorded data stored by the GEN5i can be directly used without copying the data first.

System disks need to have the Windows® 7 operating system pre-installed. To install the Windows® 7 license the system has to be returned to the factory. System disks are also setup as a RAID 0 dual disk setup. This setup has impact on the BIOS setting of the GEN5i. RAID 0 system disks cannot be replaced by standard data disks without changing your BIOS setup. Never make these setup changes in the field without backing all your data on the disks first.



#### WARNING

**Never use RAID enabled removable disk options mixed with standard non RAID disk setups. Also never mix RAID modes when using removable drives. Your disk bay might not be accessible anymore and all data on the RAID bay will be lost.**



#### HINT/TIP

All system disk option have a Windows® 7 license installed. The use of the Windows® 7 license on multiple disks is not allowed. For this reason multiple (internal or removable) system disks cannot be offered as a standard option. When ordering a system disk option the standard internal system disk will always be removed. HBM special services can work out a special project proposal to meet special needs.

**HINT/TIP**

Older GEN5i systems have Windows® Vista installed. HBM special services can work out a proposal to do a Vista to Windows 7 upgrade. As the Windows upgrade license needs to be bought in your local region no standard upgrade option is available.

**6.9.4 GEN5i hard disk and solid state disk technology**

The GEN5i supports both standard hard disks as well as solid state disks. Each technology offers pro's and con's.

Solid state disk have no moving parts and create reliable data storage medium in environments with higher shock and vibrations. The absence of the moving disk head also avoids the standard hard disk seek times. Solid state disks therefore offer a higher continuous streaming rate.

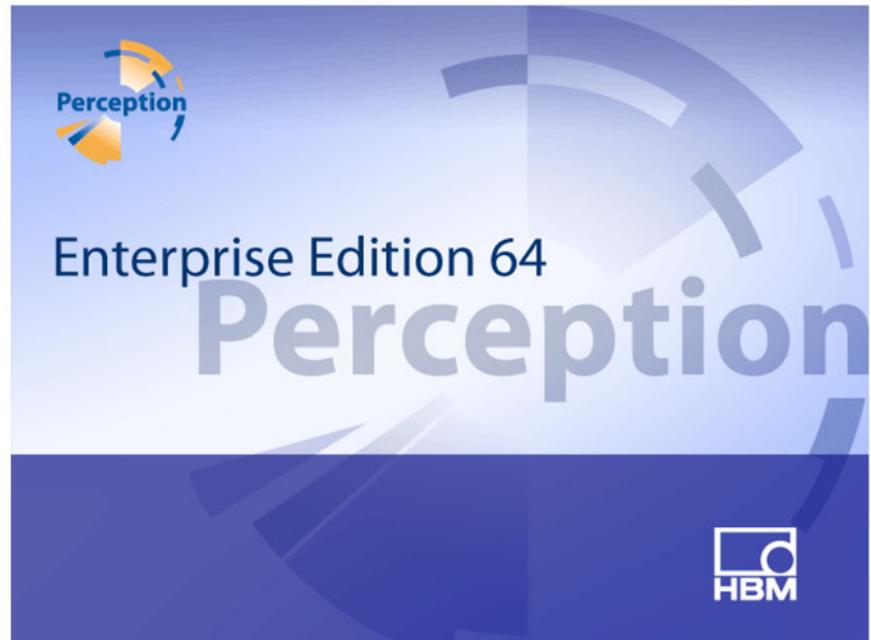
Hard disks have a better price per GByte storage capacity and offer large disk sizes.

**WARNING**

**Hard disks and solid state disks both require predictive replacement to minimize the risk of GEN5i down time or of loss of data. See appendix "Preventive maintenance" on page 499 for more details.**

### 6.10 Perception Software

For control, analysis, archiving and reporting the Perception 64-bit Enterprise edition is installed on your GEN5i.



**Figure 6.9:** Perception 64-bit Enterprise edition

Perception allows control of a variety of acquisition modes, ranging from straightforward, continuous data streaming of a few channels to multi-rack based DAQ instruments providing millions of data points per second. Perception software is equally comfortable with fast update scope type displays, streaming strip chart displays and transient recording.

The unique displays let you visualize real-time waveforms instantly. Review historical data while acquiring and displaying current data. Compare with reference curves or zoom in to see the finest details with our free-style zooming and panning. The alternate zoom feature gives you two zoom areas simultaneously within the same waveform.

Dedicated hardware support allows for live and accurate display of real-time data. HBM's StatStream® display technology enables even high resolution files to be viewed instantly regardless of acquisition size or network speed.

In addition the Perception software includes a variety of numerical displays and “VU-meters” with alarm levels that are configurable and scalable to suit various requirements and conditions.

Perception provides the measurement functionality you need to work with ease and efficiency. The cursor measurements with horizontal, vertical and slope cursors with a swiftly updated result table allows for fast and easy access to points of interest.

A variety of built-in meters can be connected directly to parameters like max, min and mean value as well as Peak-to-Peak, RMS, etc. These values are generated by the acquisition hardware and displayed in real-time on your screen.

When you find an event of interest you can print your traces with a single menu command on high-resolution printers in full-color. Or simply copy the display of interest and paste it into any document for more advanced reporting. In addition you can create quick or advanced reports using Microsoft® Word.

Perception’s thoughtful workbench concept allows for arrangement of a variety of graphical objects into logical groups for easy reference. You can freely customize the work space to suit your control and analysis needs: create an environment by selecting the required windows, displays and components, size and position them and save this as a Virtual WorkBench (\*.pvwb) file for later use. You can easily switch between saved work spaces for different requirements, and at start-up you can choose between auto-configuration and a saved work space.

You can also use the Quick start option to go directly to your preferred work environment.

A variety of options is included as standard within the Perception on your GEN5i:

- **Multiple workbooks** that allow you to create multiple ‘instances’ of your work environment and effectively use multi-monitor systems.
- **Export plus** for additional export formats.
- **Control plus** for acquisition control of multiple mainframes.
- **Video playback** that enables synchronized playback of video and time domain data with tracking cursors.
- **Analysis** that allows entry of formulas to calculate math channels and channel parameters.
- **Basic FFT:** enter the world of frequency analysis without extensive knowledge

- **Advanced reporting:** a DTP-alike tool for the creation of stunning reports with displays, tables, results, etc.
- **Information:** a tool to include a variety of information in your experiment.

Other specialized options are available as a cost option and include **Custom Software Interface** programming CSI, **STL** formulas, **BE256 / Multipro** control, **BE3200 Test Sequencer** control, and **HPHV Automated Analysis**.

In addition special functions have been implemented to support the front panel keys and integrated power-up, power-down and recovery procedures.

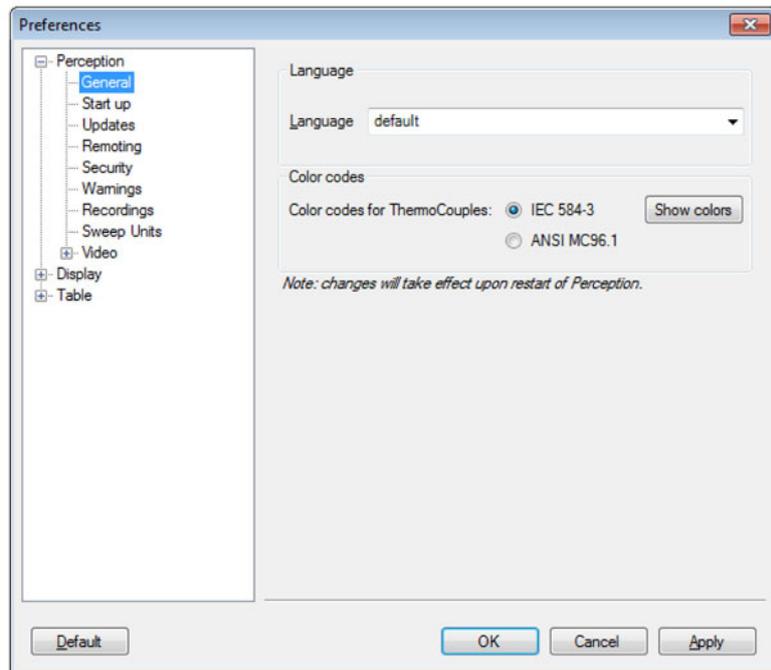


### IMPORTANT

For information on the general usage of Perception you must use the separately supplied Perception User Manual. In this manual you will find only information that is pertinent to the GEN5i.

## 6.11 Perception language setting

Various program settings are stored in the Perception Preferences. These settings include, but are not limited to, **Perception language**, start-up options, options for updates, video information, display settings, etc.



**Figure 6.10:** Preferences dialog

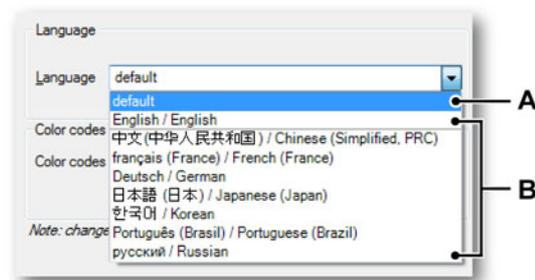
### To open the Preferences dialog:

- Click **Preferences...** in the File menu.

## User Interface Language options

To startup Perception in a specific User Interface Language:

- 1 Click **Preferences...** in the File menu.
- 2 Select **General** in the tree view of the **Preferences** dialog.
- 3 In the **Language** drop down list box you have the following choices:



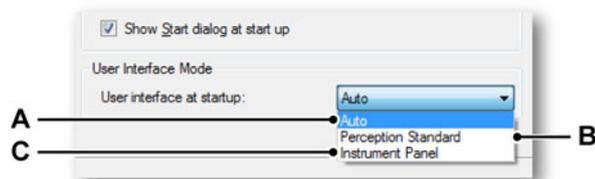
**Figure 6.11:** User Interface Language area (detail)

- A default:** The software detects the operating system language and uses that language (if available).
- B** The software runs in the selected language.

## User Interface Mode startup options

To startup Perception in a specific User Interface Mode:

- 1 Click **Preferences...** in the File menu.
- 2 Select **Start up** in the tree view of the **Preferences** dialog.
- 3 In the **User Interface Mode** drop down list box you have the following choices:



**Figure 6.12:** User Interface Mode area (detail)

- A Auto** The software detects the system it is running on and starts in the corresponding mode.

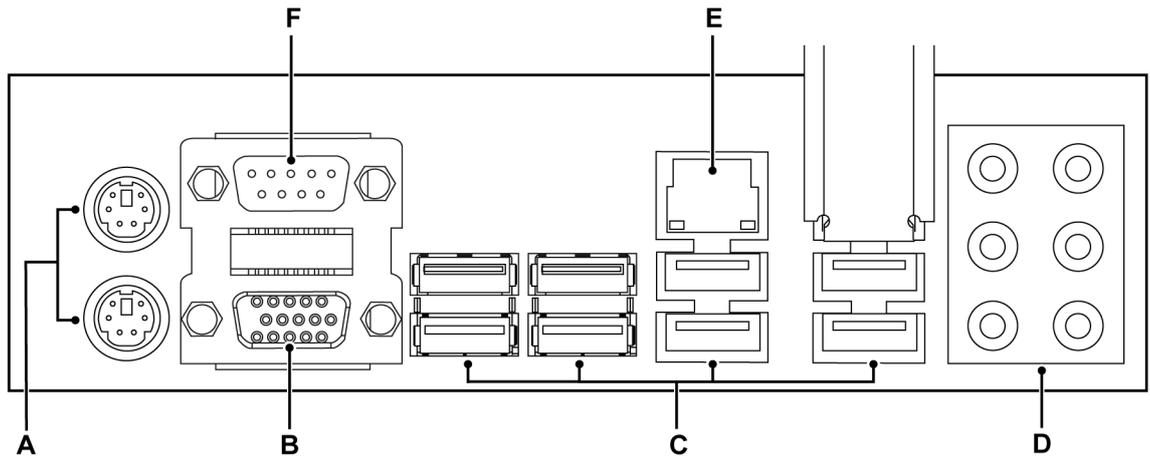
- B Perception Standard** The standard Perception GUI. This is default on PCs and the GEN5i.
- C Instrument Panel** The Instrument Panel GUI which is default for a GEN2i and GEN3i.

Perception will start in the defined User Interface mode.

# 7 Set up your GEN5i

## 7.1 PC connections

GEN5i has a PC motherboard inside. This PC motherboard has a lot of connections that can be used to connect other devices to the GEN5i system.



**Figure 7.1:** PC connections (rear)

- A** PS/2 Mouse and keyboard
- B** Display connector
- C** USB connectors
- D** Audio connectors
- E** Ethernet connector
- F** Serial port connector

- A Keyboard and PS/2 mouse connectors** This stacked connector is for PS/2 mouse (top) and keyboard (bottom). The mouse and keyboard shipped with the instrument are both USB devices and should be connected to a USB-port.
- B Display connector** An external monitor can be connected to this connector and can be used as a second screen. This is a standard SVGA connector (DB15 high-density) for analog monitors.
- C USB connectors** Eight USB connectors are available on the rear of the system. All these USB-ports are USB 2.0 allowing data transfers up to 480 Mb/s and capable for high-speed, full-speed and low-speed devices. The 5 V supply for the USB devices is on-board fused with a 2.0 A resettable fuse. The supply is common for the two channels located in top/bottom pairs.

- D Audio connectors** The onboard motherboard audio circuit implements 7.1+2 Channel High Definition Audio with UAA (Universal Audio Architecture). The GEN5i unit is shipped with an internal speaker (mono) only. Through the Microsoft Windows 7 operating system audio settings can be changed for 2, 4, 6 or 8 channel configuration. The audio connectors are color coded and depending on the number of audio channels selected, the connector configuration is as in table 4-1.

*Table 7.1: Audio connector configuration*

Audio connector	2-channel	4-channel	6-channel	8-channel
Light Blue	Line in	Line in	Line in	Line in
Lime	Front speaker out	Front speaker out	Front speaker out	Front speaker out
Pink	Mic in	Mic in	Mic in	Mic in
Gray	-	-	-	Side speaker out
Black	-	Rear speaker out	Rear speaker out	Rear speaker out
Yellow Orange	-	-	Center/ Sub-woofer	Center/ Sub-woofer

- E Ethernet connector** The motherboard supports two Ethernet channels. One of these channels is dedicated used by the GEN5i measurement section, not available to the user. The other channel 10/100/1000 Mb is free for the user to connect the system to a network.

In order to achieve the specified performance of the Ethernet port, Category 5 twisted pair cables must be used with 10/100 MB and Category 5e, 6 or 6e with 1 Gb LAN networks.

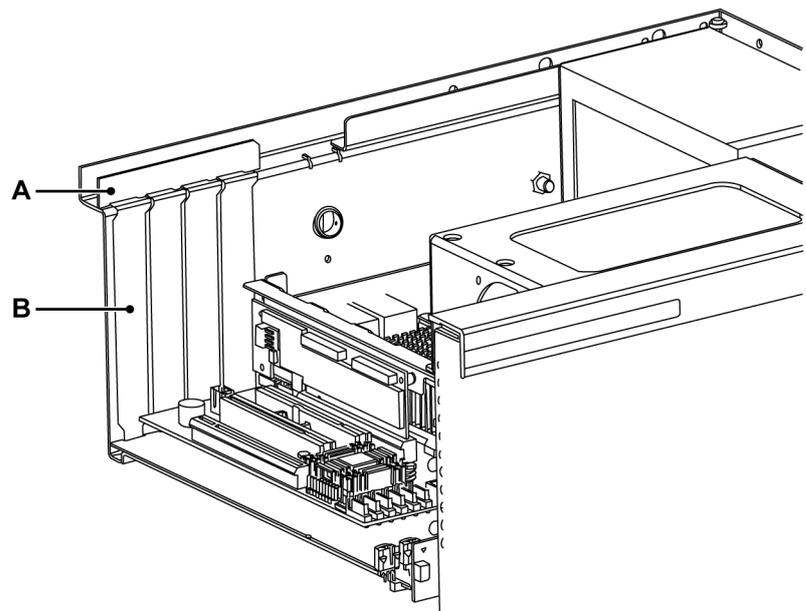
- F Serial Port connector** One RS232 serial port (Com1) is available on the motherboard. It is a DB9M connector, any DB9F connector is compatible.

## 7.2 PC plug-in cards

The motherboard in GEN5i has 3 extension slots for plug-in cards available to the user. These slots are one 4-Lane PCI-Express 4x (in 16x connector) and two PCI (slot 1 and slot 2). Max. card length for all slots is ½ length (max. 174 mm).

The fourth expansion slot on the motherboard is occupied with a LVDS video controller for the built-in TFT display. This slot is not available for the user.

Before installing any PC plug-in card to the GEN5i system read the instructions that come with the card carefully. Some cards need the software to be installed up front, other cards need to be plugged in first and software install should be done afterwards.



**Figure 7.2:** Brackets for motherboard plug-in cards

- A** Retension bracket
- B** Filter brackets

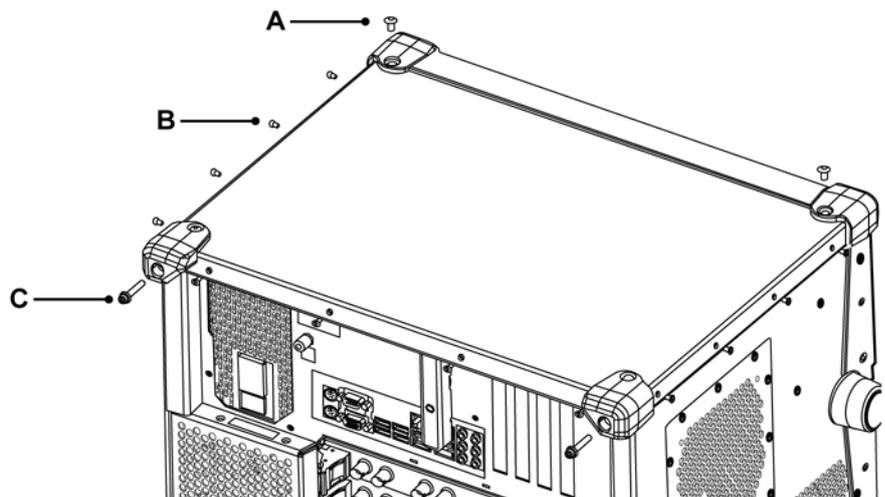

**CAUTION**

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 GEN5i system, its connections or a plug-in card.

**7.2.1 Installing plug-in cards**

To install plug-in cards:

- 1 Shut down the GEN5i system and remove the power input cable.
- 2 Open the top cover of the GEN5i unit.
  - Remove all top cover screws Phillips 1; 8x at the sides and 4x at the rear.
  - Remove 2x hex 2.5 mm screws at the front bumpers (top).
  - Remove 2x Torx 20 at the rear bumpers (rear).



**Figure 7.3:** Open GEN5i top cover

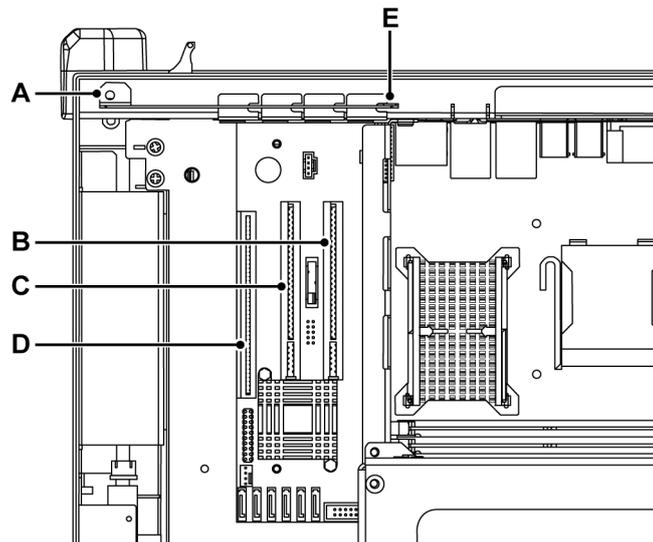
**A** Hex 2.5 mm (2x)

**B** Phillips 1 (12x)

**C** Torx 20 (2x)

- 3 Gently lift the back of the top cover and slight it backwards to remove the cover.

- 4 Remove the screw holding the card retention bracket.



**Figure 7.4:** GEN5i extension slots (top view)

- A Retention bracket/Release screw
  - B PCI slot 1
  - C PCI slot 2
  - D PCIe x4
  - E Hook-in retention bracket
- 5 Lift the card retention bracket and put it aside in a secure place.
  - 6 If installing a new card, remove the corresponding filler bracket to create a cardslot opening.
  - 7 If replacing a card that is already installed in the computer, remove the card. If necessary, disconnect any cables connected to the card. Grasp the card by its top corners, and ease it out of its connector.
  - 8 Prepare the card for installation.
    - See documentation that came with the card for information configuring the card, making internal connections, or otherwise customizing it for your GEN5i system.
  - 9 Place the card in the connector and press down firmly. Ensure that the card is fully seated in the slot.
  - 10 Replace the card retention bracket ensuring that:
    - The top of all cards and filler brackets are aligned in the chassis.
    - The notch in the top of the card or filler bracket fits around the alignment guide in the retention bracket.
  - 11 Fix the card retention bracket by replacing and tightening the screw.

- 12** Place top cover back in position.
- 13** Fasten all screws for the top cover (12x Phillips 1, 2x hex 2.5 mm and 2x Torx 20).
- 14** Connect any cables that should be attached to the card.
  - See documentation for the card for information about the card's cable connections.
- 15** GEN5i is ready for power on.
  - Follow the software instructions for the plug-in card.

## 7.3 Removing and installing acquisition modules



### 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 GEN5i system, its connections or a plug-in card.



### CAUTION

The GEN5i Data Acquisition System is factory-calibrated as delivered to the customer. Swapping, replacing or removing of boards may result in minor deviations to the original calibration. The GEN5i 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.

### 7.3.1 Removing modules



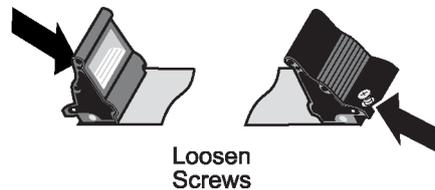
### CAUTION

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

To remove a module:

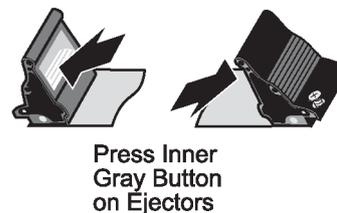
- 1 Shut down the GEN5i system and remove the power input cable.
- 2 Disconnect all cables from acquisition boards.

- 3 Loosen the small set screw on both ejectors on the module.



**Figure 7.5:** Removing modules (Part 1)

- 4 Press the inner gray button on each ejector to release the catch.



**Figure 7.6:** Removing modules (Part 2)

- 5 Press both ejectors outward to release the module. They act as levers to gently pull the module from its backplane sockets.
- 6 Slide the module out of the GEN5i unit.

### 7.3.2 Installing modules



#### CAUTION

For correct operation of the instrument, it is imperative that the board with the lowest maximum sample rate is placed in the slot marked "A".

#### To install modules proceed as follows:

- 1 Shut down the GEN5i system 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 left and right.

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



Figure 7.7: Card/module ejectors with screws



**WARNING**

Screws must be locked to meet CE emissions.



**WARNING**

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

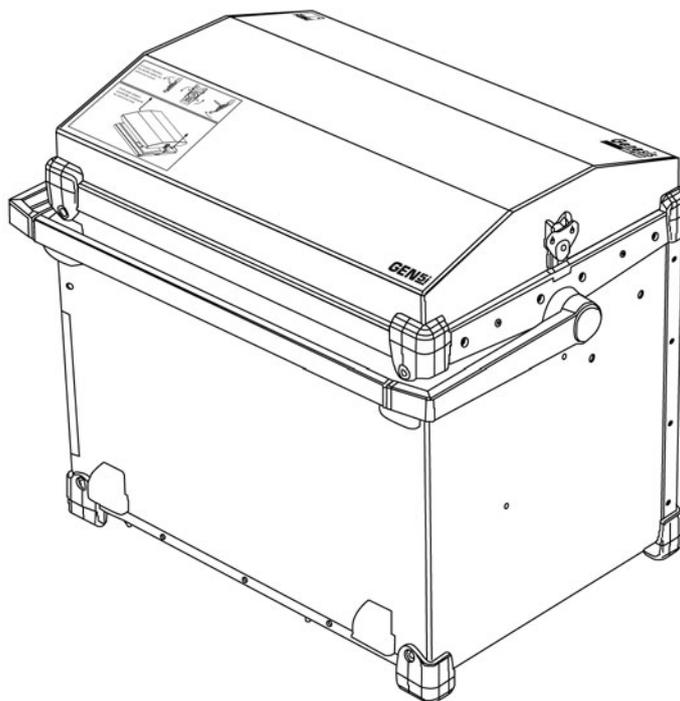
#### 7.4 Protective cover

The GEN5i is shipped with a protective cover protecting the sensitive LCD display from damage during transport or storage. Beside it protects the display it also can store the keyboard and mouse in the accessories box. Keyboard and mouse are shipped in an enclosed separate box during shipment from manufacturer to customer.

##### 7.4.1 Removing protective cover and accessories box

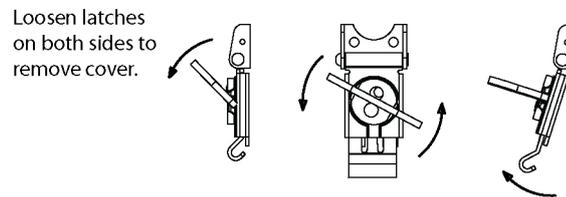
**To remove protective cover:**

- 1 Remove all cables from the rear of the instrument and put the instrument with the display facing up.
- 2 Turn handle to top or bottom so it's not above the display.



**Figure 7.8:** Removing protective cover instrument setup

- 3 Open the cover latches on both sides as shown on protective cover instructions.



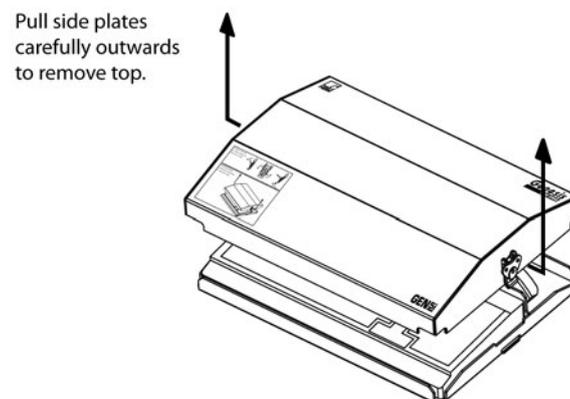
**Figure 7.9:** Open protective cover latches

- 4 Remove the protective cover.

#### 7.4.2 Opening accessories box

To open accessories box:

- 1 Put protective cover over flat surface with outside face up.
- 2 Take protective cover left and right side and gently pull these sides outwards.
- 3 The accessories box will slide out of the protective cover.



**Figure 7.10:** Opening accessories box

### 7.4.3 Closing accessories box

#### To close accessories box:

- 1 Put the accessories box on flat surface and put keyboard and mouse inside.



**Figure 7.11:** Accessories box with mouse and keyboard in it

- 2 Hold protective cover over the accessories box.
- 3 Pick up the total and gently push accessories box inside the protective cover. It will snap into position on left and right sides.

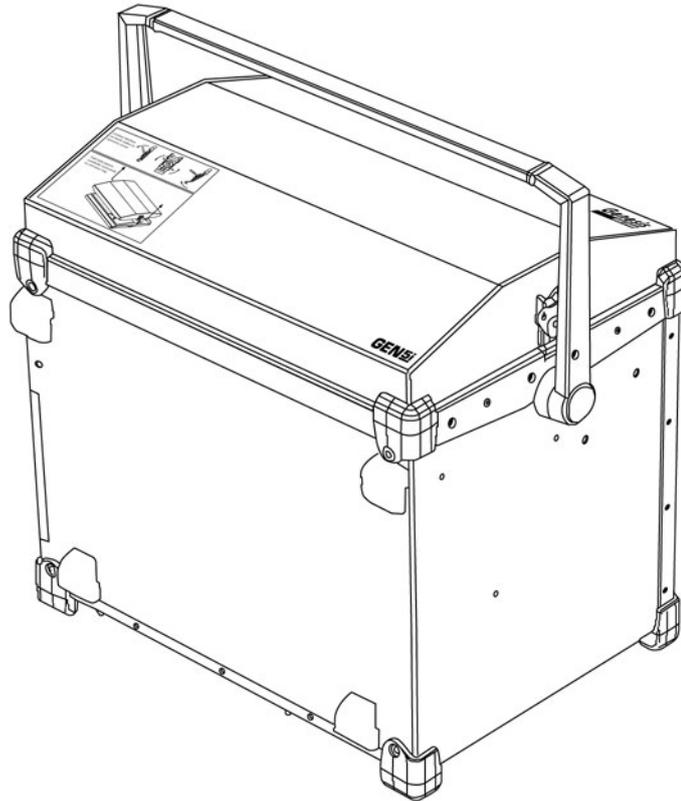
### 7.4.4 Installing protective cover

#### To install protective cover:

- 1 Shut down the GEN5i system and remove the power input cable.
- 2 Remove all cables from the rear of the instrument and put the instrument with the display facing up.
- 3 Turn handle to GEN5i top or bottom so it's not above the display.
- 4 Put protective cover over GEN5i front.
- 5 Close the cover latches on both sides as shown on protective cover instructions.

## 7.5 Handle

The handle is used to carry the GEN5i system. Only carry the instrument when the handle is in the mid-position.



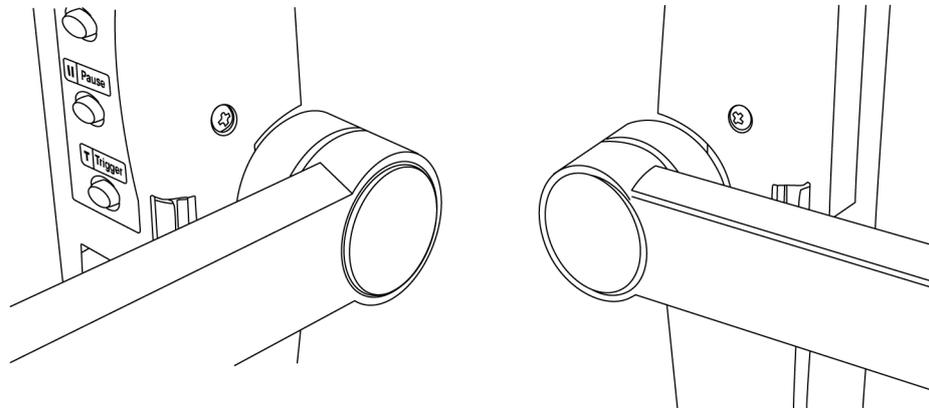
**Figure 7.12:** GEN5i with handle in the mid-position

The handle can be turned to the top- or bottom side. When the handle is turned to the bottom side it can be used to slightly lift the instrument front so the display angle is towards the user. The angle between display and vertical is about  $+4^\circ$ . When a bigger lift angle is necessary use the GEN5i front feet ( $+12^\circ$ ).

### 7.5.1 Turning handle

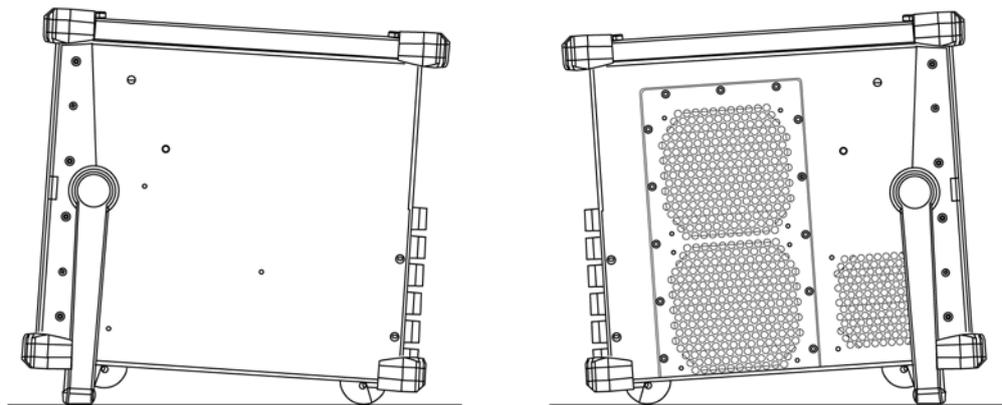
**To turn handle, act as GEN5i stand:**

- 1 Put instrument on flat surface.
- 2 Push-in both sides of the handle turning point.



**Figure 7.13:** Handle push buttons

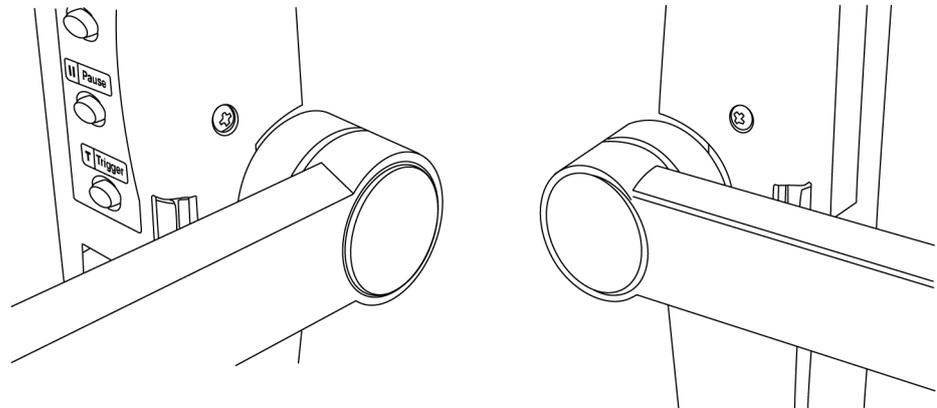
- 3 Gently lift the instrument front and turn the handle down parallel to the front.
- 4 Release the handle push buttons and the handle will snap in fixed position.
- 5 Now GEN5i can stand on its handle.



**Figure 7.14:** GEN5i stands on handle

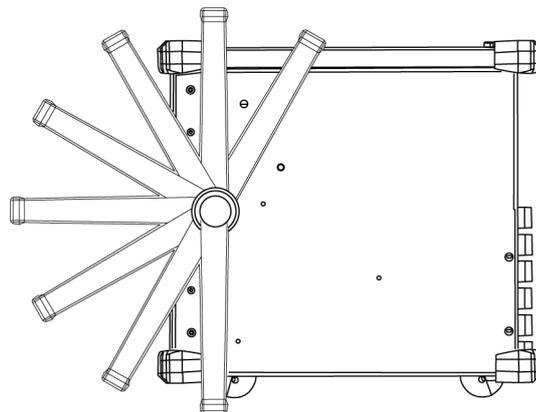
**To turn handle:**

- 1 Put instrument on flat surface.
- 2 Push-in both sides of the handle turning point



**Figure 7.15:** Handle push buttons

- 3 Turn the handle in position.
- 4 Release the handle push-in buttons and the handle will snap in one of its fixed positions (30° indexing).



**Figure 7.16:** GEN5i multiple handle positions

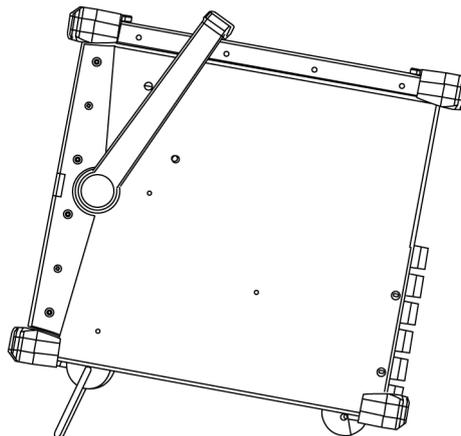
## 7.6 Feet

GEN5i is standing in normal operation position on 4 feet. Two positioned at the rear and two at the front of the instrument. The front feet can be used to lift the instrument front so the display angle is towards the user. The angle between display and vertical is about  $+12^\circ$  in this position. When a smaller angle is preferred, use the GEN5i carrying handle ( $+4^\circ$ ).

### 7.6.1 Turning feet out

To turn feet out:

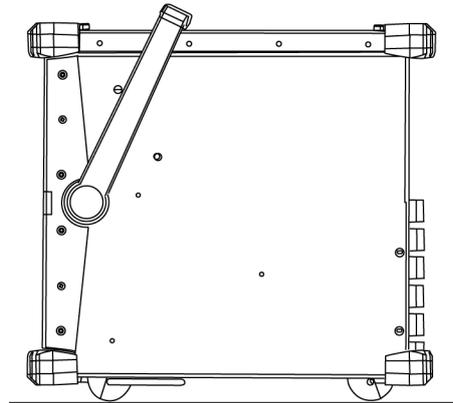
- 1 Put instrument on flat surface.
- 2 Lift the instrument front.
- 3 Pull out the front feet by turning the back of the feet towards the front of the instrument.
- 4 Gently put down GEN5i front and it will stand on its feet.



**Figure 7.17:** GEN5i stand on feet out

### 7.6.2 Turning feet in To turn feet in

- 1 Put instrument on flat surface.
- 2 Slightly lift the instrument front.
- 3 Push in the front feet by turning the feet towards the back.
- 4 Gently put down GEN5i front.



**Figure 7.18:** GEN5i stand on feet in

## 8 Getting Started

### 8.1 Front panel control

#### **Standby**

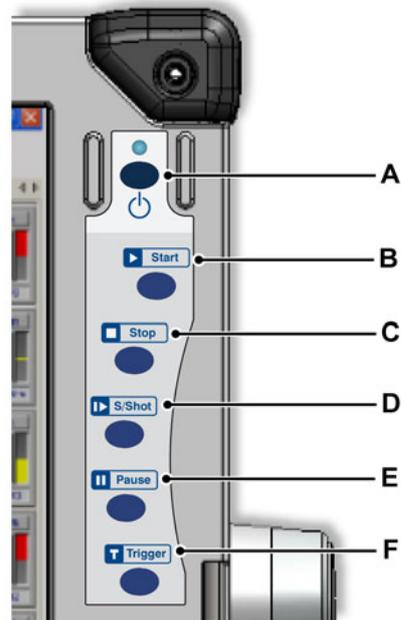
On the GEN5i the power button is located on the front panel. When this button is pressed, the instrument state toggles between operating and standby mode. In standby mode some power will be consumed and the instrument is NOT disconnected from the AC supply. To switch off the instrument completely from the mains power use the switch that is located on the back of the instrument.

When you switch off the GEN5i using this power button, the Perception software will display a confirmation dialog. Follow the on-screen instructions for a correct shutdown of the system. If, for any reason, you are not able to use a keyboard or mouse to confirm you must hold the standby button pressed for approximately four seconds to force the unit to shut down.

#### **Acquisition control**

On the GEN5i you find five buttons that allow you to easily control an acquisition without the need of a keyboard or mouse.

These buttons are located in the upper right-hand corner of the front panel. They provide the same functionality as the software-based acquisition controls.



**Figure 8.1:** Front panel control

- A Power standby
- B Start
- C Stop
- D Single Shot
- E Pause
- F Trigger

**A Power standby**

**B Start** The Start command starts acquisition of data.

**C Stop** To stop or abort an acquisition press this button. The active data storage will be finished. When in a sweep acquisition mode, a stop command while acquiring post-trigger data will be processed at the end of the sweep; this means that the sweep will be processed as specified. During this time the stop indication in the software will be active. If you want to abort the sweep you must press the Stop button a second time. The current sweep will be aborted immediately.

**D S/Shot** Starting Perception V6.30 the function of this button has been changed. It is now identical to the **Start** button. Future GEN Series systems will no longer have this button.

## E Pause

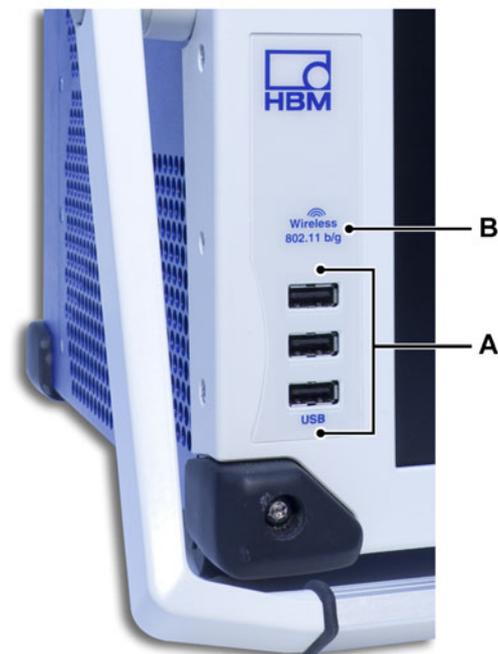
This button serves two purposes:

- 1 When no acquisition is active it will place the system in the pause or stand-by mode. Although the system is digitizing, no data is stored in memory or on disk. This is useful for monitoring purposes.
- 2 When a continuous or swept acquisition is active, it will place the system in a hold mode: although the unit is digitizing, no data is stored in memory or on disk. At this point when Start is selected, the current recording continues; when Stop is selected, the recording is finished.

**F Trigger** Press the Trigger button to send a 'manual' trigger command to the system. Typically a trigger will end and acquisition.

## USB Ports

Located on the bottom left are three front mounted USB 2.0 ports for easy access, more USB ports can be found on the back of the instrument.

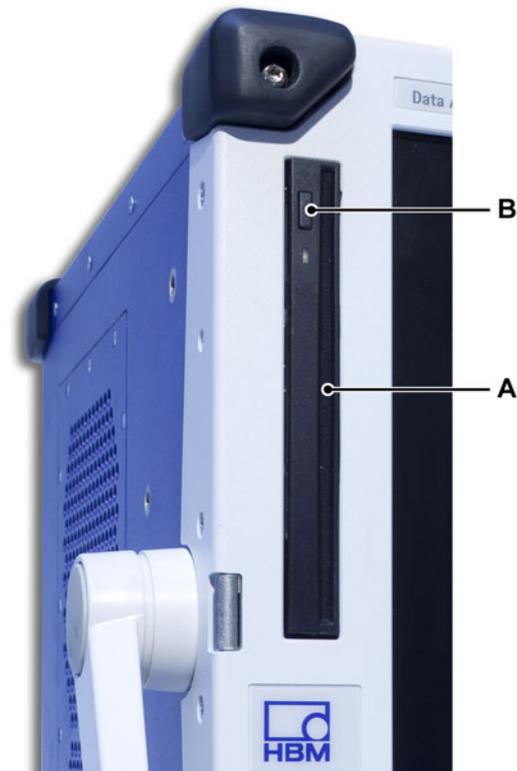


**Figure 8.2:** USB 2.0 ports (front mounted)

**A** USB ports

**B** Wireless adapter (Mounted hidden)

For information on the Wireless adapter please see "Wireless network" on page 108.

**CD/DVD device**


**Figure 8.3:** GEN5i CD/DVD reader/writer

- A** DVD slot
- B** Eject button

The GEN5i has a DVD writer built in. It supports most of the available CD and DVD formats (read and write) and sizes (4.7 GB and 8.5 GB). The DVD writer can be used to install new software and/or back up your valuable data. Perception automatically saves PNRF files larger than 8.5 GB in multiple files to enable backup to dual layer DVD disks.

To use a DVD, insert a DVD into the slot of the drive. Gently push the disk until the drive starts drawing the disk into the drive.



## 8.2 Getting started

When GEN5i is started up for the first time, the Perception software will start and automatically connect to the integrated GEN5i data acquisition unit. Perception starts in the continuous mode and the acquisition unit will go into Pause mode: incoming signals will be monitored, but no data is stored.

When you change nothing, this will be the default behavior each time you start the system.

Each time you shut down, changes made to the preferences and setting will be saved automatically. These setting are then loaded the next time you turn on the GEN2i.

### Quick Start

To set up your Quick Start:

- 1 Start the instrument
- 2 Set up your work environment
- 3 On the **File** menu, click **Preferences**
- 4 In the Preferences dialog select **Start up**
- 5 Under **Quick Start** select the **Use Quick Start** check box
- 6 To create a new Quick Start configuration click **Create**
- 7 Click **Apply** or **OK** to confirm

To disable Quick Start:

- 1 On the **File** menu, click **Preferences**
- 2 In the Preferences dialog select **Start up**
- 3 Under **Quick Start** click to clear the **Use Quick Start** check box
- 4 Click **Apply** or **OK** to confirm

Perception can also be started in another mode. To start Perception in a specific mode:

- 1 On the **File** menu, click **Preferences**
- 2 In the Preferences dialog select **Start up**
- 3 Under **User Mode** select your preferred **Default User Mode**
- 4 Click **Apply** or **OK** to confirm

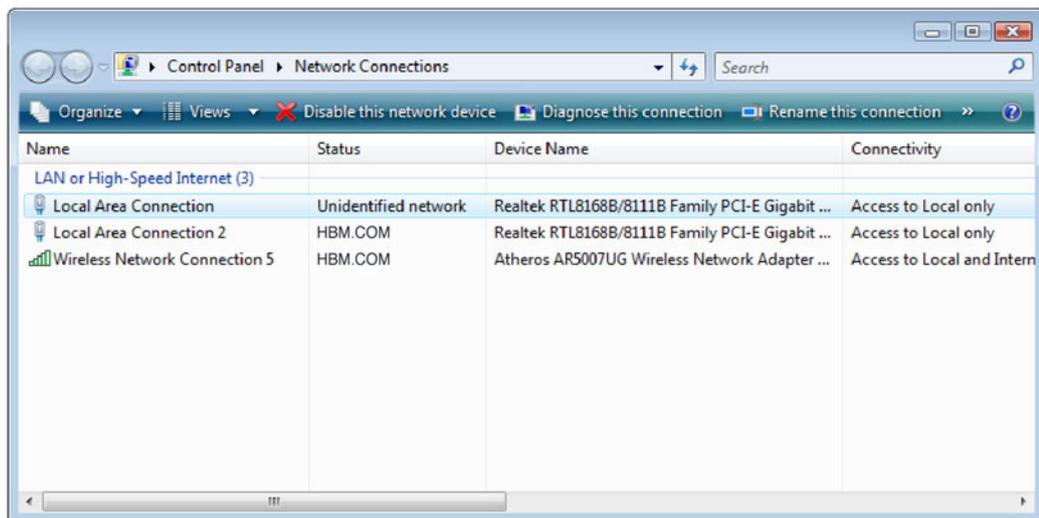
If you do not set up a Quick Start, the system will use the factory default continuous user mode the next time you start up the system.

### 8.3 Network interfacing

The GEN5i contains three network interfaces: two wired and one wireless.

One of the wired network interfaces is used internally for the communication between the PC and the acquisition system. The other network interface can be used to connect the GEN5i integrated PC to a local network or the Internet.

- 1 Click Start
- 2 Select Control Panel
- 3 Open Network Connections

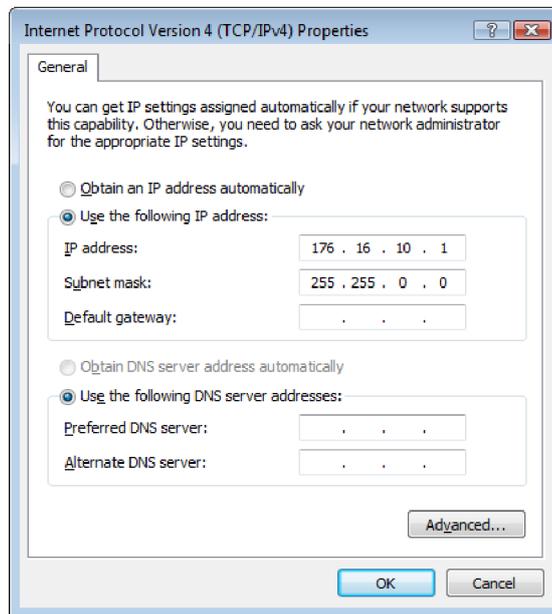


**Figure 8.4:** Network interfaces

The local area connection *unidentified network* is the one used for internal communication between the PC section and the GEN5i DAQ unit.

This network interface and the GEN2i acquisition system are organized to use a fixed configuration. The IP configuration for the internal network interface is:

- IP Address 172.16.10.1
- Subnet mask: 255.255.0.0



**Figure 8.5:** Internet Protocol property sheet

You can access these settings as follows:

- 1 In the **Network Connections** dialog right-click the icon of the network.
- 2 On the context menu click **Properties**.
- 3 In the Properties dialog click the **Internet Protocol Version 4**.
- 4 Click **Properties**.



**WARNING**

**Changing the properties of this network interface can result in problems when Perception tries to communicate with the internal acquisition system.**

## 8.4 Wireless network

Your GEN5i includes an internal wireless network adapter. With this Wi-Fi network adapter you have wireless freedom to connect to your local network.



### HINT/TIP

In some areas or application use the presence of a wireless network option in the instrument is not allowed. Disabling the wireless network within Windows® is not a satisfactory solution. Therefore HBM supports the removal or electronically disable of the wireless network. This disables the use a wireless network permanently.

Before ordering contact HBM sales and after delivery contact HBM service to remove or electronic disable the WIFI.

The adapter features full compliance with the IEEE 802.11 b/g/n wireless standard offering the best compatibility and future-proof reliability. With data rates up to 300 Mbps the adapter supports a comfortable wireless bandwidth.

GEN5i systems shipped before august 2012 do not support IEEE 802.11 N. Maximum wireless data rate then is 54 Mbps maximum.

Below is a quick start procedure to connect to your local network and a quick start procedure to disconnect from a network.

For wireless network operation details refer to the Windows Help system. If you are uncomfortable, or not yet familiar with these procedures, please contact your IT department or a network knowledgeable person to assist you.

### To connect to your local wireless network:

- 1 Start the GEN5i.
- 2 When fully booted quit Perception.
- 3 In Windows 7 access the **Connect to a network** dialog box using one of the following options:
  - By clicking **Start**, and then **Connect to** from the Windows 7 desktop.
  - From the **Manage wireless connections** dialog box.
  - From the **Connect/Disconnect** context menu option of a wireless network adapter in the Network Connections folder.
- 4 In the **Connect to a network** dialog box use Show to select:
  - **All** Wireless, dial-up, and VPN connections.
  - Wireless Only wireless connections.
- 5 To connect to a wireless network you can encounter one of the following situations (these are the most common):

- **The network is listed** To connect to a network that is listed in the **Connect to a network** dialog box, double-click the network name or click the network name and then click **Connect**. If the connection attempt is not successful, use Windows Network Diagnostics to diagnose the problem and suggest a solution.
- **The network is not listed** If the wireless network you want to connect to is not listed, click **Set up a connection or network**. Windows 7 will display the **Choose a connection option** page where you typically should select the **Manually connect to a wireless network** option. At this point you will need to have a sufficient knowledge of your network settings. If not, please contact your IT department or a network knowledgeable person to assist you.

#### **To disconnect from your local wireless network:**

By default Windows 7 connects automatically to a wireless network at start-up once you have selected it.

To prevent this you have two options:

- Remove the network connection
- Make the network connection a manual procedure (recommended when you don't want automatic connection)

For both options:

- 1 Click **Start**, click **Control Panel**, click **Network and Internet**, and click **Network and Sharing Center** and select the task **Manage Wireless Networks**.
- 2 To change a setting right-click on the network's icon. On the context menu that comes up:
  - Select **Remove Network** to remove the network connection, or
  - Select **Properties**. In the properties dialog that comes up make sure that **Connect automatically when this network is in range** is cleared.

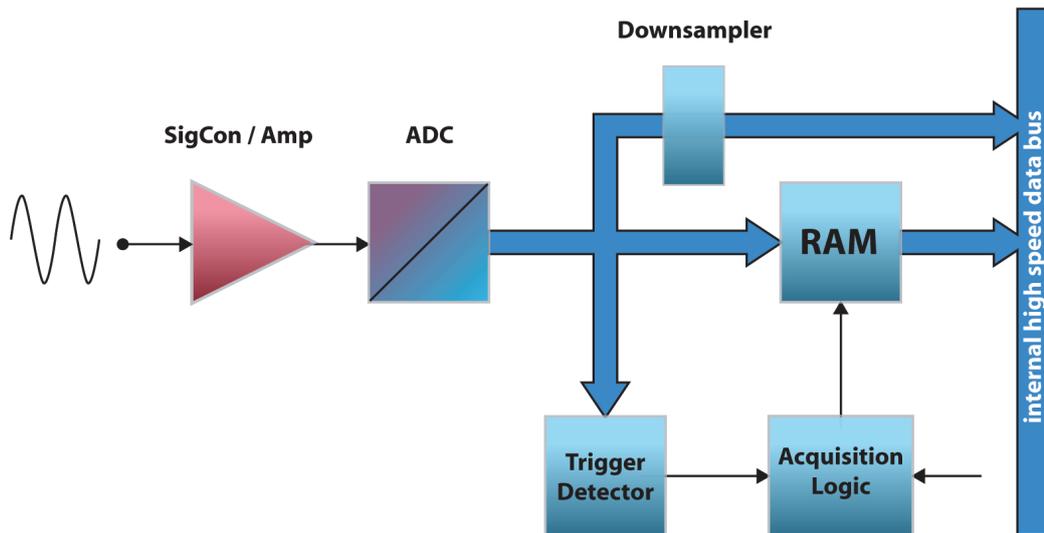
When you have selected manual connection, you can still connect to the network if you want to, but you'll need to do so manually. To do so right-click the Windows 7's networking icon in the task bar and select **Connect to a Network**.

# 9 Acquisition and Storage

## 9.1 Introduction

Data acquisition hardware within the GEN5i 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 only in this section.



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

In the GEN5i 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 makes it available for monitoring or storage. **Storage** is the actual archiving of digitized data. **Recording** (verb) is acquisition + storage.

## 9.2 Acquisition

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 GEN5i/Perception combination provides the following acquisition controls:

- **RUN** The run command starts acquisition of data. Now the recorder(s) acquire(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 an acquisition. The current recording will be closed.
- **PAUSE** This mode has two options:
  - 1 When no acquisition 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 continuous acquisition 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 acquisition controls are combined with the various storage modes.

## 9.3 Storage

The GEN5i provides two storage paths as shown in Figure 9.1 on page 110:

- 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 hard disk.

In addition to these storage paths the GEN5i provides two fundamental storage modes:

- **Sweeps:** data storage of predefined length. Sweeps typically use a trigger to define the 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 (RUN 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.

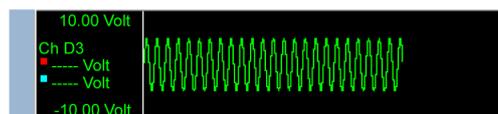
From within Perception a recording is organized as a pNRF file.



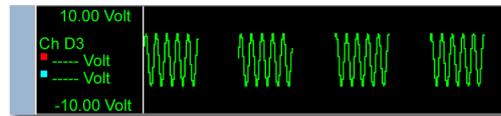
### CAUTION

**The GEN5i RAM is volatile. Therefore you will need to transfer the acquired sweeps to your PC for archiving.**

The storage mode defines how data that is digitized and acquired is saved. The continuous storage mode will always store data, regardless of the acquisition mode. The Sweeps storage mode will store only the sweeps, regardless of the acquisition mode. However, the resulting file - or recording - will be different for the various combinations of acquisition and storage mode.



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



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

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

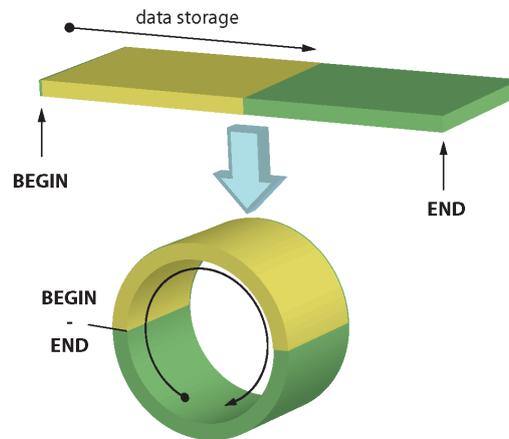
**Dual** In this mode, sweeps as well as continuous data is stored. Therefore the end result is a recording that comprises the higher speed sweeps as well as the lower speed continuous data in between the sweeps.

**Slow-Fast Sweep** In this mode sweeps as well as continuous data is stored. The difference with the dual mode is the fact that the continuous 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 110 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 recording must be ended. Once the recording has stopped, the content of the buffer memory becomes available to the control PC for processing. This is also called **circular recording**.

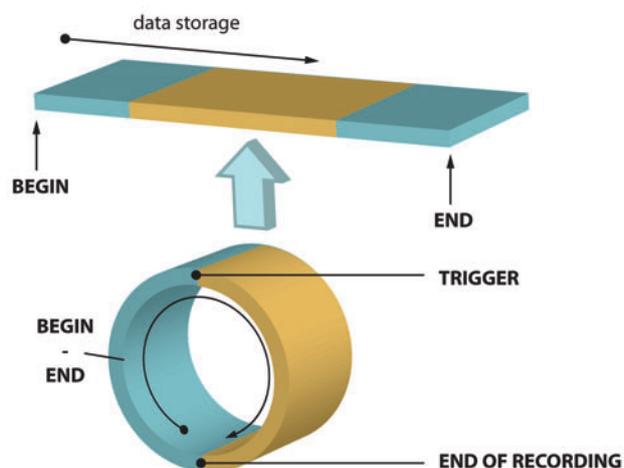
### Pre-trigger sweeps

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-recording'. 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)

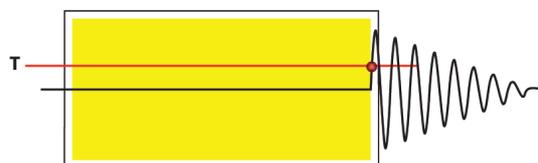
$$t_{window} = \frac{40000}{10000} = 4 \text{ seconds}$$

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 122.



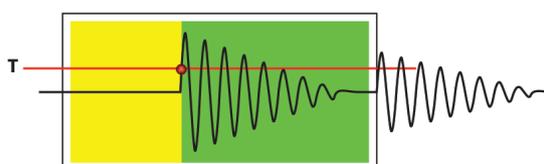
**Figure 9.5:** Ring buffer with trigger and end-of-recording

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.



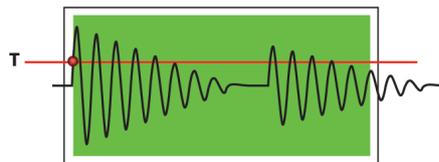
**Figure 9.6:** Full pre-trigger storage: pre-trigger = 100%

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.

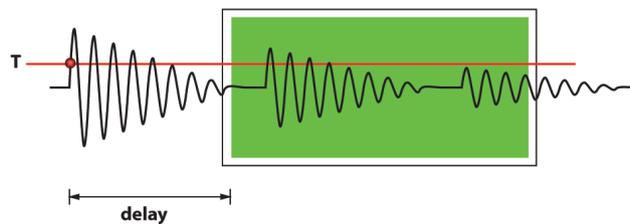


**Figure 9.7:** Pre-trigger / post-trigger storage:  $0\% < \text{pre-trigger} < 100\%$

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%



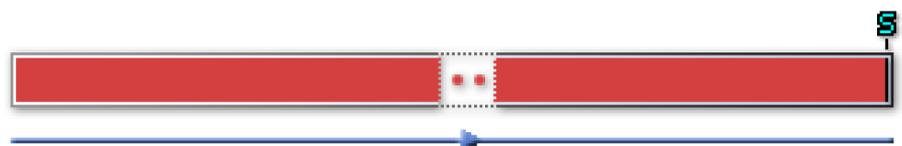
**Figure 9.9:** Delayed trigger storage: pre-trigger < 100%

### 9.3.2 More on continuous data storage

The most important difference between continuous data storage and sweeps in a GEN5i 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:

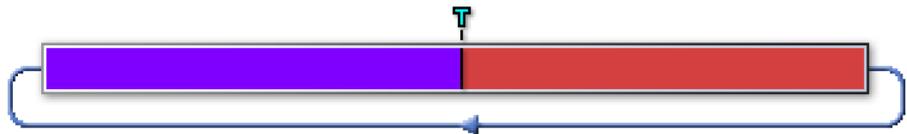
- **Standard** The continuous mode is standard when storage is started and stopped manually as depicted below (graphic taken from Perception software):



- Circular** The continuous mode is circular when storage is started and stopped manually AND the length of the buffer is defined. Operation is now equal to standard sweep storage, but 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 on PC hard disk and 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 Converter. Within the GEN5i 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 GEN5i 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 "IM1 - I/O connectors" on page 178 and "IM2 - I/O connectors" on page 148.

The above selection is made in the Perception software in the Settings Sheet  
 ▶ Recorder ▶ Time base Source.

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 selection is made in the Perception software in the Settings Sheet  
 ► Mainframe ► Internal 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  $\Delta f$  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 acquisition length or sweep length: **bin size = 1 / T** in which T is the total recording time. E.g. a one-second sweep will result in a 1 Hz bin size, a 0.5 second sweep results in a 2 Hz bin size.
- 2 Preferably the acquisition length 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 sweep 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 (SWEEP 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
10240	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 bandwidth 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)**

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

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

- Frequency resolution  $\Delta f = (1/2 * 40960) / (1/2 * 8192) = 5$  Hz
- Number of frequency domain points:  $N/2 = 4096$
- The minimum frequency component that can be measured is equal to the frequency resolution  $\Delta f = 5$  Hz
- The maximum frequency component that can be measured is  $40.96 \text{ kHz} / 2 = 20.48 \text{ kHz}$

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 GEN5i 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 GEN5i 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 into one of the modes described in this chapter.

## 10.2 Understanding digital triggering

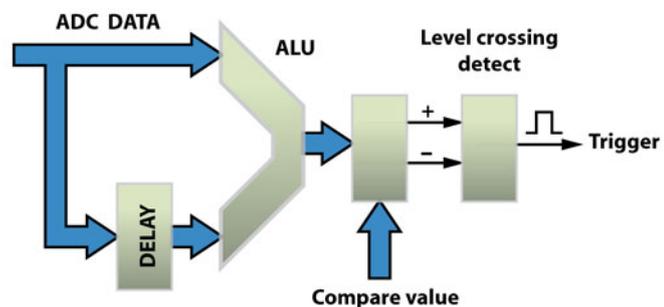
Technically speaking, there are two approaches to determine the known, pre-defined situation of the signal: analog or digital.

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 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.



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**.

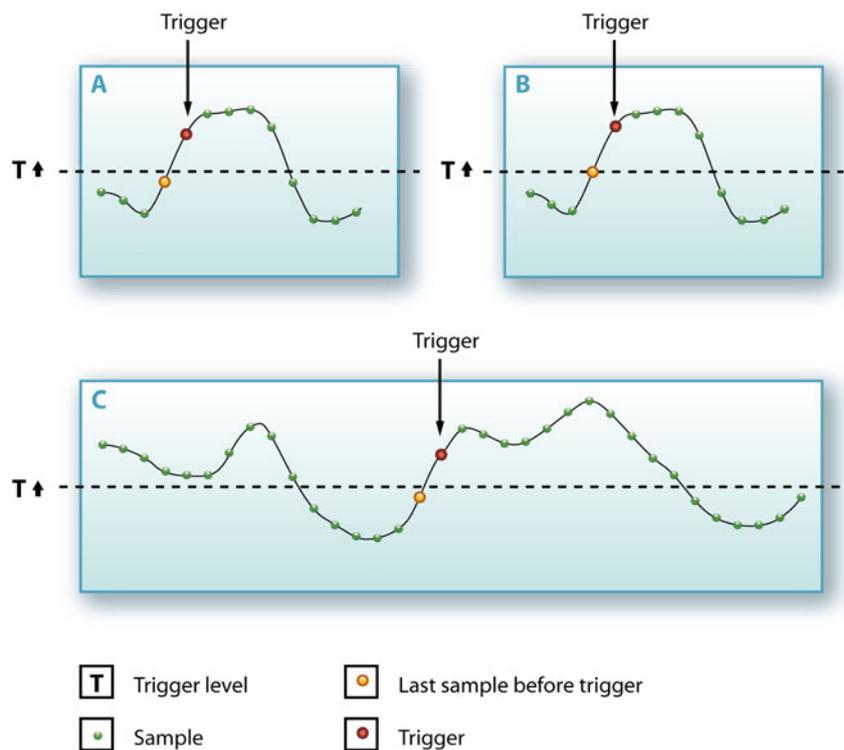
As explained later in this chapter, a signal must actually cross the preset level. This is to avoid erroneous triggering on a small amount of noise on the signal. To make the trigger detector even more stable when noisy signals are used, the single-level trigger detector has been expanded with a **hysteresis**. This basically doubles the logic.

For the advanced trigger modes the single-level trigger detector with programmable hysteresis has been implemented twice to provide a **dual-level** trigger detector with selectable hysteresis on each channel. 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 10.1:** Level crossing detector

As trigger mode basic trigger is shown with a specified level ( $T$ ), and a level crossing in positive direction. In Figure 10.1 (A) the trigger occurs on the first sample after the level crossing. Figure 10.1 (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 10.1 (C).

Figure 10.2 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.

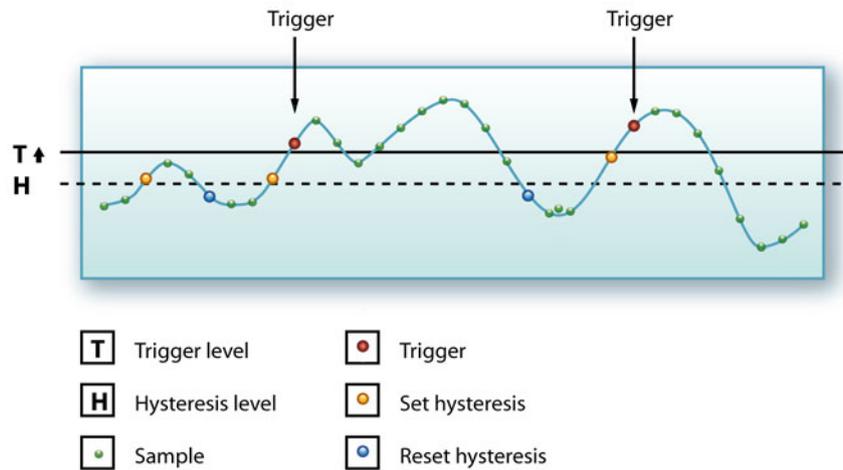


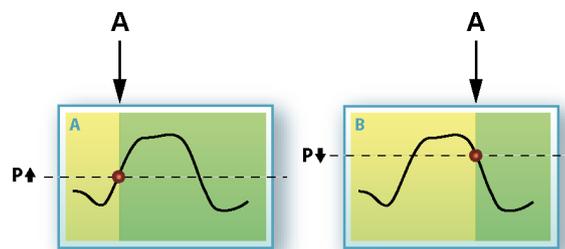
Figure 10.2: Trigger level hysteresis

### 10.3 Trigger modes

Using the various trigger modes, your GEN5i 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 10.3:** 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.

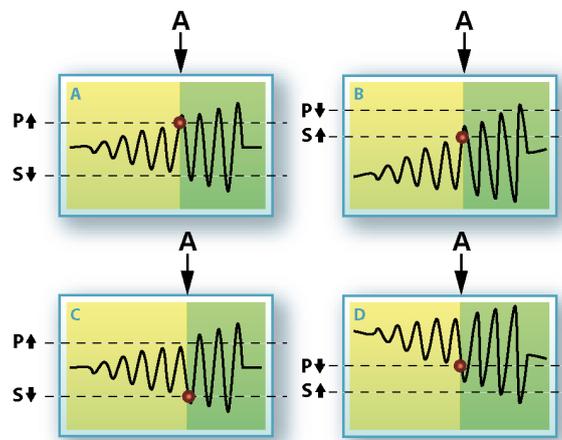
Relevant settings for this mode:

- 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 10.4 shows the various possibilities.



**Figure 10.4:** 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.

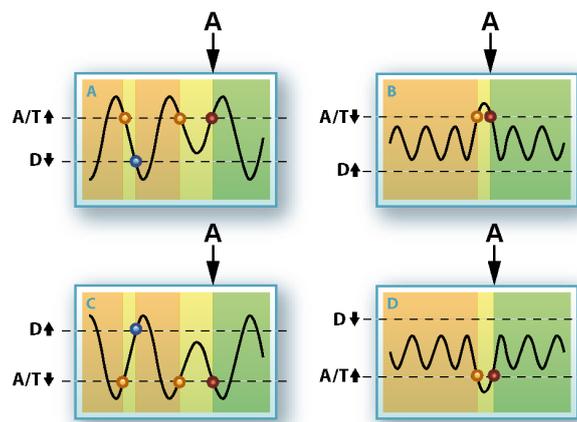
Diagrams A and C show a signal that exits the range, diagrams B and D show signals that enter the range.

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 10.5:** Window trigger mode

**A** Trigger

Diagrams A and C show the intended use of the window trigger mode: detecting a dip in a repetitive signal. Diagrams B and D show alternatives: detecting a peak pulse in a repetitive signal.

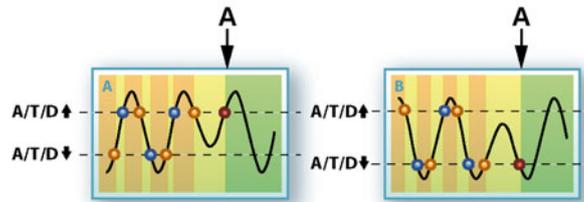
The Window trigger mode is very useful if a periodic signal is monitored and the GEN5i must be triggered on peak level changes. This mode is most effective on uni-polar signals, e.g. a TTL level pulse train. For bi-polar signals the dual-window trigger mode is more suited as described in the following 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 10.6:** Dual-window trigger mode

**A** Trigger

Diagram A shows one situation, diagram B 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

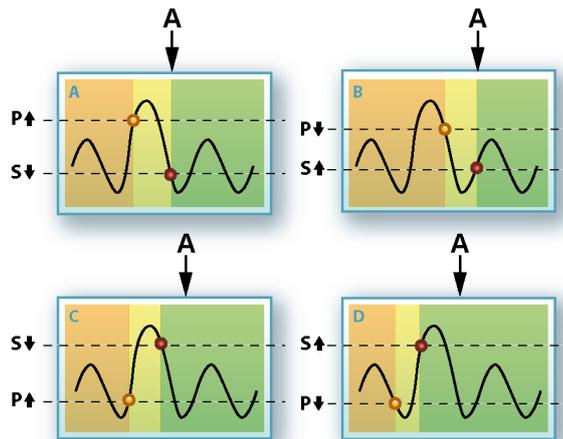
Since this is true for both levels, a “dip” in both directions is detected as shown in diagram A and B.

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 10.7:** 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 C and D.

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. For details see "Basic trigger mode" on page 127.
- Dual-level qualifier. For details see "Dual trigger mode" on page 128.

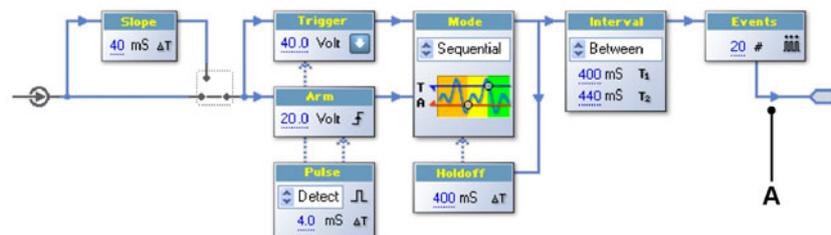
When in qualifier mode, the output of the trigger detector is sent to a qualifier line of the recorder trigger logic. For a full description of the recorder trigger features see "Recorder and system trigger" on page 141.

## 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 10.8:** Channel trigger logic

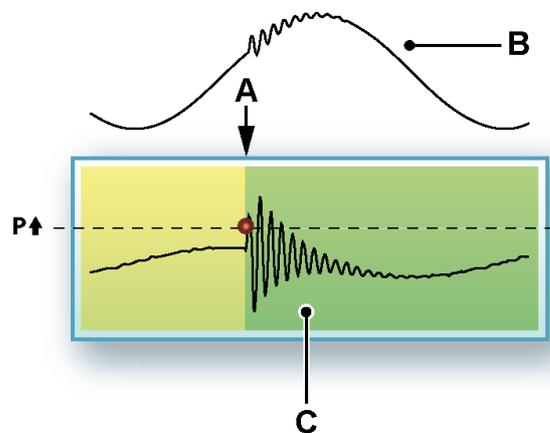
**A** To recorder trigger

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 a number of 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. Within the GEN series 'dt' is variable (delta time window) and can be set between 1 and 1023 samples, e.g. between 1  $\mu$ s and 1.023 milliseconds when sampling at 1 MS/s.



**Figure 10.9:** 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

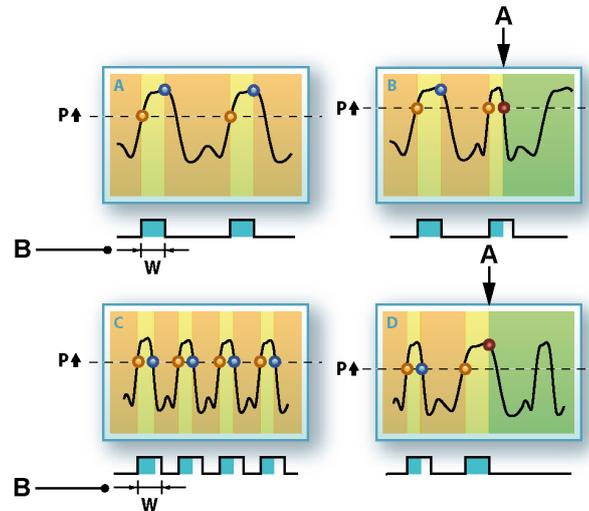
The pulse detector can be used together with the basic (slope) trigger level detector. It can be used for two opposite purposes:

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

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

The pulse detector 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.



**Figure 10.10:** Pulse detector

**A** Trigger

**B** Width

Figure 10.10: In diagrams A and B the pulse detection is depicted. In diagram A, when the trigger level is crossed, the signal remains above the trigger level for a time interval larger than pulse width  $W$ . In diagram B 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.

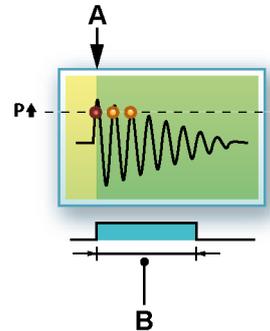
In diagrams C and D the opposite situation is depicted: pulse reject. Now “small” pulses are not recognized as trigger condition, while a wider pulse generates a trigger.

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 10.11:** 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.

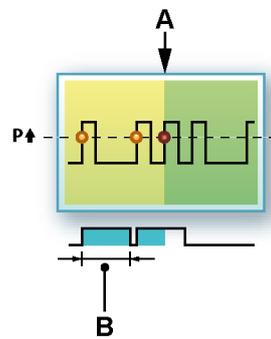
The following relations are possible:

- **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 10.12:** Interval timer - Less

**A** Trigger

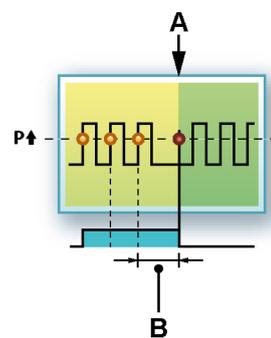
**B** Interval

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 10.13:** Interval timer - More

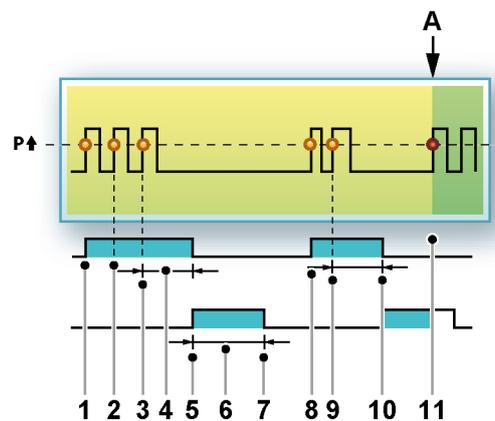
**A** Trigger

**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 10.14:** Interval timer - Between

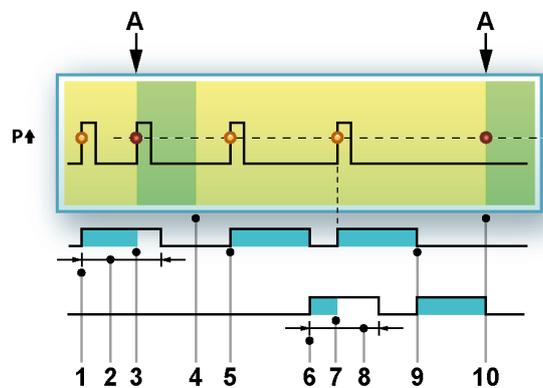
The following sequence explains what happens:

- 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.



**Figure 10.15:** 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**

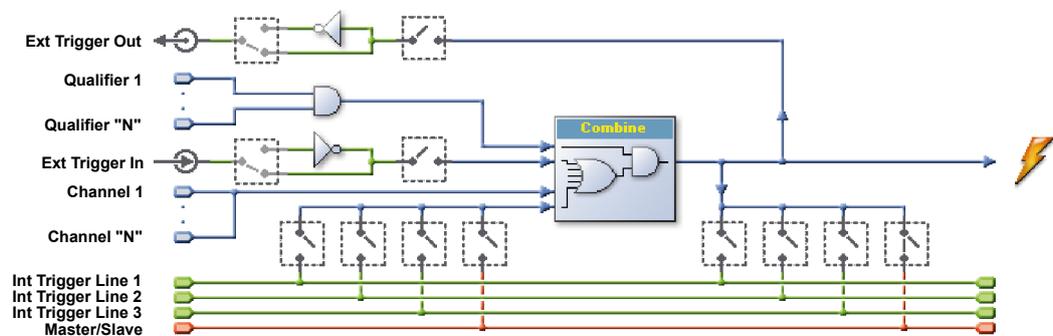
Sometimes it is not possible to trigger on a specified condition using a selected trigger mode alone, because several events meet the required situation. So far we have seen “filters” that can be used to narrow the range of trigger candidates, like holdoff and interval timer.

As a last resource the event counter can be used. The event counter adds 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 10.16:** 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 "Introduction" on page 122.
- **External Trigger In:** This is an external trigger signal that is mainframe-related: The input connector is placed on the mainframe controller. You can select to use it or not. When selected, all recorders in the mainframe use it. It is not used on a per-recorder basis.
- **Qualifier 1 through N:** These are the qualifiers as described earlier: See "Trigger qualifier" on page 132.
- **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. When selected, all recorders in the mainframe use it. It is not used on a per-recorder basis.

- **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 module. 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.

## **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. For details see "Basic trigger mode" on page 127.
- Dual-level alarm. For details see "Dual trigger mode" on page 128.

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

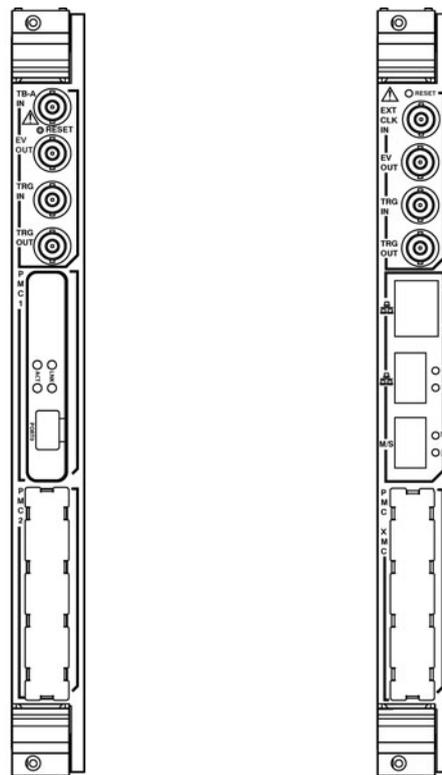
## 11.1 Introduction

The Interface/Controller Module runs 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](mailto: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 Interface/Controller Module 2 (IM2)

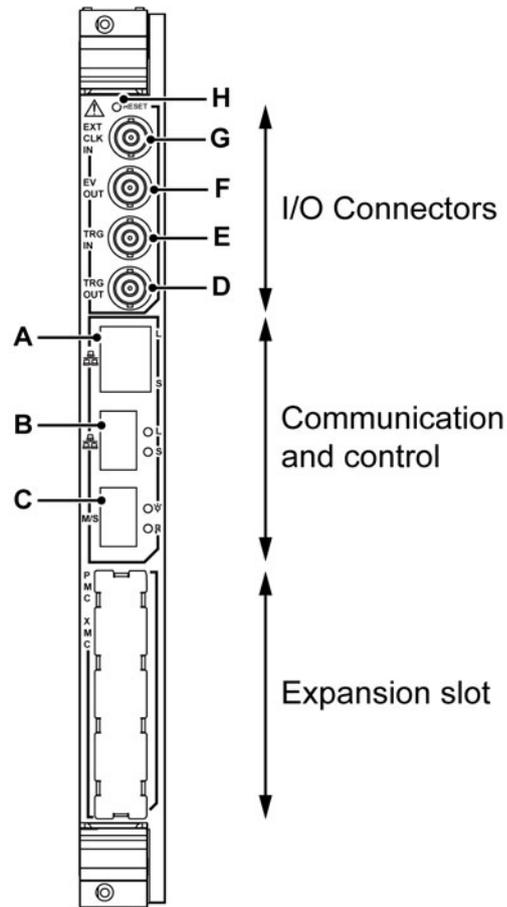


Figure 11.2: Interface/Controller module IM2

- A Standard 1 Gbit Ethernet Interface
- B Optical 1 Gbit Ethernet Interface
- C Master/Slave Synchronisation
- 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.

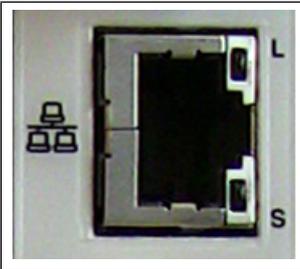
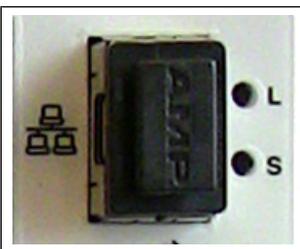
### 11.2.1 IM2 - Communication and Control

The GEN5i uses standard TCP/IP protocol over Ethernet to communicate with your PC. The system controller/Interface Modules 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.

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

## Using the 1 Gbit Option Connections

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

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

### 11.2.2 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.

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

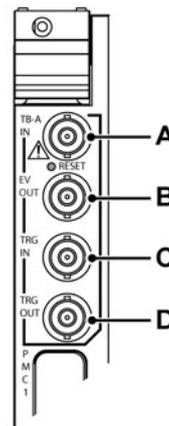
Legend:

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, user software action to trigger all mainframes synchronously.

### 11.2.3 IM2 - I/O connectors



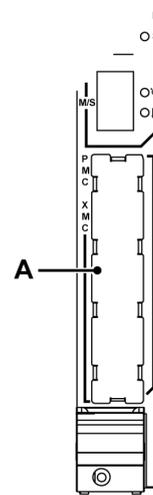
**Figure 11.3:** Interface/Controller Module IM1 - (BNC connectors)

- 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 141.

11.2.4 IM2 - Expansion slot



**Figure 11.4:** Expansion slot on Interface/Controller Module IM2

**A** Free space for option

**Note** For more details see “Interface/Controller Module options” on page 144.

### 11.3 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.

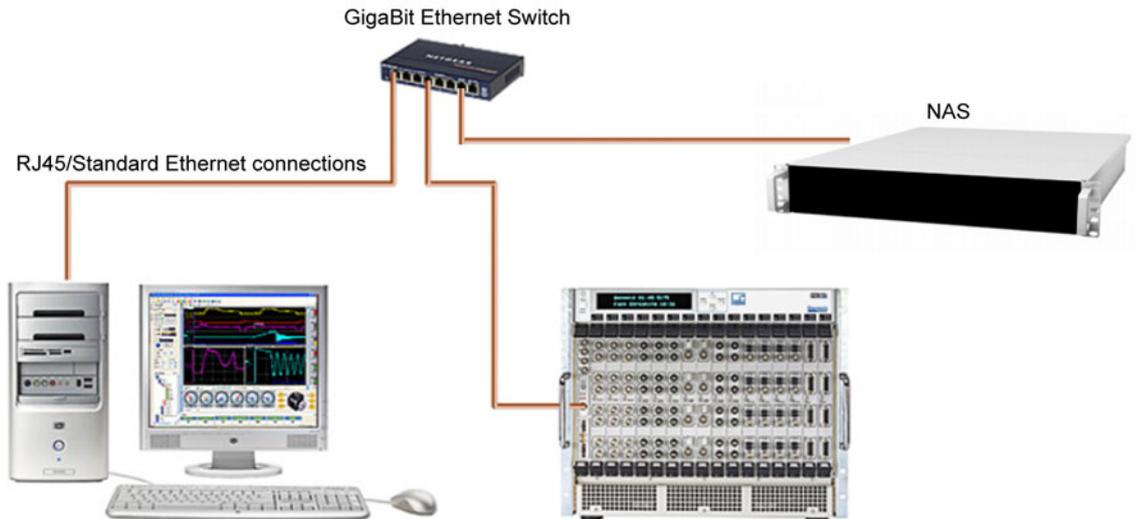
Since iSCSI is a communication protocol, it requires two parties; The Initiator and the Target.

- **Targets:** Typically **Network Attached Storage** devices (NAS).
- **Initiators:** Typically computers or in our case the GEN DAQ systems.

**11.3.1 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 11.5:** iSCSI setup with local NAS

In Figure 11.5 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.

### 11.3.2 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.

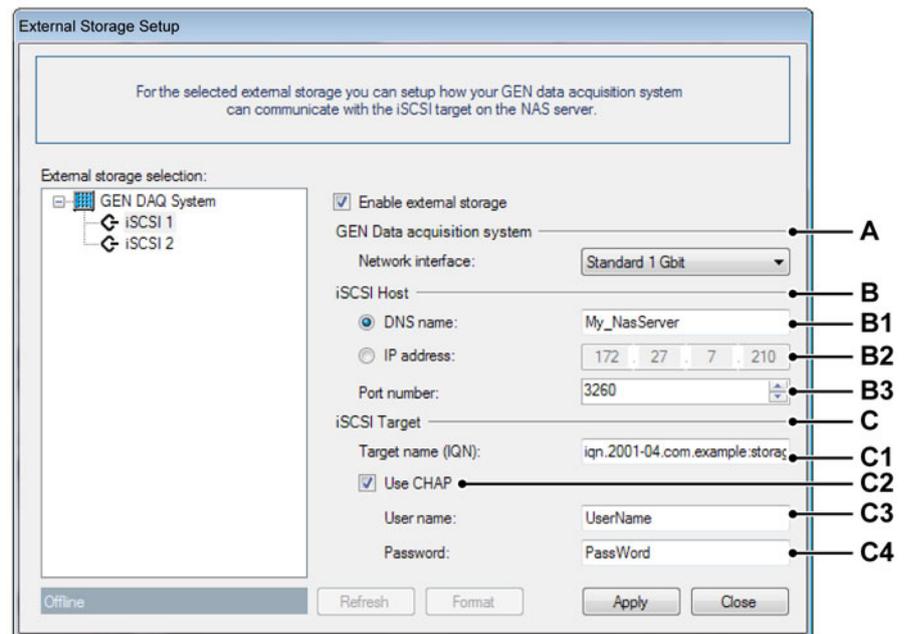
There are several ways to make these connections with different setups. When using a dedicated network as shown in Figure 11.5 with no other systems attached, a fixed IP address must be setup on your NAS. As a result it is highly recommended to also have the PC and GEN DAQ system set to fixed IP address 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 with the Synology® NAS” on page 574.*

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.

### 11.3.3 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 11.6:** 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.

### 11.3.4 GEN Data acquisition system

(See Figure 11.6 - 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.*

### 11.3.5 iSCSI Host

(See Figure 11.6 - 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.

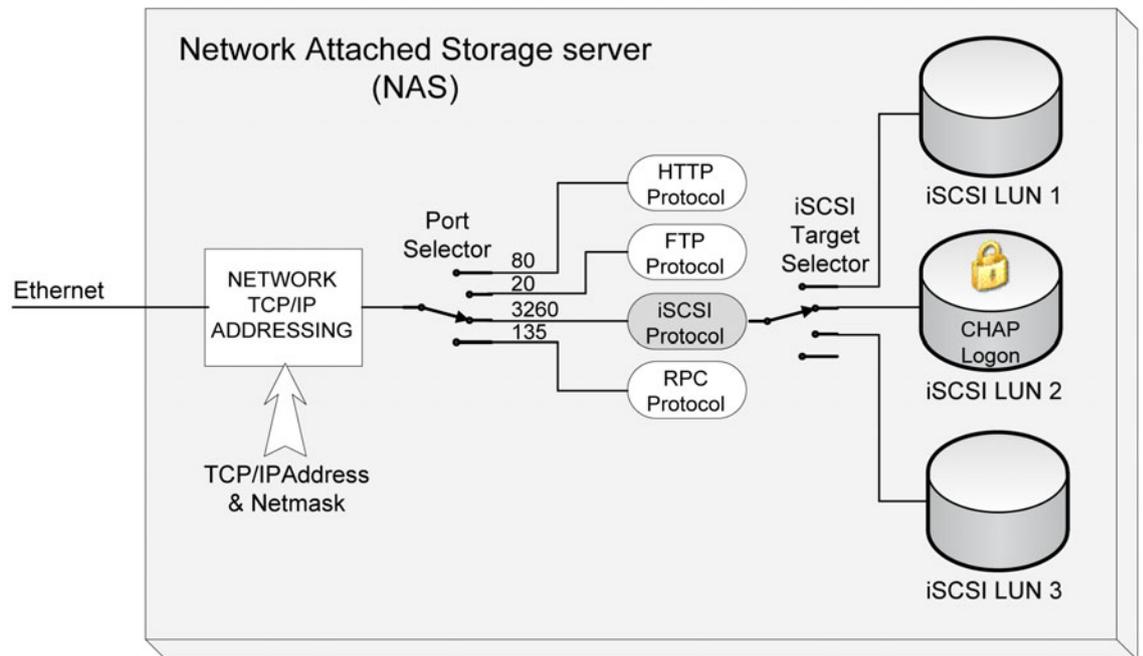
### 11.3.6 iSCSI Target

(See Figure 11.6 - 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 vice-versa; use 1 physical disk for multiple iSCSI LUNs.

Simplified, the NAS server looks like this:



**Figure 11.7:** NAS server - Overview

**11.3.7 Target Name (IQN) (See Figure 11.6 - 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.

**11.3.8 What is CHAP? (See Figure 11.6 - 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.

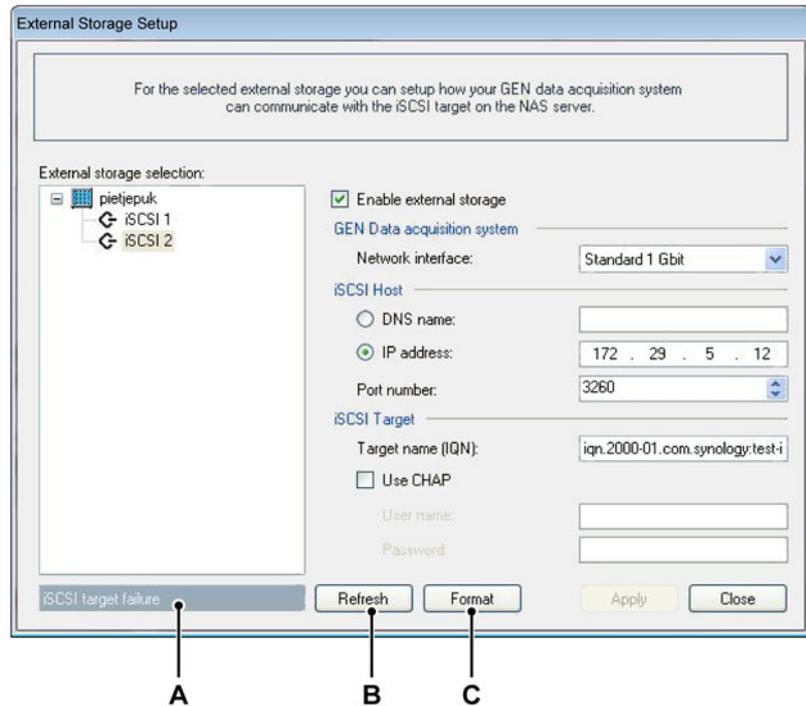
- **User Name:**

The same name that was defined during the NAS setup process, for reference see Figure J.1 "Synology Assistant" on page 574.

**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 J.7 "Create a new iSCSI target dialog" on page 580.

**Refresh/Format the iSCSI**



**Figure 11.8:** 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.

**11.3.9 How to Format the iSCSI (See Figure 11.8 - C)**

**Note** *The **Format** option is not available from the front panel.*

To format the iSCSI for the first time click **Format**.



**Figure 11.9:** iSCSI Format option - Warning dialog

A Warning dialog (Figure 11.9) 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.

### 11.3.10 Status messages/ troubleshooting (See Figure 11.8 - A)

Standard operating feedback is given in the **Status** box.

Status	Meaning
<b>Connecting to iSCSI server</b>	The iSCSI protocol is busy attempting to connect to the server
<b>Offline</b>	iSCSI is currently offline or not enabled
<b>Ok</b>	The iSCSI is mounted successfully

**Error messages:**

The Status box also shows errors as detailed below.

Status	Meaning	Check solution
<b>Host unreachable</b>	Cannot communicate with iSCSI	<ul style="list-style-type: none"> <li>● GEN DAQ interface cable not connected</li> <li>● NAS is turned off</li> <li>● Wrong or missing Default gateway</li> <li>● DNS name didn't resolve and Fixed IP address is incorrect</li> <li>● Cables connected incorrectly</li> </ul>

Status	Meaning	Check solution
<b>No iSCSI host found</b>	Connection to NAS succeeded, Can't find an iSCSI on host port	<ul style="list-style-type: none"> <li>• TCP/IP host was not configured as iSCSI server</li> <li>• NAS uses a different iSCSI Port number</li> </ul>
<b>Unknown target</b>	iSCSI protocol connection made but iSCSI target name not found	<ul style="list-style-type: none"> <li>• Check the iSCSI target name</li> </ul>
<b>Login failed</b>	Could not log in on iSCSI target	<ul style="list-style-type: none"> <li>• Login details incorrect. Check the user name and password</li> <li>• Disk in use by another system</li> </ul>
<b>Mount failed</b>	iSCSI connection was made, but mount failed	<ul style="list-style-type: none"> <li>• Check iSCSI formatted correctly in ext4 format</li> </ul>
<b>In Use</b>	This Network interface is already being used by another iSCSI	<ul style="list-style-type: none"> <li>• Select a different iSCSI interface</li> <li>• Disable one of the iSCSI connections</li> </ul>

When connected correctly and if configured properly using the manufacturer's setup procedure, the iSCSI should be available from Perception.



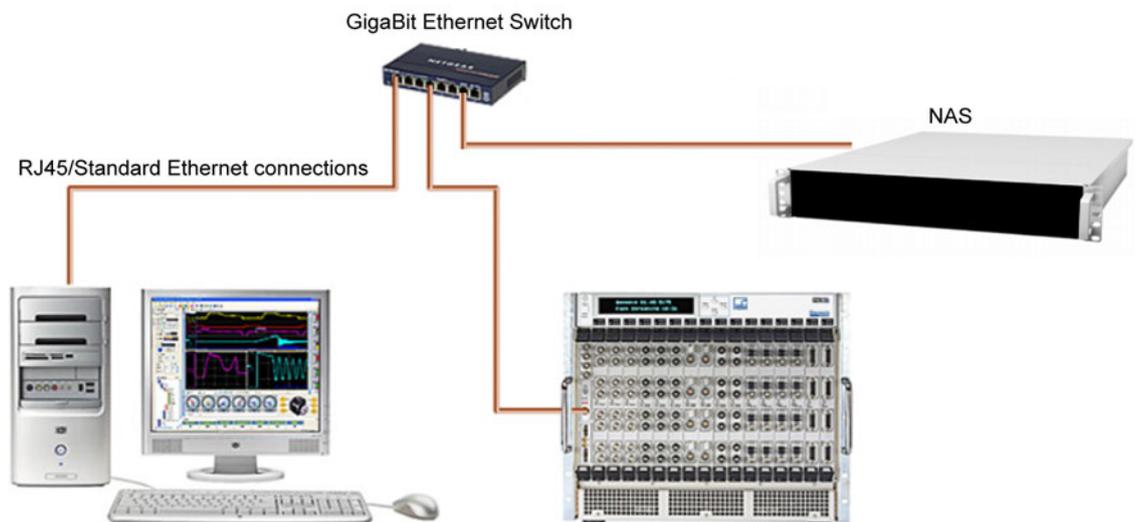
**WARNING**

**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.**

### 11.3.11 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 11.10:** 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.

Please read "PC connections" on page 83 for GEN DAQ setup.

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 with Synology® NAS” on page 574. 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.*

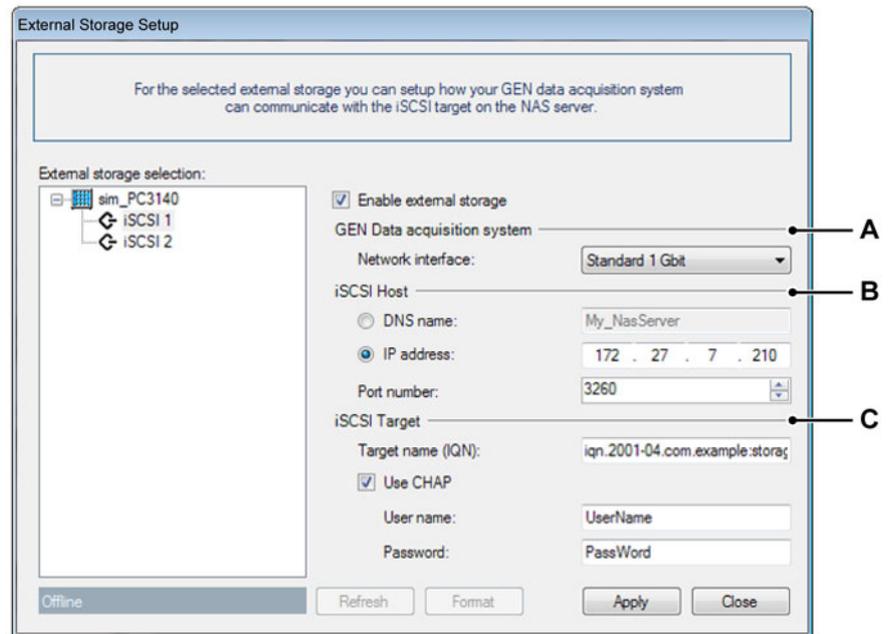
**2 Setup in Perception:**

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 11.11) 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 with Synology® NAS” on page 574 when necessary for an example using Synology®.



**Figure 11.11:** 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** (See Figure 11.11 - A)  
interface:

Select the Standard 1 Gbit Ethernet port that is connected to the Ethernet switch.



**Figure 11.12:** Network interface connections/Standard 1 Gbit option

**4 iSCSI Host** (See Figure 11.11 - 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 574.*
- **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 11.11 - 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 Synology® NAS" on page 574.*
- **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 J.7 "Create a new iSCSI target dialog" on page 580).

- 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.

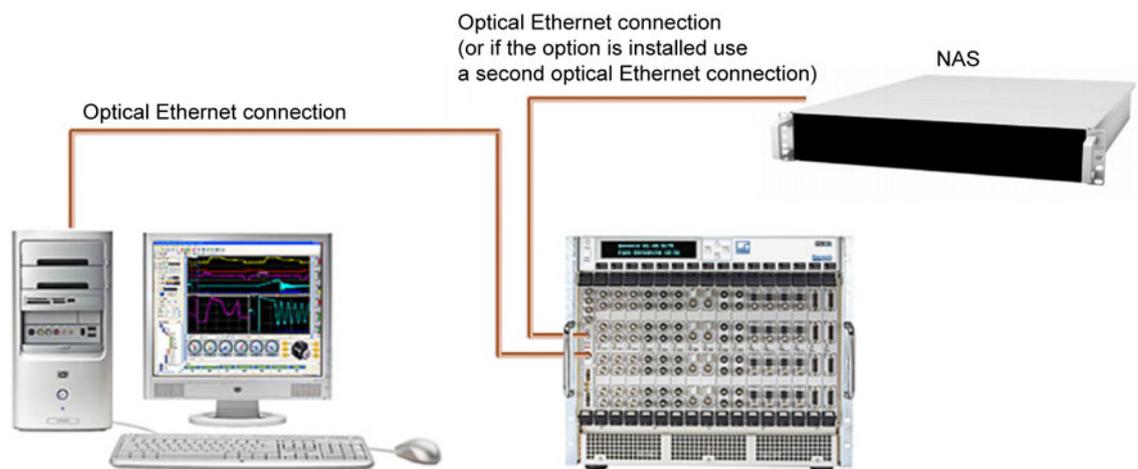
General Mainframe	Name	Storage location	Sync source
GEN DAQ 4310	GEN DAQ 4310	PC Storage iSCSI 1 iSCSI 2 PC Storage	RTC

Figure 11.13: Storage location with options

**11.3.12 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 11.14:** 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 11.14)**

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" for GEN DAQ setup in the GEN DAQ manual.

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.*

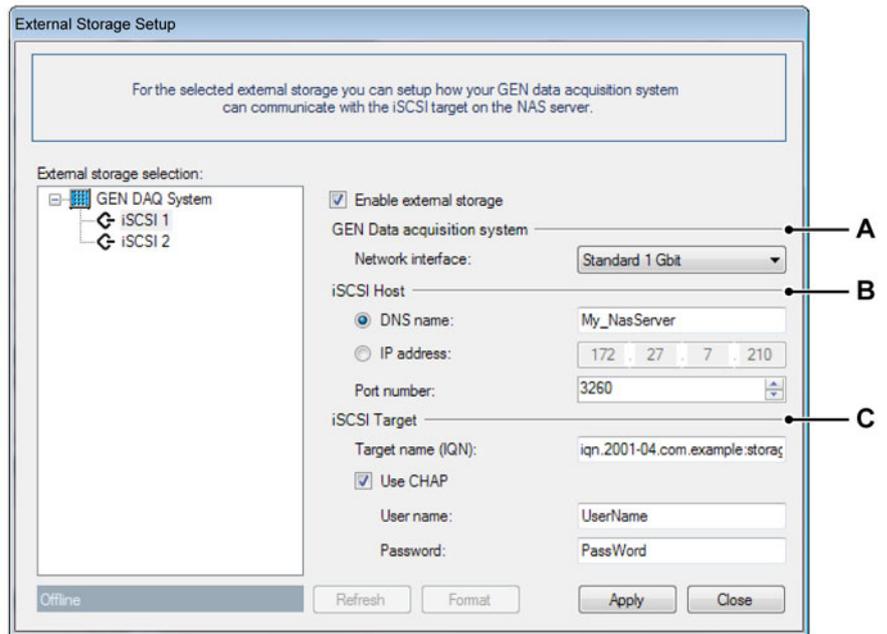
**2 Setup in Perception: (See Figure 11.15)**

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 11.11) 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 with Synology® NAS” on page 574 when necessary for an example using Synology®.

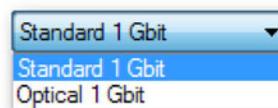


**Figure 11.15:** External Storage Setup dialog (Setup an iSCSI NAS connected without an Ethernet switch)

- A GEN Data acquisition system
- B iSCSI Host
- C iSCSI Target

**3 GEN Data acquisition system - Network interface:** (See Figure 11.11 - A)

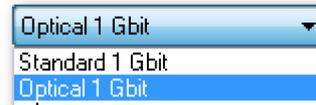
If you have connected the NAS server to the RJ45 connector of the GEN series mainframe then select the Standard 1 Gbit Ethernet.



**Figure 11.16:** 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 11.17:** Network interface connections/Optical 1 Gbit option

#### 4 iSCSI Host

(See Figure 11.11 - 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 J.1 "Synology Assistant" on page 574).

- **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 11.11 - 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 with Synology® NAS" on page 574.*

- 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 J.7 "Create a new iSCSI target dialog" on page 580).

- **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.



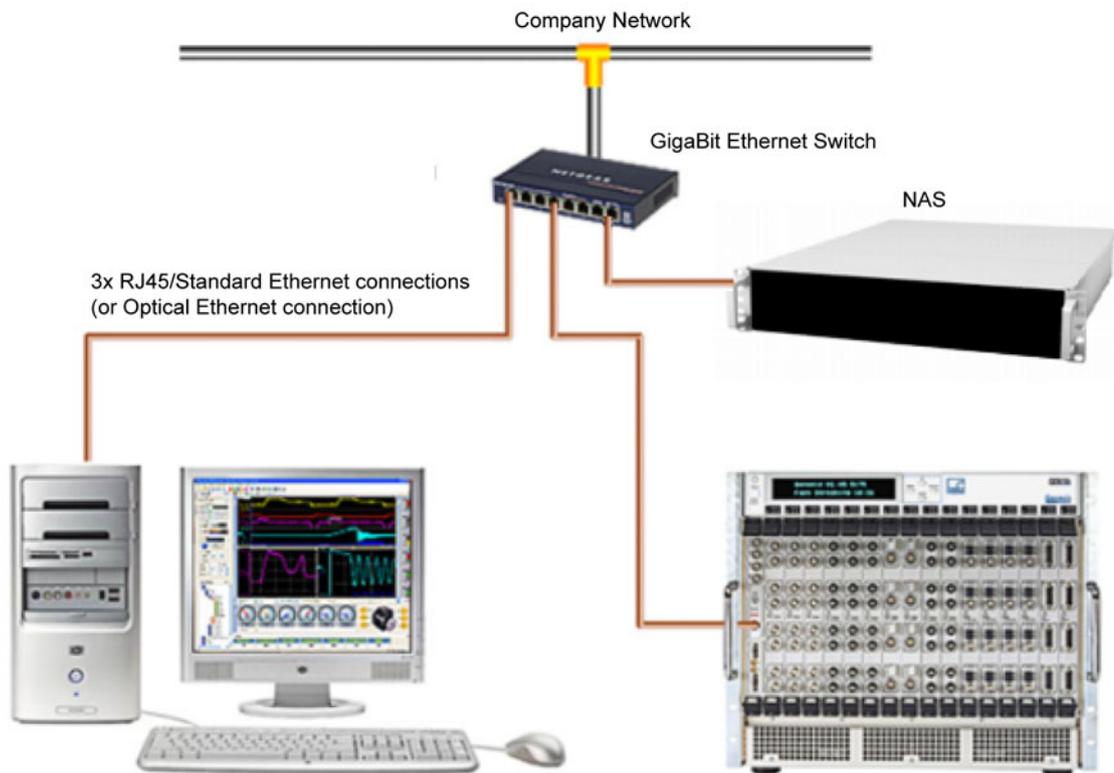
**Figure 11.18:** Storage location with options

**11.3.13 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 11.19:** 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 "PC connections" on page 83 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.

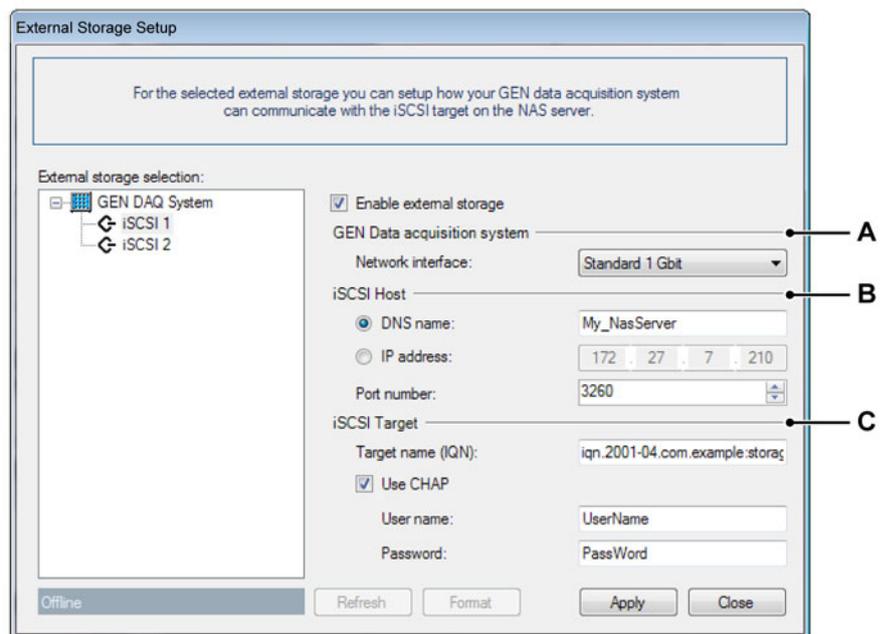
## 2 Setup in Perception:

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 11.20) 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 with Synology® NAS” on page 574 when necessary for an example using Synology®.



**Figure 11.20:** 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 11.20 - A)

Select the Standard 1 Gbit Ethernet port that is connected to the Ethernet switch.



**Figure 11.21:** Network interface connections/Standard 1 Gbit option

#### 4 iSCSI Host (See Figure 11.20 - 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 J.7 "Create a new iSCSI target dialog" on page 580).

- **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 11.20 - 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 574.*

- **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 J.7 "Create a new iSCSI target dialog" on page 580).

- **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.



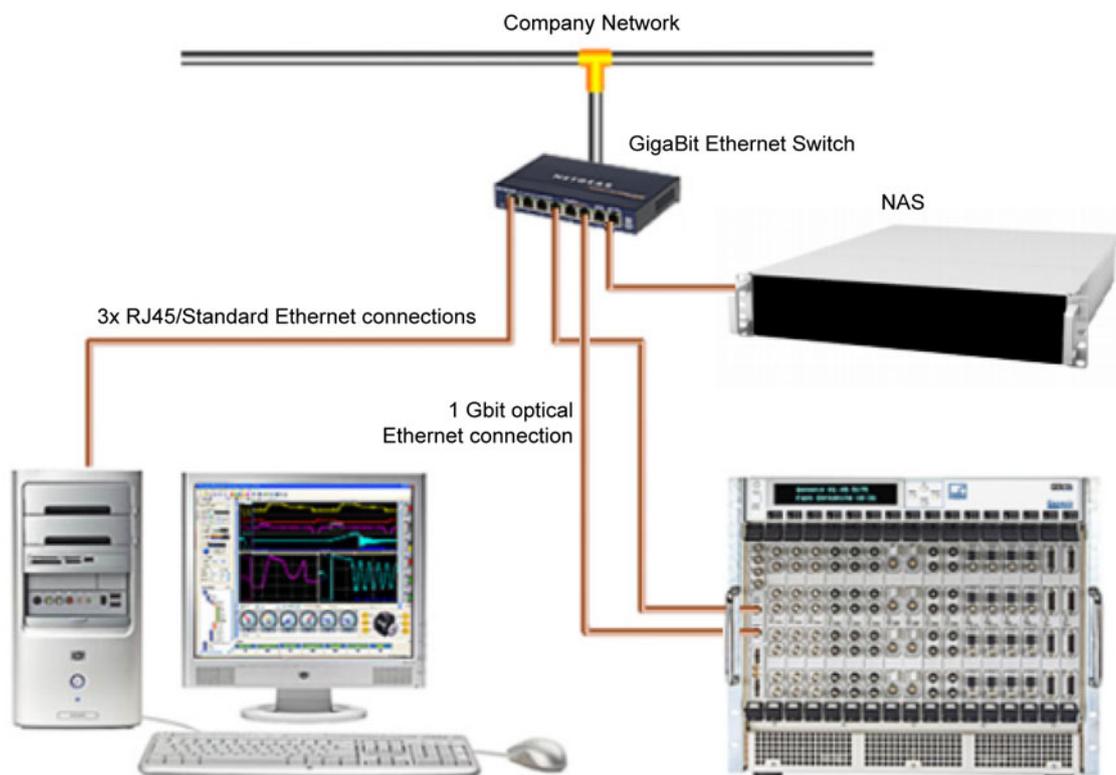
**Figure 11.22:** Storage location with options

**11.3.14 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 163) 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 11.23:** GEN DAQ with iSCSI NAS connected across an Ethernet switch and connected to a corporate network (Advanced Setup)

## 1 Connect equipment (See Figure 11.23)

- 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.

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.

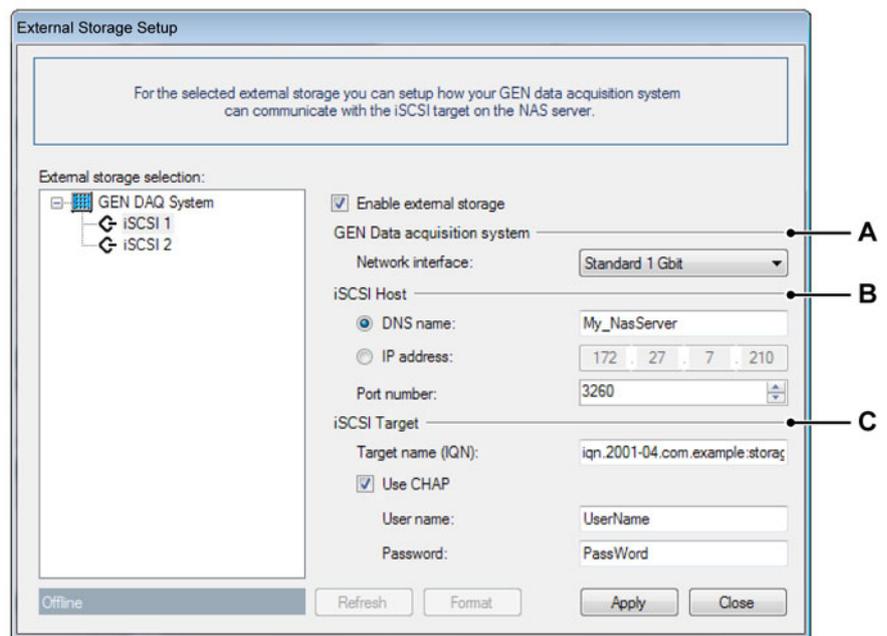
## 2 Setup in Perception: (See Figure 11.24)

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 11.24) 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 with Synology® NAS” on page 574 when necessary for an example using Synology®.

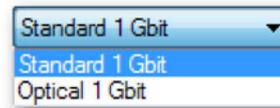


**Figure 11.24:** External Storage Setup dialog (Setup an iSCSI NAS connected to a corporate network – advanced setup)

- A GEN Data acquisition system
- B iSCSI Host
- C iSCSI Target

**3 GEN DAQ - Network interface:** **(See Figure 11.24 - A)**

If you have connected the NAS server to the RJ45 connector of the GEN series mainframe then select the Standard 1Gbit Ethernet.



**Figure 11.25:** 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 11.26:** Network interface connections/Optical 1 Gbit option

**4 iSCSI Host** **(See Figure 11.24 - 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 J.7 "Create a new iSCSI target dialog" on page 580).

- **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 11.24 - 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 Synology® NAS" on page 574.*

- 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 J.7 "Create a new iSCSI target dialog" on page 580).
- 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 J.7 "Create a new iSCSI target dialog" on page 580).
- Password:**  
 Enter the details used during the setup procedure of the CHAP authentication on the NAS. If none were chosen, leave these field blank.

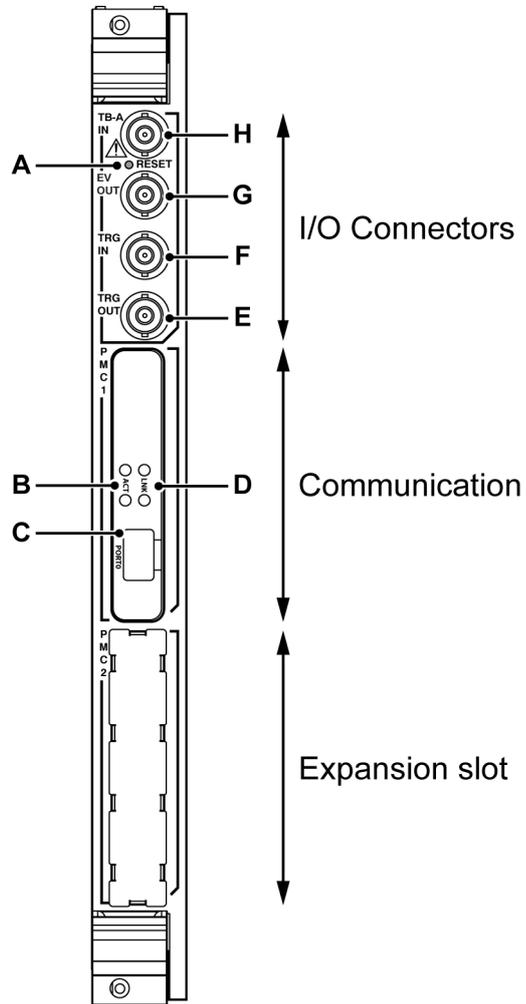
Click **Apply** when done to set the new settings and then click **Close**.

The NAS should now be available in the setup of your GEN series mainframe.



**Figure 11.27:** Storage location with options

11.4 IM1 - Interface/Controller Module 1



**Figure 11.28:** 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.

#### 11.4.1 IM1 - Communication and Control - Standard Ethernet Interface

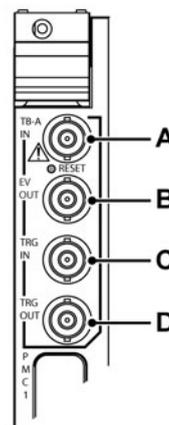
The GEN5i uses standard TCP/IP protocol over Ethernet to communicate with your PC. The System Interface/Controller Module provides access to the Ethernet network.

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 "PC connections" on page 83.

LED's are used to indicate activity as well as connection.

#### 11.4.2 IM1 - I/O connectors



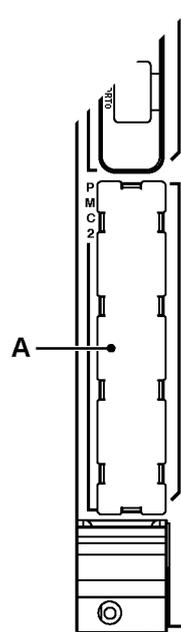
**A** External Time base In (TB-A IN)

- 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” in “GEN series Data Acquisition” manual.

### 11.4.3 IM1 - Expansion slot



**Figure 11.29:** Free slot on Interface/Controller Module IM1

- A** Free space for option

## 11.5 IM2 - Interface/Controller Module options

Your GEN5i 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 <sup>(1)</sup>
SFP 1 Gbit (1-G062-2, 1-G063-2)	No
10 Gbit Ethernet (1-G064-2) <sup>(2)</sup>	Yes <sup>(1)</sup>
IRIG (1-G001-2)	Yes <sup>(1)</sup>
IRIG/GPS (1-G002-2)	Yes <sup>(1)</sup>

(1) Factory installed option only.

(2) To complete this option the following is needed SFP+ 10 Gbit (1-G065-2, 1-G066-2)

### 11.5.1 Option - Solid State Disk (SSD)

This is an on-board factory installed option and needs to be ordered at the time of purchase.



**Figure 11.30:** 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 "B3723-1.0 en (GEN series GEN5i Portable Data Recorder)" on page 312.

### 11.5.2 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.



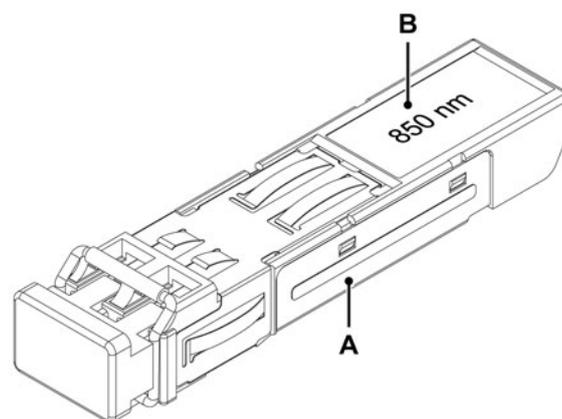
#### **WARNING**

##### **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 11.31:** 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 Multimode (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 "B3723-1.0 en (GEN series GEN5i Portable Data Recorder)" on page 312.

For Installation and removal of the SFP module Please see section "Installation of 1 Gbit SFP/10 Gbit SFP+ Module" on page 189.

**11.5.3 Option - 10 Gbit Ethernet interface**

The 10 Gbit Ethernet option is a Factory installed, ready to use Ethernet option with two available Ethernet interfaces.

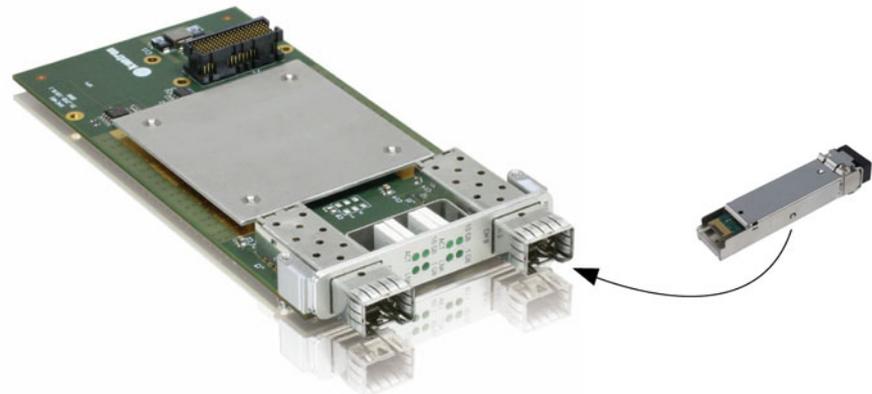
The 10 Gbit Ethernet Card can be installed in addition to the standard on-board 1 Gbit Ethernet connection. The 10 Gbit Ethernet Card allows you to double the throughput speed of communication when compared to the standard 1 Gbit Ethernet. If installed, the 10 Gbit Ethernet option can replace the use of the standard 1 Gbit Ethernet connection.



**WARNING**

**Laser Safety**

**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 11.32:** 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.*

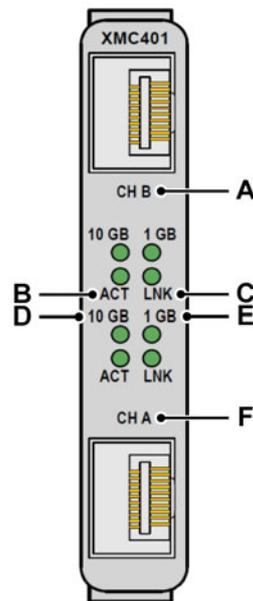
### Connections and using the 10 Gbit Option

		<p><b>A 10Gbit LC Connection Using the SFP+ Option</b> 10Gbit LC optical connections need an SFP+ module to enable their use with LC connected optical cable.</p>
--	--	---

**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 566 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 11.33:** 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 11.33 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.

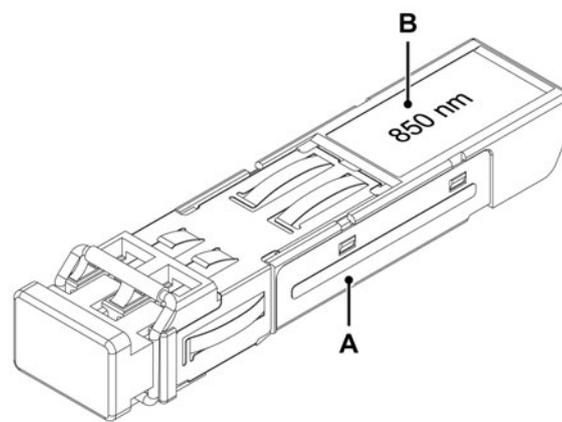
### 10 Gbit Ethernet Option accessories

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 11.34:** 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 Multimode (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.

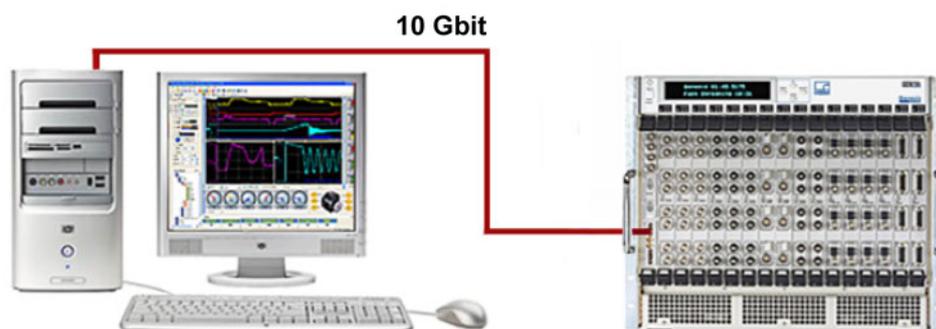
For Installation and removal of the SFP+ module see section "Installation of 1 Gbit SFP/10 Gbit SFP+ Module" on page 189.

### 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.

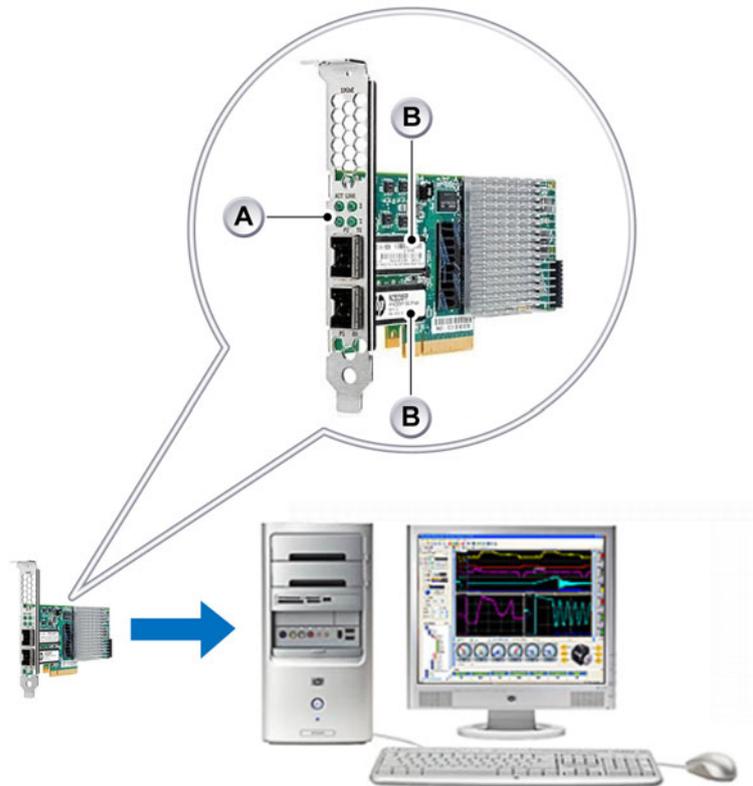
The following Figure 11.35 shows a simple setup using the 10 Gbit Ethernet Card. A PC with an optical Ethernet interface which has SFP+ support is connected via optical cable to the interface of the 10 Gbit Ethernet card option of the GENDAQ unit. This setup utilizes the higher speed communication of the 10 Gbit Ethernet Card for communication with Perception.



**Figure 11.35:** 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 11.36:** Connect the 10 Gbit Ethernet Option to a PC

- A** 10 Gbit Ethernet card
- B** SFP+ modules

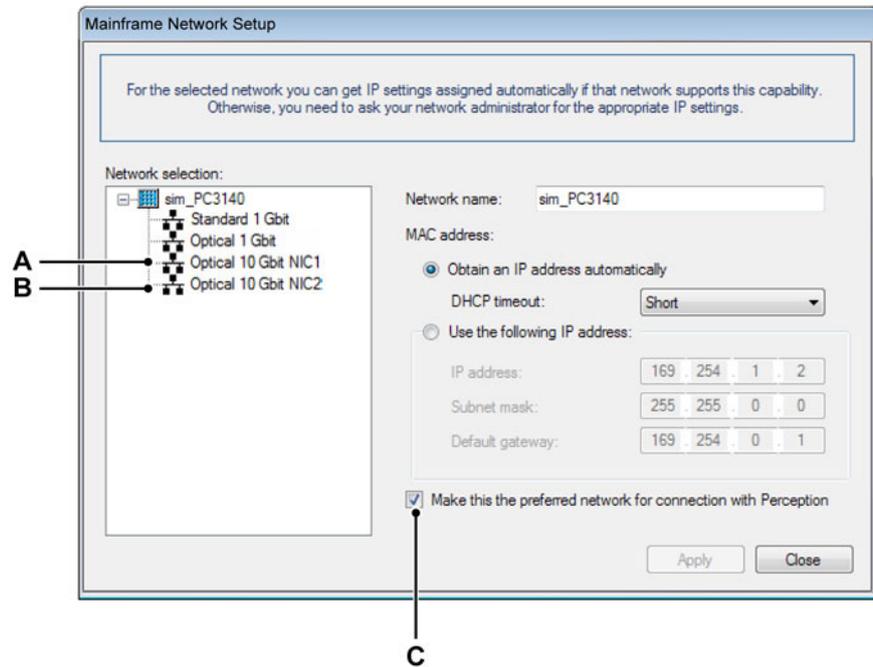
A 10 Gbit PC network card without SFP+ modules inserted and Ethernet switch with an SC optical connection can be used to communicate with the 10 Gbit Ethernet card.

**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 11.37 below.



**Figure 11.37:** 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 11.37, 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 566.

**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.*

#### 11.5.4 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 GEN5i system, its connections or a plug-in card.



## WARNING

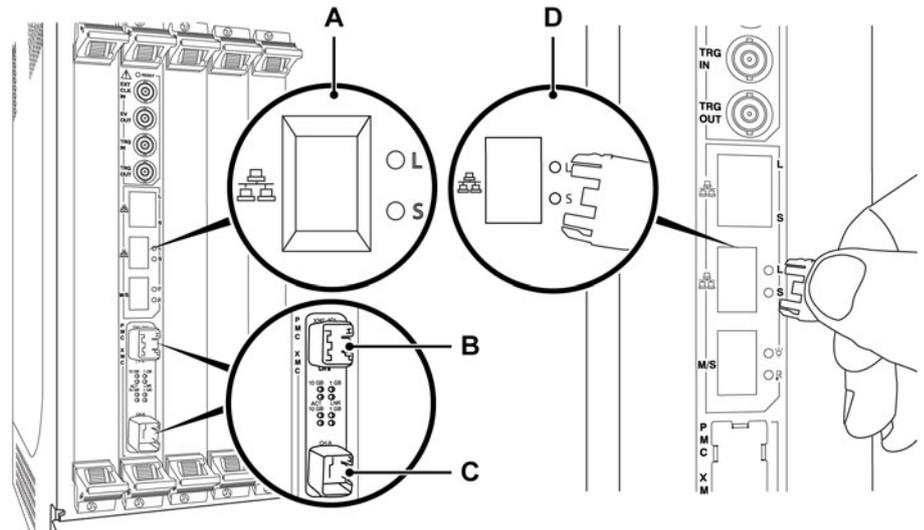
### Laser Safety

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 11.38:** Interface/Controller Module SFP location

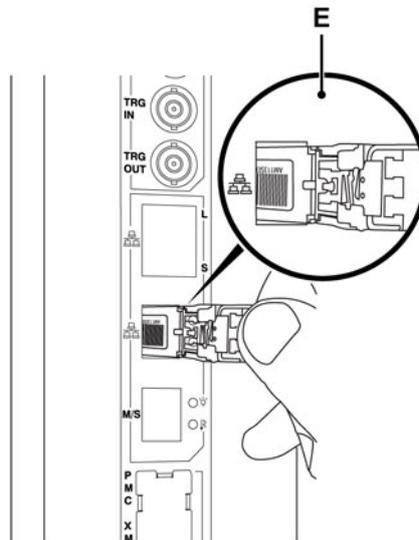
- A** Interface/Controller Module SFP/SFP+ locations
- B,C** Interface/Controller Module SFP+ location
- D** Remove cap\*

\* In some cases you may have to remove a covering over the SFP slot. Please see explanation of how to do this in chapter “Removing protective cover on GEN2i and GEN5i” on page 195.

**Note** *This installation is valid for any interface that supports the SFP or SFP+ options.*

Figure 11.38 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.

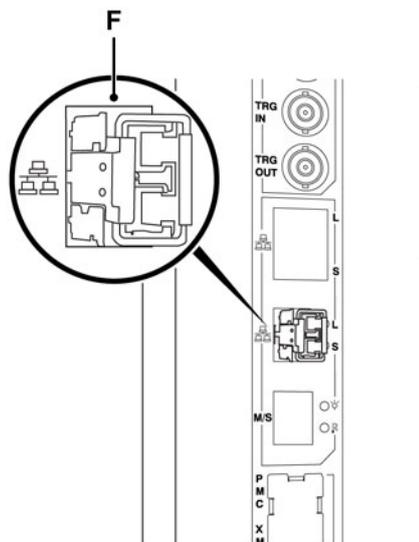
- 2 Grasp module between fingers and thumb at the end with the small black removal-bar and Insert back end into the available SFP slot, until you hear a click.



**Figure 11.39:** Insert device in IM2 Module

**E** Insert device

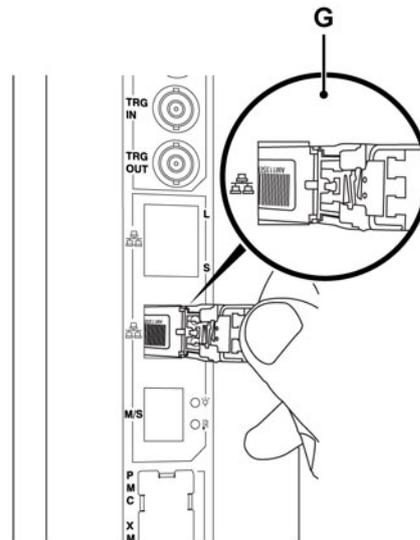
- 3 Embedded software will recognize the device and connect to it automatically when the mainframe is powered on. When there is an optical connection the RJ45 connector will be disabled.



**Figure 11.40:** 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 11.41:** IM2 Module - Remove device

**G** Remove device

Then, if available replace the small plastic plug to protect the optical inlet.

### 11.5.5 Optical Network (SFP) - Trouble shooting

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 print on the label of the SFP module to compare (1310 nm is single-mode, 850 nm is 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.

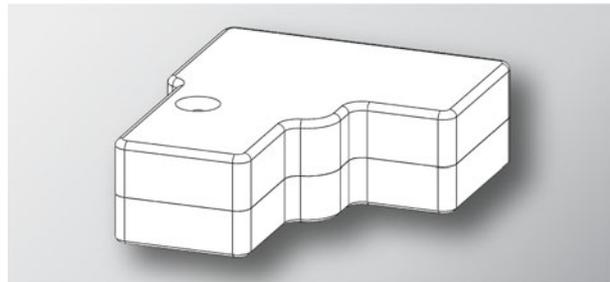
### 11.5.6 Removing protective cover on GEN2i and GEN5i

Within the standard pack contents of this option are two protective covers for use with the GEN2i and the GEN5i. These covers are replacements for the older covers that are installed on the GEN2i and GEN5i. If using a GEN2i or GEN5i you can follow this replacement procedure.

#### Removing SFP protective cover on a GEN2i

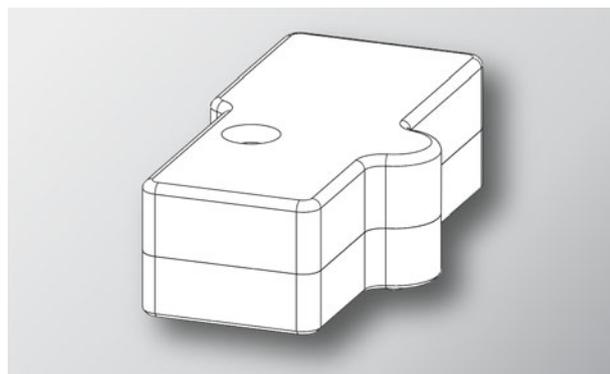
- 1 To use the SFP option on a GEN2i with IM2 you need to remove the protective cover first.

**Note** *Requires screw driver Torx T10.*



**Figure 11.42:** (GEN2i SFP cover - standard)

- 2 When removed replace with the new cap to keep the socket protected.

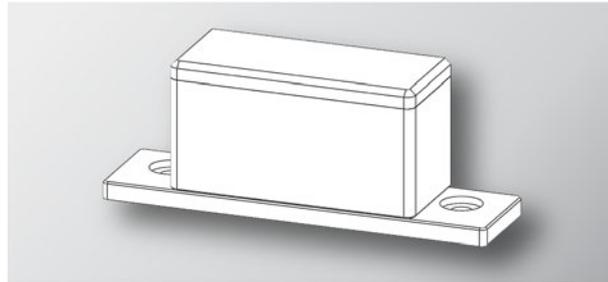


**Figure 11.43:** (GEN2i SFP cover - new)

**Removing SFP protective cover on a GEN5i**

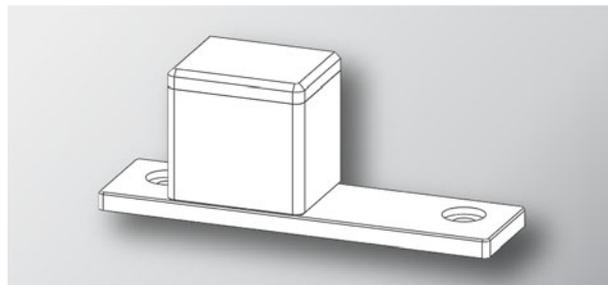
- 1 To use the SFP option on a GEN5i with IM2 you need to remove the protective cover first.

**Note** *Requires screw driver Phillips #2.*



**Figure 11.44:** (GEN5i SFP cover - standard)

- 2 When removed replace with the new cap to keep the socket protected.



**Figure 11.45:** (GEN5i SFP cover - new)

**11.5.7 Option - IRIG and IRIG/GPS time synchronization**

The IRIG boards provide precise time and frequency reference to the GEN5i 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.

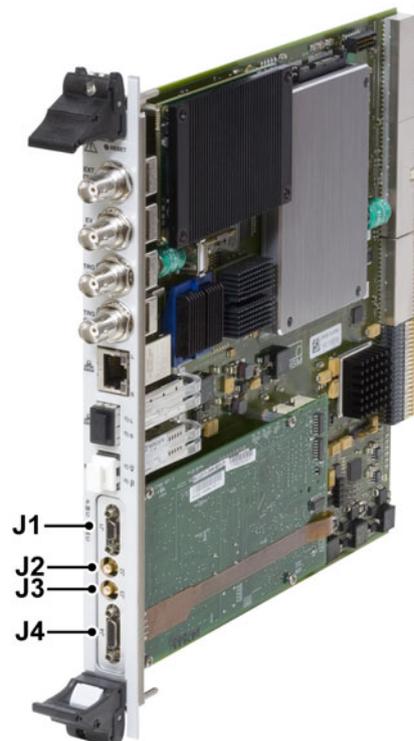
For specifications and ordering information see "B3723-1.0 en (GEN series GEN5i Portable Data Recorder)" on page 312.

**Note** *Available for IM1 and IM2*



**Figure 11.46:** IRIG & IRIG/GPS board

### 11.5.8 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](http://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 arrester 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 arrester and the GPS receiver is longer than four meters, it is good practice to place a second lightning arrester within four meters of the GPS receiver. The second arrester reduces any lightning-induced voltages in the cable to the receiver.

**C** *Grounding*

The lightning arrester 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.

### 11.6 IM1 - Interface/Controller Module 1 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) <sup>(2)</sup>	Yes <sup>(4)</sup>
External SCSI drive (1-G005-2) <sup>(3)</sup>	No
Rack mount SCSI drive (1-G006-2) <sup>(3)</sup>	No
Fiber optic Ethernet (1-G050-2) <sup>(1)(2)</sup>	No <sup>(4)</sup>
IRIG (1-G001-2)	Yes <sup>(4)</sup>
IRIG/GPS (1-G002-2)	Yes <sup>(4)</sup>

- (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.

#### 11.6.1 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 11.47:** Fiber Optic Ethernet Board

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**

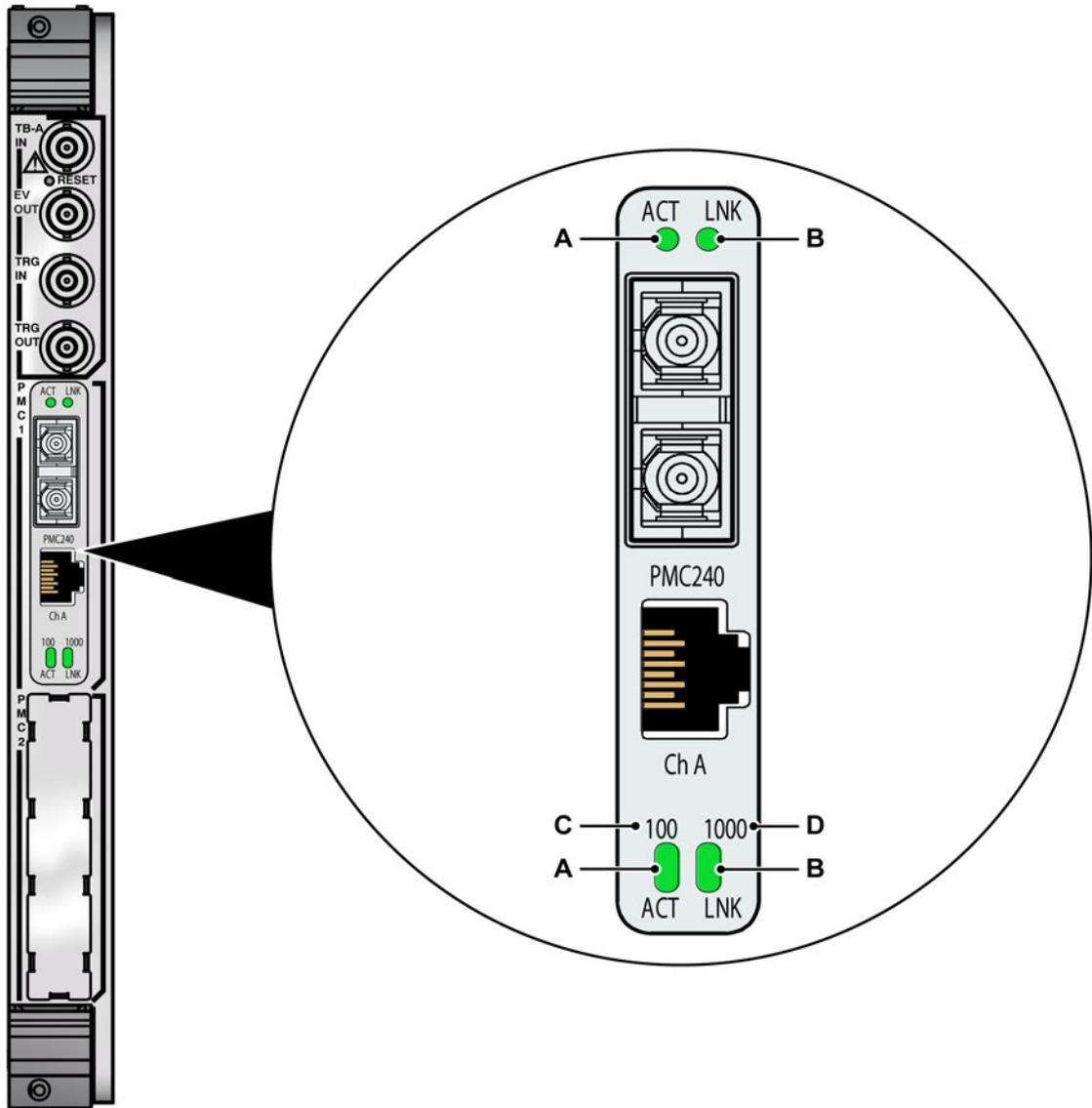
At the system start-up the option auto-detects which of the interfaces is used i.e. copper or fiber. When both interfaces are connected the fiber optic connection has priority and will be used.

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.

<b>High Speed Ethernet</b>			
<b>Component</b>	<b>Unit Description</b>		<b>Value</b>
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**

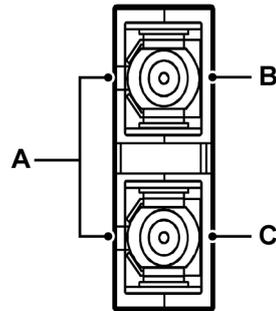
With the option installed the front-panel of the interface/controller module has the following layout:



**Figure 11.48:** 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 11.49 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 11.49:** Receive (RX) - Transmit (TX) connector

- A** Keying
- B** Receive (RX)
- C** Transmit (TX)

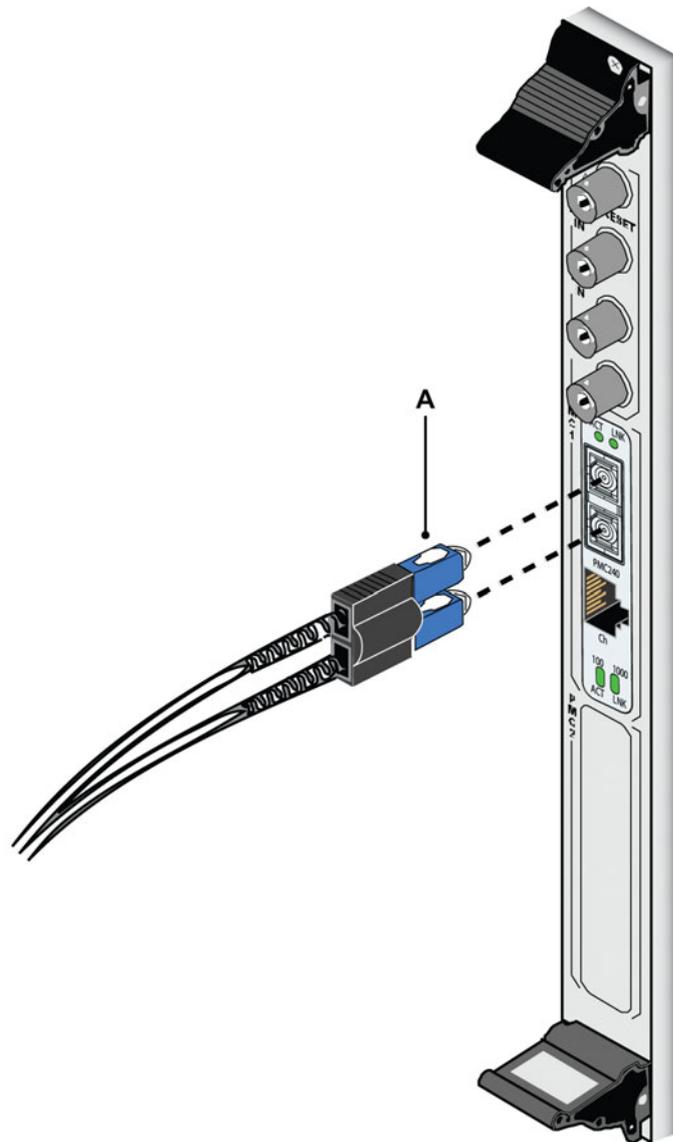
**Connection**

Connect to the fiber optic interface using fiber optic cable with self-locking duplex SC-type male connectors.



**Figure 11.50:** 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 11.51. 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 11.51:** Connecting the fiber optic cable

A SC connector

<b>Fiber Optic Ethernet Specifications</b>	
Fiber optic Ethernet	1000 Base-SX full duplex, 1 GB/s
<b>Connectors</b>	
SC-Type	connectors for dual channel fiber optic data 1 Ch. in, 1 Ch. out
RJ45	8 contact, female for dual channel standard copper communication
<b>Fiber optic</b>	
Wavelength	850 nm
Cable type	Multimode
Maximum cable length	500 m
Auto-Detection <sup>(1)</sup>	Auto-detects at power-on if copper or fiber connection used, the fiber connection has priority if both connections are used.
<b>Interface <sup>(2)</sup></b>	
Copper	Half and full duplex with auto detection up to 100 m cable length 10 Base-T 100 Base-TX 1000 Base-T
Fiber	Ethernet standards supported: Full duplex, up to 500 meters link length 1000 Base-SX
Indicators	Two sets of green LED's for indicating Ethernet channel operational status: <ul style="list-style-type: none"> <li>● ACT: indicates channel activity</li> <li>● LNK: Indicates Ethernet link status</li> <li>● 100: Indicates link speed = 100 M-bits</li> <li>● 1000: Indicates link speed = 1000 M-bits (Gigabit)</li> </ul>

(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

**11.6.2 Option - SCSI interface board**

The SCSI option provides expansion and flexibility, allowing GEN5i 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

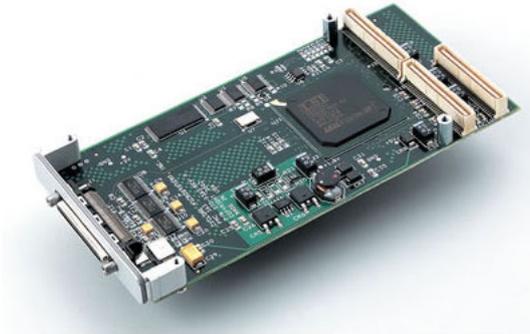
The SCSI option requires the external connection of a SCSI disk that support Ultra320 SCSI. When using a lower graded disk a warning will be generated and specified through put can not be guaranteed.

When the external SCSI disk is used attach the external disk prior to booting the GEN5i mainframe. Only during boot of the GEN5i mainframe the attached SCSI disk will be recognized.



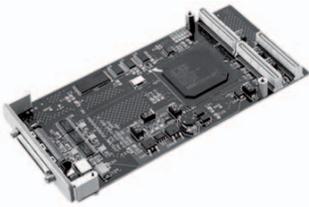
**WARNING**

**Never disconnect the SCSI disk while the GEN5i mainframe is still powered ON. Serious danger exists of loosing your valuable data. The GEN5i SCSI disk is not a plug and play device.**



**Figure 11.52:** SCSI interface board

<b>SCSI</b>	
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

<b>Ordering Information</b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
Interface 	Fits the PMC slot of a GEN series Interface Controller Module IM1	1-G004-2

<b>Ordering Information</b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
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. <i>More details on request</i>	on request

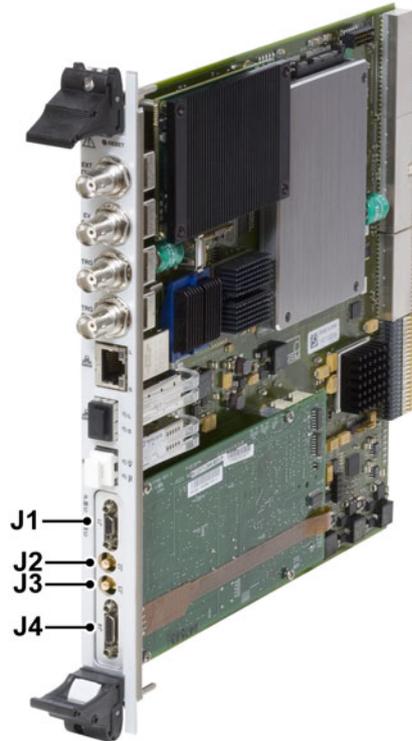
### 11.6.3 Option - IRIG and IRIG/GPS time synchronization

The IRIG boards provide precise time and frequency reference to the GEN5i 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 "B3723-1.0 en (GEN series GEN5i Portable Data Recorder)" on page 312.

**Note**      *Available for IM1 and IM2*

### 11.6.4 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](http://www.symmetricom.com) for option and detailed support on BC635PMC (IRIG) or BC637PMC (GPS)

#### **Rule 1. Antenna placement**

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**C** *Maintenance considerations*

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**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 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**

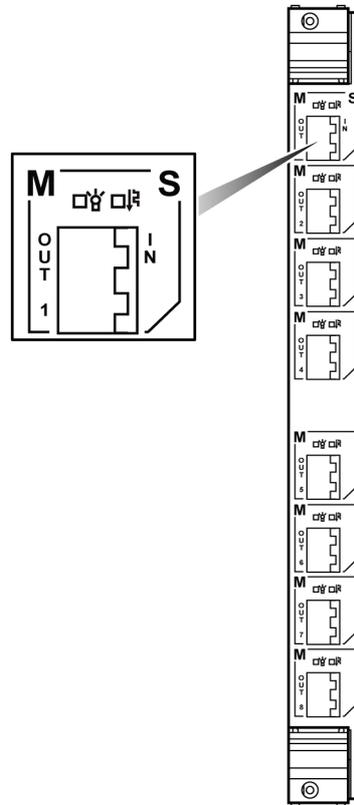
The Master/Slave card has optical I/O (IN/OUT) that connects to other Master/Slave cards.

The fiber optic cable:

- allows up to a 500 m cable between the master and each slave
- 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

#### **11.7.1 Master/Slave card operations**

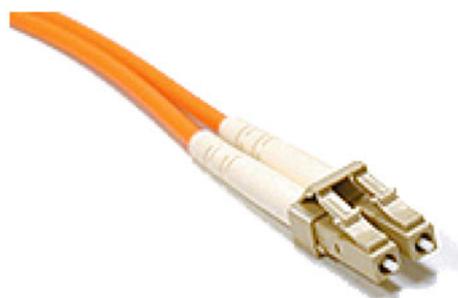
The Master/Slave card is easily inserted into the GEN series mainframe and is automatically recognized by the Perception software. A Master/Slave card can be used as a master or slave. One card is required in the master mainframe and one card is required per slave mainframe. Each card has eight LC<sup>®</sup> connectors for the fiber optic cable.



**Figure 11.53:** 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.



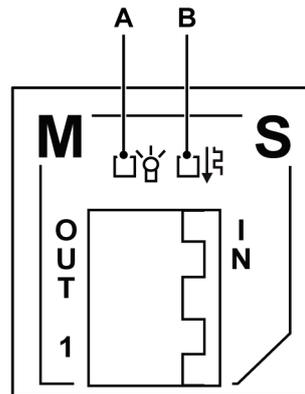
**Figure 11.54:** Example of a duplex LC® connector

**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 11.55:** LED indicators

**A**  icon

**B**  icon

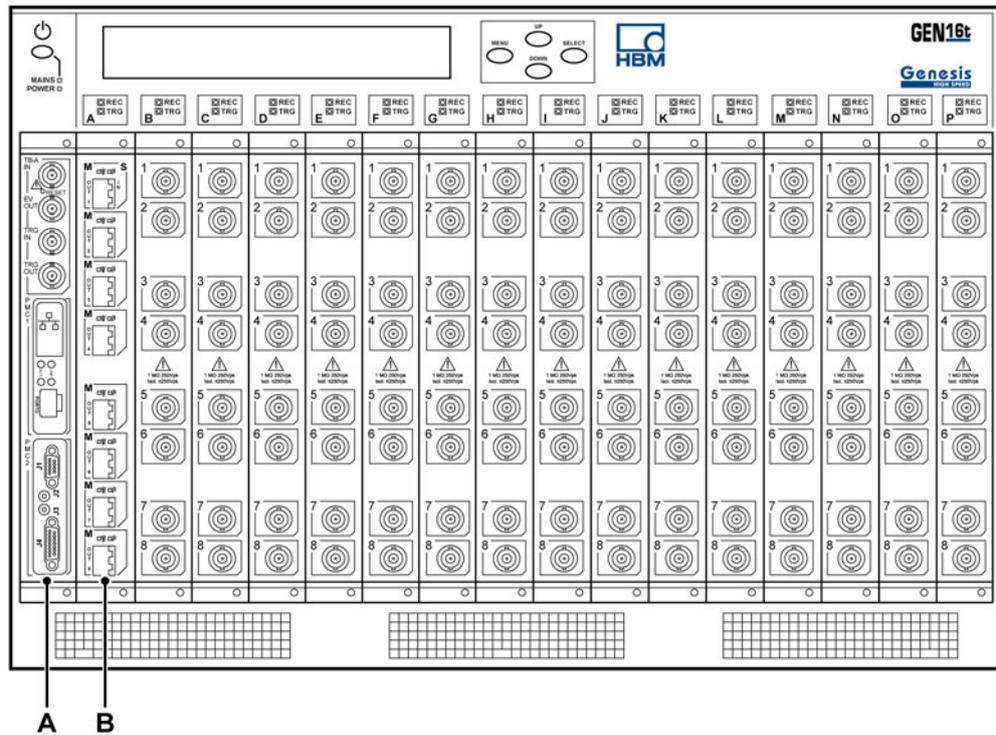
The following table shows the function and possible combinations of the two LEDs.

*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 19" rack model the Master/Slave card is installed into Slot **A** on the right-hand side of the Interface/Controller module.



**Figure 11.57:** 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).*

## 11.7.2 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<sup>®</sup> Optical Transceiver 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:

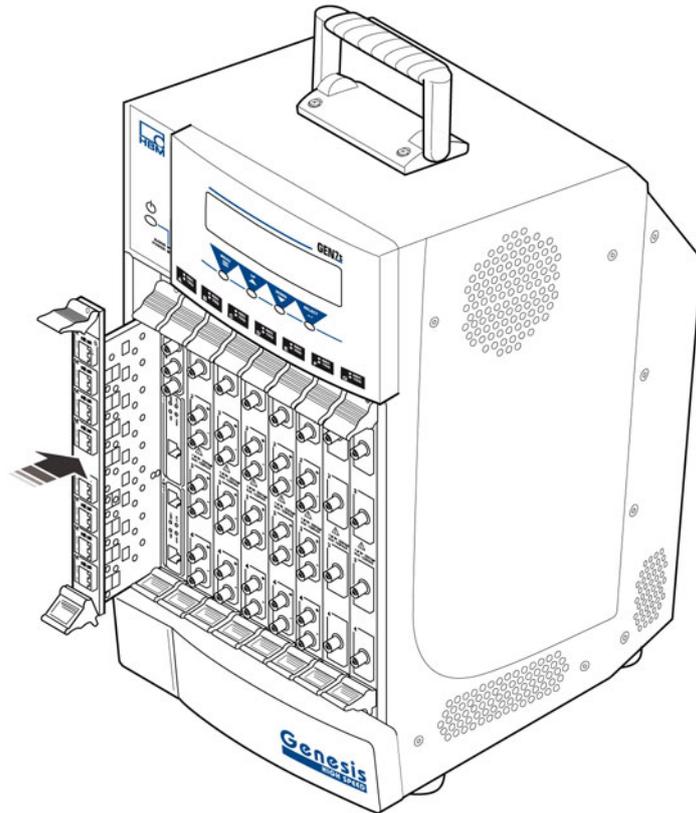
- In the USA, the Master/Slave card is certified as a Class 1 laser product conforming to the requirements contained in the Department of Health and Human Services (DHHS) regulation CDRH 21 CFR, Chapter I Subchapter J Part 1040.10.
- Outside the USA, the Master/Slave card is certified as a Class 1 laser 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:

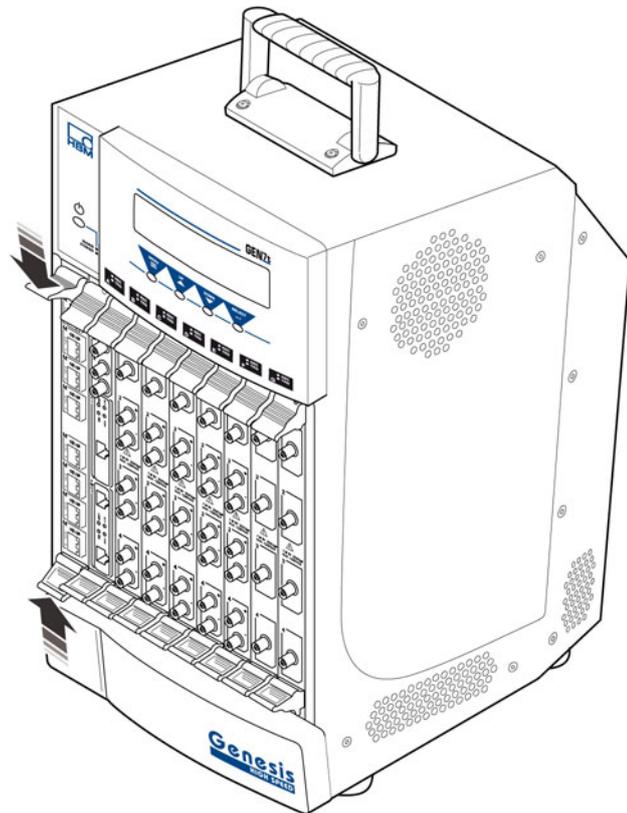
- 1** Shut down the GEN series and remove the power input cable.
- 2** Ensure that the ejector levers are in the outermost position, tilting away from the card.

- 3 Slide the card into its guide rails until the ejectors contact the perforated metal strips at top and bottom.



**Figure 11.58:** 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 11.59:** Press ejectors inwards

- 5 Fasten the small set screw on both ejectors on the card.



**Figure 11.60:** 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.



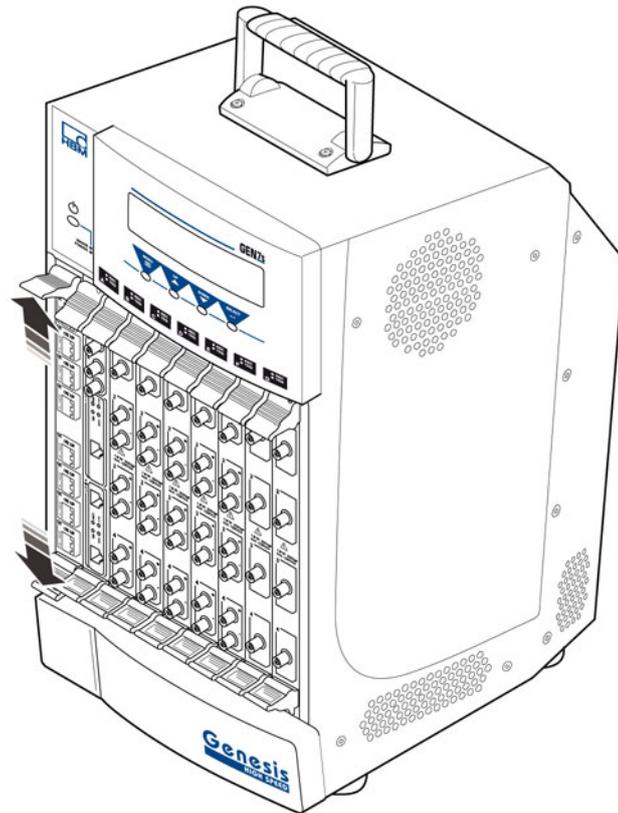
**Figure 11.61:** Ejector set screw

- 3 Press the inner gray button on each ejector to release the catch.



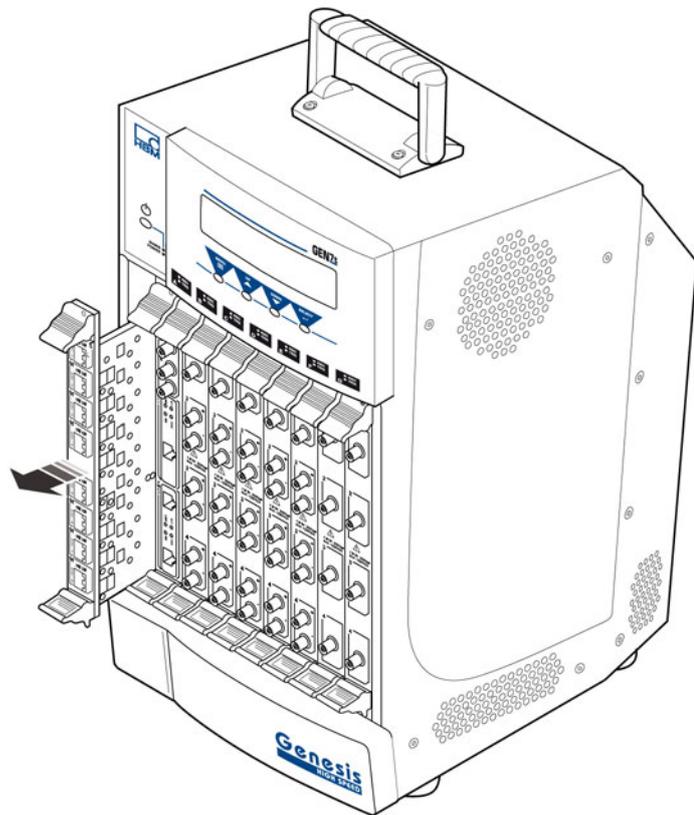
**Figure 11.62:** Inner gray button on ejector

- 4 Press both ejectors outwards to release the card. They act as levers to gently pull the card from its backplane sockets.



**Figure 11.63:** Press ejectors outwards

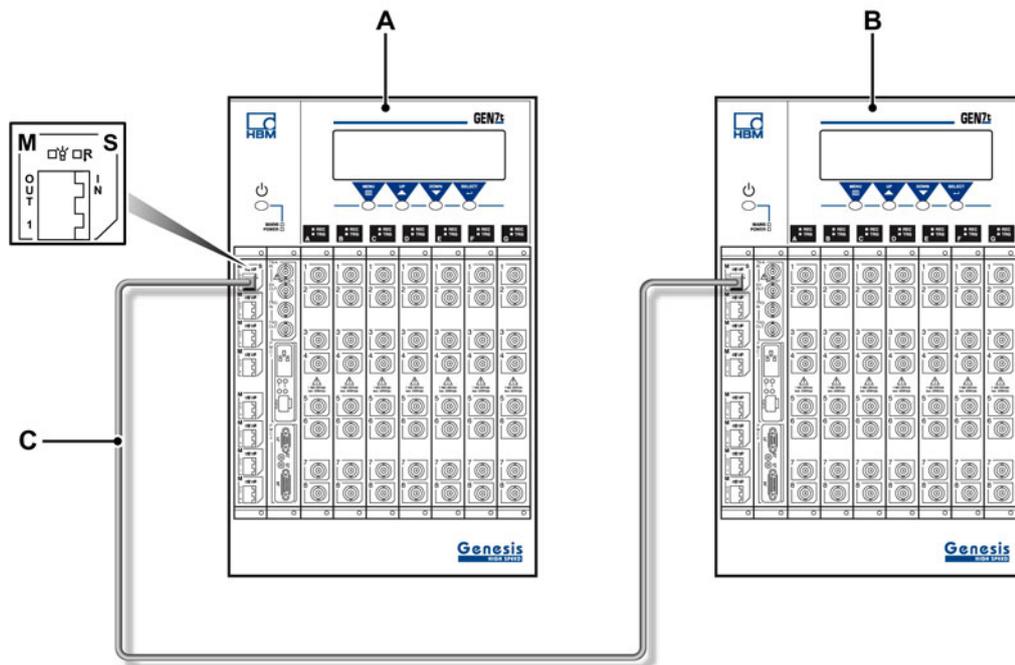
- 5 Slide the card out of the GEN series unit.



**Figure 11.64:** Remove the card

### 11.7.3 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 11.65:** Connecting the Master/Slave

- A Master mainframe (**M**, **OUT**)
- B Slave mainframe (**M/S IN**)
- C Fiber optic cable

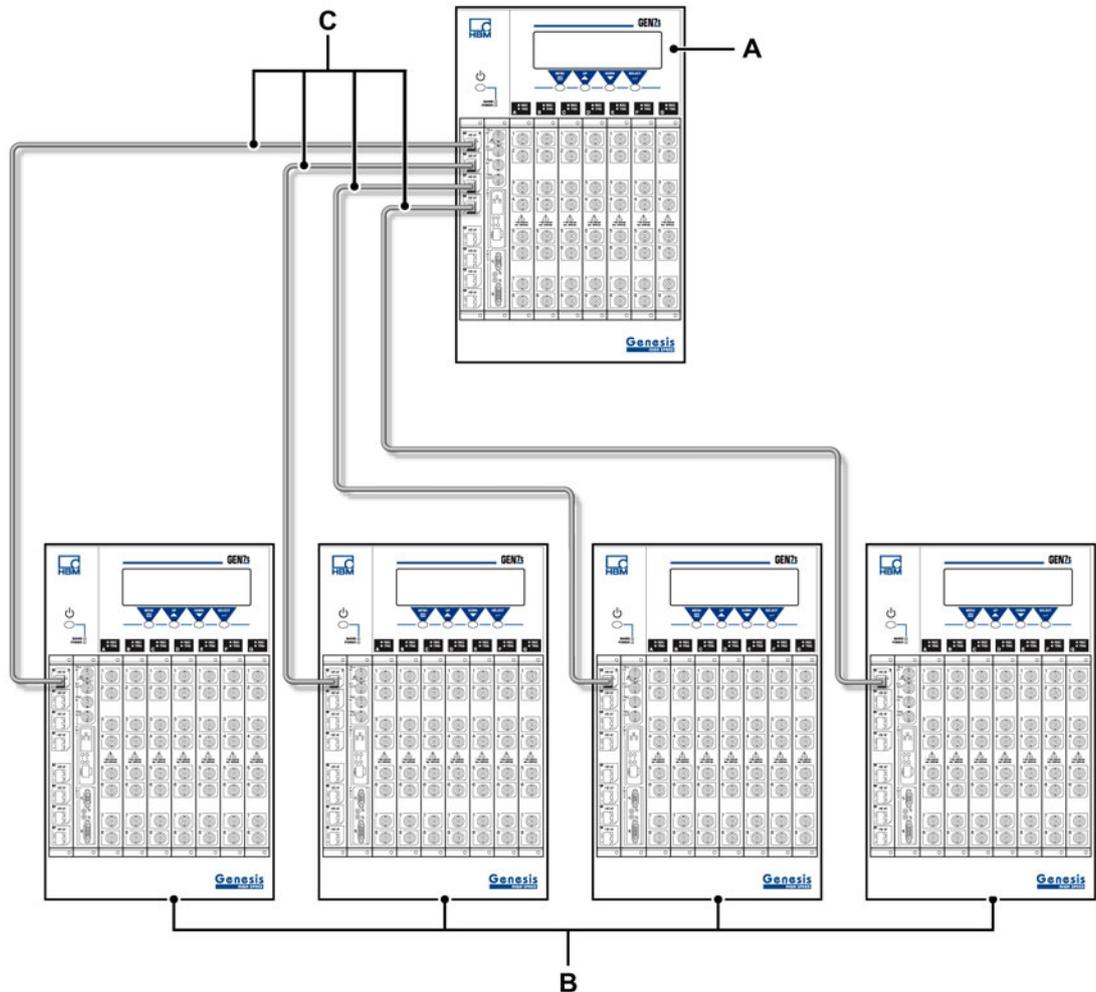


#### IMPORTANT

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.

### 11.7.4 Example of a Master/Slave configuration

The following diagram shows an example of a Master/Slave configuration with a master driving four slave mainframes.



**Figure 11.66:** Example of a Master/Slave configuration with four slave mainframes

- A Master mainframe
- B Slave mainframes
- C Fiber optic cable

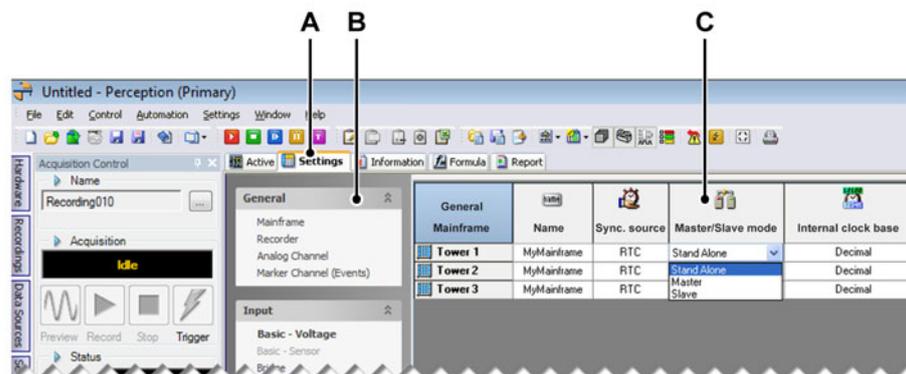
- 1 Connect the Master/Slave card connector labelled **M/S, OUT 1** of the master mainframe to the top connector labelled **M/S IN** of the Master/Slave card of the first slave mainframe.
- 2 Connect the Master/Slave card connector labelled **M, OUT 2** of the master mainframe to the top connector labelled **M/S IN** of the Master/Slave card of the second slave mainframe.

- 3** Connect the Master/Slave card connector labelled **M, OUT 3** of the master mainframe to the top connector labelled **M/S IN** of the Master/Slave card of the third slave mainframe.
- 4** Connect the Master/Slave card connector labelled **M, OUT 4** of the master mainframe to the top connector labelled **M/S IN** of the Master/Slave card of the fourth slave mainframe.

### 11.7.5 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 11.67:** 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 11.68:** Mainframe in Master mode

If you have set the mainframe to Slave mode, the letter "S" appears in the GEN series front panel.



**Figure 11.69:** Mainframe in Slave mode

The installation of the Master/Slave option is completed.

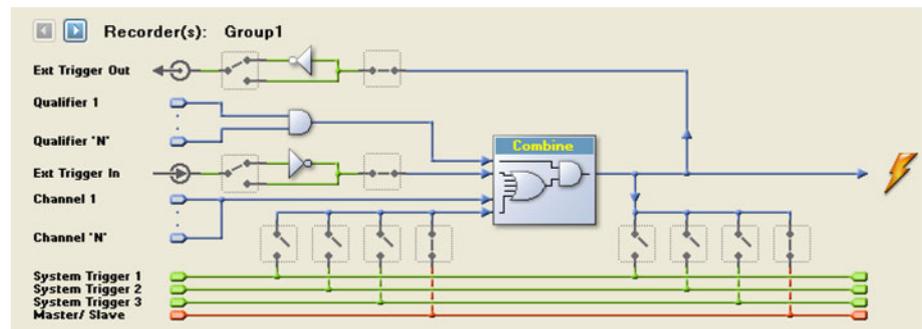
### 11.7.6 Setting the Master/Slave trigger

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.

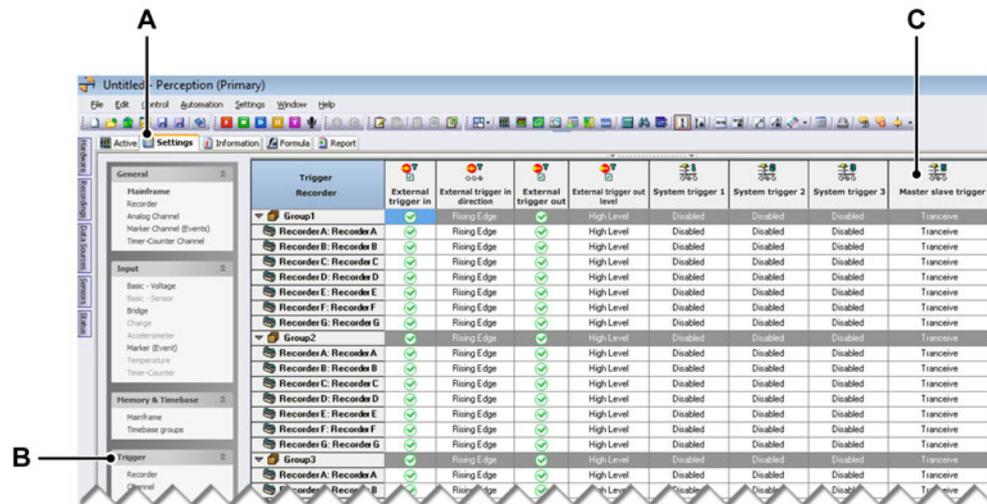
There are four settings that can be selected in the Perception software:

- 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 11.70:** Block diagram



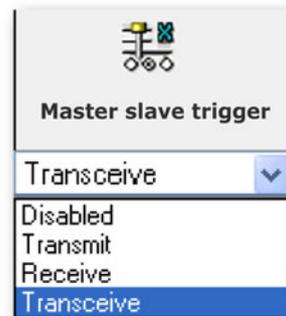
**Figure 11.71:** Perception work area with Master/Slave trigger

- 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.

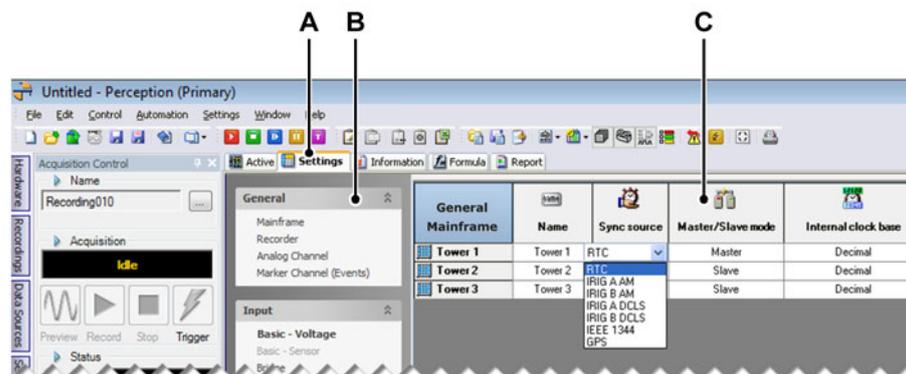


**Figure 11.72:** Master/Slave trigger list

### 11.7.7 Setting the synchronization source (Sync source)

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 11.73:** 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 mainframe that you want to set.

**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.

### 11.7.8 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 with each a Master/Slave card installed and with each at least one recorder card installed.
- 2 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.
- 3 Switch on both GEN series mainframes and wait until they have completed the booting process.
- 4 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.
- 5 Check if both LEDs on both Master/Slave cards are illuminated green.

#### 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**.

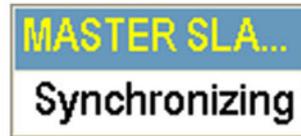


Figure 11.74: MASTER SLAVE Synchronizing

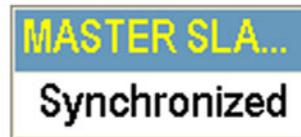


Figure 11.75: MASTER SLAVE Synchronized

- 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**.

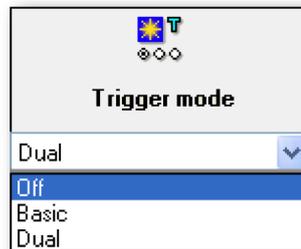
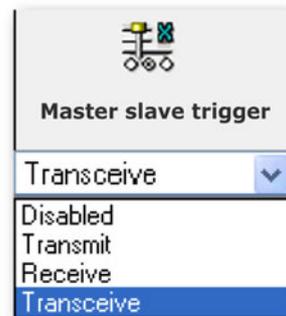


Figure 11.76: Trigger mode list

- 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.

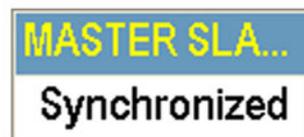


**Figure 11.77:** Master/Slave trigger list

- 15 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 11.78:** 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  $\pm 50$  ns.

If all signals match in time, the recordings were completed successfully.

# 12 Input Cards

## 12.1 Available input cards

- **[Isolated 1kV](#)** - on page 244  
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 on either input of each channel. The signal conditioner provides six channels of voltage inputs from  $\pm 20$  mV to  $\pm 1000$  V.
- **[Basic](#)** - on page 258  
Ideally suited for high definition transient recording. 8 channels with single-ended or isolated inputs on one board. 200 kS/s or 1 MS/s digitizing rate. 16-bit resolution. The signal conditioner provides eight channels of voltage inputs from  $\pm 1$  V to  $\pm 50$  V.
- **[Basic XT](#)** - on page 261  
Has all the features of the basic input card with higher voltage input ranges up to  $\pm 100$  V. 8 channels with single-ended or isolated inputs on one board. 200 kS/s or 1 MS/s digitizing rate. 16-bit resolution. The signal conditioner provides eight channels of voltage inputs from  $\pm 2$  V to  $\pm 100$  V.
- **[Bridge](#)** - on page 264  
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 289  
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 296  
A special input board enables up to 64 "digital" recorded channels. This board 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 297  
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](#)** - on page 290  
Developed for versatility in the following application areas:  
As a differential amplifier or non-isolated entry level electrical input amplifiers. In Accelerometer mode they offer inputs for an array of IEPE based sensors. In Charge mode they can be used directly with charge type sensors. In Single ended mode the cards can serve as coupler inputs for preconditioned signals.
- **[High speed digitizers](#)** - on page 291  
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 305  
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 modules](#)** - on page 331  
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 connected directly to 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 and modules are described in a separate document.*

*Table 12.1: Available acquisition cards with signal conditioning (Part 1)*

<b>MODEL</b>	<b>INPUT TYPE</b>	<b>Isolation</b>	<b>Max. SR<sup>(1)</sup></b>
<b>Basic200</b>	Single Ended	no	200 kS/s
<b>Basic200 XT ISO</b>	Unbalanced Differential	yes	200 kS/s
<b>Basic1M</b>	Single Ended	no	1 MS/s
<b>Basic1M ISO</b>	Unbalanced Differential	yes	1 MS/s
<b>Basic1M XT ISO</b>	Unbalanced Differential	yes	1 MS/s
<b>Bridge200 ISO</b>	Bridge/Differential	yes	200 kS/s
<b>Bridge1M ISO</b>	Bridge/Differential	yes	1 MS/s
<b>Uni200 ISO</b>	Differential/IEPE/ Shunt	yes	200 kS/s
<b>Uni1M ISO</b>	Differential/IEPE/ Shunt	yes	1 MS/s
<b>Basic20k-16</b>	Differential	no	20 kS/s
<b>Basic20k-32</b>	Differential	no	20 kS/s
<b>HiRes250k-16</b>	Differential/IEPE/ Charge	no	250 kS/s
<b>HiRes250k-32</b>	Differential/IEPE/ Charge	no	250 kS/s
<b>HiSpeed 25M</b>	Differential/Single Ended	no	25 MS/s
<b>HiSpeed 100M</b>	Differential/Single Ended	no	100 MS/s
<b>Fiber100M 6600</b>	Multi Mode Optical Fiber	yes	100 MS/s
<b>Fiber100M 7600</b>	Single Mode Optical Fiber	yes	100 MS/s
<b>Iso1kV200</b>	Balanced Differential	yes	200 kS/s
<b>Iso1kV2M</b>	Balanced Differential	yes	2 MS/s
<b>Marker1M</b>	Binary	no	1 MS/s
<b>Marker1M HV</b>	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)*

<b>MODEL</b>	<b>Resolution</b>	<b>Memory<sup>(2)</sup></b>	<b>Channels</b>	<b>Event, T/C<sup>(3)</sup></b>
<b>Basic200k</b>	16 bit	128 MB	8	0, 0
<b>Basic200k XT ISO</b>	16 bit	128 MB	8	0, 0
<b>Basic1M</b>	16 bit	256 MB	8	0, 0
<b>Basic1M ISO</b>	16 bit	512 MB	8	0, 0
<b>Basic1M XT ISO</b>	16 bit	512 MB	8	0, 0
<b>Bridge200k ISO</b>	16 bit	128 MB	4	0, 0
<b>Bridge1M ISO</b>	16 bit	512 MB	4	0, 0
<b>Uni200k ISO</b>	16 bit	128 MB	4	0, 0
<b>Uni1M ISO</b>	16 bit	512 MB	4	0, 0
<b>Basic20k-16</b>	16 bit	200 MB	16	16, 0
<b>Basic20k-32</b>	16 bit	200 MB	32	16, 0
<b>HiRes250k-16</b>	16/24 bit	1800 MB	16	16, 2
<b>HiRes250k-32</b>	16/24 bit	1800 MB	32	16, 2
<b>HiSpeed 25M</b>	15 bit	128 MB	4	0, 0
<b>HiSpeed 100M</b>	14 bit	1800 MB	4	0, 0
<b>Fiber100M 6600</b>	--(4)	1800 MB	4(4)	0, 0
<b>Fiber100M 7600</b>	--(4)	1800 MB	4(4)	0, 0
<b>Iso1kV200k</b>	16/18 bit	200 MB	6	16, 2
<b>Iso1kV2M</b>	16/18 bit	1800 MB	6	16, 2
<b>Marker1M</b>	1 bit	512 MB	64	0, 0
<b>Marker1M HV</b>	1 bit	512 MB	8 & 32	0, 0

(2) Total recording memory/card.

(3) Digital Events, Timer/Counter channels (Supported by GEN3i, GEN3t and GEN2i Digital Event/Timer/Counter connector only).

(4) This card supports a maximum of four optical fiber transmitter channels.

<b>Optical Fiber Transmitter Channels</b>					
<b>Transmitter</b>					
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.					
<b>Model</b>	<b>Receiver Card</b>	<b>Power</b>	<b>Sample rate</b>	<b>Resolution</b>	<b>Isolation</b>
HV6600 100M	Fiber100M 6600	Battery	100 MS/s	14 bit	User application defined
HV6600 25M	Fiber100M 6600	Battery	25 MS/s	15 bit	User application defined
MV6600 100M	Fiber100M 6600	120/ 240 V AC	100 MS/s	14 bit	1800 V RMS
MV6600 25M	Fiber100M 6600	120/ 240 V AC	25 MS/s	15 bit	1800 V RMS
7600 100M	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
- $\pm 20$  mV to  $\pm 1000$  V input range
- 600 V RMS CAT II 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  $\pm 20$  mV to  $\pm 1000$  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 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 operating at up to 2 MS/s.

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 "B3618-3.0 en (GEN series GN610)" on page 356.

### 12.2.2 GN611, Isolated 1 kV 200kS/s input card

- 6 analog channels
- Isolated, balanced differential inputs
- $\pm 20$  mV to  $\pm 1000$  V input range
- 600 V RMS CAT II 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  $\pm 20$  mV to  $\pm 1000$  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 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 "B3716-2.0 en (GEN series GN611)" on page 381.

### 12.2.3 Using the GN610 and GN611



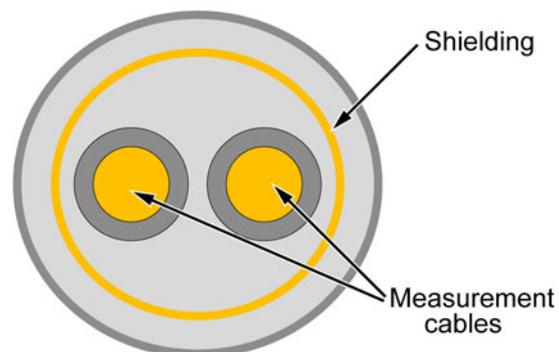
#### **WARNING**

#### **High bandwidth and measurement cabling**

Due to the high bandwidth measurement capabilities of the acquisition board in combination with the high measurement sensitivity of the board 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<sup>(1)</sup>

(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 board.
- 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 57 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  $\pm 1000$  V for all ranges except for the  $\pm 1000$  V range that is limited to  $\pm 1250$  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 boards 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

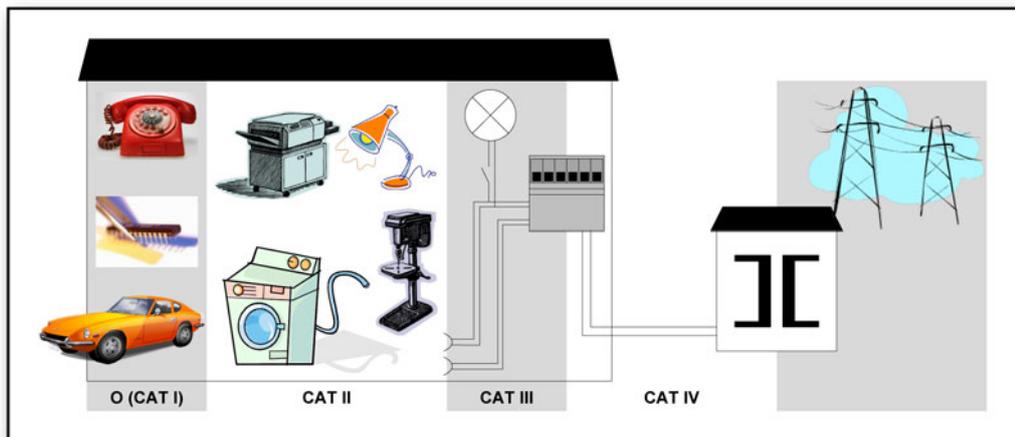


Figure 12.4: Category indication according to IEC 61010-2-030:2010

**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 deduce 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.

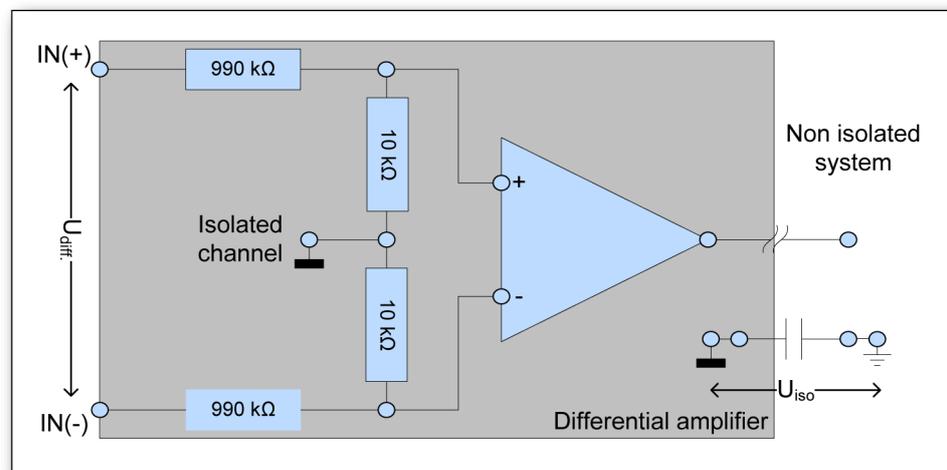
### 12.2.5 Understanding the GN610 and GN611 input

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 of the GN610.

The input channels of the GN610 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.

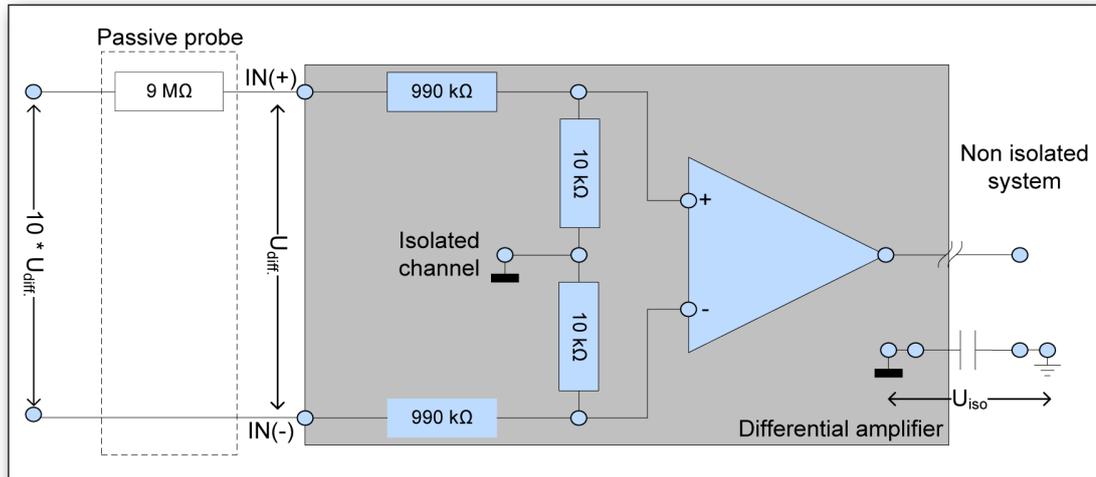


**Figure 12.5:** Isolated balanced input channel

#### (not) using probes:

Using passive voltage probes together with balanced isolated inputs is very difficult and not recommended. 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  $|U_{iso}| \leq 1$  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  $|U_{IN(-)}| \leq 1$  kV. Assuming  $U_{IN(-)}$  is connected to 0 V we can calculate the voltages at  $U_{iso}$  and  $U_{IN(+)}$

Assuming:	$U_{IN(-)} = 0V$ 10:1 probe used, probe input Voltage applied is $10 * U_{diff}$
Results in:	$U_{IN(+)} = 10 * U_{diff} / 11M * 2M = 1.82 * U_{diff}$ $U_{iso} = 10 * U_{diff} / 11M * 1M = 0.91 * U_{diff}$

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:  $U_{IN(-)} = 10 * U_{diff}$   
 $U_{IN(+)} = 0 V$

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

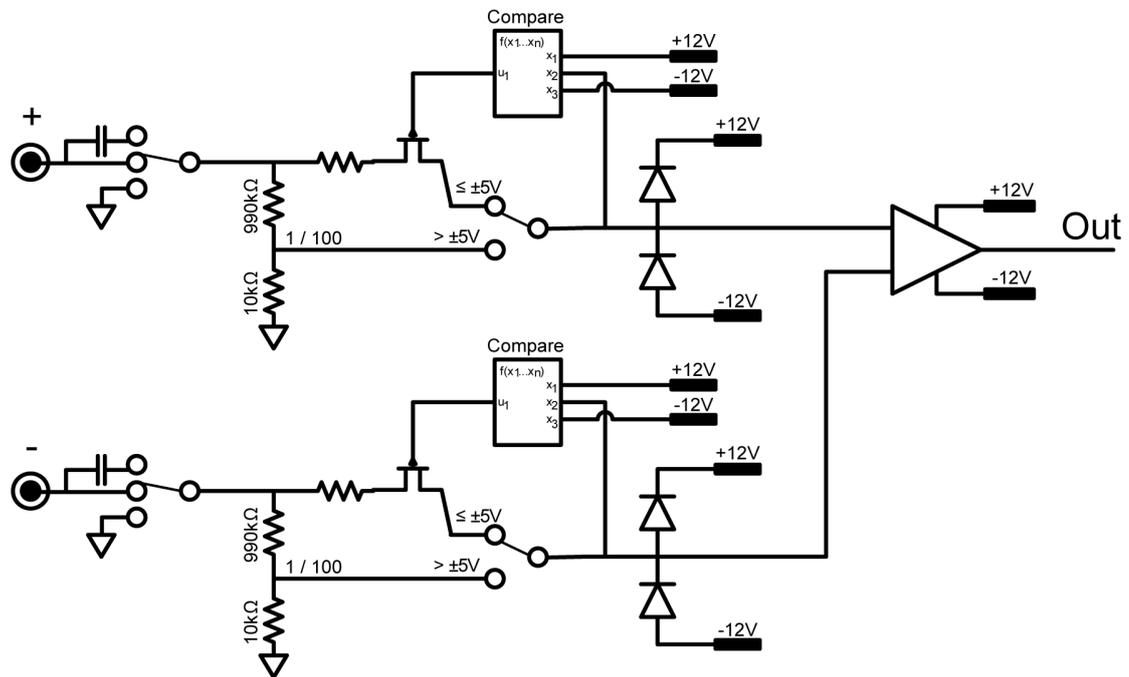
The input section has several methods to protect against Voltage overload on the input.

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 ( $\leq \pm 5 V$  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 result in auto ranging. Longer overload conditions will lead to higher local temperature and this will start the auto ranging process.

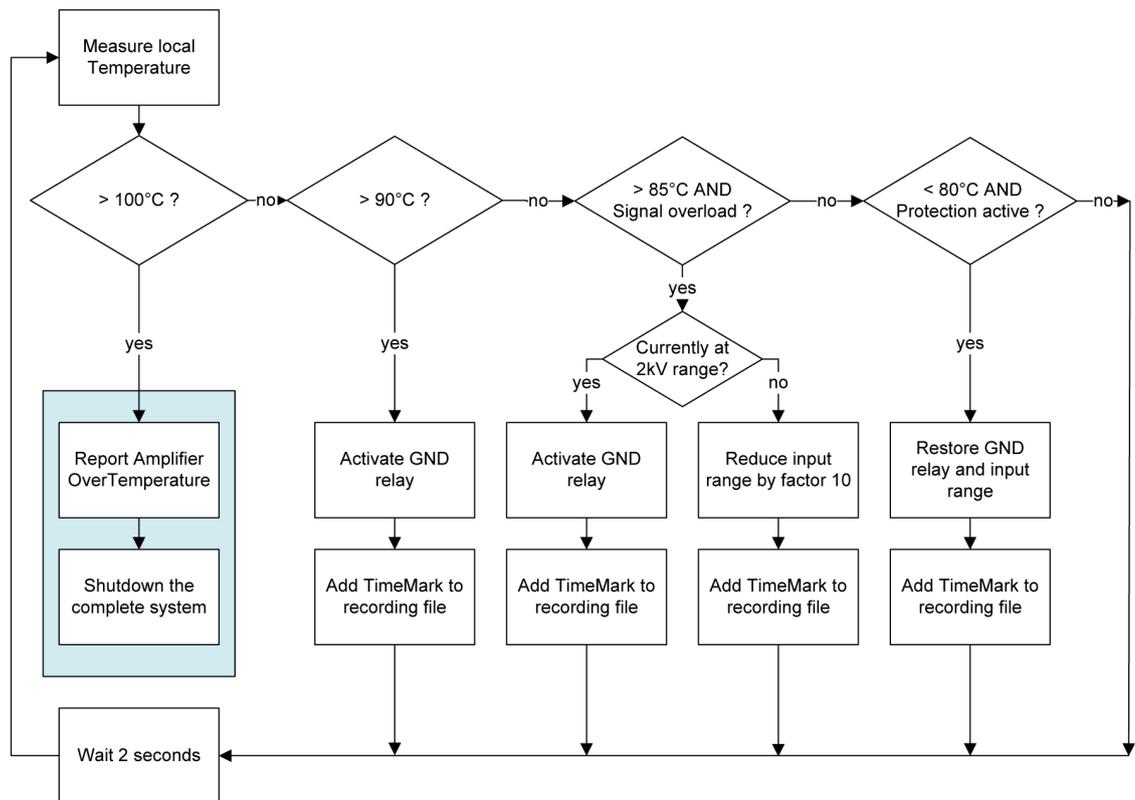
Whenever an overload condition pushes local temperature to above the maximum level, the input range will be adapted to a factor 10 less sensitive range. Eg. User selected  $\pm 40$  mV range, when required the system will change the range to  $\pm 400$  mV. As this might not be enough due to an even 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 downscale the input 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  $\pm 1$  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  $\pm 1$  kV range and local temperature is not within 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 Basic amplifier none isolated input cards

### 12.3.1 GN810 Basic 200K input card

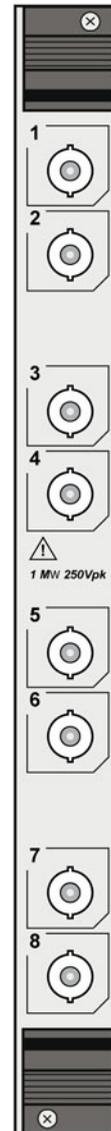
- 8 analog channels
- Single ended inputs
- $\pm 1\text{ V}$  to  $\pm 50\text{ V}$  input range
- User selectable digital Bessel and FIR filters
- 200 kS/s sample rate
- 16 bit resolution
- 128 MB memory
- Single metal BNC for each channel

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  $\pm 1\text{ V}$  to  $\pm 50\text{ V}$  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 M $\Omega$  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 403.



### 12.3.2 GN811 Basic 1M input card

- 8 analog channels
- Single ended inputs
- $\pm 1\text{ V}$  to  $\pm 50\text{ V}$  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

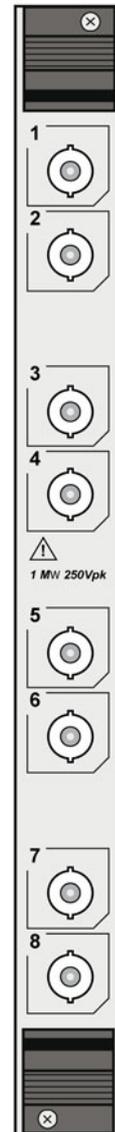
The GEN DAQ Basic 1 MS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or probes and current clamps.

The basic signal conditioner provides eight channels of single ended voltage inputs from  $\pm 1\text{ V}$  to  $\pm 50\text{ V}$  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  $1\text{ M}\Omega$  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 416.



## 12.4 GN812 Basic 1M Isolated input card

- 8 analog channels
- Unbalanced differential inputs
- $\pm 1$  V to  $\pm 50$  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

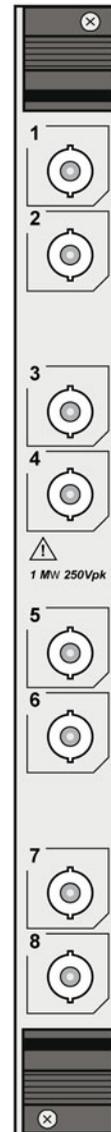
The GEN DAQ Basic ISO 1 MS/s input card is a general purpose signal conditioner for use with voltage inputs, externally conditioned signals or isolated probes and current clamps.

The basic signal conditioner provides eight channels of isolated single ended voltage inputs from  $\pm 1$  V to  $\pm 50$  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 M $\Omega$  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 430.

## 12.5 Basic Extended Isolated amplifier card

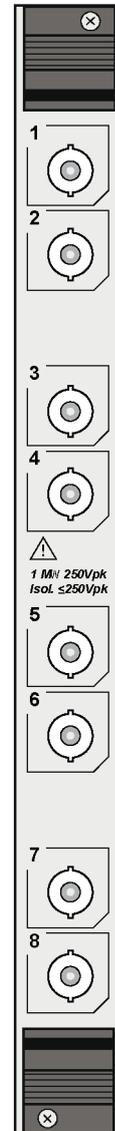
### 12.5.1 GN813 Basic XT ISO 1 MS/s input card

- 8 analog channels
- Unbalanced differential inputs
- $\pm 2\text{ V}$  to  $\pm 100\text{ V}$  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  $\pm 2\text{ V}$  to  $\pm 100\text{ V}$  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 M $\Omega$  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 444.

### 12.5.2 GN814 Basic XT ISO 200K input card

- 8 analog channels
- Unbalanced differential inputs
- $\pm 2\text{ V}$  to  $\pm 100\text{ V}$  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  $\pm 2\text{ V}$  to  $\pm 100\text{ V}$  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 M $\Omega$  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 458.

## 12.6 GN410 and GN411 Bridge input cards

The GN410 and GN411 bridge input cards are suitable for strain gages, strain-gage 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  $\Omega$  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 472.



### **12.6.1 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.

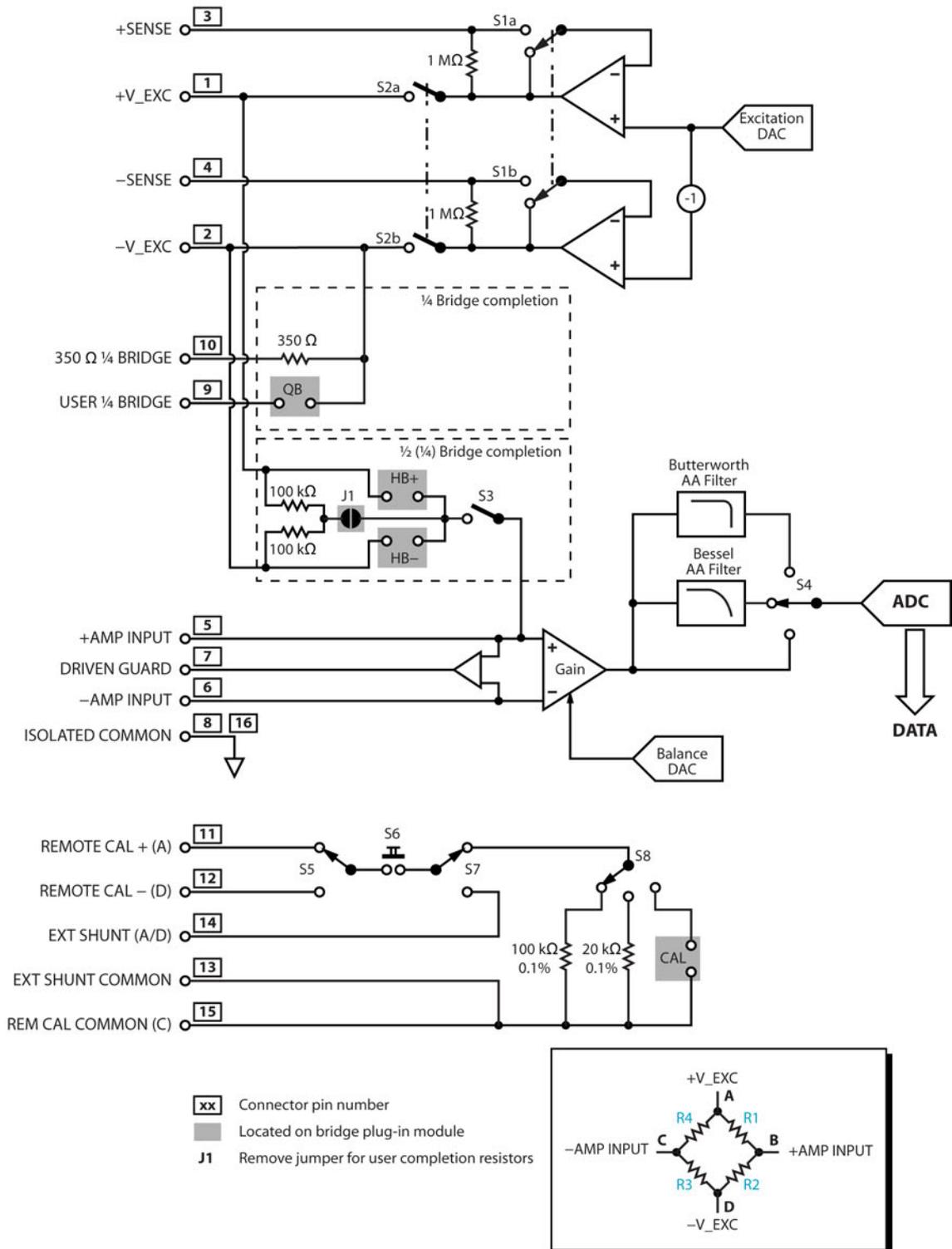


Figure 12.9: Bridge amplifier block diagram with pinning

### 12.6.2 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.

### 12.6.3 Bridge completion

Each bridge amplifier channel contains a pair of fixed 10 k $\Omega$  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  $\Omega$  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.

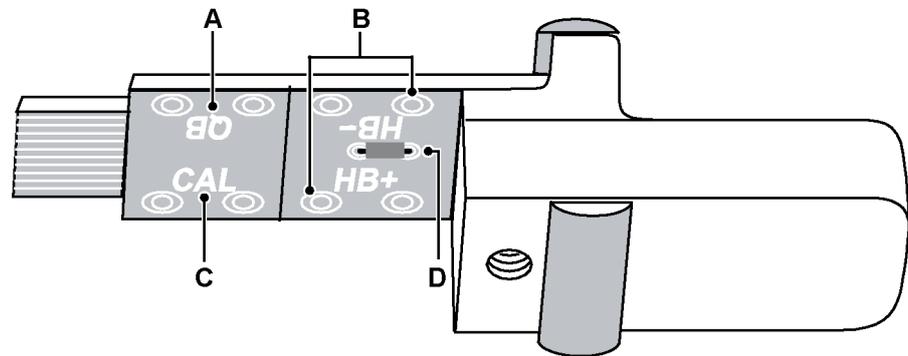
### 12.6.4 Shunt calibration

Each bridge amplifier channel contains 100 K $\Omega$  and 20 K $\Omega$ , 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 12.4: Deflection for various bridge configurations*

BRIDGE	100 K $\Omega$			20 K $\Omega$		
	1000 $\Omega$	350 $\Omega$	120 $\Omega$	1000 $\Omega$	350 $\Omega$	120 $\Omega$
mV/V	2.4888	0.873	0.299	12.20	4.337	1.495
$\mu$ str full bridge	1244	437	150	6098	2169	748
$\mu$ str $1/2$ bridge	2488	873	300	12195	4337	1496
$\mu$ str $1/4$ 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.



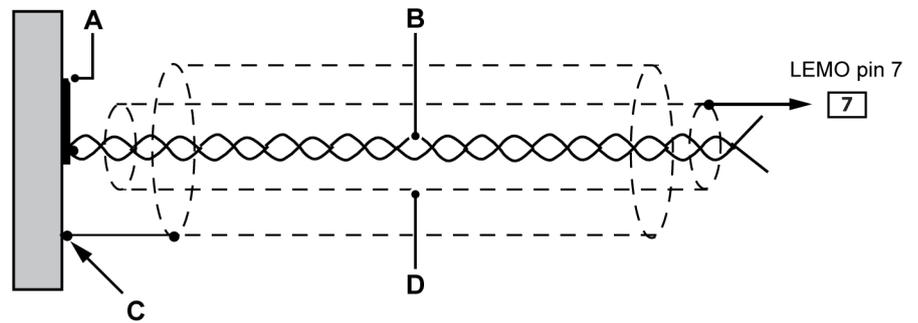
**Figure 12.10:** Shunt calibration completion plug-in module

- A User Quarter-Bridge Completion
- B User Half-Bridge Completion
- C User Shunt Cal
- D JUMPER! *Remove when installing Half-Bridge completion*

### 12.6.5 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 input shield is connected only to the drive pin of the conditioner and where 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 mutual capacitance between them and the electrostatic coupling between the shield and the internal conductors. In all cases, the driven shield is terminated only at the driven guard conditioner terminal where the driven shield is surrounded by an outer shield that is terminated to ground preferably at the strain gage installation site as shown in Figure 12.11.

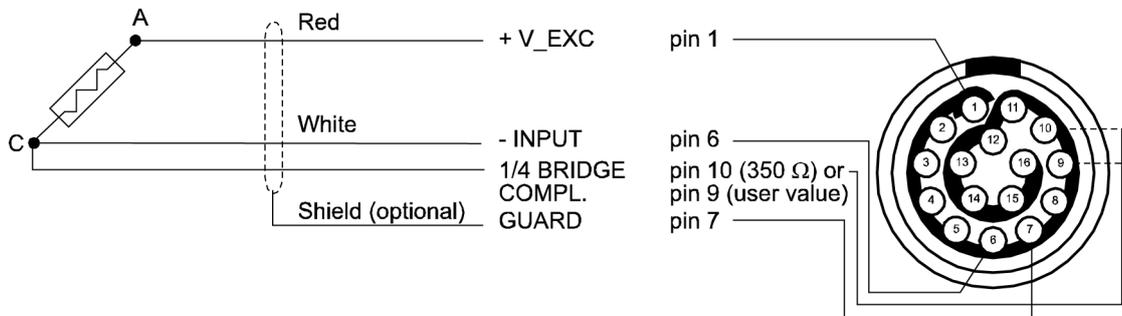


**Figure 12.11:** The driven guard approach to minimize induced noise

- A** Strain gages
- B** Signal conductors
- C** Outer shield  
Terminated near strain gages - signal source
- D** Inner shield  
Driven guard at +Vcm

**12.6.6 Various bridge configurations**

The diagrams below shows possible bridge configurations.



**Figure 12.12:** Three-wire quarter bridge

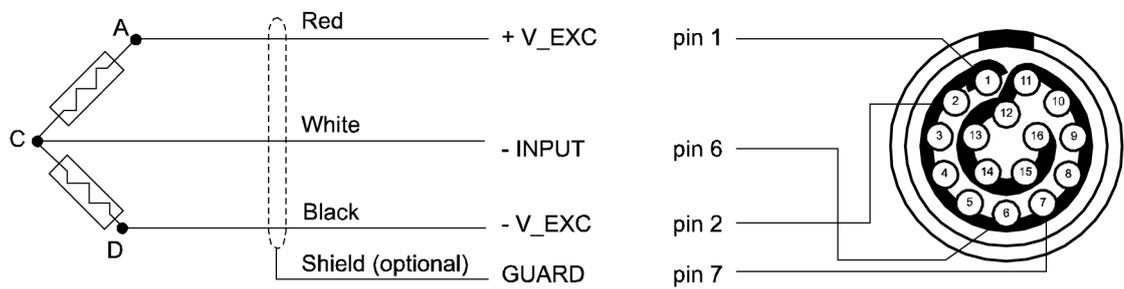


Figure 12.13: Half bridge standard wiring

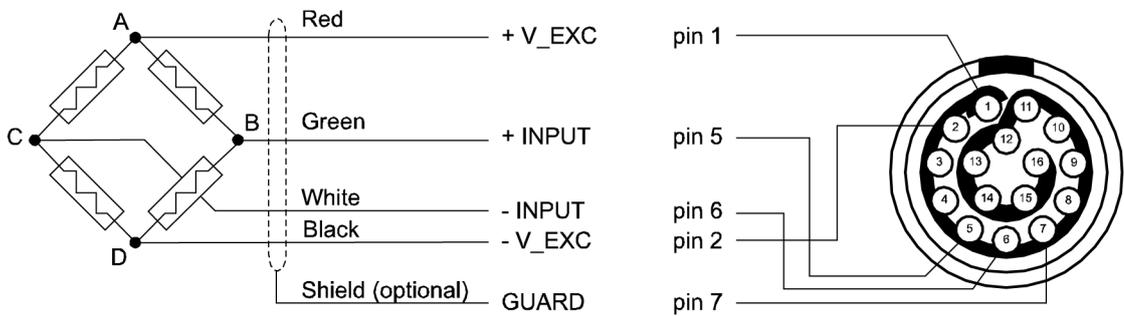
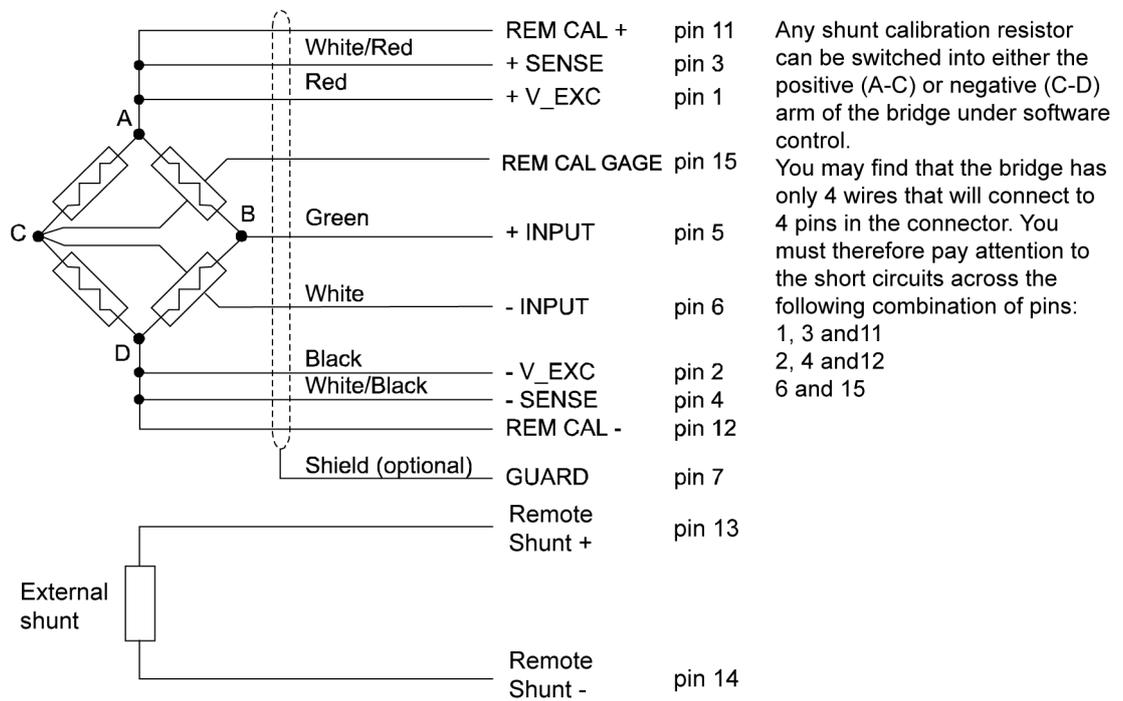


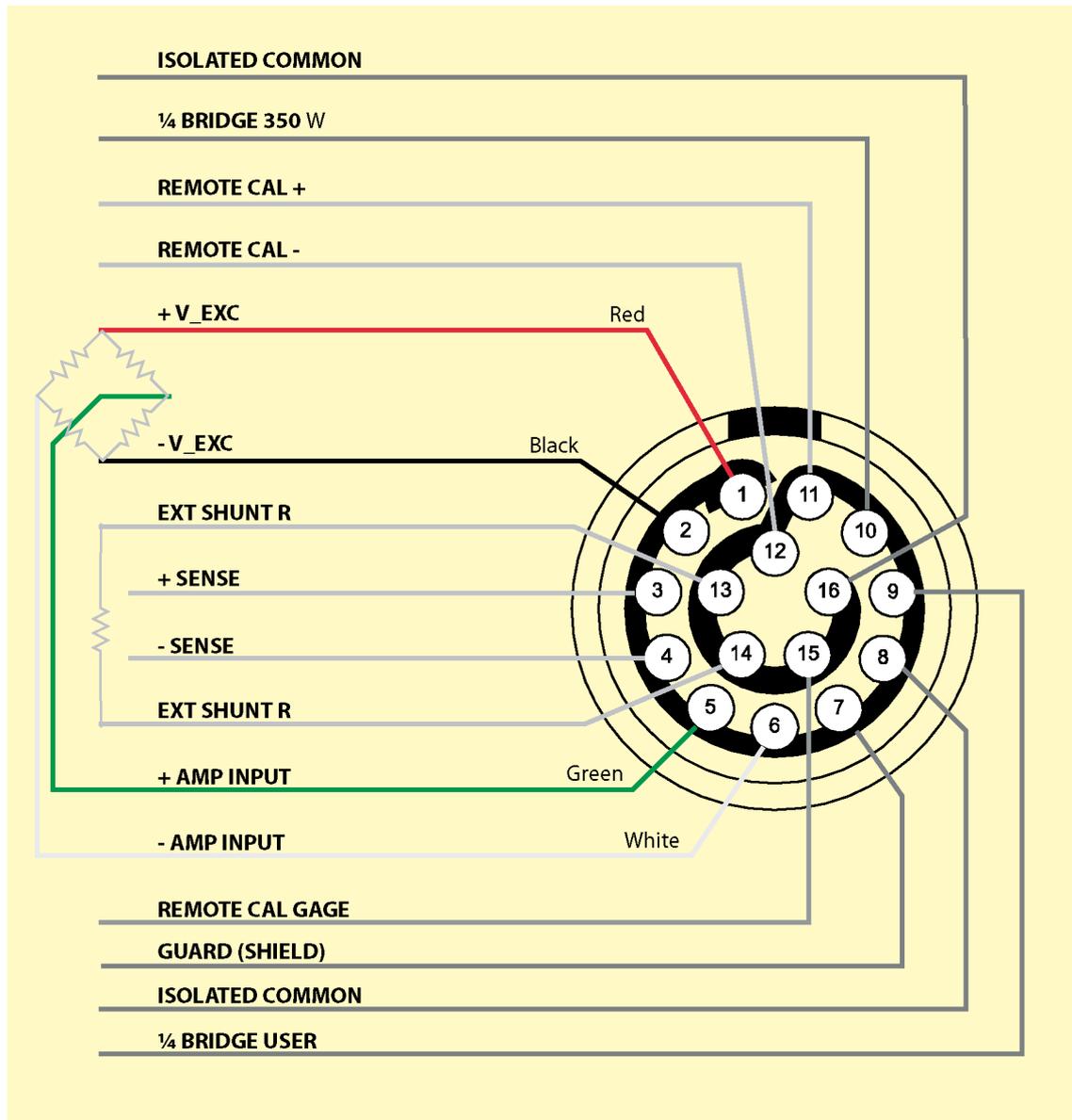
Figure 12.14: Full bridge standard wiring



**Figure 12.15:** Full bridge with remote sensing and remote calibration

### 12.6.7 Bridge connector reference card

Make copies of this page to record and document your test setups.

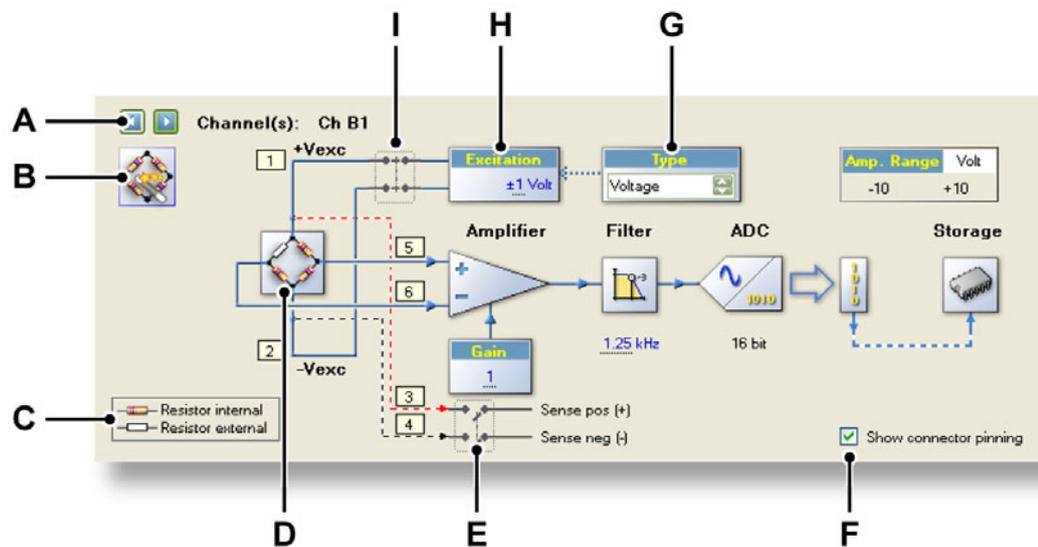


**Figure 12.16:** Reference card: LEMO FGG.2B.316 Connector, solder cup view of male connector

### 12.6.8 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 12.17:** Perception Bridge Amplifier simplified block diagram

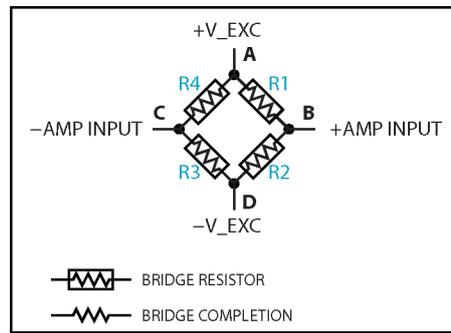
- A Channel select
- B Start Bridge Wizard
- C Legend
- D Bridge representation (click to toggle bridge completion)
- E Sense on/off (S1a and S1b in Figure 12.9 on page 266)
- F Show connector pinning on/off
- G Excitation type
- H Excitation value
- I Excitation on/off (S2a and S2b in Figure 12.9 on page 266)

### Bridge completion

The Wheatstone bridge used in most strain gage 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 12.18:** Full bridge layout

To connect such a bridge you need a minimum of four wires. Refer to Figure 12.15 for connection details. When using a full bridge you need to inform the Perception software about this.

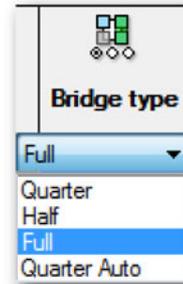
**To select full bridge completion in Perception**

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**.

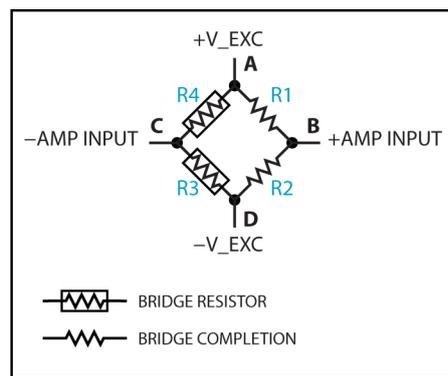


- In the simplified graphical diagram click on the bridge icon (D in Figure 12.17 on page 273) until you see the full bridge representation.



**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 12.19:** 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 k $\Omega$  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 12.9 on page 266 for electrical/schematic details and to for mechanical/location details.

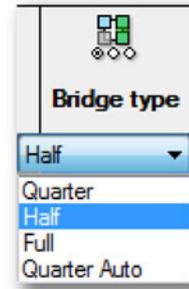
To connect such a bridge you need a minimum of three wires. Refer to Figure 12.14 for connection details. When using a half bridge you need to inform the Perception software about this.

#### **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**.



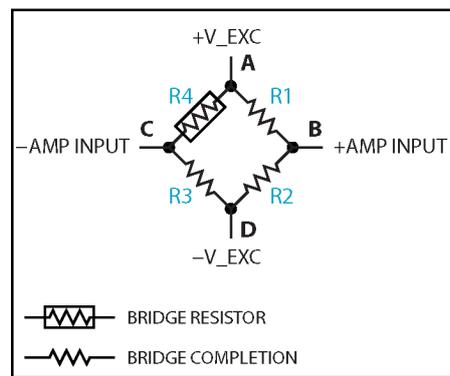
- In the simplified graphical diagram click on the bridge icon (**D** in Figure 12.17 on page 273) until you see the half bridge representation.



- 5 When you select half bridge completion, switch S3 in Figure 12.9 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 12.20:** 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  $\Omega$  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 12.9 on page 266 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 12.12 for connection details.

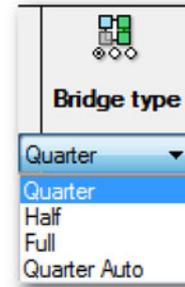
When using a quarter bridge you need to inform the Perception software about this.

#### **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 12.17 on page 273) until you see the quarter bridge representation.



- 5 When you select quarter bridge completion, switch S3 in Figure 12.9 on page 266 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 12.9 on page 266.
- Add a connection from pin 4 (-sense) to the bridge connection marked D in Figure 12.9 on page 266.

**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

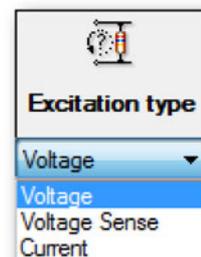
To make the required settings in the Perception software do the following:

- 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 12.9):
  - In the spreadsheet style matrix double-click in the correct row(s) on the **Excitation** column.



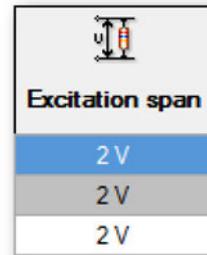
- In the simplified graphical diagram click on the excitation switch (I in Figure 12.17 on page 273).
- 5 To select an excitation type do one of the following:
    - In the spreadsheet style matrix in the **Excitation type** column make your selection



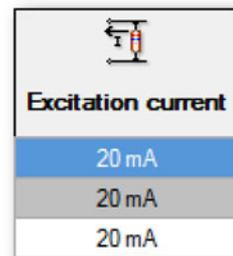
- In the simplified graphical diagram click the **Type** spinner (G in Figure 12.17 on page 273) until you see your selection.

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 12.17 on page 273) 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 12.17 on page 273 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 12.17 on page 273) 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 12.17 on page 273) 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 k $\Omega$  or 100 k $\Omega$  precision resistors.
  - **User installed:** you will need to add the resistor on the plug-in module on the location marked **CAL**. Refer to Figure 12.9 on page 266 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.

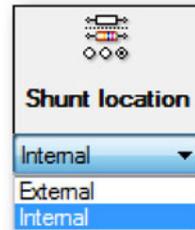
For an example refer to Figure 12.15 "Full bridge with remote sensing and remote calibration " on page 271.

### In Perception

To make the required settings in the Perception software do the following:

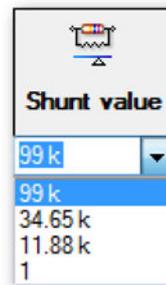
- 1 In Perception go to the **Settings** sheet.
- 2 In the task pane select the **Bridge** in the **Input** section.
- 3 Select one or more channels.

- 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 12.9.



Depending on the selection:

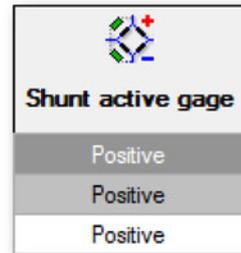
- When **internal** is chosen select the correct value in the **Shunt value** column:



or type the value of the CAL resistor. This selection operates switch S8 in Figure 12.9 on page 266.

- 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 12.9 on page 266:
  - 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 12.17 on page 273) to switch between the two gages.

#### Shunt verification - procedure

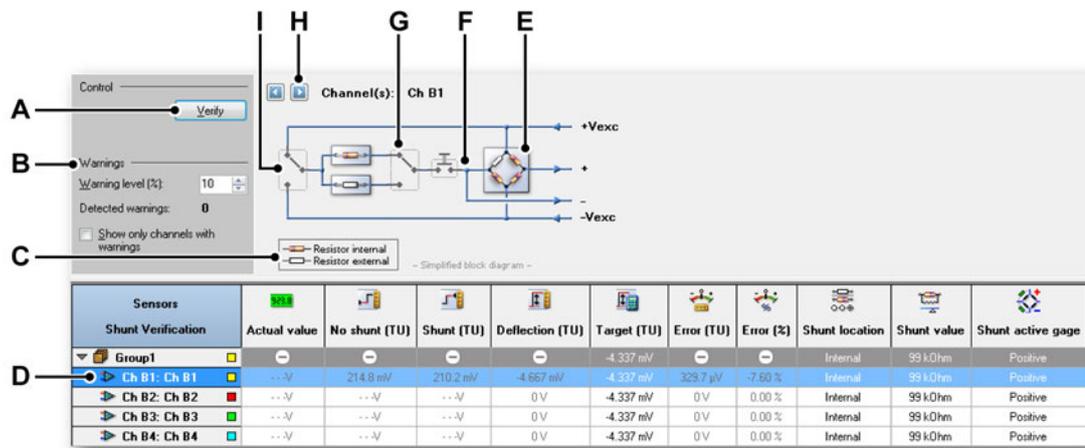
Once you have correctly set up all wiring and resistors you can do an actual shunt verification.

#### 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 12.21).
- 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 12.21).

The actual shunt verification is done using the shunt verification dialog.



**Figure 12.21:** 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 12.9 on page 266)

**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 12.16. In Figure 12.21 on page 286 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 12.9 on page 266 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 gage(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.

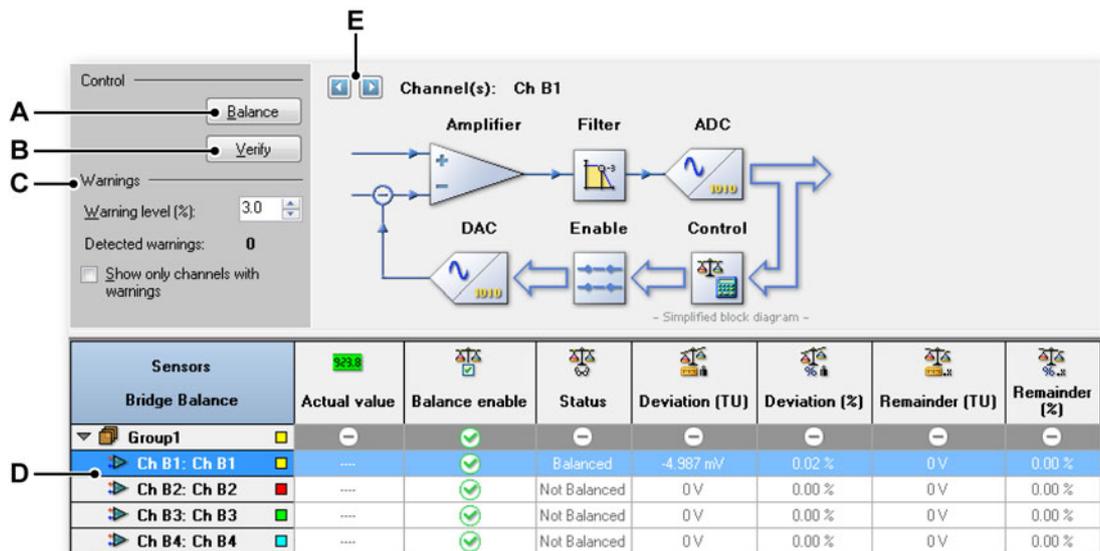
While resistive-balance circuits are widely used in strain gage instrumentation, the GN410 and GN411 uses an alternative electronic method of balancing the output to zero involving measuring the output of the bridge and injecting an equal and opposite voltage. This method permits rapid automatic balancing in multi-channel systems and eliminates the bridge loading errors that are possible in the resistive system when making measurements with precision strain gage 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 12.22:** 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.

## 12.7 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  $\pm 10$  mV to  $\pm 100$  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

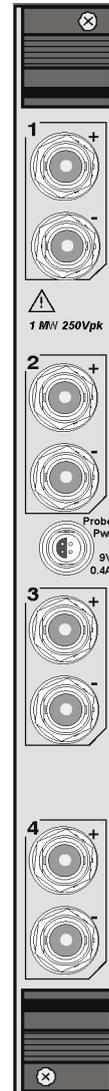
"Current mode", the built-in shunt can be used to measure up to 1 ampere in a safe, isolated and fused manner, without the need of external shunt resistors.

For more information about the Universal amplifier input card, please refer to "B3250-1.0 en (GEN series GN440 and GN441)" on page 476.



**12.8 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 off 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 353.

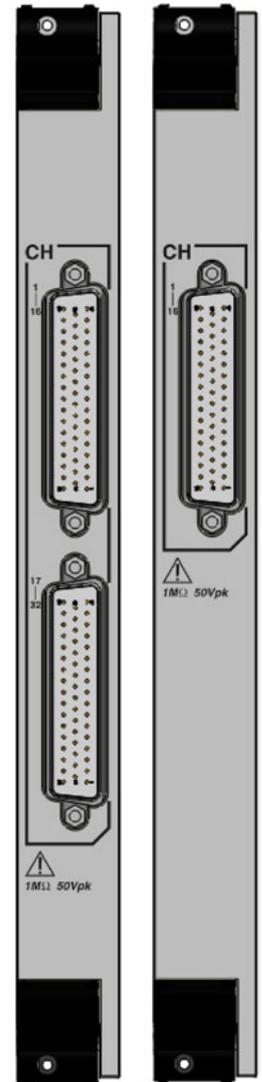
## 12.9 High channel count basic input cards

### 12.9.1 GN1610 and GN3210 IEPE and charge 250 kS/s input cards

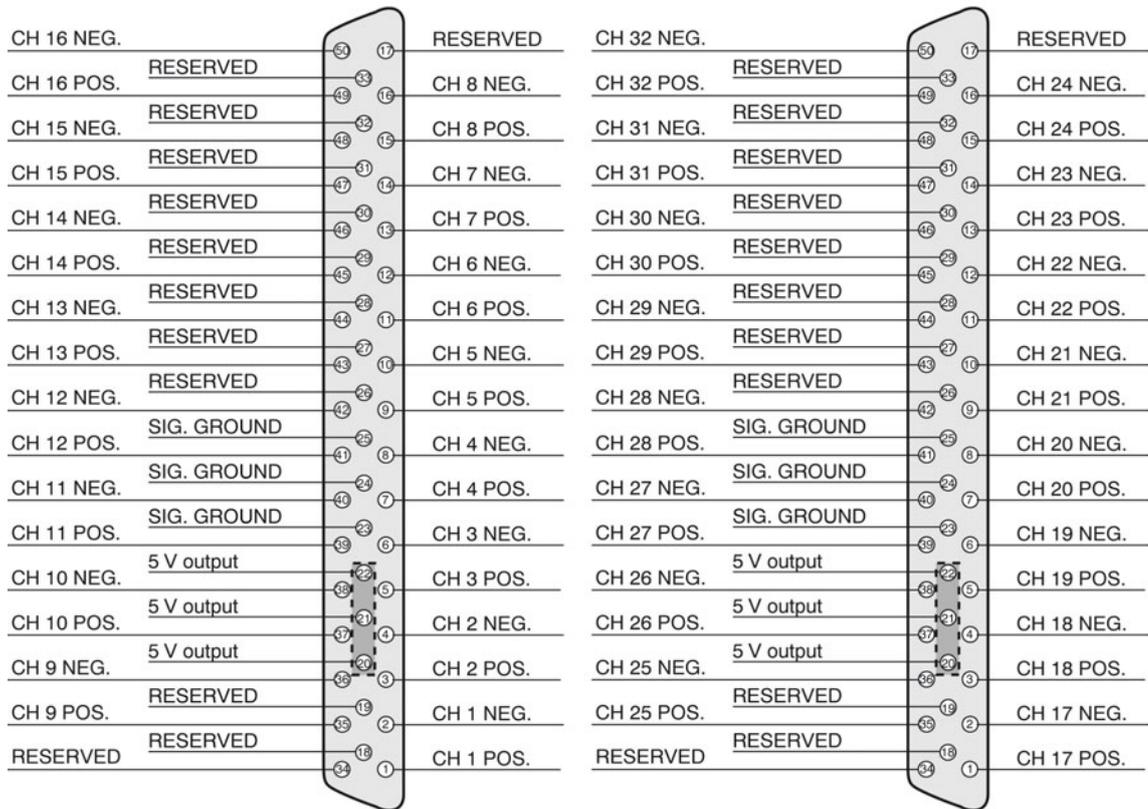
The **GN1610 and GN3210 IEPE and charge 250 kS/s** input cards are a no-compromise solution for high channel count data acquisition systems.

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 to 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.

**Front View**


**Figure 12.23:** 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 479.

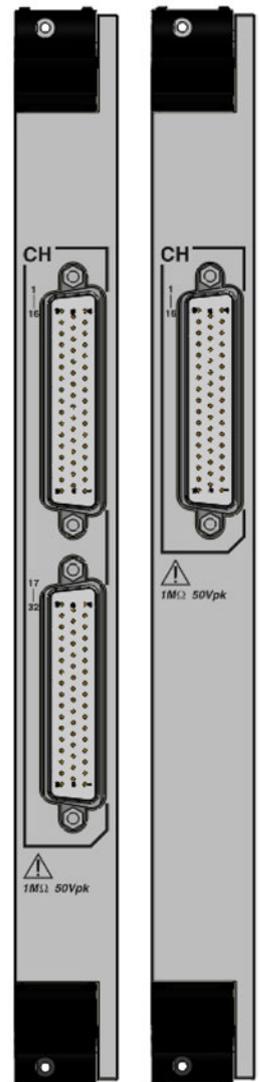
### 12.9.2 GN1611 and GN3211 basic 20 kS/s input cards

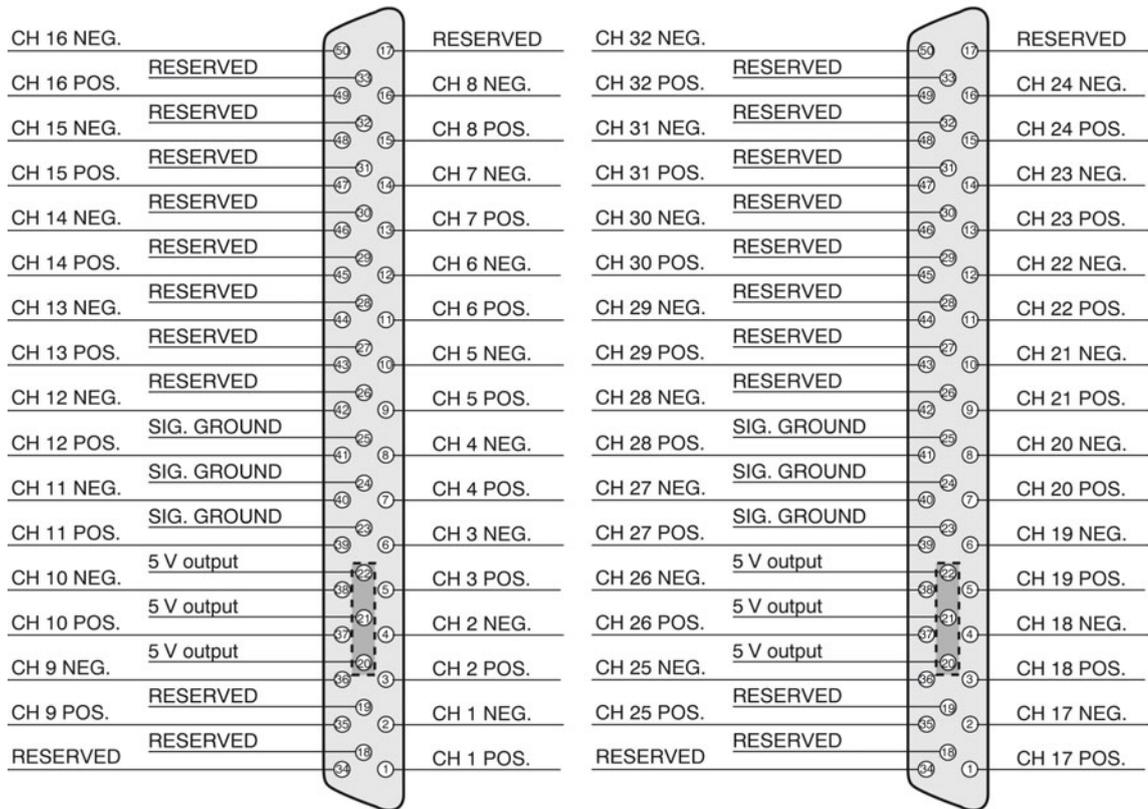
The **GN1611** and **GN3211** basic **20 kS/s** input cards are a no-compromise solution for high-channel-count data acquisition systems.

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 12.24:** 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 487.

### 12.10 GN401 Optical Fiber Isolated 100 MS/s input card

- 4 analog channels/receiver
- Digital fiber optic link
- 2 GB memory
- Calibrated isolated analog output
- Isolated, unbalanced differential inputs
- GN110 and GN111 battery powered transmitter (HV6600)
- GN112 and GN113 continuous power; 1.8 kV RMS CAT II isolation transmitter (MV6600)
- $\pm 50$  mV to  $\pm 100$  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 comprises 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 optical stream any optical drift and error is eliminated. The GN401 receiver records the digital optical information from the GN110, GN111, GN112 and GN113 without the need to convert back to analog first.

The GN401 receiver card therefore eliminates any errors introduced by the digital to analog reconstruction process. 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 hard- or software.

The GN112 and GN113 offer continuous powered isolation at 1.8 kV RMS CAT II 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 331.

## 12.11 Binary marker cards

### 12.11.1 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 496.

### 12.11.2 GN4070 Binary marker HV card

The binary marker HV input board allows you to acquire 32 digital event signals (markers) as well as 8 digital event signals that are optically isolated. Although general purpose, this board 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

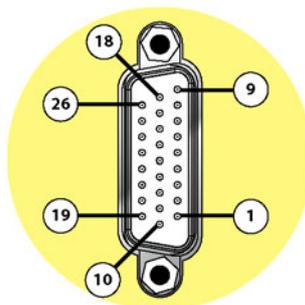
The counter/timer functionality uses up to 3 event bits per channel. These event bits also keep their original functionality. You can, for example, use a quadrature encoder and at the same time look at the quadrature signals separately.

For more information about the Binary Marker HV input card, please refer to "B3246-1.0 en (GEN series GN4070)" on page 492.



### 12.11.3 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 12.25:** Binary marker card connector pinning

*Table 12.5: Event bit (marker) connector pinning*

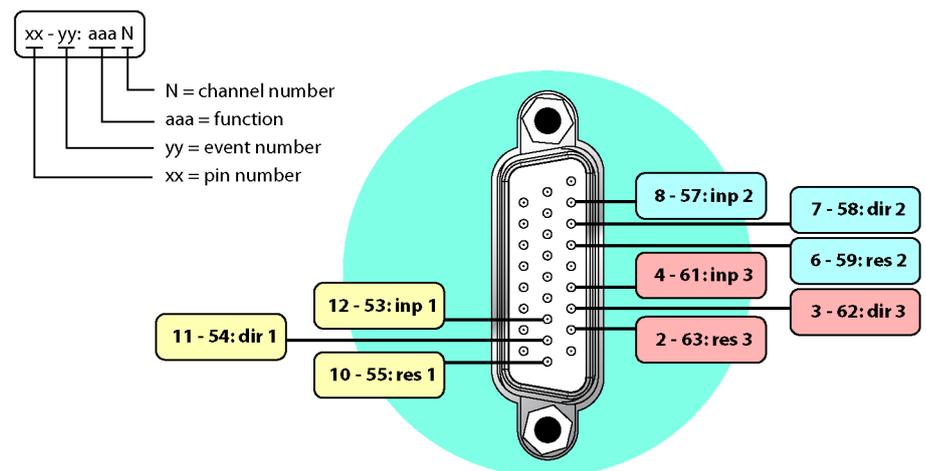
PIN #	EV1-16	EV17-32	EV33-48	EV49-64
1	Event Bit 16	Event Bit 32	Event Bit 48	Event Bit 64
2	Event Bit 15	Event Bit 31	Event Bit 47	Event Bit 63 *
3	Event Bit 14	Event Bit 30	Event Bit 46	Event Bit 62 *
4	Event Bit 13	Event Bit 29	Event Bit 45	Event Bit 61 *
5	Event Bit 12	Event Bit 28	Event Bit 44	Event 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

#### 12.11.4 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 12.26:** Counter pinning layout

*Table 12.6: 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

PIN #	EVENT	COUNTER	FUNCTION
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.

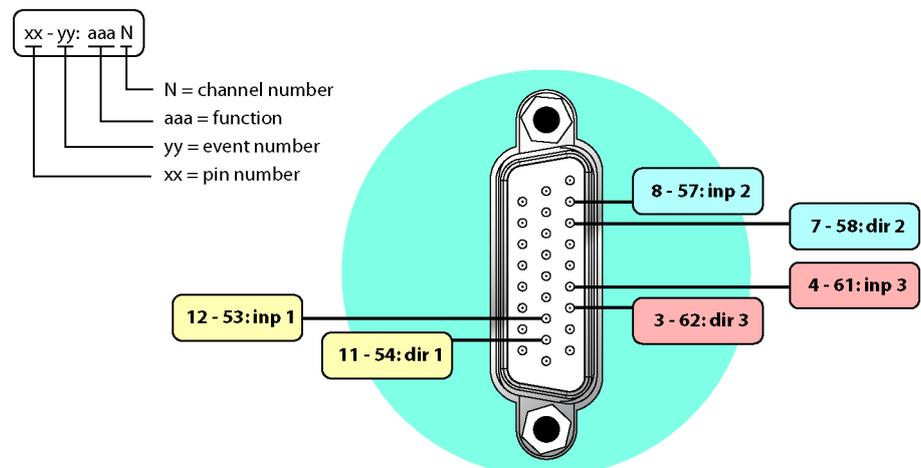
**Direction** The direction signal determines if the counter will be incremented (direction = "0"), or decremented (direction = "1") on each rising edge of the counter input.

**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.

**12.11.5 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 12.27:** Frequency measurement pinning layout

*Table 12.7: Counter bit connector pinning*

<b>PIN #</b>	<b>EVENT</b>	<b>FREQ. CH.</b>	<b>FUNCTION</b>
<b>12</b>	Event Bit 53	1	Counter input
<b>11</b>	Event Bit 54	1	Direction: increment / decrement
<b>10</b>	Event Bit 55	–	Not used
<b>8</b>	Event Bit 57	2	Counter input
<b>7</b>	Event Bit 58	2	Direction: increment / decrement
<b>6</b>	Event Bit 59	–	Not used
<b>4</b>	Event Bit 61	3	Counter input
<b>3</b>	Event Bit 62	3	Direction: increment / decrement
<b>2</b>	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  $\mu$ s, the maximum gate-time is 10 s.

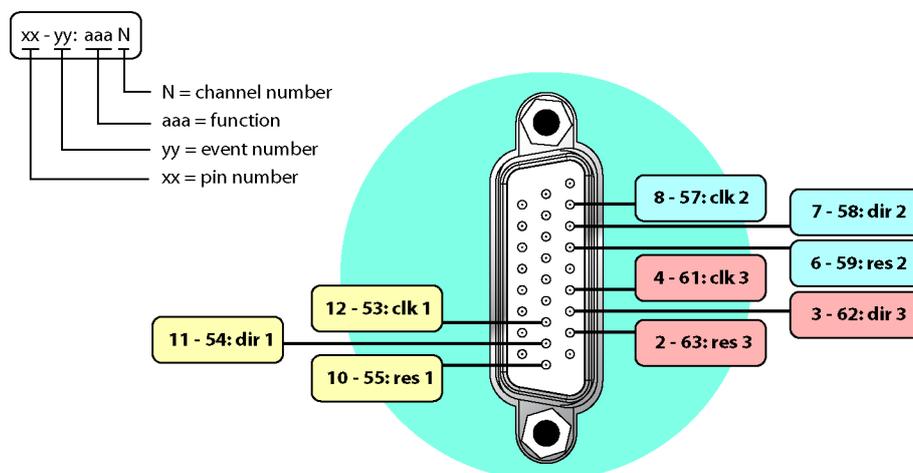
**Counter input** The counter input is the actual signal input. The counter will be incremented on each rising edge of this signal. The maximum input frequency is 10 MHz.

**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.

#### **12.11.6 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 12.28:** Quadrature measurement pinning layout

*Table 12.8: 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.

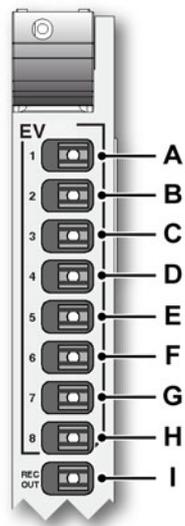
The most common type of incremental encoder uses two output channels (A and B) to sense position. Using two code tracks with sectors positioned 90 degrees out of phase, the two output channels of the quadrature encoder indicate both position and direction of rotation. If A leads B, for example, the disk 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.

#### **12.11.7 GN4070 Connectors and pinning**

The binary marker HV modules come with nine (9) fiber optic connectors (see Figure 12.29) 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.



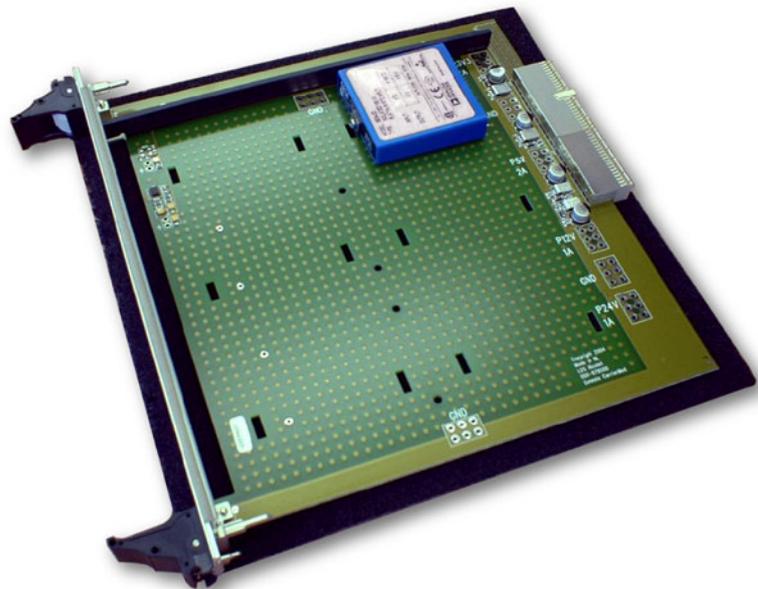
**Figure 12.29:** GN4070 Binary marker HV card (detail)

- 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

## 12.12 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 12.30:** 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 12.31:** 5B module

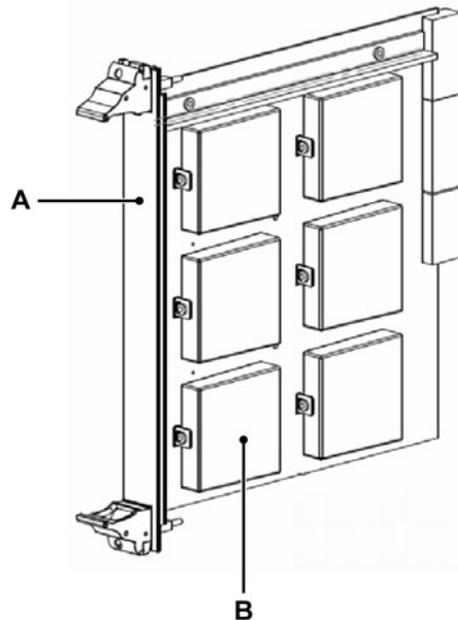
There are several hundred different types of modules available for nearly each and every physical signal.

5B modules are available for signals like:

- Isolated AC and DC
- True RMS
- Current
- Strain gage
- 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 12.32:** 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 customers requirements.
- B** Up to six 5B modules can be mounted on the 5B Integration card.

After signal conditioning, using the made 5B module, the signal is then fed into a standard input channel of any Genesis input card.

### Customization and ordering

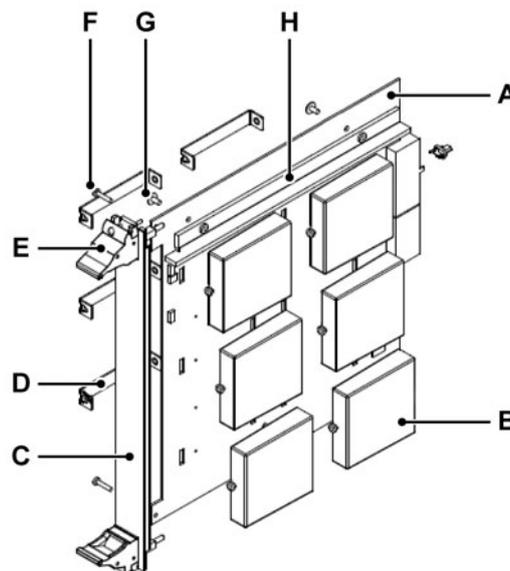
First check whether there are 5B modules available that do the job with respect to their fixed input range and the other limitations. Very often the input range is ok, because the Genesis input cards used behind the 5Bs are offering a 16 bit resolution and therefore most likely high enough resolution 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 12.33:** 5B Integration card components

- A** Genesis 5B Integration card 1x
- B** Signal conditioner module 6x
- C** Execution/Genesis blind single with handle 1x
- D** Bracket/Genesis 5B Carrier Clamp 6x
- E** PAN/Genesis blind single with handle 1x
- F** Screw M2.5x0.45 12Torx 2x
- G** Screw M3x0.5 6ST 2x
- H** 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.

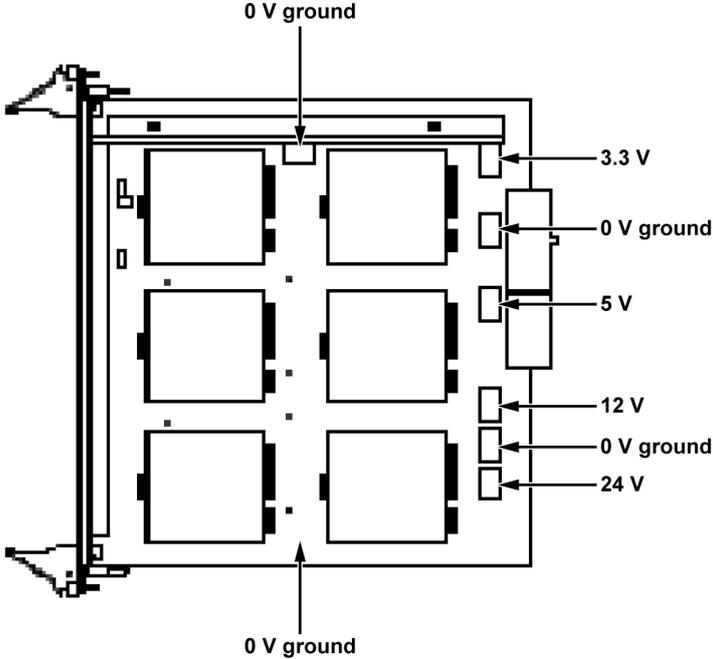
Save this setup as hardware setting and start any future measurements from there.

Input	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 12.34:** 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 Modules	6 (mounting components 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
Microphone input	Signal is amplified and AC coupled to an output. For demo purposes only

**Note** *The card has mounting holes for two Vision demo cards (signal generators). For demo purposes only.*

**Note** *The card alone does not serve any function and must be combined with 5B modules, 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 modules output signal, HBM's Basic module series (GN810, GN811) are most suited for this task. For further help or information on the construction of this board 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. <b>Note</b> <i>5B modules, I/O Connectors and cabling not included. Basic card required for acquisition.</i>	1-G028-2

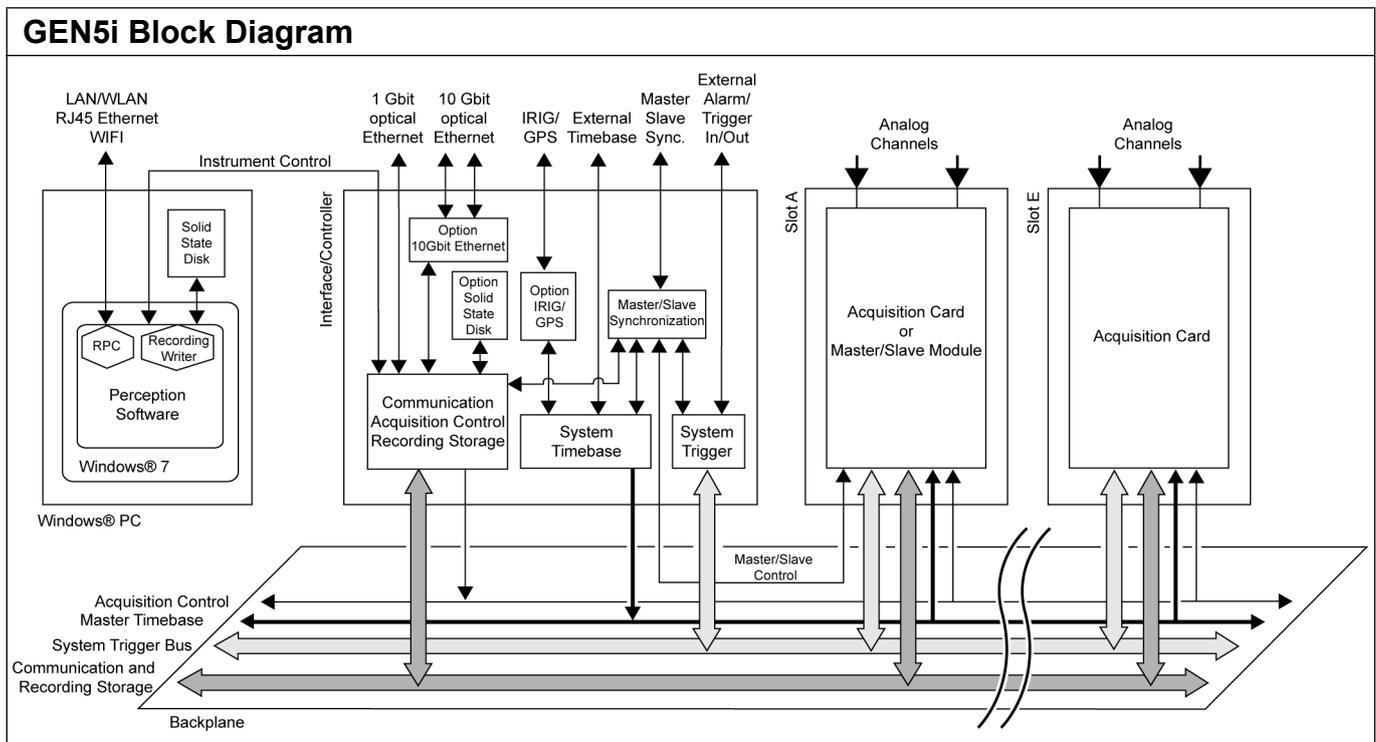
# A Specifications

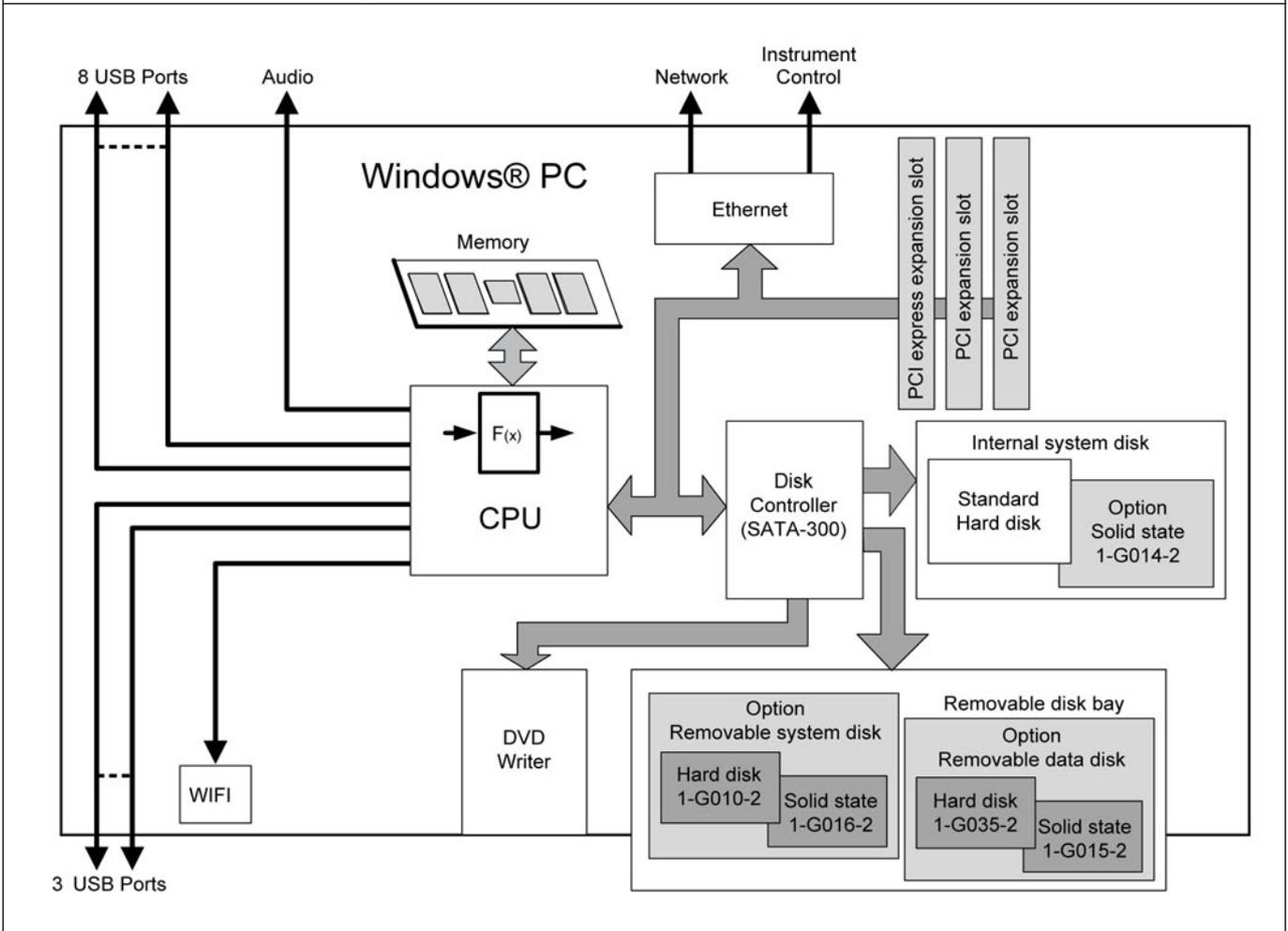
## A.1 B3723-1.0 en (GEN series GEN5i Portable Data Recorder)

- PC integrated mainframe
- Robust and portable
- Five slots for acquisition cards
- Accepts any mix of GEN DAQ acquisition cards
- Up to 160 analog channels
- 50 MB/s continuous streaming rate
- 100 MB/s continuous streaming rate using SSD disk options
- Remote use from external PC
- Perception Enterprise software for advanced review and analysis

The GEN5i is a robust portable transient recorder and data acquisition system and part of the proven GEN DAQ series data acquisition systems. The GEN5i comes with a Core 2 Duo Intel CPU, 4 GB of memory, large, high-resolution TFT screen, full dual monitor support, Windows® 7 Ultimate 64 Bit and Perception Enterprise software for performance based analysis, computing and reporting. The GEN5i has Windows® 7 pre-installed with five different languages; Perception comes with these five plus three more languages pre-installed.

To maximize storage speed, the GEN5i uses a RAID 0 drive setup to guarantee 50 MB/s sustained continuous recording speed. Using solid state disk options increases this speed to 100 MB/s. For more reliable storage the GEN5i supports different storage options ranging from internal RAID 0 solid state disk to replacement of the internal fixed system disk with a fully removable RAID 0 hard disk or solid state disk. Using one of the removable system disk options guarantees enhanced data security, since no classified data will be left behind when the removable system disk has been taken out of the GEN5i.



**Windows® PC Block Diagram**

<b>Windows® PC</b>	
Memory	DDR2 RAM; 4 GB
Processor	Intel Core 2 Duo Desktop E6400, Conroe, 2.13 GHz, 2 MB Cache
Ethernet	RJ45 Ethernet connection; 1 Gbit/s
Instrument Control	RJ45 Ethernet connection dedicated for GEN DAQ communication only. (Access covered by protective housing). Fixed IP address 172.16.10.1
Wireless LAN	Embedded 801.11b/g/n; 54, 100 and 300 Mbit/s <sup>(1)</sup>
USB Connectors	USB 2.0, 8 on back + 3 on front
Internal Storage PC disk	SATA-300; RAID 0 (striping, no redundancy) hard disk 1.5 TB <sup>(2)</sup>
CD/DVD drive	DVD-R/+R (4.7 GB) Read/Write, DVD-R/+R DL (8.5 GB) Read/Write, DVD-RW/+RW (4.7 GB) Read/Write, CD-R/RW Read/Write, CD/DVD-ROM Read
Display	TFT SXGA screen, 17" / 1280x1024 resolution, 16.7 M colors
Video connection	CRT 2048 x 1536 and DVI-D 1600 x 1200
Multiple Monitors Support	Clone mode and extended mode
Speaker/Line Out	Internal speaker/jack plug 3.5 mm
Microphone	Jack plug 3.5 mm
Accessories	USB Keyboard and USB optical mouse TFT protective cover with storage for keyboard and mouse
Expansion cards	2; Full height, half length PCI slots 1; Full height, half length PCIe 4x slot
Front panel buttons	5 recording control buttons; Start/Stop/Pause/Trigger/Single shot

- (1) GEN5i systems shipped before August 2012, only support 801.11b/g; 54 Mbit/s.  
 (2) GEN5i systems shipped before August 2011, are built with smaller drive configurations.

<b>Disk Option Overview</b>							
Disk option	System/data disk	Hard disk/solid state	Removable	Factory installed	RAID 0 striping	Size unformatted	Continuous write speed
Standard	System	HDD	No	Yes	Yes	1.5 TB	50 MB/s
1-G014-2	System	SSD	No	Yes	Yes	600 GB	100 MB/s <sup>(1)</sup>
1-G010-2	System	HDD	Yes	Yes	Yes	640 GB	40 MB/s <sup>(2)</sup>
1-G016-2	System	SSD	Yes	Yes	Yes	600 GB	100 MB/s <sup>(1)</sup>
1-G035-2	Data	HDD	Yes	No	No	320 GB	25 MB/s <sup>(3)</sup>
1-G015-2	Data	SSD	Yes	No	No	300 GB	100 MB/s <sup>(1)</sup>
<b>Combination Overview</b>							
Disk option	Standard system disk	1-G014-2	1-G010-2	1-G016-2	1-G035-2	1-G015-2	
1-G014-2	✗	✗	✗	✗	✓	✓	
1-G010-2	✗	✗	✗	✗	✗	✗	
1-G016-2	✗	✗	✗	✗	✗	✗	
1-G035-2 <sup>(4)</sup>	✓	✓	✗	✗	✓	✓	
1-G015-2 <sup>(4)</sup>	✓	✓	✗	✗	✓	✓	

- (1) Speed limited by Instrument Control transfer speed; Max 50 MB/s for systems shipped before January 2012.  
 (2) Speed limited by removable 2.5" RAID 0 hard disk.  
 (3) Speed limited by removable 2.5" single hard disk.  
 (4) Multiple data disks can be ordered, but only used one at the time.

<b>Software</b>	
DAQ software	Perception Enterprise package. Refer to Perception specification sheet for details.
DAQ Software and Instrument panel languages	English, German, French, Chinese, Japanese, Korean, Russian, Portuguese (Brazilian)
Operating system	Microsoft Windows® 7 Ultimate 64 Bit version

<b>Software</b>	
Operating system installed languages	English, German, French, Chinese, Japanese Other languages can be downloaded and installed using "Windows® Update"

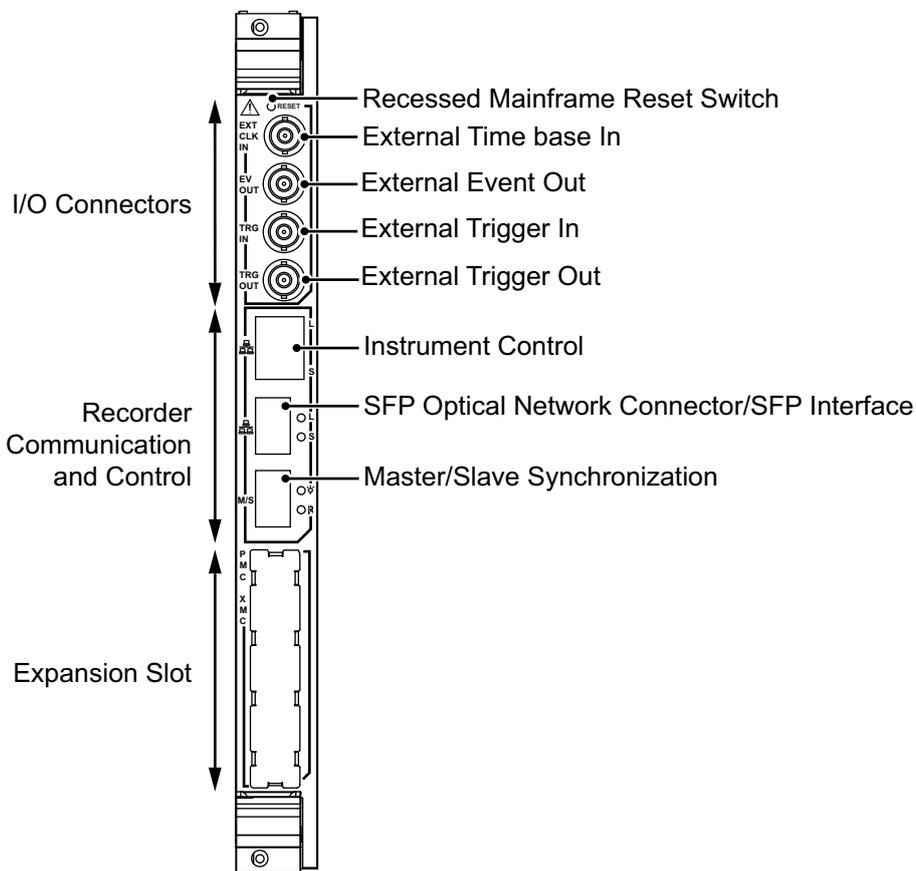
<b>Application Programmers Interfaces (API)</b>	
<b>PNRF reader (free of charge)</b>	
Functions	Read PNRF, NRF and LRF recording files directly in your own application
COM interface	The PNRF reader comes as COM interface and can be used from any application or programming language which supports COM 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
<b>DCE/RPC (Distributed Computing Environment/Remote Procedure Calls)</b>	
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
<b>CSI (Customer Software Interface)</b>	
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
<b>Training/Support Program</b>	
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.	

<b>Acquisition System</b>	
<b>Interface/Controller Module</b> Standard integrated in every GEN5i mainframe; creates central time base and synchronization	
<b>Acquisition Slots</b> Unused slots must be covered using the GEN DAQ blank 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.	
Maximum slots	5
Acquisition boards	All slots support any combination of GEN DAQ Acquisition boards
Master/Slave board	Master/Slave board supported in Slot A only.
Digital Event/Timer/Counter connector	0
Thermal control	Every acquisition board 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.

## Power

Power Inlet	47-63 Hz, 90-264 V AC
Total Power of unit (maximum)	500 VA

### IM2 Interface/Controller Module



Systems shipped before January 2012, are equipped with IM1 Interface/Controller Module.

<b>Recorder Communication and Control</b>	
Network Interface	
Instrument Control	1 Gbit/s, Ethernet (use fixed TCP/IP address: 172.16.5.1, access covered by protective housing)
Optional 1 Gbit/s Ethernet, optical	1 Gbit/s, optical SFP module using LC connector 850 nm optical wavelength, MultiMode fiber cable, 500 m maximum length or 1310 nm optical wavelength, SingleMode fiber cable, 10 km maximum length. Uses dedicated SFP interface
Optional 10 Gbit/s Ethernet, optical	Maximum 2 interfaces of 10 Gbit/s optical SFP+ modules using LC connectors 850 nm optical wavelength, MultiMode fiber cable, 66 m maximum length or 1310 nm optical wavelength, SingleMode fiber cable, 10 km maximum length 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® PCs
Gateway setup	Gateway setup supported for control through VPN and/or Internet
Maximum Transfer Speed	
Instrument Control	50 MB/s; 100 MB/s using solid state disk options <sup>(1)</sup>
1 Gbit/s network to a remote PC	100 MB/s <sup>(1)(3)</sup>
10 Gbit/s network to a remote PC	200 MB/s <sup>(1)(3)</sup>
CPU and Software	
CPU	ATOM based
Operating System	Linux <sup>(2)</sup>

(1) Tested using several combinations of acquisition modules.

(2) Linux GPL open source code can be downloaded from HBM website.

(3) Tested using Windows® 7 PC using Intel i7 CPU and SSD RAID drive with write speeds exceeding 700 MB/s sustained.

<b>Time base and Master/Slave Synchronization</b>	
Central Time base <sup>(1)</sup>	
Accuracy	± 3.5 ppm; aging after 10 years ± 10 ppm <sup>(2)</sup>
Clock base	Binary, Decimal or External
Master/Slave Synchronization	Supported by the optional Master/Slave card 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.

<b>I/O Connectors</b>	
External Time base In	TTL compatible
Pulse width	100 ns min.
Maximum frequency	5 MHz
Active edge	Rising
Rounding resolution	4.01 $\mu$ s; 250 kS/s and 20 kS/s acquisition cards
	1.01 $\mu$ s; 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	$\pm$ 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	$\pm$ 30 V DC
Delay <sup>(1)</sup>	$\pm$ 1 $\mu$ s + 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 $\mu$ s Hold High selected : Active from first trigger to end of recording
Output impedance	50 $\Omega$
Short circuit protected	Continuous
Delay <sup>(1)</sup>	516 $\pm$ 1 $\mu$ s + maximum 1 sample period when Clock base: decimal, Filter: wideband <sup>(2)</sup>
	504 $\pm$ 1 $\mu$ s + maximum 1 sample period when Clock base: binary, Filter: wideband <sup>(2)</sup>
External Event Out	TTL compatible
Function	Selectable Alarm or Recording Active output
Active level	Selectable High/Low for Alarm output Recording active High output
Pulse width	Alarm: Active from start of alarm condition until condition ends Recording: Active until recording stops
Output impedance	50 $\Omega$
Short circuit protected	Continuous
Delay <sup>(1)</sup>	515 $\pm$ 1 $\mu$ s + maximum 1 sample period when Clock base: decimal, Filter: wideband <sup>(2)</sup>
	503 $\pm$ 1 $\mu$ s + maximum 1 sample period when Clock base: binary, Filter: wideband <sup>(2)</sup>

(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.

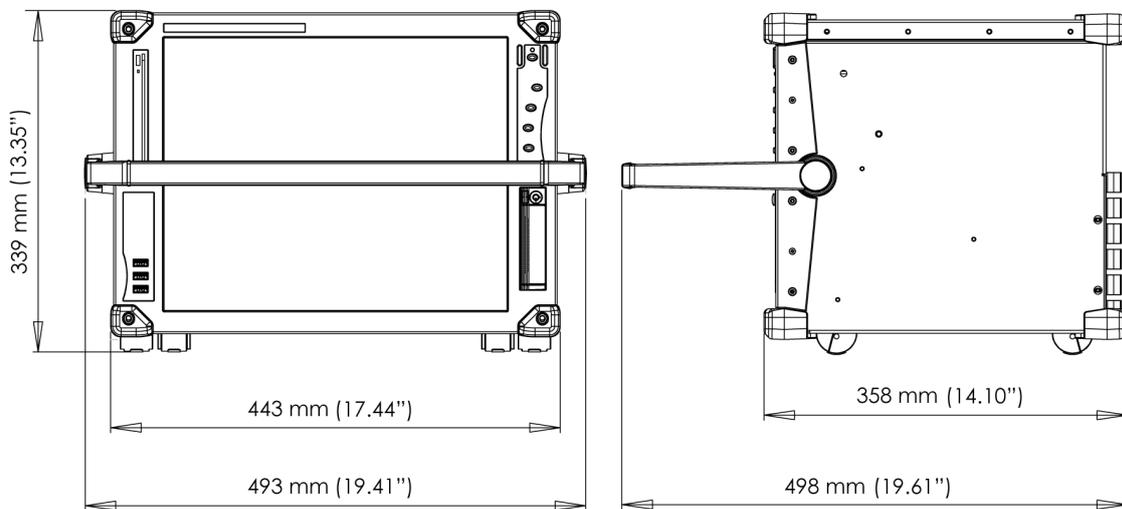
<b>Local Storage options<sup>(1)</sup></b>	
<b>Solid State Disk<sup>(2)</sup></b> Built inside the GEN DAQ series mainframes to optimally secure data storage. Recorded data can be copied to permanent archive using Perception software.	
Size	300 GByte
Maximum continuous storage speed	50 MB/s <sup>(3)</sup> , 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
<b>iSCSI Storage</b> 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 <sup>(3)(4)</sup> , 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 <sup>®</sup> without using 3 <sup>rd</sup> party tools). 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 <sup>®</sup> 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<sup>®</sup> DS212+ and RS3412 using 1 Gbit/s or 10 Gbit/s Ethernet links.

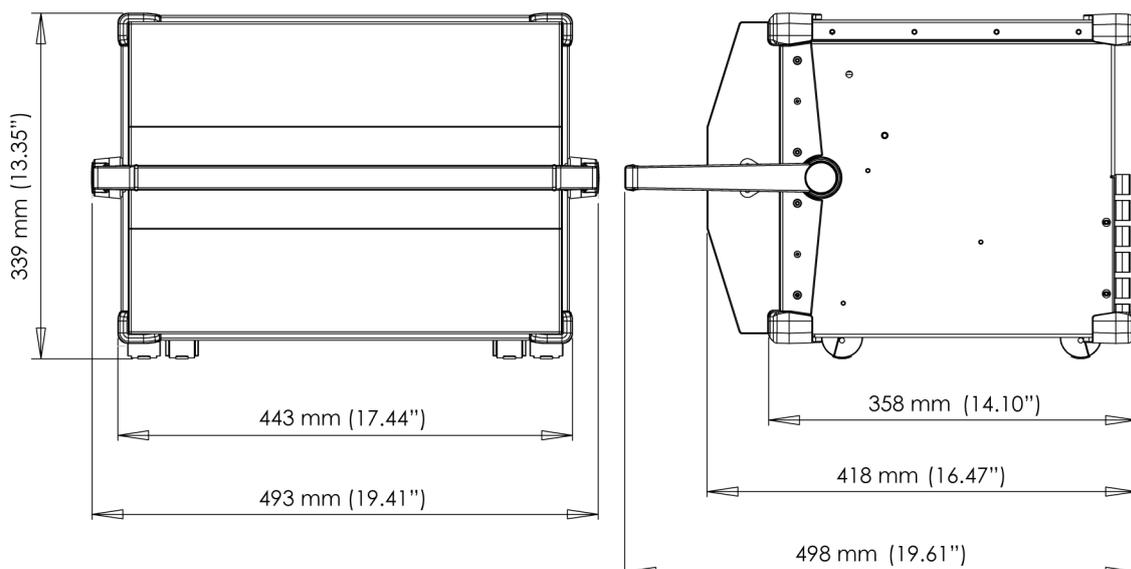
<b>Expansion Slot options (1 slot available)</b>	
IRIG	IRIG A and B, AM modulated or DCLS (DC level shifted)
IRIG/GPS	IRIG A and B, AM modulated or DCLS (DC level shifted) GPS, comes with GPS antenna and 15 m (590") GPS cable (used for time synchronization only)
10 Gbit/s Ethernet	Maximum 2 interfaces of 10 Gbit/s SFP+ modules using LC connectors

### Physical, Weight and Dimensions

Weight	
Mainframe (Maximum including cover)	20 kg (44 lbs), add ≈ 1 kg (2.2 lbs) per acquisition board installed
Dimensions	
Height	339 mm (13.4")
Width/Width including handle	443 mm/493 mm (17.4"/19.4")
Depth/Depth including handle/cover	358 mm/498 mm (14.1"/19.6")
Temperature Sensors	Temperature monitoring and air flow control
Cooling Fans	4
Handle	One carrying handle, also used for higher tilt angles
Tilting Feet	Two retractable feet for small tilt angles
Grounding	Mains and 4 mm Banana plug
Casing	Aluminum/Plastic cover
Soft carry case	Option to be ordered separately; carry case with storage pouches for mouse, keyboard and accessories



**Figure A.1:** Dimensions GEN5i (without cover)



**Figure A.2:** Dimensions GEN5i (with cover)

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 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
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#### EMISSION

EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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); contact discharge $\pm 4$ kV/air discharge $\pm 8$ kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains $\pm 2$ kV using coupling network. Channel $\pm 2$ kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test Mains $\pm 0.5$ kV/ $\pm 1$ kV Line-Line and $\pm 0.5$ kV/ $\pm 1$ kV/ $\pm 2$ kV Line-earth Channel $\pm 0.5$ kV/ $\pm 1$ 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 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 Dips: performance criteria A; Interruptions: performance criteria C

### IRIG, IRIG/GPS (options, to be ordered separately; available Q3 2014)

#### IRIG<sup>(1)</sup>

Supported by IRIG and IRG/GPS option

#### Time Code Translator (Input)

Time Code formats	IRIG A and IRIG B, IEEE 1344 compliant 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  
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<sup>(1)</sup>

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  
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

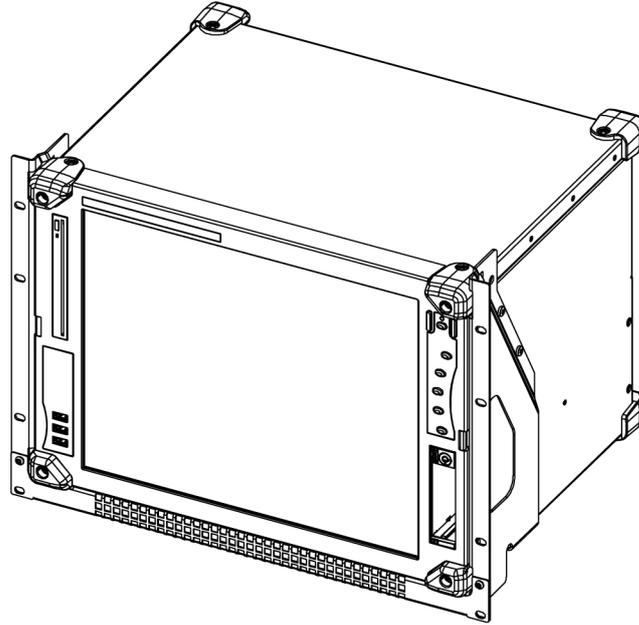
(1) Requires factory installation

<b>Master/Slave Card (option, to be ordered separately)</b>	
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 $\mu$ m) 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	$\pm$ 100 ns
Extended Synchronization <sup>(1)</sup>	
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.

<b>GEN5i Shipping Case (option, to be ordered separately)</b>	
<b>Figure A.3: Hardcover reusable shipment case with wheels and transport handle</b>	
Dimensions	575 mm (22.63") x 444 mm (17.50") x 670 mm (26.37") (H x W x D)
Weight Empty Case	20.3 kg (44.75 lbs)
GEN5i Storage Area	Special area for GEN5i, slides in from the top for easy storage and removal from the shipment case. Protects the GEN5i TFT for impact during drop, shock and vibrations
GEN5i Accessories Area	Separate area for GEN5i keyboard, mouse, power cable and some cables
Reliable Case Transport	Wheels and extendable handle constructed for stable transportation with low gravitation point to avoid tumbling of case in any direction during roll transport
Case Extras	Two lift handles and locks on side of the case for easy transport
Shock and Vibration	Tested with GEN5i inside case according to ASTM D4728 E
Drop Test	Tested with GEN5i inside case according to ASTM D4169-04 Level I

**GEN5i Rack Mount Kit (option, to be ordered separately)**



**Figure A.4:** GEN5i with installed 19-inch brackets

GEN5i Rack Mount Kit

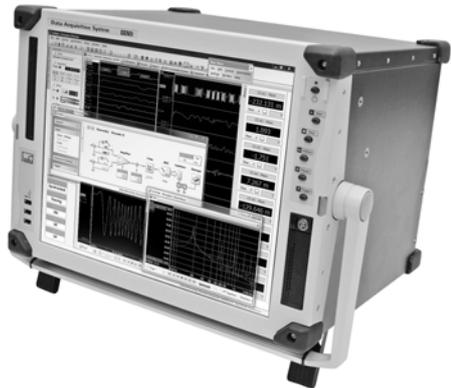
Mounting GEN5i mainframe in a standard 19" rack. Does not support the mouse and keyboard delivered with the GEN5i. Requires no additional mounting materials. User installed option.

<b>Acquisition Cards</b>							
Model	Type	Isolation	Max. SR <sup>(1)</sup>	Resolution	Memory <sup>(2)</sup>	Channels	Event, T/C <sup>(3)</sup>
Basic200k	Single Ended	no	200 kS/s	16 bit	128 MB	8	0, 0
Basic200k XT ISO	Unbalanced Differential	yes	200 kS/s	16 bit	128 MB	8	0, 0
Basic1M	Single Ended	no	1 MS/s	16 bit	256 MB	8	0, 0
Basic1M ISO	Unbalanced Differential	yes	1 MS/s	16 bit	512 MB	8	0, 0
Basic1M XT ISO	Unbalanced Differential	yes	1 MS/s	16 bit	512 MB	8	0, 0
Bridge200k ISO	Bridge/Differential	yes	200 kS/s	16 bit	128 MB	4	0, 0
Bridge1M ISO	Bridge/Differential	yes	1 MS/s	16 bit	512 MB	4	0, 0
Uni200k ISO	Differential/IEPE/Shunt	yes	200 kS/s	16 bit	128 MB	4	0, 0
Uni1M ISO	Differential/IEPE/Shunt	yes	1 MS/s	16 bit	512 MB	4	0, 0
Basic20k-16	Differential	no	20 kS/s	16 bit	200 MB	16	16, 0
Basic20k-32	Differential	no	20 kS/s	16 bit	200 MB	32	16, 0
HiRes250k-16	Differential/IEPE/Charge	no	250 kS/s	16/24 bit	1800 MB	16	16, 2
HiRes250k-32	Differential/IEPE/Charge	no	250 kS/s	16/24 bit	1800 MB	32	16, 2
HiSpeed 25M	Differential/Single Ended	no	25 MS/s	15 bit	128 MB	4	0, 0
HiSpeed 100M	Differential/Single Ended	no	100 MS/s	14 bit	1800 MB	4	0, 0
Fiber100M 6600	Multi Mode Optical Fiber	yes	100 MS/s	...(4)	1800 MB	4 <sup>(4)</sup>	0, 0
Fiber100M 7600	Single Mode Optical Fiber	yes	100 MS/s	...(4)	1800 MB	4 <sup>(4)</sup>	0, 0
Iso1kV200k	Balanced Differential	yes	200 kS/s	16/18 bit	200 MB	6	16, 2
Iso1kV2M	Balanced Differential	yes	2 MS/s	16/18 bit	1800 MB	6	16, 2
Marker1M	Binary	no	1 MS/s	1 bit	512 MB	64	0, 0
Marker1M HV	Optical & Binary	yes & no	1 MS/s	1 bit	512 MB	8 & 32	0, 0

- (1) Maximum Sample Rate/channel (not multiplexed).  
 (2) Total recording memory/card.  
 (3) Digital Events, Timer/Counter channels (Supported by GEN2i Digital Event/Timer/Counter connector only).  
 (4) This card supports a maximum of four optical fiber transmitter channels.

<b>Optical Fiber Transmitter Channels</b>					
<b>Transmitter</b>					
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
HV6600 100M	Fiber100M 6600	Battery	100 MS/s	14 bit	User application defined
HV6600 25M	Fiber100M 6600	Battery	25 MS/s	15 bit	User application defined
MV6600 100M	Fiber100M 6600	120/240 V AC	100 MS/s	14 bit	1800 V RMS
MV6600 25M	Fiber100M 6600	120/240 V AC	25 MS/s	15 bit	1800 V RMS
7600 100M	Fiber100M 7600	External 12 V DC	100 MS/s	14 bit	User application defined

<b>Special Function Cards</b>	
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. 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 gages, frequencies, potentiometers, slide wires and other signals into standardized, isolated analog outputs.

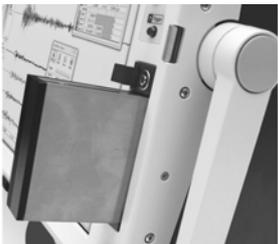
<b>Ordering Information<sup>(1)</sup></b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
GEN5i	 <p>GEN5i rugged, portable data recorder.<sup>(2)</sup> Integrated Instrument, with five acquisitions slots, 50 MB/s streaming rate, integrated PC, Windows® 7 Ultimate, 17 inch TFT, 1.5 TB RAID disk, Mouse, Keyboard, protective front cover with integrated mouse and keyboard storage. Includes Perception Enterprise software package.</p>	1-GEN5i-2

(1) All GEN series systems are intended for exclusive professional and industrial use.

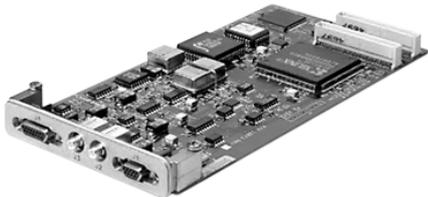
(2) GEN5i ships with keyboard layout in English, German, French, Chinese or Japanese. Specify on order.

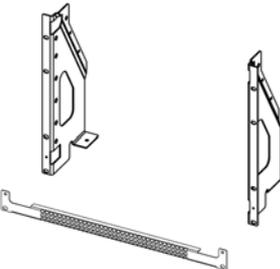
<b>Software Options, to be ordered separately<sup>(1)</sup></b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
CSI Interface	Allows the development of and running CSI programs.	1-PERC-OP-CSI-01-2
RPC/COM	Remote control of Perception, including basic hardware setup and control.	1-PERC-OP-IF-01-2
SEQUENCE	To control BE3200 Test Sequencer from Perception via USB port. 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 TDG data (Test Data Generator) for verification. 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). 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 licenses packages and multiple network license seats.

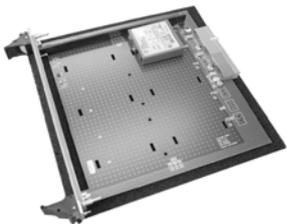
<b>Windows PC Storage options, to be ordered separately</b>			
<b>Article</b>		<b>Description</b>	<b>Order No.</b>
Internal system solid state disk		Factory installed option. Windows® 7 64 Bit preinstalled internal system solid state disk. Replaces internal system hard disk with an internal 2.5" RAID 0 solid state disk. Unformatted capacity 600 GB. Continuous streaming rate 100 MB/s. <sup>(1)</sup> Cannot be combined with options 1-G010-2 and 1-G016-2.	1-G014-2
Removable system hard disk		Factory installed option. Windows® 7 64 Bit preinstalled removable system hard disk. Replaces internal system hard disk with an 2.5" RAID 0 hard disk in the removable bay. Unformatted capacity 640 GB. Continuous streaming rate 40 MB/s. <sup>(1)</sup> Cannot be combined with options 1-G014-2, 1-G016-2, 1-G035-2 and 1-G015-2.	1-G010-2
Removable system solid state disk		Factory installed option. Windows® 7 64 Bit preinstalled removable system solid state disk. Replaces internal system hard disk with a 2.5" RAID 0 solid state disk in the removable bay. Unformatted capacity 600 GB. Continuous streaming rate 100 MB/s. <sup>(1)</sup> Cannot be combined with options 1-G010-2, 1-G014-2, 1-G035-2 and 1-G015-2.	1-G016-2
Removable data hard disk		Removable 2.5" data hard disk mounted in an additional carrier bay. One disk installed per bay. Bays can be exchanged when the disk is not used. Perception can use this disk as standard storage disk. Unformatted capacity 320 GB. Continuous streaming rate 25 MB/s. <sup>(1)</sup> Cannot be combined with options 1-G010-2 and G016-2.	1-G035-2
Removable solid state disk		Removable 2.5" data solid state disk mounted in an additional carrier bay. One disk installed per bay. Bays can be exchanged when the disk is not used. Perception can use this disk as standard storage disk. Unformatted capacity 300 GB. Continuous streaming rate 100 MB/s. <sup>(1)</sup> Cannot be combined with options 1-G010-2 and G016-2.	1-G015-2
PC USB carrier - US			External USB-based carrier; connects removable data drive bay (1-G035-2 or 1-G015-2) to a USB port of a windows PC. Perception software can directly read the stored PNRF files. Comes with US power supply.
PC USB carrier - UK	External USB-based carrier; connects removable data drive bay (1-G035-2 or 1-G015-2) to a USB port of a windows PC. Perception software can directly read the stored PNRF files. Comes with UK power supply.		1-G505-2
PC USB carrier - EU	External USB-based carrier; connects removable data drive bay (1-G035-2 or 1-G015-2) to a USB port of a windows PC. Perception software can directly read the stored PNRF files. Comes with EU power supply.		1-G506-2

(1) Systems shipped before January 2013 use smaller disk size and lower continuous streaming rates.

<b>Options, to be ordered separately</b>			
<b>Article</b>		<b>Description</b>	<b>Order No.</b>
IRIG PMC card		Factory installed option. GEN DAQ IRIG interface fits into open XMC/PMC slot of GEN DAQ Interface/Controller module. Cannot be used in combination with 10 Gbit Ethernet XMC card.	1-G001-1
IRIG/GPS PMC card		Factory installed option. GEN DAQ IRIG/GPS interface fits into open XMC/PMC slot of GEN DAQ Interface/Controller module, comes with antenna and 15 m cable. Cannot be used in combination with 10 Gbit Ethernet XMC card.	1-G002-2
Solid State Disk		Factory installed option. 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. 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. 1 Gbit SFP modules are not compatible with the 10 Gbit SFP+ modules.	1-G063-2
10 Gbit Ethernet XMC card		Factory installed option. 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. 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. 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

<b>Accessories, to be ordered separately</b>			
<b>Article</b>		<b>Description</b>	<b>Order No.</b>
GEN5i Carrying Bag		GEN5i Soft-Sided Carrying Case. Protects the GEN5i from scratches while carrying it around. Slides around the GEN5i with access to the standard carrying handle.	1-G036-2
GEN5i 19 inch rack mount kit		GEN5i rack mount kit (does not include mouse and keyboard mountings). User installed option.	1-G038-2
GEN5i shipping case		GEN5i shipping case, with wheels and handle Tested according to ASTM D4169-04 Level I (drop), and ASTM D4728 E (vibration & shock) Gross weight (empty) 20.3 kg (44.75 lbs).	1-G037-2
Fiber cable standard MM LC-LC		GEN DAQ standard zipcord fiber optic duplex Multi Mode 50/125 $\mu\text{m}$ cable, 3.0 dB/km loss, LC-LC connectors, aqua, ISO/IEC 11801 type OM3. Typically used for fixed cable routing or LAB environments. Lengths 3, 10, 20 and 50 meter (10, 33, 66 and 164 ft)  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 1-KAB280-10 1-KAB280-20 1-KAB280-50
Fiber optic Single Mode standard cable		GEN DAQ standard zipcord fiber optic duplex Single Mode 9/125 $\mu\text{m}$ cable, 0.5 dB/km loss, LC-LC connectors, yellow, ISO/IEC 11801 type OS2. Typically used for fixed cable routing or LAB environments. Lengths 2, 10, 20, 50 and 100 meter (6.5, 33, 66, 164 and 328 ft)  Used with 1310 nm optical 1 Gbit or 10 Gbit Ethernet (1-G063-2 and 1-G066-2).	1-KAB288-2 1-KAB288-10 1-KAB288-20 1-KAB288-50 1-KAB288-100
Fiber optic Single Mode heavy duty cable		GEN DAQ heavy duty fiber optic duplex Single Mode 9/125 $\mu\text{m}$ cable, 0.5 dB/km loss, LC-LC connectors, black, ISO/IEC 11801 type OS2. Typically used for test cell environments. Lengths 10, 20, 50, 100, 150 and 300 meter (33, 66, 164, 328, 492 and 984 ft)  Used with 1310 nm optical 1 Gbit or 10 Gbit Ethernet (1-G063-2 and 1-G066-2).	1-KAB289-10 1-KAB289-20 1-KAB289-50 1-KAB289-100 1-KAB289-150 1-KAB289-300

## Accessories, to be ordered separately

Article		Description	Order No.
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 B2629–2.0 en (GEN series GN401)**

<b>Capabilities Overview</b>	
Receiver model	GN401
Transmitter models	GN110, GN111, GN112 and GN113
Maximum sample rate per channel	100 MS/s (ADC and DAC) 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 1 input per transmitter (GN110, GN111, GN112 or GN113)
ADC resolution	14 bit (ADC and DAC) 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

GN401 Block diagram

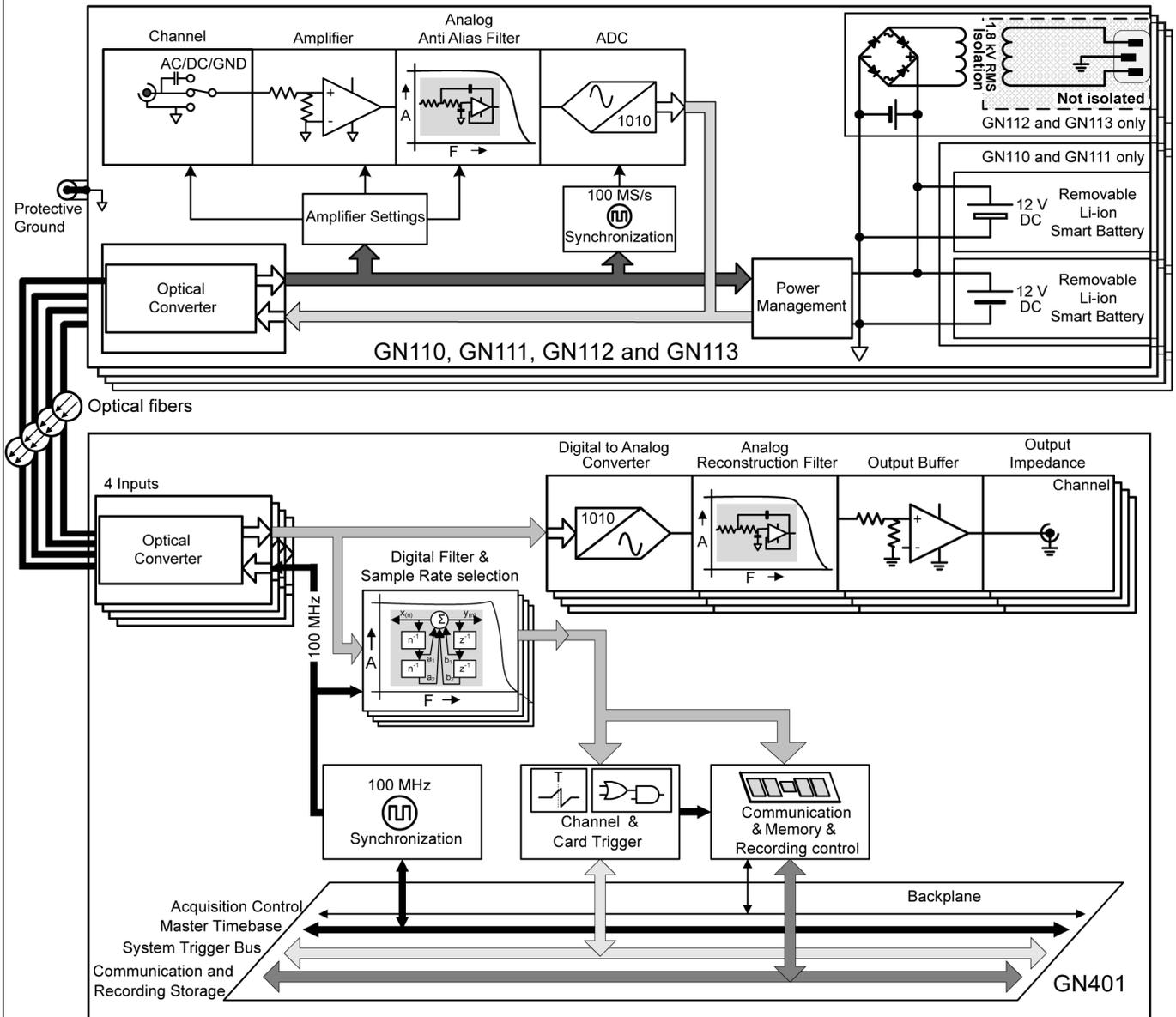
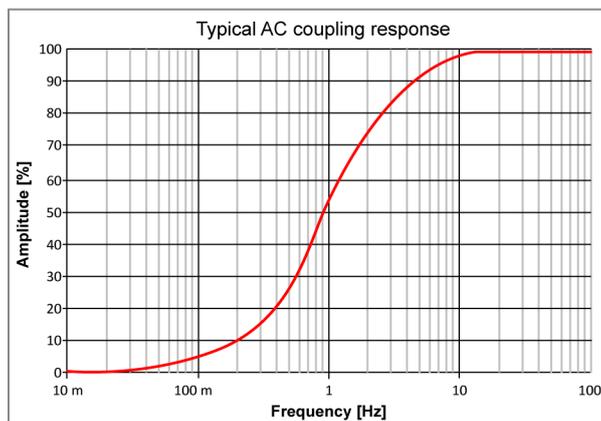


Figure A.5: Block Diagram GN401 with GN110, GN111, GN112 or GN113

**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 ( $\pm 10\%$ ); - 3 dB


**Figure A.6:** Typical AC coupling response

Impedance	1 M $\Omega$ ( $\pm 2\%$ ) // 38 pF ( $\pm 5\%$ )
Ranges	$\pm 20$ mV, $\pm 50$ mV, $\pm 100$ mV, $\pm 200$ mV, $\pm 500$ mV, $\pm 1$ V, $\pm 2$ V, $\pm 5$ V, $\pm 10$ V, $\pm 20$ V, $\pm 50$ V and $\pm 100$ V
Offset	$\pm 50\%$ in 1000 steps (0.1 %) $\pm 100$ V range has fixed 0 % offset
DC Offset error	
Wideband	0.1 % of Full Scale $\pm 50$ $\mu$ V
Bessel filter	0.1 % of Full Scale $\pm 50$ $\mu$ V
Offset error drift	GN110 and GN111: $\pm(60$ ppm + 10 $\mu$ V)/ $^{\circ}$ C ( $\pm(36$ ppm + 6 $\mu$ V)/ $^{\circ}$ F) GN112 and GN113: $\pm(100$ ppm + 10 $\mu$ V)/ $^{\circ}$ C ( $\pm(60$ ppm + 6 $\mu$ V)/ $^{\circ}$ F)
DC Gain error	
Wideband	0.1 % of Full Scale $\pm 50$ $\mu$ V
Bessel filter	0.1 % of Full Scale $\pm 50$ $\mu$ V
Gain error drift	GN110 and GN111: $\pm 100$ ppm/ $^{\circ}$ C ( $\pm 60$ ppm/ $^{\circ}$ F) GN112 and GN113: $\pm(100$ ppm + 10 $\mu$ V)/ $^{\circ}$ C ( $\pm(60$ ppm + 6 $\mu$ V)/ $^{\circ}$ F)
Maximum static error (MSE)	
Wideband	0.1 % of Full Scale $\pm 50$ $\mu$ V
Bessel filter	0.1 % of Full Scale $\pm 50$ $\mu$ V
RMS Noise (50 $\Omega$ terminated)	
Wideband	0.05 % of Full Scale $\pm 100$ $\mu$ V
Bessel filter	0.05 % of Full Scale $\pm 100$ $\mu$ V
Common Mode (referred to ground and protective ground not connected) 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) >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

<b>Analog input GN110, GN111, GN112 and GN113 (Transmitter)</b>	
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	$\pm 125$ V DC; Ranges $< \pm 2$ V $\pm 250$ V DC; Ranges $\geq \pm 2$ V
Overload recovery time	Restored to 0.1 % accuracy in less than 50 ns after 200 % overload Restored to 10 % accuracy in less than 10 ns after 200 % overload

<b>Analog to Digital Conversion</b>	
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: $\pm 3.5$ ppm <sup>(1)</sup> ; aging after 10 years $\pm 10$ 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:  $\pm 30$  ppm

<b>Amplifier Bandwidth and Filtering</b>	
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.

<b>Wideband</b>	
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 <sup>(1)</sup>	0.1 dB; DC to 1 MHz

Wideband

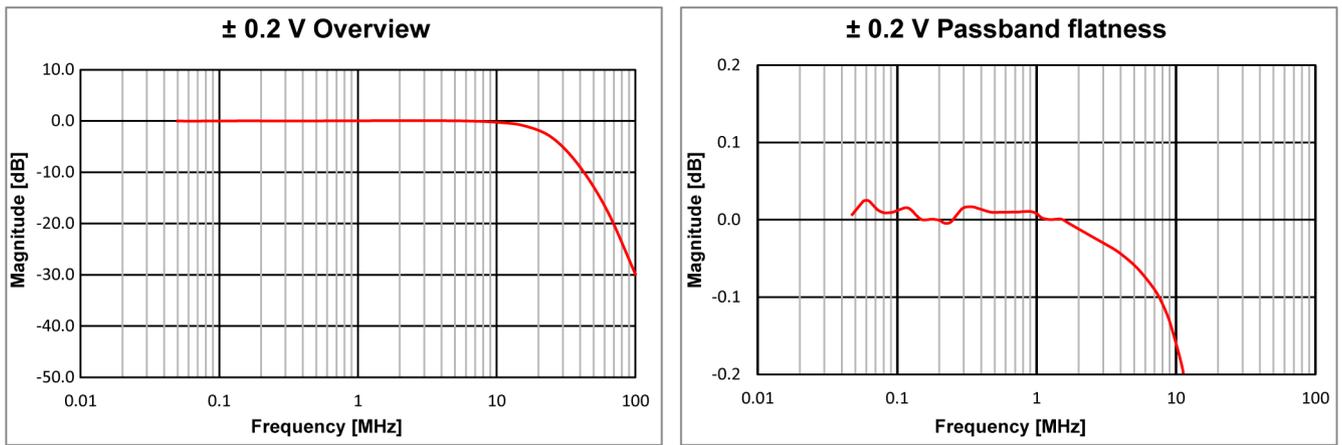


Figure A.7: Typical  $\pm 0.2$  V Wideband overview and passband flatness

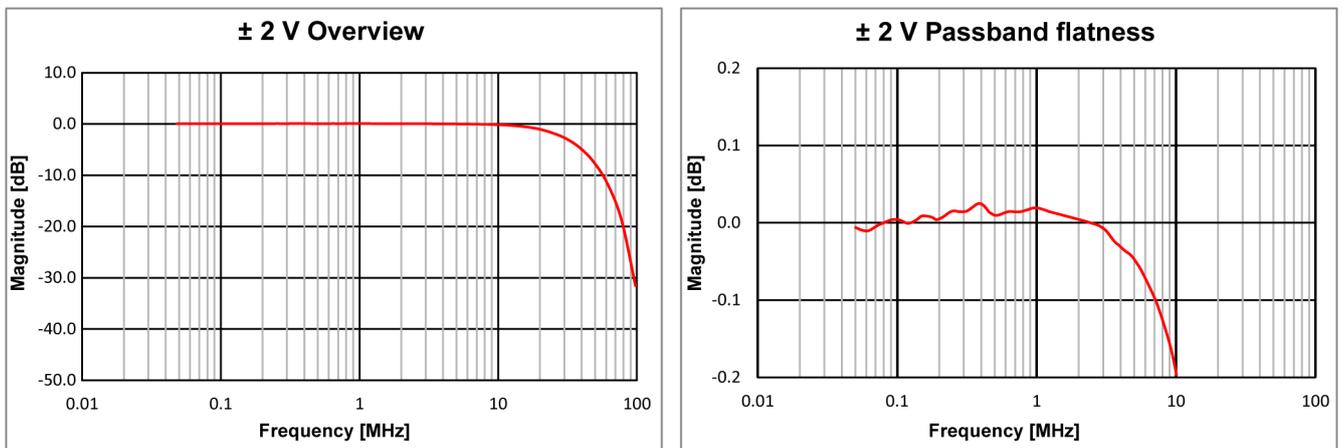


Figure A.8: Typical  $\pm 2$  V Wideband overview and passband flatness

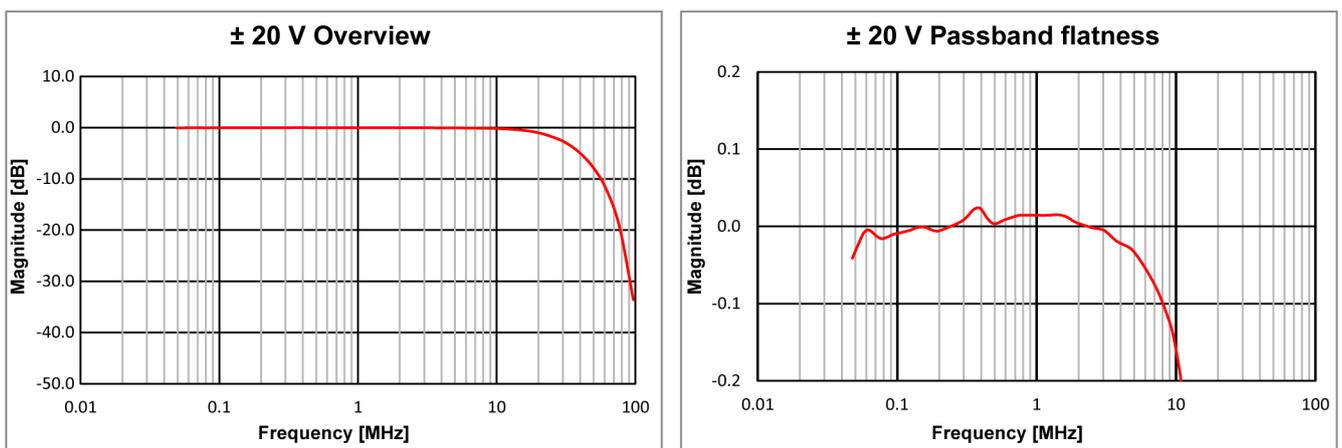
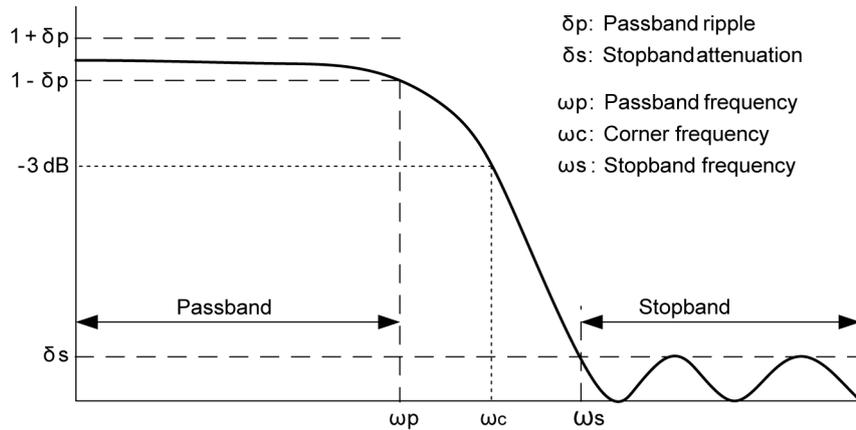


Figure A.9: Typical  $\pm 20$  V Wideband overview and passband flatness

(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 $\pm$ 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 ( $\omega_c$ )	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; Fix bandwidth selections
Bessel IIR passband flatness ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to 1 MHz @ $\omega_c = 5$ MHz
Bessel IIR filter stop band attenuation ( $\delta_s$ )	-60 dB
Bessel IIR filter roll-off	-48 dB/Octave

(1) Measured using Fluke 5700 calibrator, DC normalized

**Bessel and Bessel IIR filter**

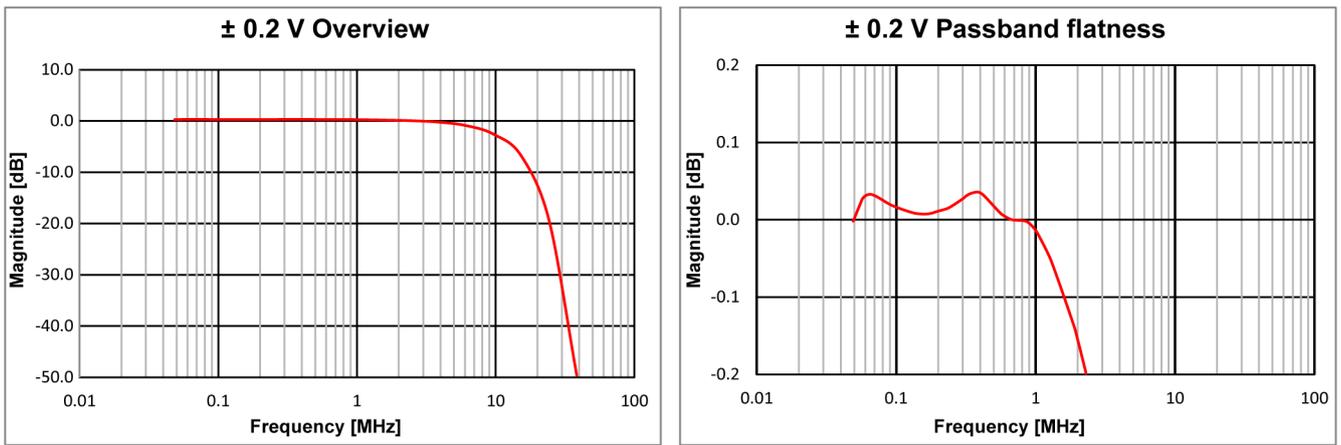


Figure A.11: Typical  $\pm 0.2$  V Bessel 10 MHz overview and passband flatness

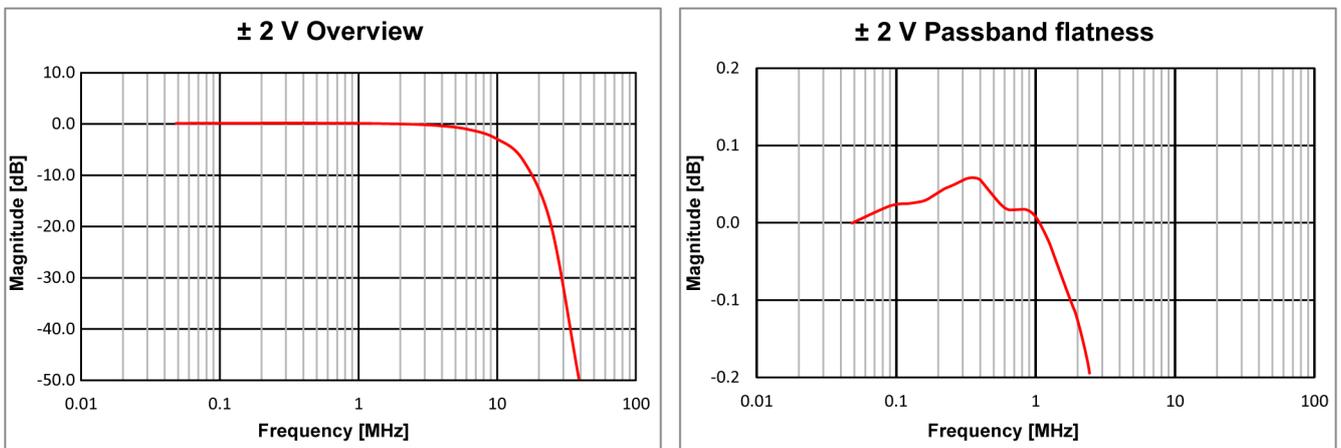


Figure A.12: Typical  $\pm 2$  V Bessel 10 MHz overview and passband flatness

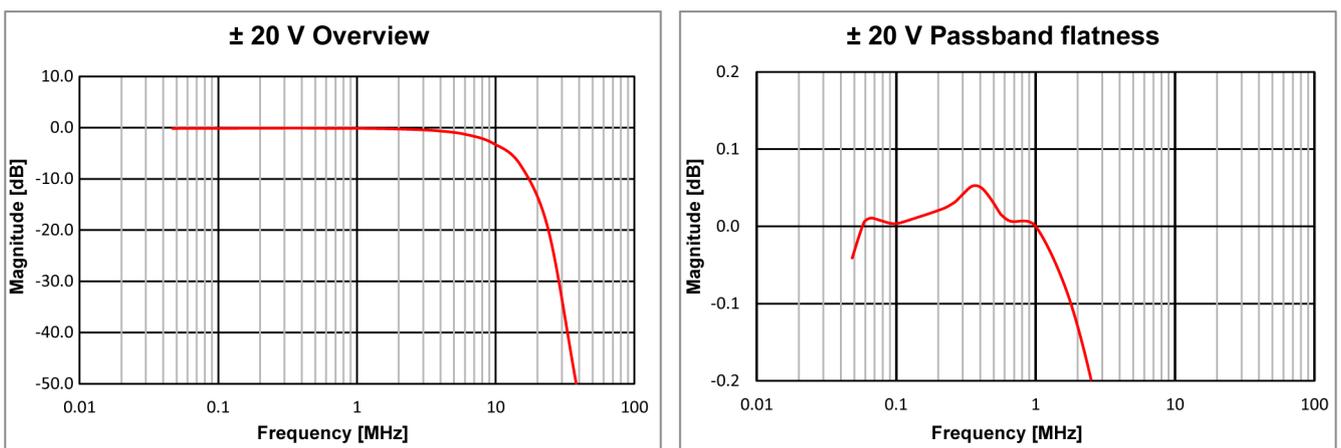


Figure A.13: Typical  $\pm 20$  V Bessel 10 MHz overview and passband flatness

### 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 $\pm 10$ 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	$\pm 1 \mu\text{s}$ + 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 $\mu\text{s}$ Hold high: Active from first mainframe trigger to end of recording Pulse width created by mainframe
Delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
Cross channel triggering	
Channels on card	Logical OR; Analog triggers of all channels Logical AND; Qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
System trigger bus	
Connections	3 System trigger busses connecting all cards within mainframe 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 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

<b>Triggering</b>	
Pulse detect/reject	Disable/Detect/Reject selectable. Maximum pulse width 65 535 samples
dY/dT conversion	dY : 16 bit (0.0015 %) for both levels 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 Maximum holdoff time sample rate dependent
Interval timer	
Modes	Less then, trigger when rate is too low More then, trigger when rate is too high Between, trigger when rate between lower and upper limit 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 1 to 256 trigger events

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

<b>Real-Time Analysis</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

<b>Acquisition Modes</b>	
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.

Acquisition Modes	
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 Multiple Sweeps 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 Maximum 20 MS/s		
Max. continuous streaming rate	not used			20 MS/s 40 MB/s	40 MS/s 80 MB/s	80 MS/s <sup>(1)</sup> 160 MB/s <sup>(1)</sup>	20 MS/s 40 MB/s	40 MS/s 80 MB/s	80 MS/s <sup>(1)</sup> 160 MB/s <sup>(1)</sup>

(1) Requires a mainframe able to continuously stream this data. At time of release of this specification only GEN3i mainframes can do this.

Single Sweep	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 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 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

<b>Multiple Sweeps</b>	
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 trigger occurs.

<b>Slow Fast Sweep</b>	
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

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.

<b>Dual</b>	
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

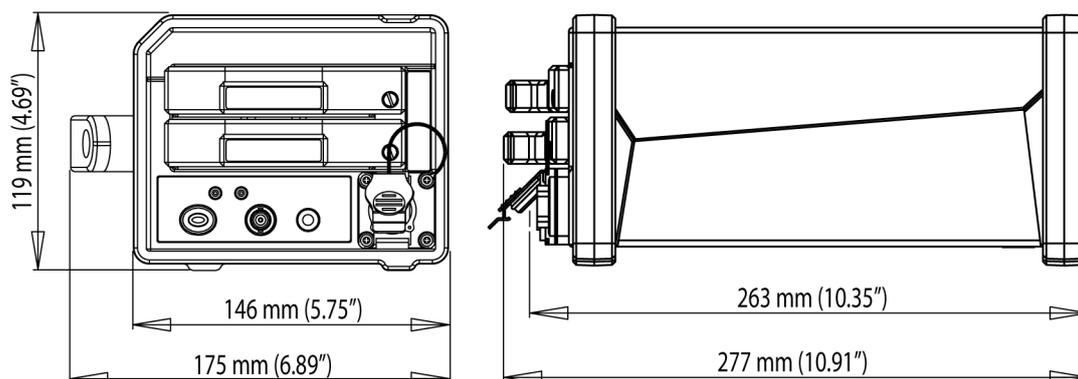
<b>Fiber optic link</b>	
Light source	Class 1 laser product
Transfer rate	2 Gbit/s
Wavelength	850 nm
Connector	LC duplex on GN401 SCRJ/IP67 duplex on GN110, GN111, GN112 and GN113
Cable	
Isolation	10 <sup>15</sup> Ω/m
Maximum length	800 m (26245 ft); using ISO/IEC 11801 type OM2, OM3 or OM4 cable and no extra couplers. 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

<b>Analog output GN401 (receiver)</b>	
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 <sup>th</sup> order Bessel reconstruction filter
Output impedance	13 Ω typical
Calibrated full scale Output level	± 5 V; 1 MΩ load

<b>Power requirement GN110 and GN111 (transmitter)</b>	
Battery	11.1 V @ 6600 mAh, removable, rechargeable, Li-ion 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)

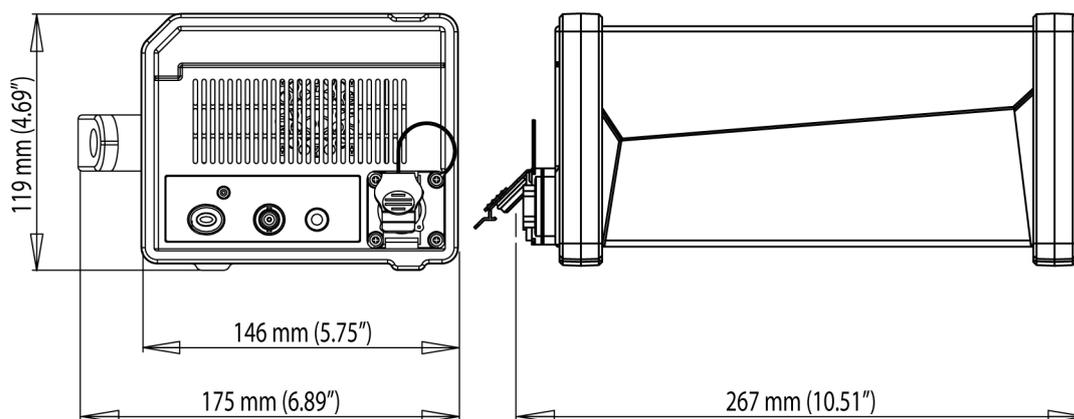
<b>Power requirement GN112 and GN113 (transmitter)</b>	
Power supply	115/230 V AC @ 47 - 63 Hz (Manual voltage selector)
Power consumption	12 VA maximum
Power supply isolation	
Protective ground connected	0 V, both sides grounded
Protective ground not connected	1.8 kV RMS (IEC 61010-1:2010) Requires 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)

<b>Physical, Weight and Dimensions GN110 and GN111</b>	
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

<b>Physical, Weight and Dimensions GN112 and GN113</b>	
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

**Physical, Weight and Dimensions GN112 and GN113**


**Figure A.15:** Dimensions GN112 and GN113 transmitter

<b>Environmental Specifications</b>	
Temperature Range	
Operational	GN110 and GN111: -15 °C to +50 °C (+5 °F to +122 °F) GN112 and GN113: 0 °C to +40 °C (+32 °F to +104 °F) 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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 6 Cycles, cycle duration 24 hours

<b>Harmonized standards for CE compliance, according to the following directives</b>	
Low voltage directive (LVD): 2006/95/EC Electromagnetic compatibility directive (EMC): 2004/108/EC	
<b>Electrical Safety</b>	
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
<b>Electromagnetic Compatibility</b>	
EN 61326-1 (2006)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
<b>EMISSION</b>	
EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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
<b>IMMUNITY</b>	
EN 61000-4-2	Electrostatic discharge immunity test (ESD); contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test 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 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 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

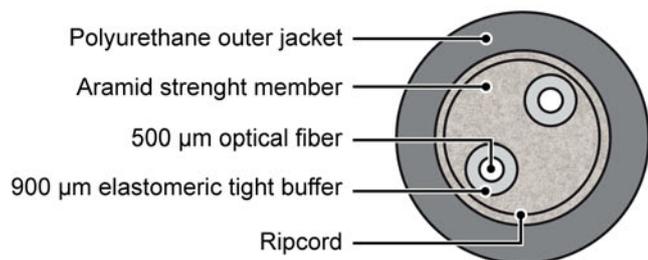
Smart battery support	SmBus Level 3
Maximum charge current	3 A, or limited by smart battery
Battery recalibration	SmBus 1.2 A @ 12 V
Charge strategy	Parallel for two batteries. Ten bay charges two batteries parallel then next two batteries etc.



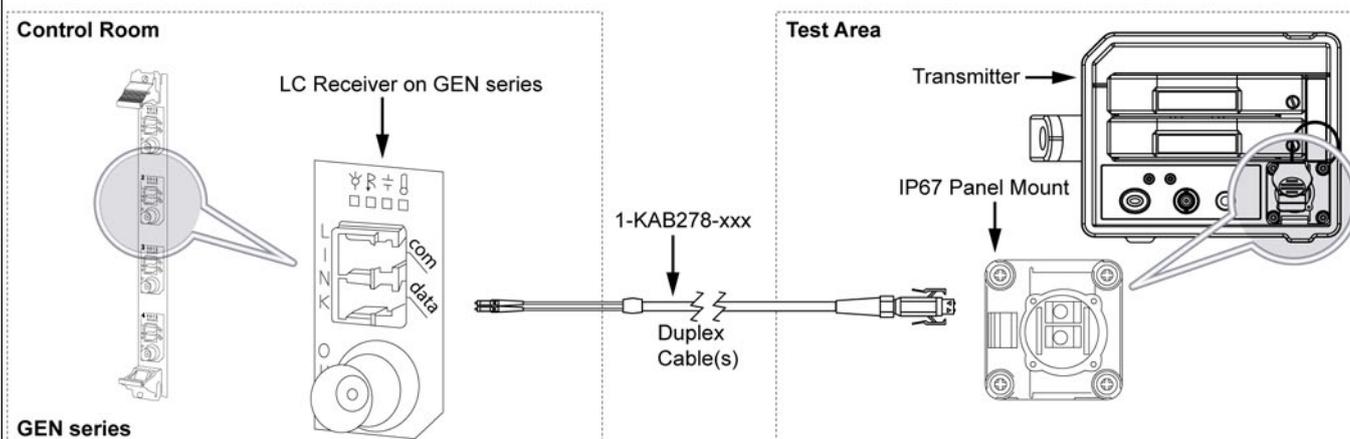
**Figure A.17:** Ten (Left) and Two (right) bay Li-ion chargers

**Fiber cables (option, to be ordered separately)**

Heavy duty fiber optic duplex cable (1-KAB278-xxx)

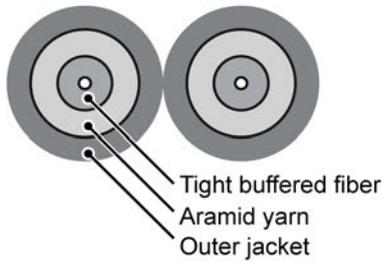


Connector type	LC - SCRJ/IP67
Glass rating	OM2; Multi Mode
Core/Cladding diameter	50/125 μm
Jacket size	6 mm (0.24")
Jacket rating	Polyurethane, halogen free, non-corrosive
Jacket coating	High chemical resistance against acids/alkalis
Attenuation	≤ 2.7 dB/km @ 850 nm
Available lengths	10, 20, 50, 100, 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)

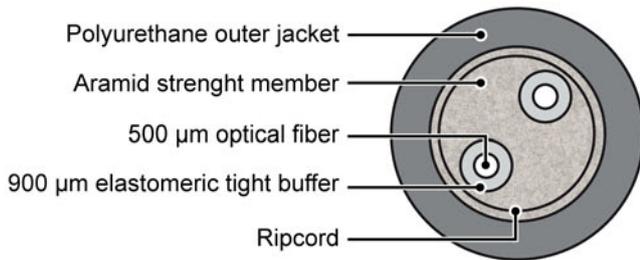
**Fiber cables (option, to be ordered separately)**

Standard fiber optic duplex cable (1-KAB277-xxx)



Connector type	LC - SCRJ
Glass rating	OM2; Multi Mode
Core/Cladding diameter	50/125 $\mu\text{m}$
Jacket size	2 mm (0.08")
Jacket rating	Low-smoke zero-halogen
Attenuation	$\leq 2.7$ 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

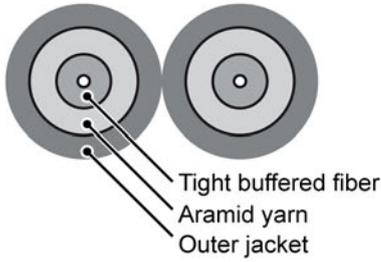
Heavy duty fiber optic duplex patch cable (1-KAB279-xxx)



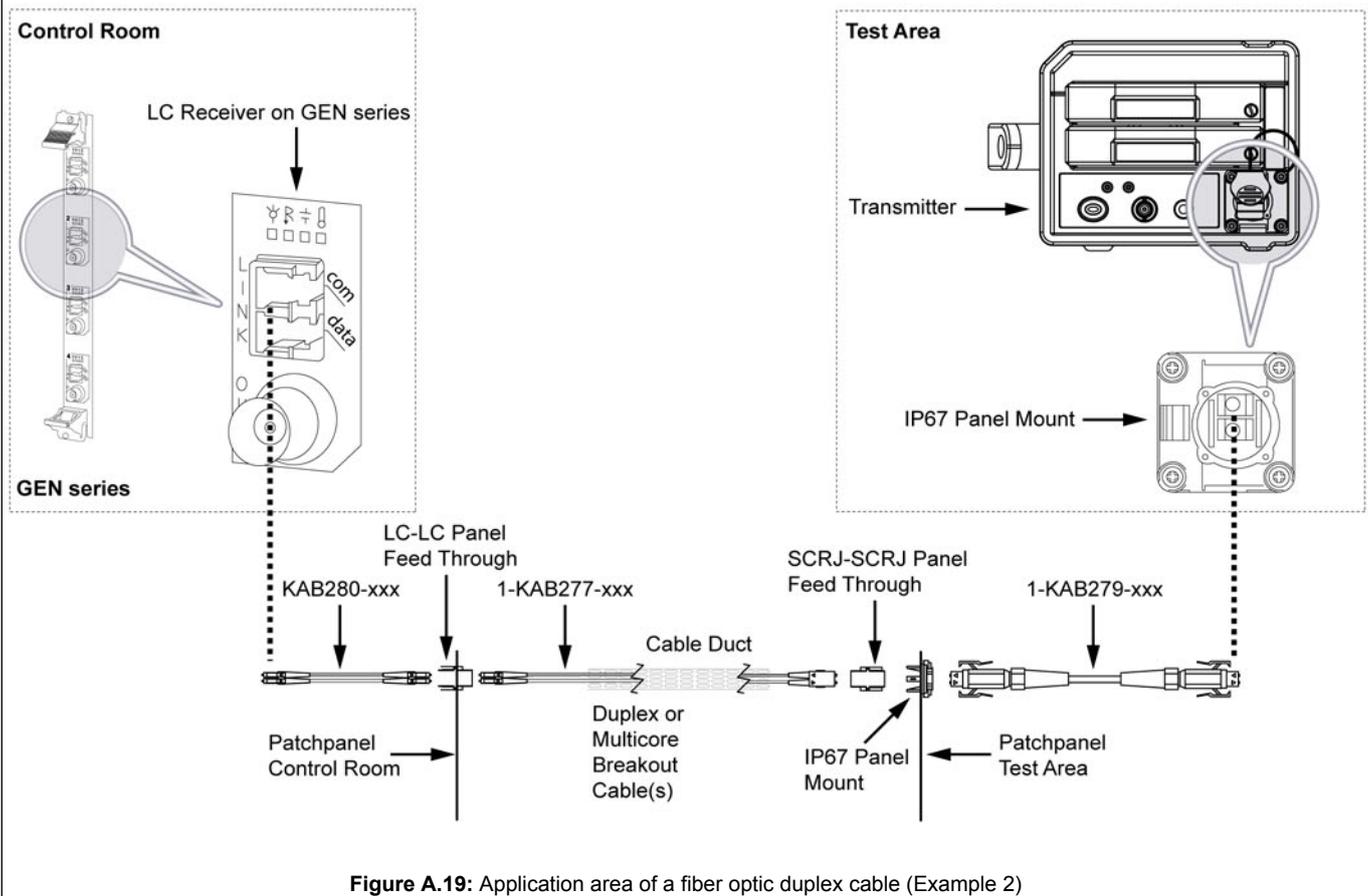
Connector type	SCRJ/IP67 - SCRJ/IP67
Glass rating	OM2; Multi Mode
Core/Cladding diameter	50/125 $\mu\text{m}$
Jacket size	6 mm (0.24")
Jacket rating	Polyuerthane, halogen free, non-corrosive
Jacket coating	High chemical resistance against acids/alkalis
Attenuation	$\leq 2.7$ dB/km @ 850 nm
Available 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 $\mu$ m
Jacket size	2 mm (0.08")
Jacket rating	Low-smoke zero-halogen
Attenuation	$\leq 2.7$ 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



Ordering information <sup>(1)</sup>			
Article		Description	Order No.
GN110 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 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 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 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 4 ch Receiver		GN401 optical isolated receiver, 4 channels, 4 x LC in, 4 x BNC out, 2 GB memory  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.

<b>Accessories, to be ordered separately</b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
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 $\mu$ m cable, 3.0 dB/km loss, LC-SCRJ connectors, orange, ISO/IEC 11801 type OM2. Typically used for fixed cable routing or LAB environments. Lengths 10, 20, 50 and 100 meter (33, 66, 164 and 328 ft)	1-KAB277-10 1-KAB277-20 1-KAB277-50 1-KAB277-100
Fiber cable heavy duty MM LC-SCRJ 	GEN DAQ heavy duty fiber optic duplex Multi Mode 50/125 $\mu$ m cable, 3.0 dB/km loss, LC-SCRJ/IP67 connectors, orange, ISO/IEC 11801 type OM2. Typically used for test cell environments. Lengths 10, 20, 50, 100, 150 and 300 meter (33, 66, 164, 328, 492 and 984 ft)	1-KAB278-10 1-KAB278-20 1-KAB278-50 1-KAB278-100 1-KAB278-150 1-KAB278-300
Fiber cable heavy duty MM SCRJ-SCRJ 	GEN DAQ heavy duty fiber optic duplex Multi Mode 50/125 $\mu$ m 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. Lengths 20 and 50 meter (66, 164 ft)	1-KAB279-20 1-KAB279-50
Fiber cable standard MM LC-LC 	GEN DAQ standard zipcord fiber optic duplex Multi Mode 50/125 $\mu$ m cable, 3.0 dB/km loss, LC-LC connectors, aqua, ISO/IEC 11801 type OM3. Typically used for fixed cable routing or LAB environments. Lengths 3, 10, 20 and 50 meter (10, 33, 66 and 164 ft)	1-KAB280-3 1-KAB280-10 1-KAB280-20 1-KAB280-50

**Note** Other fiber cable lengths can be ordered through special projects team.

**A.3 B3248-1.0 en (GEN series GN412 and GN413)**

<b>Capabilities Overview</b>		
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	

<b>General Specifications</b>			
<b>Analog Input Section</b>			
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 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 <sup>(1)</sup>		10 MHz @ -3 dB	25 MHz @ -3 dB
Rise time <sup>(1)</sup>	@ 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 V <sub>peak</sub>	
	For ranges ≥ ± 20 V	250 V <sub>peak</sub>	
	For all other ranges	40 V <sub>peak</sub>	
Overload protection	Peak protected	250 V <sub>peak</sub>	

(1) Analog bandwidth specifications. Values will differ when the digital IIR filter is used at the same time.

<b>Analog to Digital Conversion</b>		
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 $\leq 10$ 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 5 MHz to 50 kHz	

<b>On-board Memory</b>		
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 (with all 4 channels used)	16 MS (64 MS)	100 MS (400 MS)

<b>Triggering</b>		
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
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

**Real-time Analysis**

Component	Description
StatStream <sup>®</sup>	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		<b>Diff 25MS, 128M</b> 4 channel 25 MS/s Diff HighSpeed Digitizer, 128 MB RAM (16 MS/ch), 15 bit
Fast differential 100M		4 channel 100 MS/s Diff HighSpeed Digitizer, 1800 MB RAM (225 MS/ch), 14 bit Digitizer

**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.4 B3618-3.0 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
Digital Event/Timer/Counter support	Yes
Isolation	Yes; channel to channel and channel to chassis
Input type	Analog isolated balanced differential <sup>(1)</sup>
Real time calculations	Yes; Automatic zero crossing detection with calculations of Cycle and Cycle Frequency, RMS, Mean, Minimum, Maximum, Peak to Peak, Area and Energy. All calculations can be used to trigger the recording.

(1) No probes supported

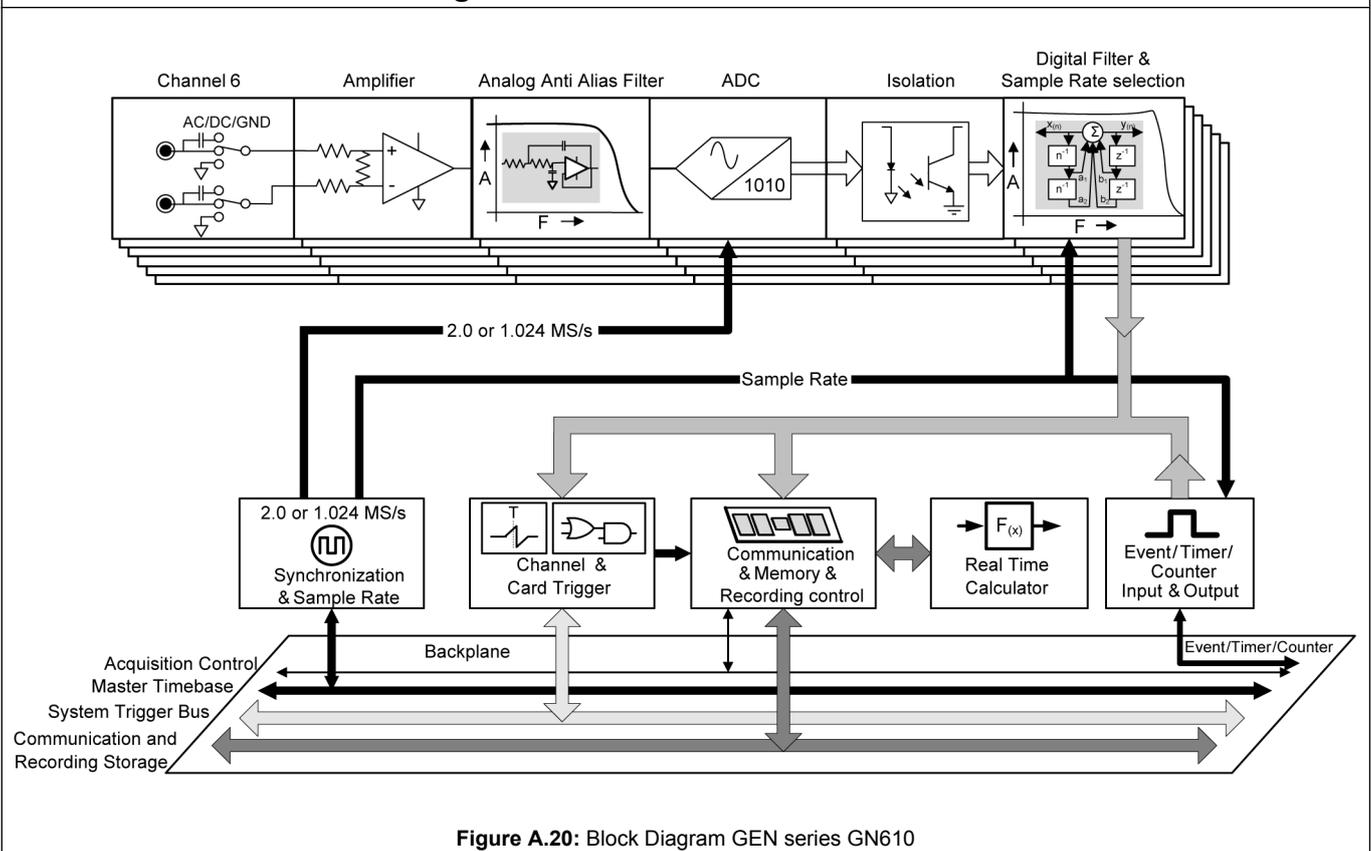
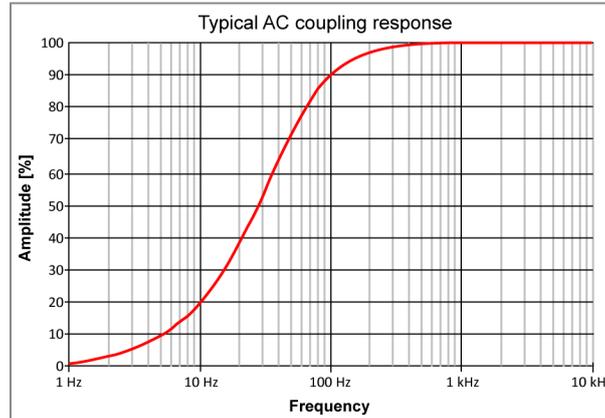
**GEN series GN610 Block diagram**


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 $\pm$ 5 Hz (-3 dB)



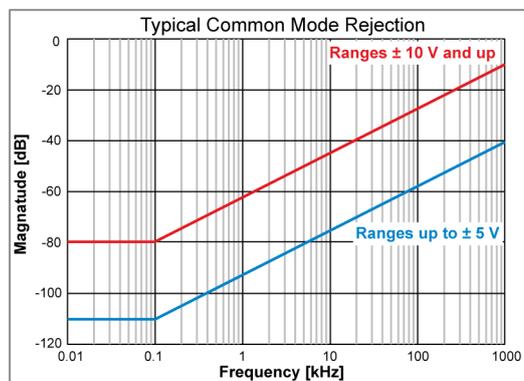
**Figure A.21:** Typical AC coupling response

Impedance	$2 * 1 \text{ M}\Omega \pm 1 \% // 33 \text{ pF} \pm 10\%$ ranges larger than $\pm 5 \text{ V}$ . All other ranges $57 \text{ pF} \pm 10\%$	
Ranges	$\pm 20 \text{ mV}$ , $\pm 50 \text{ mV}$ , $\pm 0.1 \text{ V}$ , $\pm 0.2 \text{ V}$ , $\pm 0.5 \text{ V}$ , $\pm 1 \text{ V}$ , $\pm 2 \text{ V}$ , $\pm 5 \text{ V}$ , $\pm 10 \text{ V}$ , $\pm 20 \text{ V}$ , $\pm 50 \text{ V}$ , $\pm 100 \text{ V}$ , $\pm 200 \text{ V}$ , $\pm 500 \text{ V}$ , $\pm 1000 \text{ V}$	
Offset	$\pm 50 \%$ in 1000 steps (0.1 %); $\pm 1000 \text{ V}$ range has fixed 0 % offset	
DC Offset error		
Wideband	0.02 % of Full Scale $\pm 400 \mu\text{V}$	
All IIR filters	0.02 % of Full Scale $\pm 10 \mu\text{V}$	
Offset error drift	$\pm(20 \text{ ppm} + 10 \mu\text{V})/^{\circ}\text{C}$ ( $\pm(12 \text{ ppm} + 6 \mu\text{V})/^{\circ}\text{F}$ )	
DC Gain error		
Wideband	0.1 % of Full Scale $\pm 20 \mu\text{V}$	
All IIR filters	0.1 % of Full Scale $\pm 10 \mu\text{V}$	
Gain error drift	$\pm 30 \text{ ppm}/^{\circ}\text{C}$ ( $\pm 17 \text{ ppm}/^{\circ}\text{F}$ )	
Maximum static error (MSE)		
Wideband	0.075 % of Full Scale $\pm 400 \mu\text{V}$	
All IIR filters	0.075 % of Full Scale $\pm 10 \mu\text{V}$	
RMS Noise (50 $\Omega$ terminated)		
Wideband	0.035 % of Full Scale $\pm 50 \mu\text{V}$	
All IIR filters	0.035 % of Full Scale $\pm 50 \mu\text{V}$	

## Analog Input Section

Common Mode (referred to system ground)

Ranges	Less than or equal to $\pm 5$ V	Larger than $\pm 5$ 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	$\pm 2000$ 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 $\mu$ s after 200 % overload

## Isolation

		CAT II	CAT III
Channel-to-chassis (earth)	1000 V RMS	600 V RMS <sup>(1)</sup>	300 V RMS <sup>(1)</sup>
Channel-to-channel	2000 V RMS	<sup>(2)</sup>	<sup>(2)</sup>

(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.

<b>Analog to Digital Conversion</b>	
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: $\pm 3.5$ ppm <sup>(1)</sup> ; aging after 10 years $\pm 10$ 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 <sup>20</sup>
External time base level	TTL
External time base minimum pulse width	200 ns

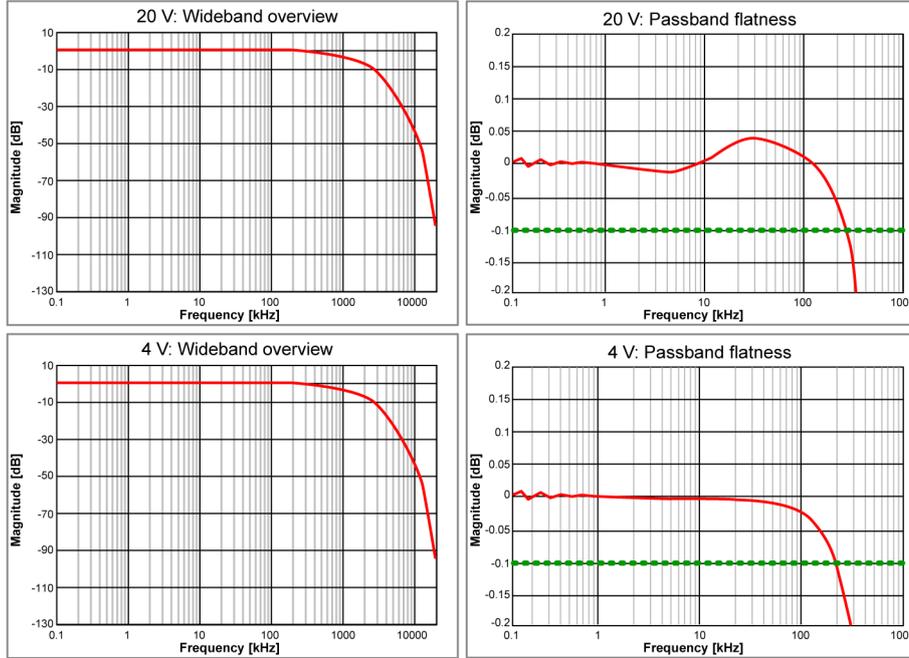
(1) Mainframes using Interface/Controller Modules shipped before 2012:  $\pm 30$  ppm.

<b>Amplifier Bandwidth and Filtering</b>	
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. 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. 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. 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

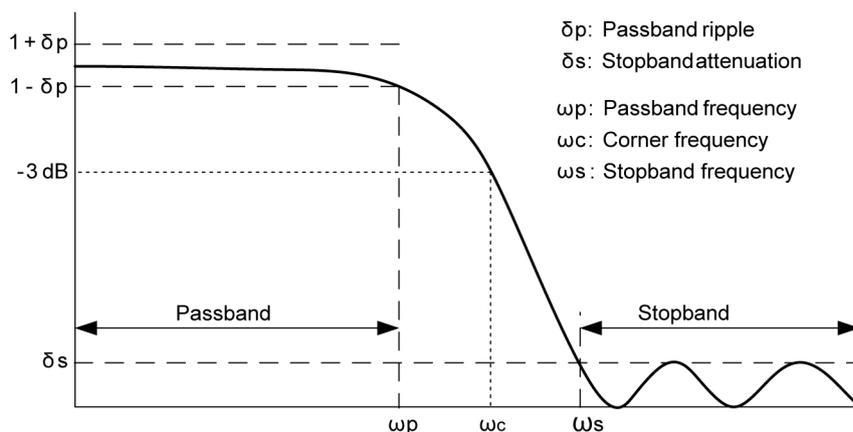
When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

Wideband bandwidth	Between 900 kHz and 1500 kHz (-3 dB)
Passband flatness	0.1 dB; DC to 200 kHz <sup>(1)</sup>



**Figure A.23:** Wideband overview and passband flatness

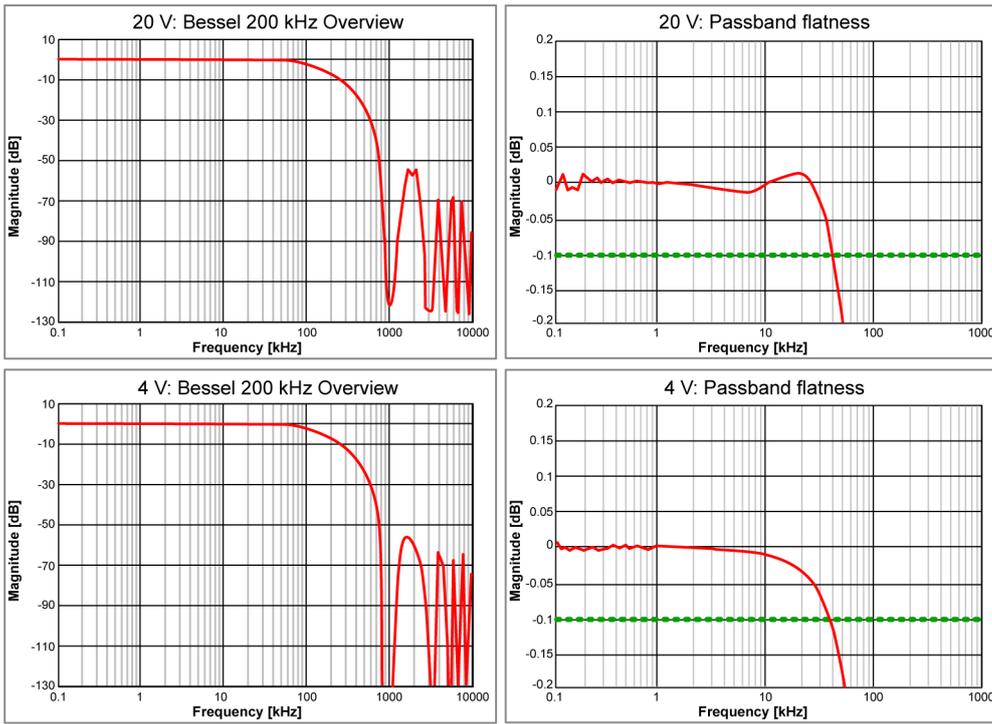
(1) Measured using a Fluke 5700A calibrator, DC normalized

**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	User selectable from 0.4 Hz to 200 kHz
Bessel IIR passband ripple ( $\delta_p$ )	0.1 dB <sup>(1)</sup>
Bessel IIR passband ( $\omega_p$ )	DC to 35 kHz @ $\omega_c = 200$ kHz <sup>(1)</sup>
Bessel IIR filter stopband attenuation ( $\delta_s$ )	-60 dB With Bessel IIR filter bandwidth selection $\omega_c = 200$ 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

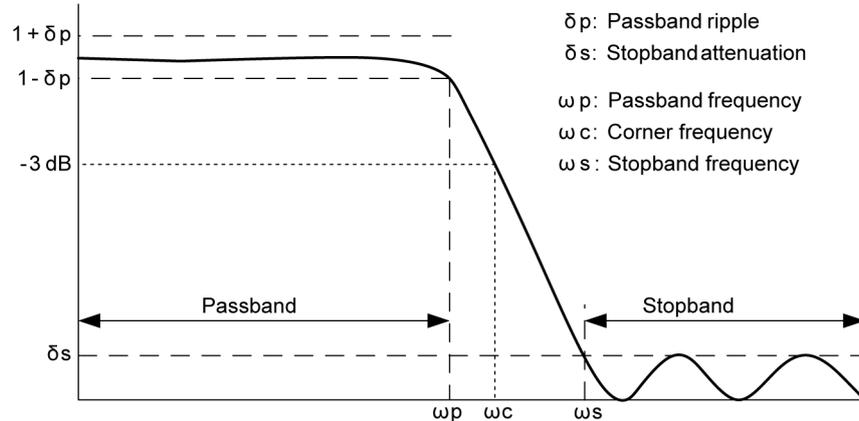
**Bessel IIR Filter**



**Figure A.25:** Bessel IIR 200 kHz Overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

## Butterworth IIR Filter

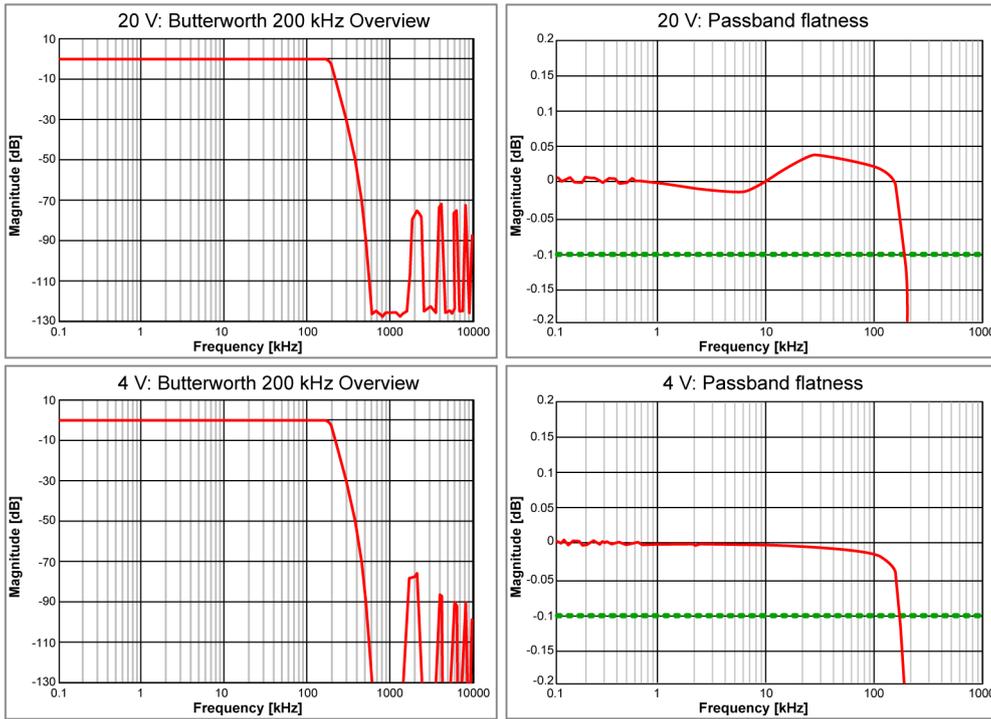


**Figure A.26:** Digital Butterworth IIR Filter

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 $\pm$ 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 <sup>(1)</sup> , 10, 20, 40 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed.
Butterworth IIR filter bandwidth ( $\omega_c$ )	User selectable from 1 Hz to 250 kHz
Butterworth IIR passband ripple ( $\delta_p$ )	0.1 dB <sup>(2)</sup>
Butterworth IIR passband ( $\omega_p$ )	DC to 150 kHz @ $\omega_c = 200$ kHz <sup>(2)</sup>
Butterworth IIR filter stopband attenuation ( $\delta_s$ )	-75 dB
Butterworth IIR filter roll-off	-48 dB/octave

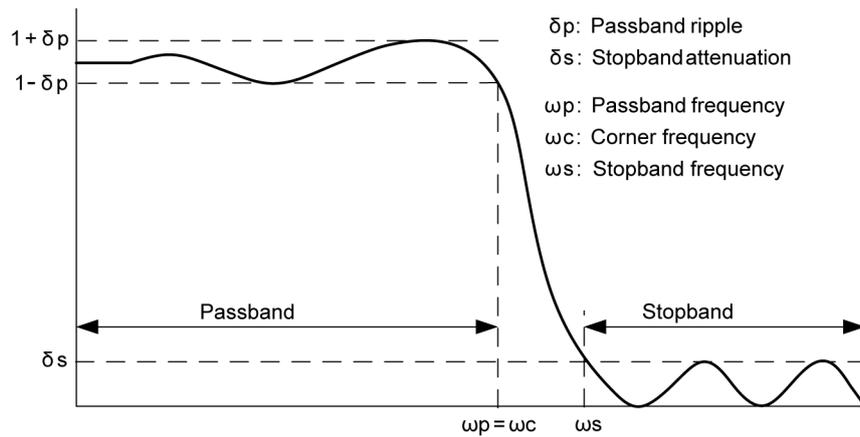
**Butterworth IIR Filter**



**Figure A.27:** 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

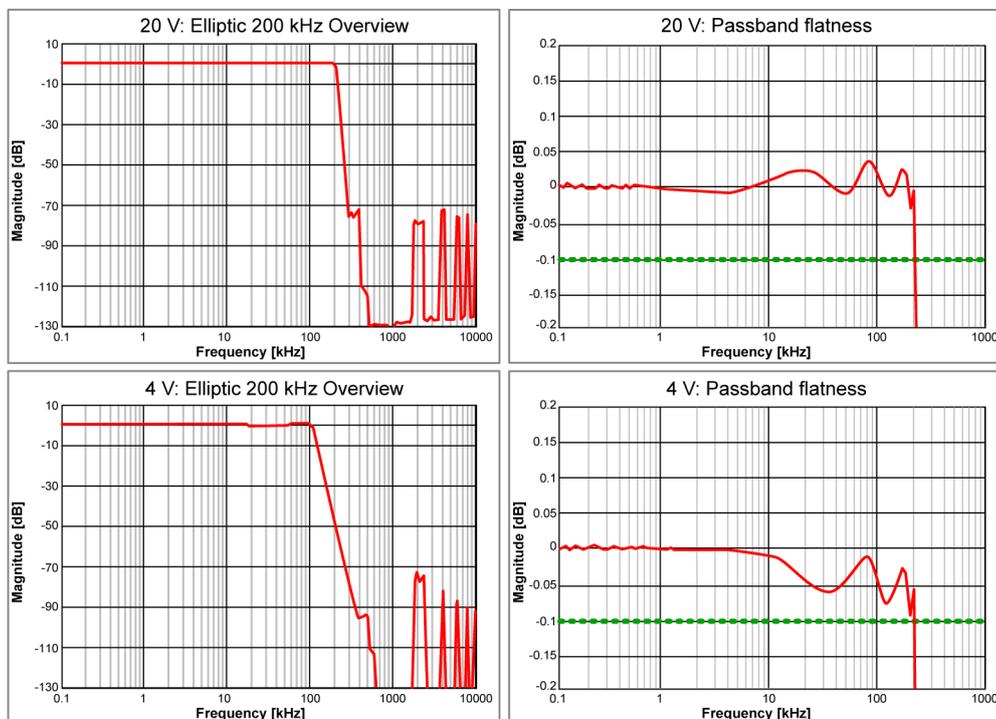
## Elliptic IIR Filter



**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 $\pm$ 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 <sup>(1)</sup> , 10, 20, 40 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Elliptic IIR filter bandwidth ( $\omega_c$ )	1 Hz to 250 kHz
Elliptic IIR passband ripple ( $\delta_p$ )	0.1 dB <sup>(2)</sup>
Elliptic IIR passband ( $\omega_p$ )	DC to filter bandwidth ( $\omega_c$ ) <sup>(2)</sup>
Elliptic IIR filter stopband attenuation ( $\delta_s$ )	-75 dB
Elliptic IIR filter roll-off	-72 dB/octave



**Figure A.29:** 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

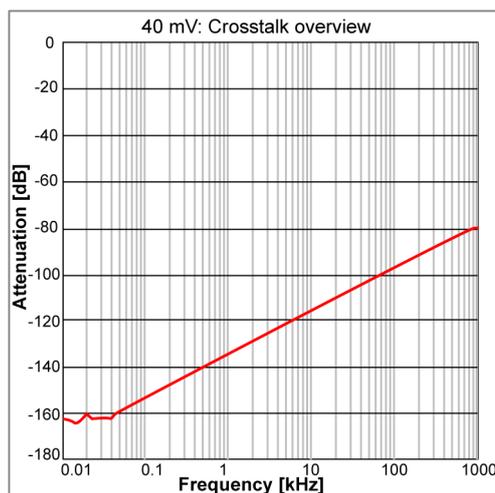
### Channel to Channel Phase Match

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 enabled channels
Memory diagnostics	Automatic memory test when system is powered and not recording
Storage sample size	16 bits, 2 bytes/sample 18 bits, 4 bytes/sample (required for Timer/Counter usage)

<b>Digital Event/Timer/Counter <sup>(1)</sup></b>	
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) 12.8 µs minimum pulse width 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) 200 µs ± 1 µs ± 1 sample period alarm event delay
Recording active	High when recording, low when in idle or pause mode 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 Bi-directional quadrature count 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 <sup>31</sup> ; unidirectional count. -2 <sup>31</sup> to +2 <sup>31</sup> ; bidirectional count
Reset input	User selectable level invert
Reset options	Manual: On user request by software command Start recording: Count value set to 0 at start of recording First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored. Each reset pulse: On each external reset pulse the counter value is reset to 0.
Direction input	Only used when in bi-directional count Low: increment counter 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 <sup>31</sup> to +2 <sup>31</sup>
Reset input	User selectable level invert
Reset options	Manual: On user request by software command Start recording: Count value set to 0 at start of recording First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored. Each reset pulse: On each external reset pulse the counter value is reset to 0.

<b>Digital Event/Timer/Counter <sup>(1)</sup></b>	
Uni- and bi-directional frequency/RPM measurement	
Inputs	2 pins; signal, direction
Maximum input frequency	5 MHz
Accuracy	0.1 %
Gate measuring time	0.5 $\mu$ s to 50 s; user selectable to control update rate independent of sample rate
Direction input	Only used when in bi-directional frequency/RPM mode Low: Positive frequency/RPM, e.g. left rotations 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

<b>Triggering</b>	
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
<b>External Trigger In</b>	
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	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold High: Active from first mainframe trigger to end of recording Pulse width created by mainframe; see mainframe datasheet for details
Trigger out delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; analog triggers of all channels Logical AND; qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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
<b>Analog channel trigger modes</b>	
Basic	POS or NEG crossing; single level
Dual level	One POS and one NEG crossing; two individual levels, logical OR
<b>Analog channel qualifier modes</b>	
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
<b>Event channel trigger <sup>(1)</sup></b>	
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

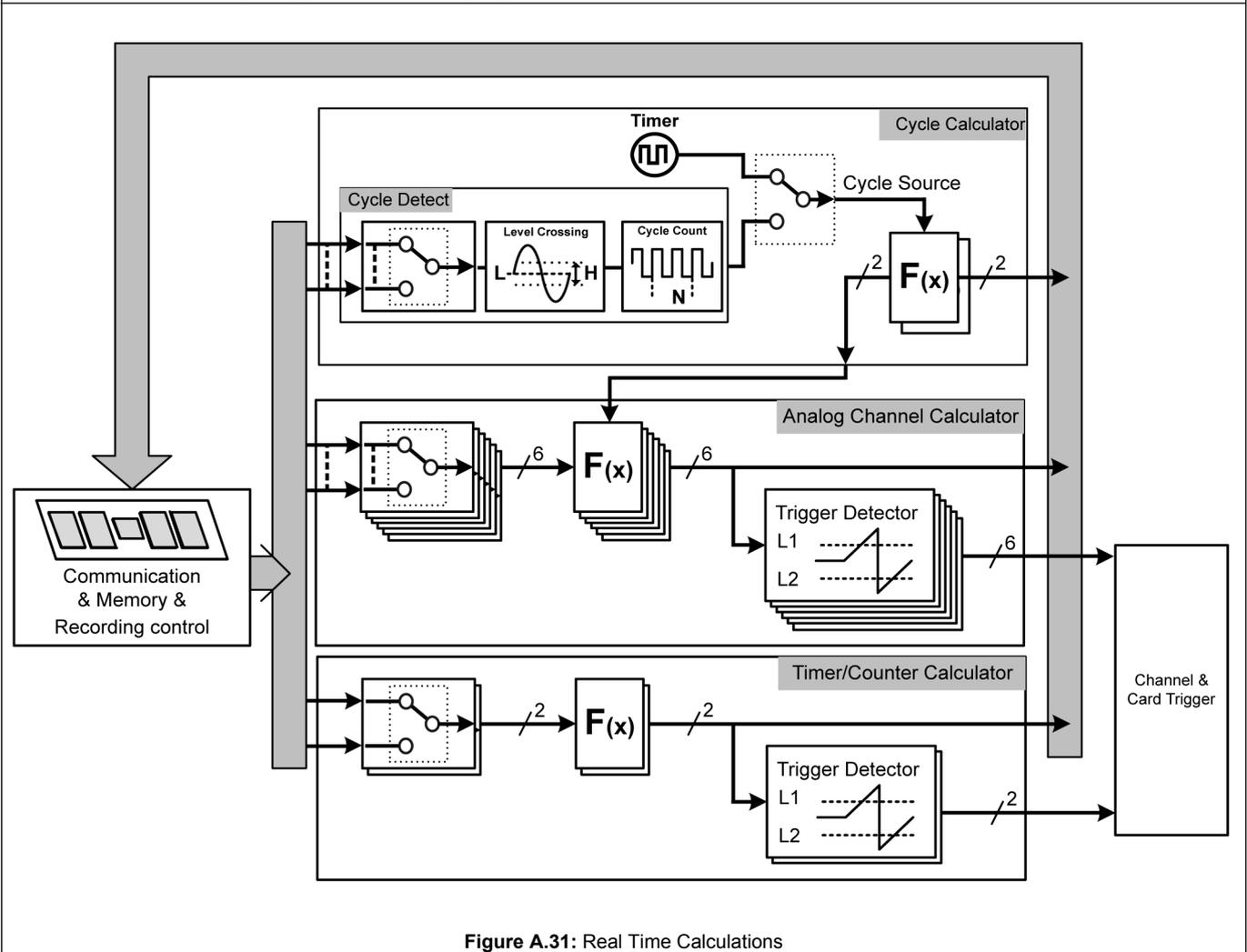
(1) Only if supported by mainframe

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

## Real-Time Analysis

<b>StatStream®</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

### Real-Time Calculations (Perception V6.40 and higher)



**Figure A.31:** Real Time Calculations

<b>Real-Time Analysis</b>	
Cycle Source	Determines the periodic based real time calculations 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 <sup>(1)</sup>	Maximum detectable Cycle period 0.25 s (4 Hz) Minimum detectable period 0.91 ms (1.1 kHz) Calculations stops when Cycle period exceeds maximum cycle period (0.25 s). Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms). Exceeding Cycle period or automatic Cycle count increases are indicated with time event notification in channel data.
Cycle calculator	
Number of calculators	2; At highest sample rate
Calculations	Cycle and Frequency
Cycle	Square wave signal, 50 % duty cycle. 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)
Analog channel calculator	
Number of calculators	6; At highest sample rate
Calculations	RMS, Minimum, Maximum, Mean, Peak to Peak, Area, Energy
Timer/Counter channel calculator	
Number of calculators	2; At highest sample rate
Calculations	Frequency; Requires Timer/Counter channel in frequency mode
Trigger detector	
Number of detectors	9; One each for Cycle frequency, every analog channel and timer/counter 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 Sinewave with 25 % Full Scale hysteresis.

<b>Acquisition Modes</b>	
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.

<b>Acquisition Mode Details</b>									
<b>16 Bit resolution</b>									
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	954 MS	159 MS	136 MS	not used			762 MS	126 MS	108 MS
Max. sweep sample rate	2 MS/s			not used			2 MS/s		
Max. continuous FIFO	not used			954 MS	159 MS	136 MS	190 MS	31 MS	27 MS
Max. continuous sample rate	not used			2 MS/s			Sweep Sample Rate / 2		
Max. continuous streaming rate	not used			2 MS/s 4 MB/s	12 MS/s 24 MB/s	14 MS/s 28 MB/s	2 MS/s 4 MB/s	12 MS/s 24 MB/s	14 MS/s 28 MB/s
<b>18 Bit resolution</b>									
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	477 MS	79 MS	53 MS	not used			381 MS	63 MS	42 MS
Max. sweep sample rate	2 MS/s			not used			2 MS/s		
Max. continuous FIFO	not used			477 MS	79 MS	53 MS	95 MS	15 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 8 MB/s	12 MS/s 48 MB/s	18 MS/s 72 MB/s	2 MS/s 8 MB/s	12 MS/s 48 MB/s	18 MS/s 72 MB/s

<b>Single Sweep</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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 Recording stops at end of sweep even if specified sample rates switches did not happen

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 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
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#### EMISSION

EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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); contact discharge $\pm 4$ kV/air discharge $\pm 8$ kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains $\pm 2$ kV using coupling network. Channel $\pm 2$ kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test Mains $\pm 0.5$ kV/ $\pm 1$ kV Line-Line and $\pm 0.5$ kV/ $\pm 1$ kV/ $\pm 2$ kV Line-earth Channel $\pm 0.5$ kV/ $\pm 1$ kV using coupling network: performance criteria B

**Harmonized standards for CE compliance, according to the following directives**

Low voltage directive (LVD): 2006/95/EC

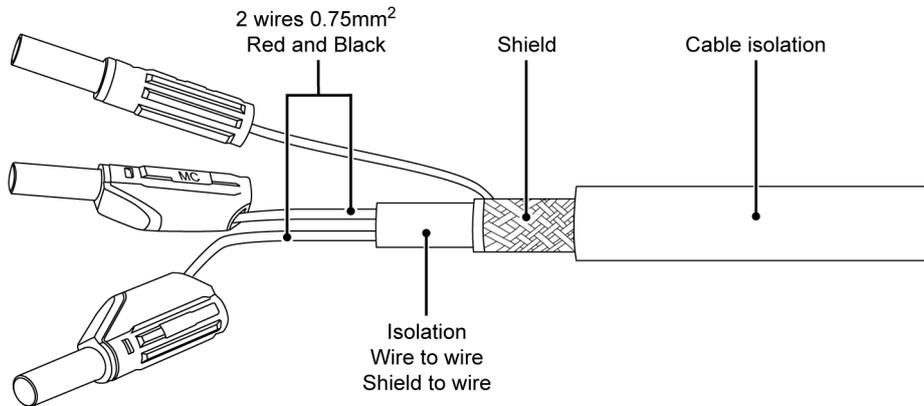
Electromagnetic compatibility directive (EMC): 2004/108/EC

EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 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 Dips: performance criteria A; Interruptions: performance criteria C

### Shielded Cable 1-KAB290-xx (option, to be ordered separately)

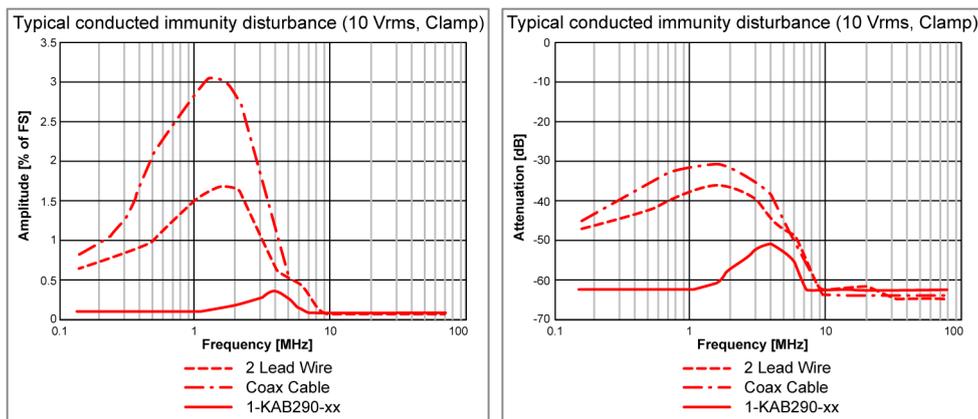
This cable is specially designed to be used with the GN610 and GN611 boards

Cable setup	2 wires with shield and isolation 3 shrouded banana plugs on each side; Red, Black and Yellow
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**Figure A.32:** Shielded cable setup

Wire thickness	2 * 0.75 mm <sup>2</sup>
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)

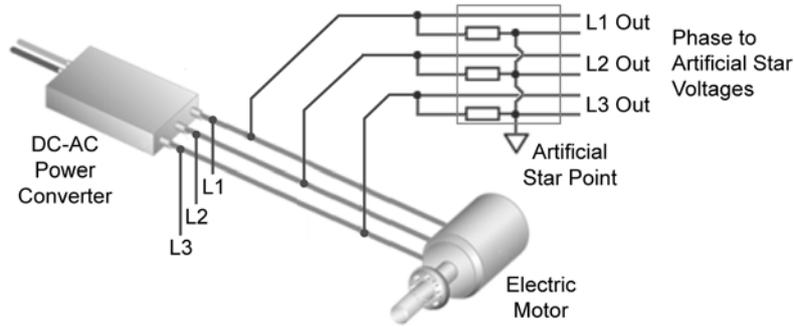


**Figure A.33:** Typical conducted immunity, tested using ± 10 V range

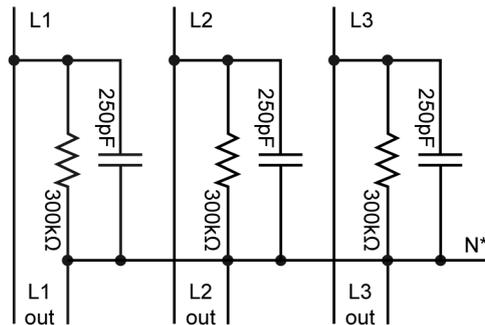
### Artificial Star Adapter (option, to be ordered separately)

The artificial star adapter creates an artificial star point for measuring 3 phase signals

Maximum input voltage	1000 V DC (707 V RMS) between every 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

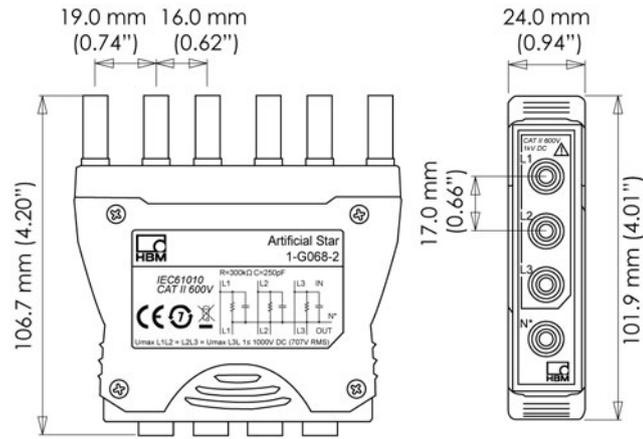


**Figure A.35:** Electrical schematic

Weight	170 g
Material housing	Poly Urethane, vacuum resin casting
Set-up	2 boxes can be plugged onto a single GN610/GN611 card 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

<b>Ordering information<sup>(1)</sup></b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
Basic 1 kV ISO 2 MS/s 	6 channel, 18 bit, 2 MS/s, $\pm 20$ mV to $\pm 1000$ 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  Supported by Perception V6.30 and higher	1-GN610-2

(1) All GEN series systems are intended for exclusive professional and industrial use.

<b>Accessories, to be ordered separately</b>		
<b>Article</b>	<b>Description</b>	<b>Order No.</b>
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. 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. 600 V RMS CAT II, safety-shrouded stackable banana plugs. Significantly reduces signal disturbance pickup by using earthed shield. 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 1-KAB290-3 1-KAB290-6

**A.5 B3716-2.0 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
Digital Event/Timer/Counter support	Yes
Isolation	Yes; channel to channel and channel to chassis
Input type	Analog isolated balanced differential <sup>(1)</sup>
Real time calculations	Yes; Automatic zero crossing detection with calculations of Cycle and Cycle Frequency, RMS, Mean, Minimum, Maximum, Peak to Peak, Area and Energy. All calculations can be used to trigger the recording.

(1) No probes supported

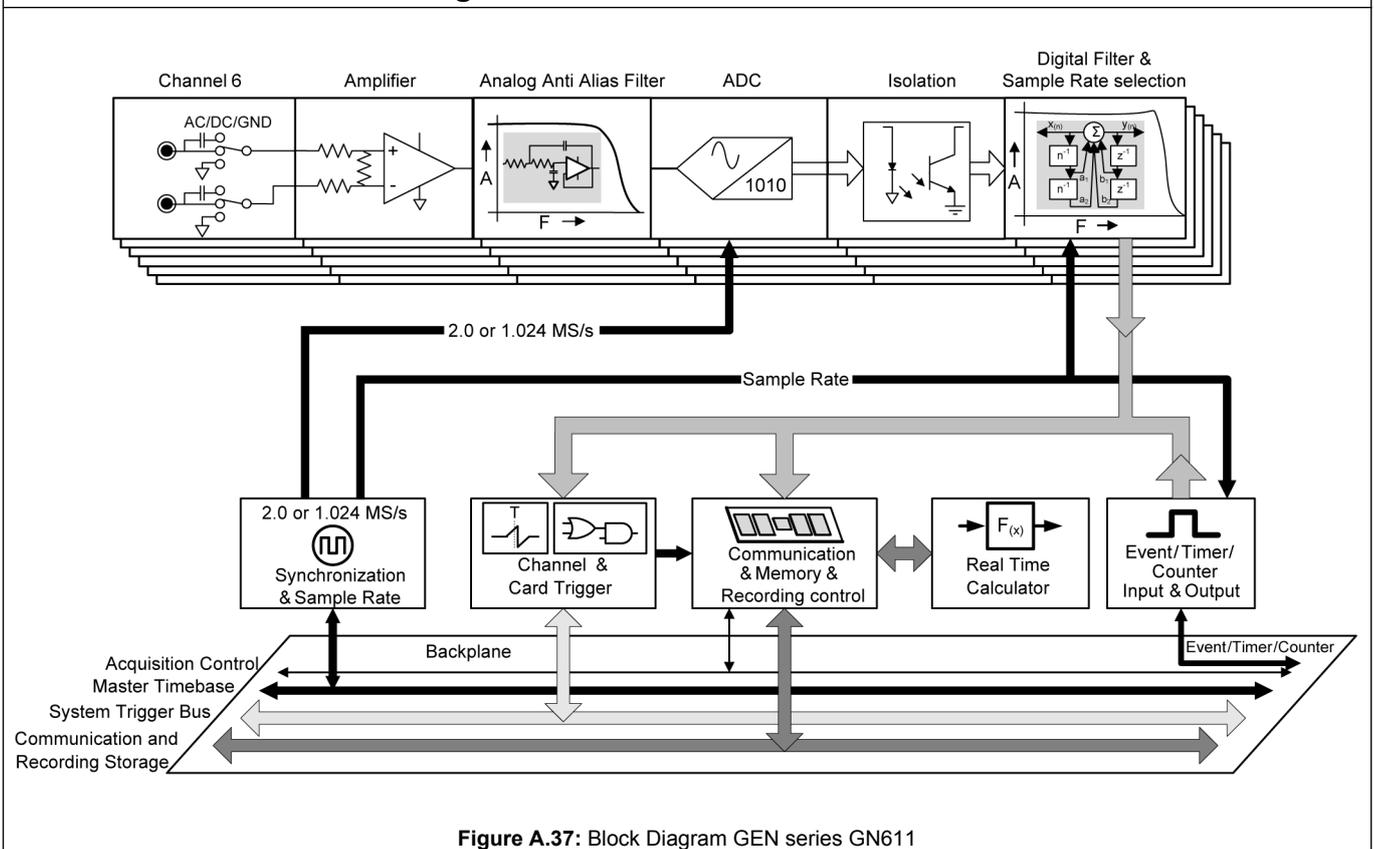
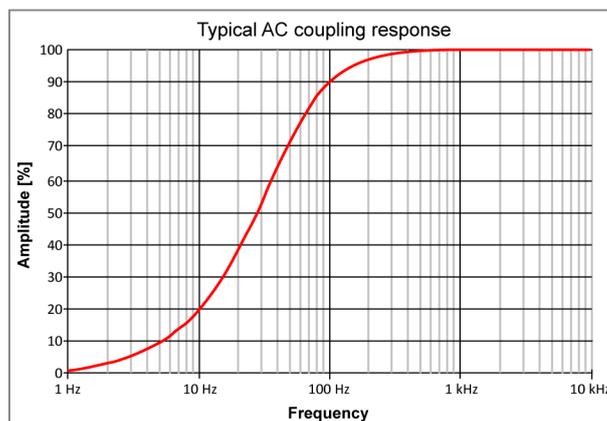
**GEN series GN611 Block diagram**


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 $\pm$ 5 Hz (-3 dB)



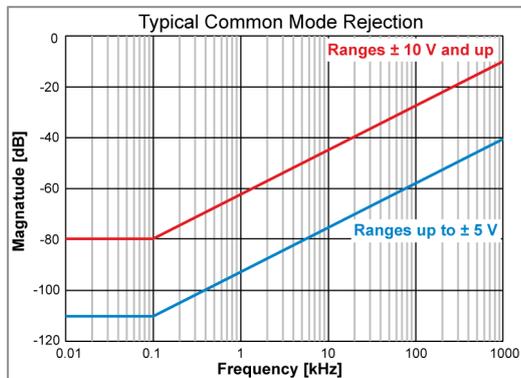
**Figure A.38:** Typical AC coupling response

Impedance	$2 * 1 \text{ M}\Omega \pm 1 \% // 33 \text{ pF} \pm 10\%$ ranges larger than $\pm 5 \text{ V}$ . All other ranges $57 \text{ pF} \pm 10\%$	
Ranges	$\pm 20 \text{ mV}$ , $\pm 50 \text{ mV}$ , $\pm 0.1 \text{ V}$ , $\pm 0.2 \text{ V}$ , $\pm 0.5 \text{ V}$ , $\pm 1 \text{ V}$ , $\pm 2 \text{ V}$ , $\pm 5 \text{ V}$ , $\pm 10 \text{ V}$ , $\pm 20 \text{ V}$ , $\pm 50 \text{ V}$ , $\pm 100 \text{ V}$ , $\pm 200 \text{ V}$ , $\pm 500 \text{ V}$ , $\pm 1000 \text{ V}$	
Offset	$\pm 50 \%$ in 1000 steps (0.1 %); $\pm 1000 \text{ V}$ range has fixed 0 % offset	
DC Offset error		
Wideband	0.02 % of Full Scale $\pm 400 \mu\text{V}$	
All IIR filters	0.02 % of Full Scale $\pm 10 \mu\text{V}$	
Offset error drift	$\pm(20 \text{ ppm} + 10 \mu\text{V})/^{\circ}\text{C}$ ( $\pm(12 \text{ ppm} + 6 \mu\text{V})/^{\circ}\text{F}$ )	
DC Gain error		
Wideband	0.1 % of Full Scale $\pm 20 \mu\text{V}$	
All IIR filters	0.1 % of Full Scale $\pm 10 \mu\text{V}$	
Gain error drift	$\pm 30 \text{ ppm}/^{\circ}\text{C}$ ( $\pm 17 \text{ ppm}/^{\circ}\text{F}$ )	
Maximum static error (MSE)		
Wideband	0.075 % of Full Scale $\pm 400 \mu\text{V}$	
All IIR filters	0.075 % of Full Scale $\pm 10 \mu\text{V}$	
RMS Noise (50 $\Omega$ terminated)		
Wideband	0.035 % of Full Scale $\pm 50 \mu\text{V}$	
All IIR filters	0.035 % of Full Scale $\pm 50 \mu\text{V}$	

## Analog Input Section

Common Mode (referred to system ground)

Ranges	Less than or equal to $\pm 5$ V	Larger than $\pm 5$ 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 then 200 % of the selected input range or 1250 V whichever is the smallest value.
Maximum nondestructive voltage	$\pm 2000$ 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 then 5 $\mu$ s after 200 % overload

## Isolation

		CAT II	CAT III
Channel-to-chassis (earth)	1000 V RMS	600 V RMS <sup>(1)</sup>	300 V RMS <sup>(1)</sup>
Channel-to-channel	2000 V RMS	<sup>(2)</sup>	<sup>(2)</sup>

(1) IEC61010-1 Category voltage ratings are RMS voltages.

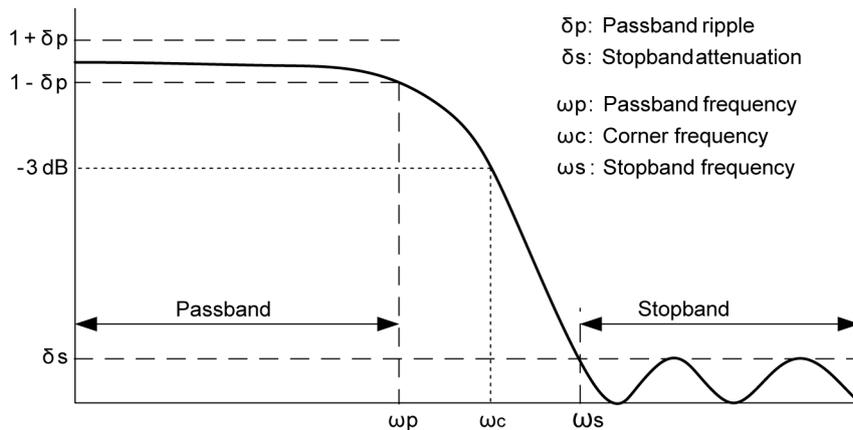
(2) Channel to Channel CAT II and CAT III ratings are not a valid method to specify.

<b>Analog to Digital Conversion</b>	
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: $\pm 3.5$ ppm <sup>(1)</sup> ; aging after 10 years $\pm 10$ 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 <sup>20</sup>
External time base level	TTL
External time base minimum pulse width	200 ns

(1) Mainframes using Interface/Controller Modules shipped before 2012:  $\pm 30$  ppm.

<b>Amplifier Bandwidth and Filtering</b>	
Using different filter selections (Wideband/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. 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. 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. 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.

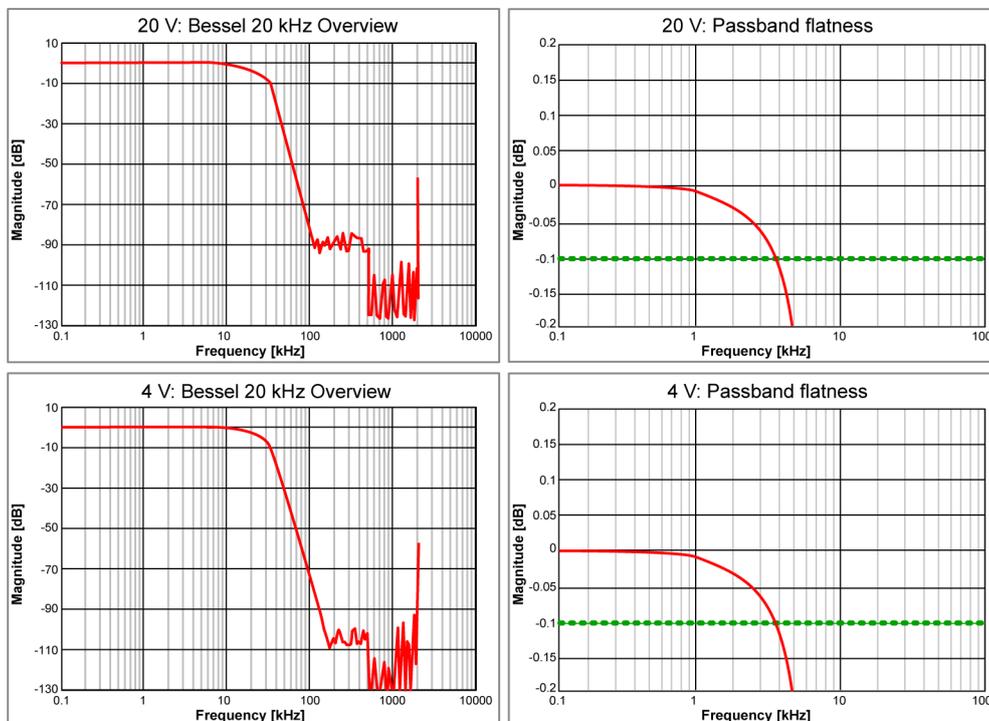
## Bessel IIR Filter



**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	User selectable from 0.4 Hz to 20 kHz
Bessel IIR passband ripple ( $\delta_p$ )	0.1 dB <sup>(1)</sup>
Bessel IIR passband ( $\omega_p$ )	DC to 3.5 kHz @ $\omega_c = 20$ kHz <sup>(1)</sup>
Bessel IIR filter stopband attenuation ( $\delta_s$ )	-60 dB
Bessel IIR filter roll-off	-48 dB/octave



**Figure A.41:** Bessel IIR 20 kHz Overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

### Butterworth IIR Filter

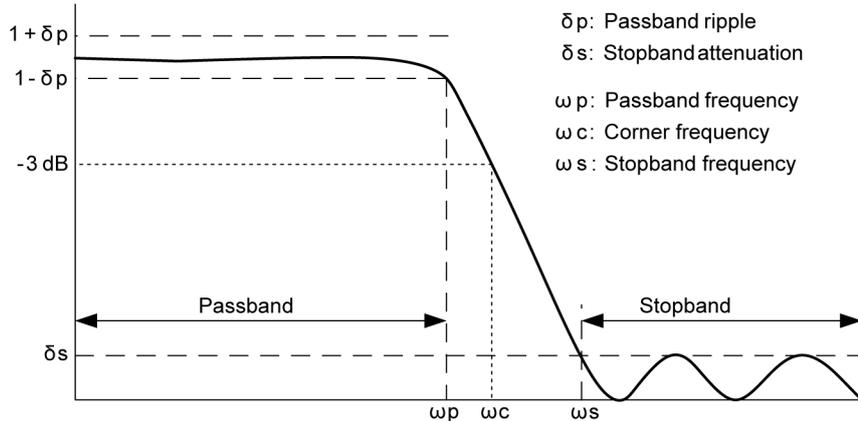


Figure A.42: Digital Butterworth IIR Filter

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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed.
Butterworth IIR filter bandwidth ( $\omega_c$ )	User selectable from 1 Hz to 50 kHz
Butterworth IIR passband ripple ( $\delta_p$ )	0.1 dB <sup>(1)</sup>
Butterworth IIR passband ( $\omega_p$ )	DC to 35 kHz @ $\omega_c = 50$ kHz <sup>(1)</sup>
Butterworth IIR filter stopband attenuation ( $\delta_s$ )	-75 dB
Butterworth IIR filter roll-off	-48 dB/octave

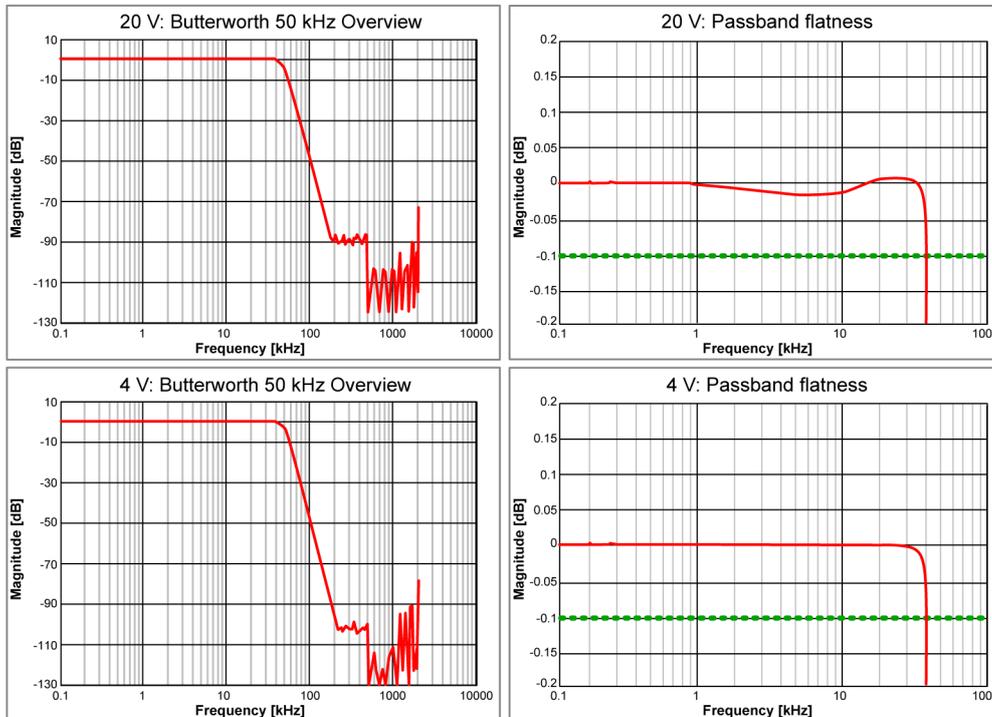
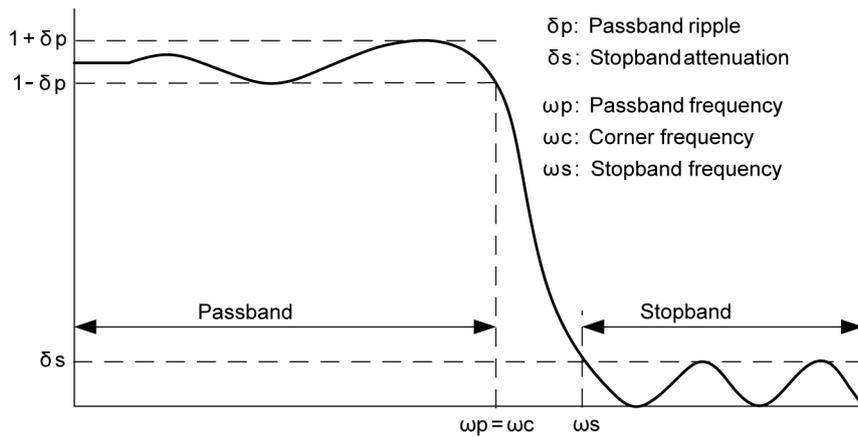


Figure A.43: Butterworth IIR 50 kHz Overview and passband flatness

(1) Measured using Fluke 5700A calibrator, DC normalized

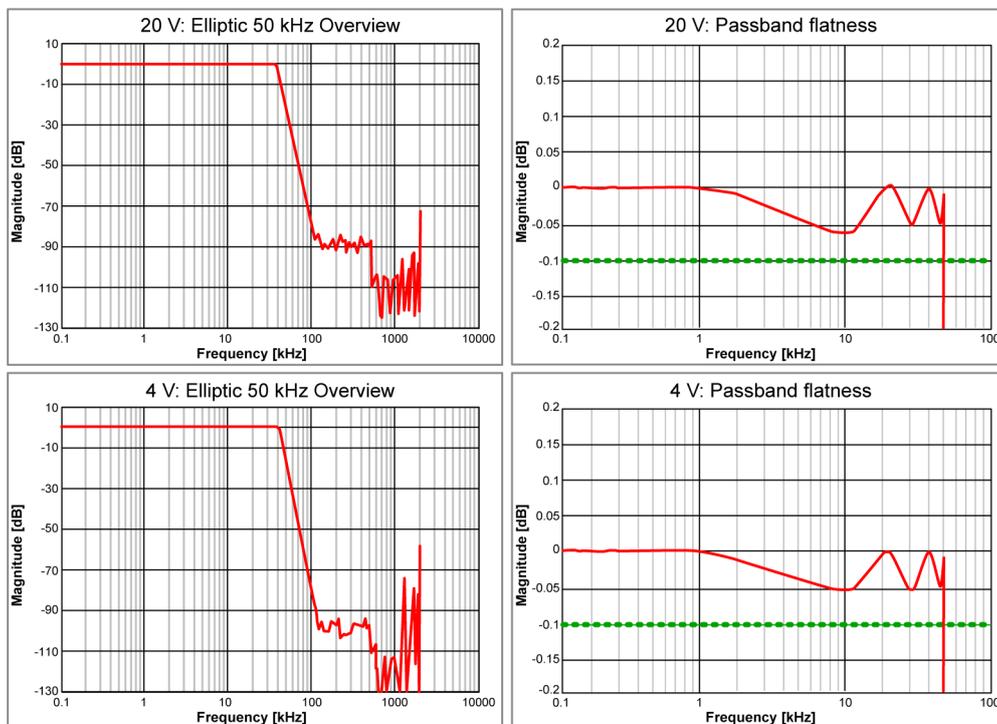
## Elliptic IIR Filter



**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Elliptic IIR filter bandwidth ( $\omega_c$ )	User selectable from 1 Hz to 50 kHz
Elliptic IIR passband ripple ( $\delta_p$ )	0.1 dB <sup>(1)</sup>
Elliptic IIR passband ( $\omega_p$ )	DC to filter bandwidth ( $\omega_c$ ) <sup>(1)</sup>
Elliptic IIR filter stopband attenuation ( $\delta_s$ )	-75 dB
Elliptic IIR filter roll-off	-72 dB/octave



**Figure A.45:** 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 (Wideband/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 $\mu$ s)
GN611 Channels within mainframe	0.6 deg (0.17 $\mu$ s)

Butterworth IIR, Filter frequency 50 kHz @ 200 kS/s; 10 kHz sine wave

Channels on card	0.5 deg (0.14 $\mu$ s)
GN611 Channels within mainframe	0.5 deg (0.14 $\mu$ s)

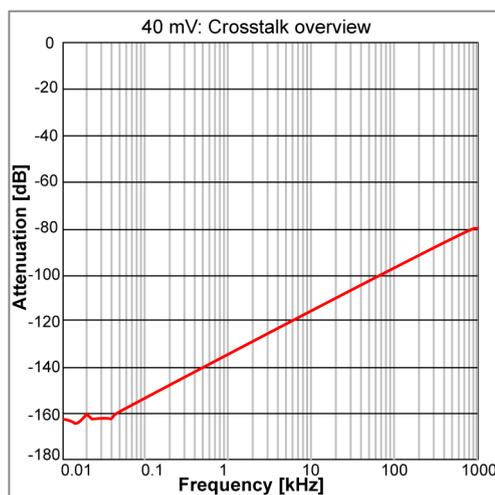
Elliptic IIR, Filter frequency 50 kHz @ 200 kS/s; 10 kHz sine wave

Channels on card	0.5 deg (0.14 $\mu$ s)
GN611 Channels within mainframe	0.5 deg (0.14 $\mu$ s)

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  $\Omega$  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  $\Omega$  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 enabled channels
Memory diagnostics	Automatic memory test when system is powered and not recording
Storage sample size	16 bits, 2 bytes/sample 18 bits, 4 bytes/sample (required for Timer/Counter usage)

<b>Digital Event/Timer/Counter <sup>(1)</sup></b>	
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) 12.8 µs minimum pulse width 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) 200 µs ± 1 µs ± 1 sample period alarm event delay
Recording active	High when recording, low when in idle or pause mode 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 Bi-directional quadrature count 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 <sup>31</sup> ; unidirectional count. -2 <sup>31</sup> to +2 <sup>31</sup> ; bidirectional count
Reset input	User selectable level invert
Reset options	Manual: On user request by software command Start recording: Count value set to 0 at start of recording First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored. Each reset pulse: On each external reset pulse the counter value is reset to 0.
Direction input	Only used when in bi-directional count Low: increment counter 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 <sup>31</sup> to +2 <sup>31</sup>
Reset input	User selectable level invert
Reset options	Manual: On user request by software command Start recording: Count value set to 0 at start of recording First reset pulse: After start of recording the first reset pulse sets counter value to 0. Next reset pulses are ignored. Each reset pulse: On each external reset pulse the counter value is reset to 0.

<b>Digital Event/Timer/Counter <sup>(1)</sup></b>	
Uni- and bi-directional frequency/RPM measurement	
Inputs	2 pins; signal, direction
Maximum input frequency	5 MHz
Accuracy	0.1 %
Gate measuring time	0.5 $\mu$ s to 50 s; user selectable to control update rate independent of sample rate
Direction input	Only used when in bi-directional frequency/RPM mode Low: Positive frequency/RPM, e.g. left rotations 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

<b>Triggering</b>	
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
<b>External Trigger In</b>	
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	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold High: Active from first mainframe trigger to end of recording Pulse width created by mainframe; see mainframe datasheet for details
Trigger out delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; analog triggers of all channels Logical AND; qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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
<b>Analog channel trigger modes</b>	
Basic	POS or NEG crossing; single level
Dual level	One POS and one NEG crossing; two individual levels, logical OR
<b>Analog channel qualifier modes</b>	
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
<b>Event channel trigger <sup>(1)</sup></b>	
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

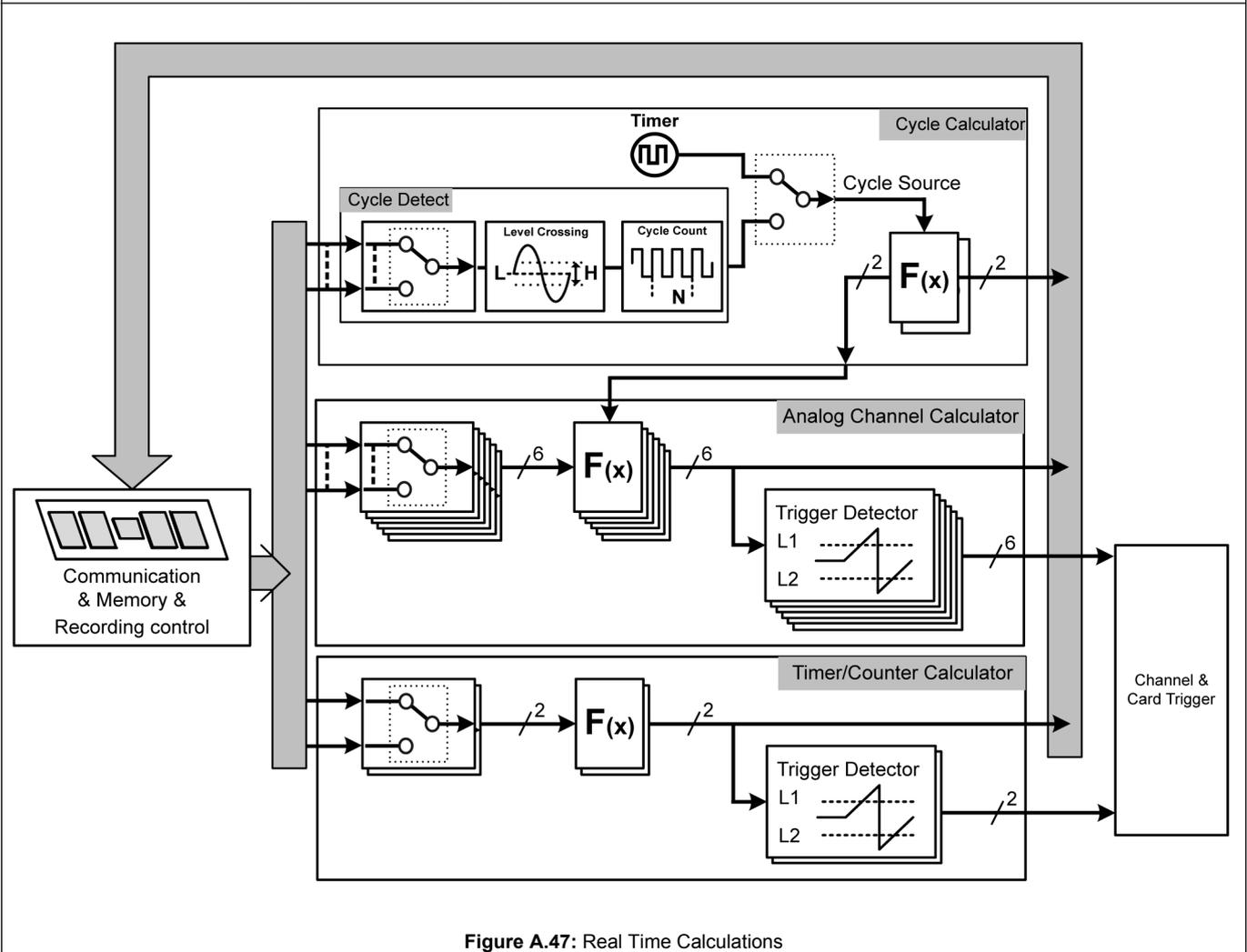
(1) Only if supported by mainframe

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

## Real-Time Analysis

<b>StatStream®</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

### Real-Time Calculations (Perception V6.40 and higher)



**Figure A.47:** Real Time Calculations

<b>Real-Time Analysis</b>	
Cycle Source	Determines the periodic based real time calculations 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 <sup>(1)</sup>	Maximum detectable Cycle period 0.25 s (4 Hz) Minimum detectable period 0.91 ms (1.1 kHz) Calculations stops when Cycle period exceeds maximum cycle period (0.25 s). Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms). Exceeding Cycle period or automatic Cycle count increases are indicated with time event notification in channel data.
Cycle calculator	
Number of calculators	2; At highest sample rate
Calculations	Cycle and Frequency
Cycle	Square wave signal, 50 % duty cycle. 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)
Analog channel calculator	
Number of calculators	6; At highest sample rate
Calculations	RMS, Minimum, Maximum, Mean, Peak to Peak, Area, Energy
Timer/Counter channel calculator	
Number of calculators	2; At highest sample rate
Calculations	Frequency; Requires Timer/Counter channel in frequency mode
Trigger detector	
Number of detectors	9; One each for Cycle frequency, every analog channel and timer/counter 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 Sinewave with 25 % Full Scale hysteresis.

<b>Acquisition Modes</b>	
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	16.5 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	16.5 MS	14 MS	20 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 0.4 MB/s	1.2 MS/s 2.4 MB/s	1.4 MS/s 2.8 MB/s	0.2 MS/s 0.4 MB/s	1.2 MS/s 2.4 MB/s	1.4 MS/s 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	5.5 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	5.5 MS	10 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 0.8 MB/s	1.2 MS/s 4.8 MB/s	1.8 MS/s 7.2 MB/s	0.2 MS/s 0.8 MB/s	1.2 MS/s 4.8 MB/s	1.8 MS/s 7.2 MB/s

## Single Sweep

Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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 Recording stops at end of sweep even if specified sample rates switches did not happen

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 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
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#### EMISSION

EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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); contact discharge $\pm 4$ kV/air discharge $\pm 8$ kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains $\pm 2$ kV using coupling network. Channel $\pm 2$ kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test Mains $\pm 0.5$ kV/ $\pm 1$ kV Line-Line and $\pm 0.5$ kV/ $\pm 1$ kV/ $\pm 2$ kV Line-earth Channel $\pm 0.5$ kV/ $\pm 1$ kV using coupling network: performance criteria B

**Harmonized standards for CE compliance, according to the following directives**

Low voltage directive (LVD): 2006/95/EC

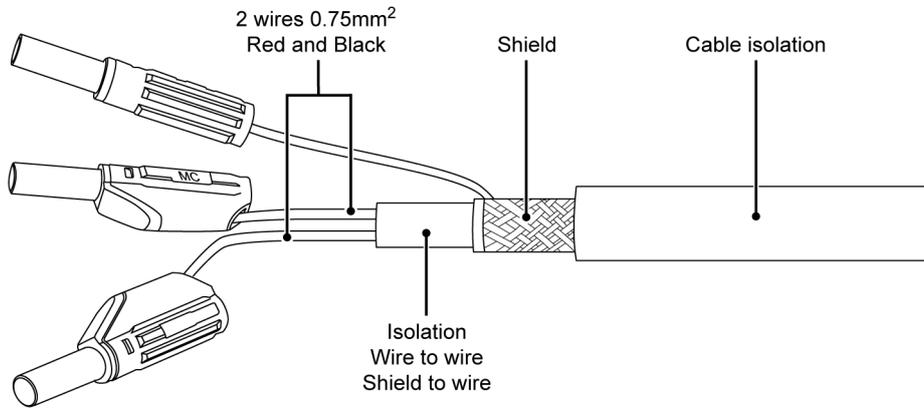
Electromagnetic compatibility directive (EMC): 2004/108/EC

EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 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 Dips: performance criteria A; Interruptions: performance criteria C

### Shielded Cable 1-KAB290-xx (option, to be ordered separately)

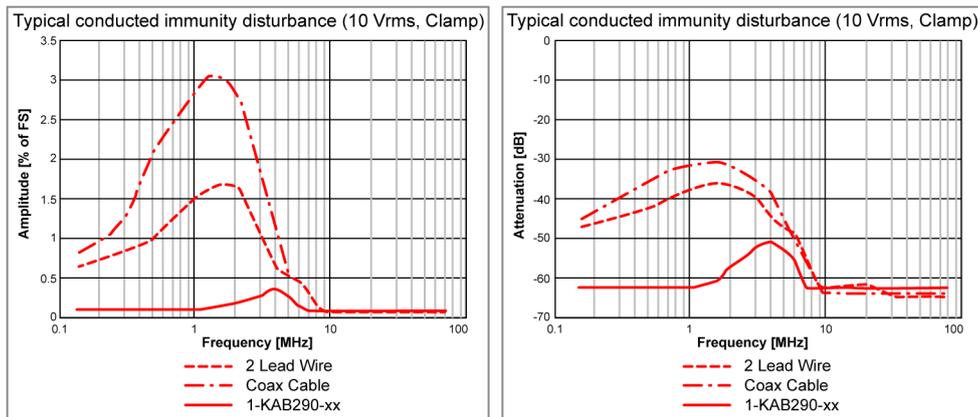
This cable is specially designed to be used with the GN610 and GN611 boards

Cable setup	2 wires with shield and isolation 3 shrouded banana plugs on each side; Red, Black and Yellow
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**Figure A.48:** Shielded cable setup

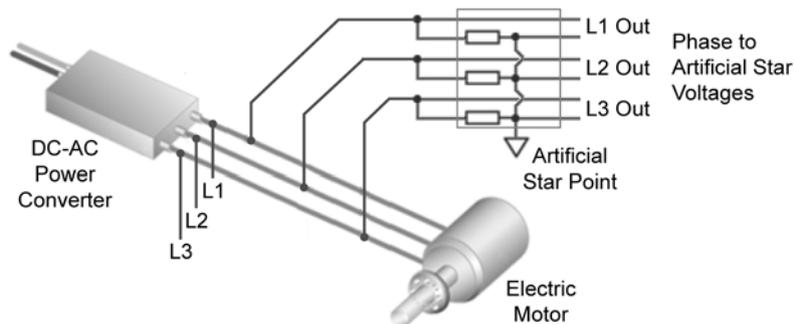
Wire thickness	2 * 0.75 mm <sup>2</sup>
Maximum wire resistance	0.250 Ω / m (0.0763 Ω / ft)
Weight	Approximately 143 g / m (1.54 ounce / ft)
Outside cable diameter	Approximately 9 mm (0.354 inch)
Minimum bend radius	10 times cable diameter
Isolation	
Resistance	20 MΩ / km
Voltage	600 V RMS CAT II; wire 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)



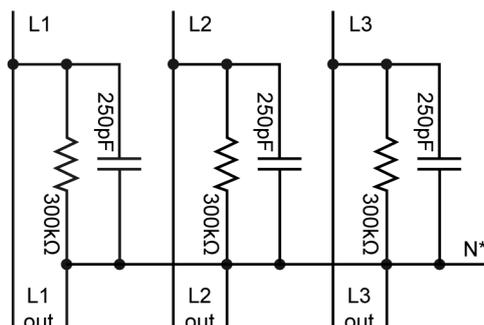
### Artificial Star Adapter (option, to be ordered separately)

The artificial star adapter creates an artificial star point for measuring 3 phase signals

Maximum input voltage	1000 V DC (707 V RMS) between every 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

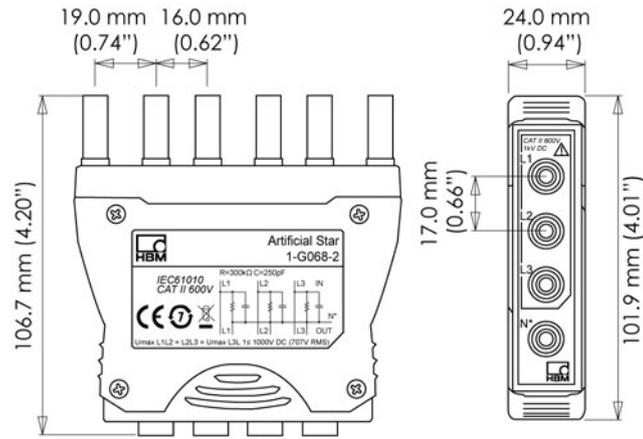


**Figure A.51:** Electrical schematic

Weight	170 g
Material housing	Poly Urethane, vacuum resin casting
Set-up	2 boxes can be plugged onto a single GN610/GN611 card 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

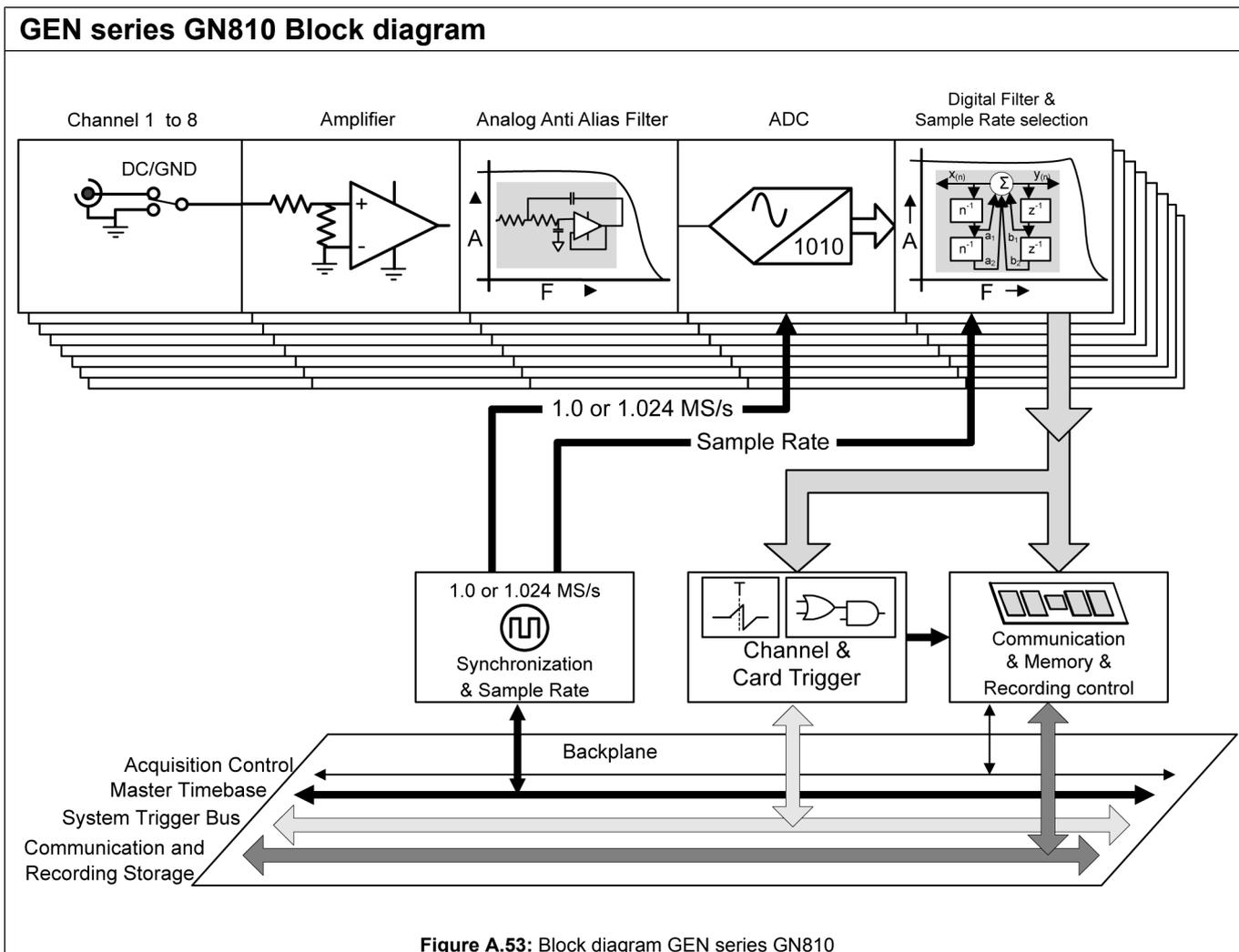
Ordering information <sup>(1)</sup>		
Article	Description	Order No.
Basic 1 kV ISO 200 kS/s 	6 channel, 18 bit, 200 kS/s, $\pm 20$ mV to $\pm 1000$ V input range, 200 MB RAM, 1 kV isolated balanced differential input (600 V RMS CAT II isolation), 4 mm fully isolated banana plugs. Real time cycle based calculations with triggering on calculated results.  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. 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. 600 V RMS CAT II, safety-shrouded stackable banana plugs. Significantly reduces signal disturbance pickup by using earthed shield. 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 1-KAB290-3 1-KAB290-6

**A.6 B2632-3.0 en (GEN series GN810)**

<b>Capabilities Overview</b>	
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



**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.*

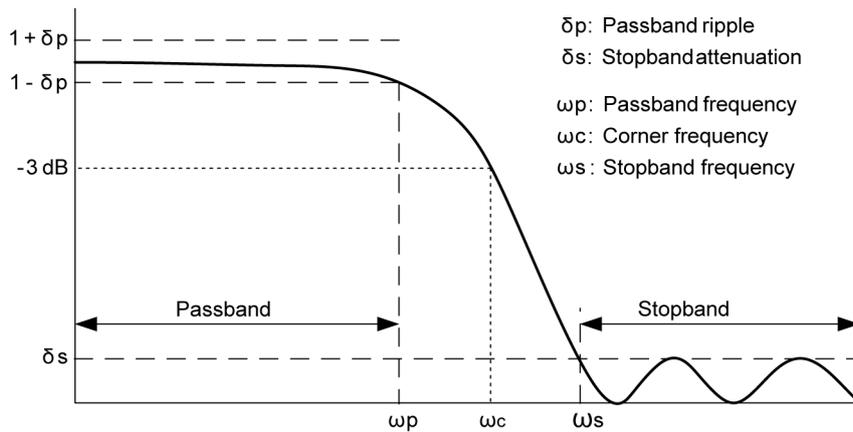
<b>Analog Input Section</b>	
Channels	8
Connectors	Metal BNC, 1 per channel

<b>Analog Input Section</b>	
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 Each fixed range supports a variable gain with 1000 steps (0.1 %). Variable gain creates 1000 extra ranges between 2 fixed ranges.
Offset	± 50 % in 1000 steps (0.1 %); ± 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

<b>Analog to Digital Conversion</b>	
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 ADS8401B
Time base accuracy	Defined by mainframe: ± 3.5 ppm <sup>(1)</sup> ; 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

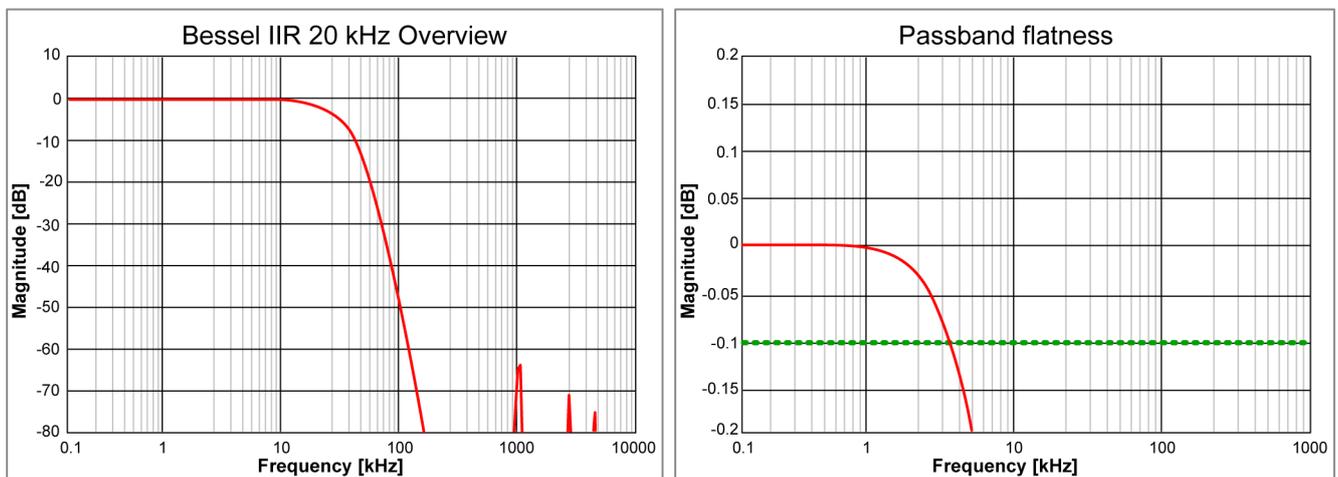
(1) Mainframes using Interface/Controller modules shipped before 2012: ± 30 ppm

<b>Amplifier Bandwidth and Filtering</b>	
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. 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. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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) Supported by Perception V6.40 and higher	Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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.

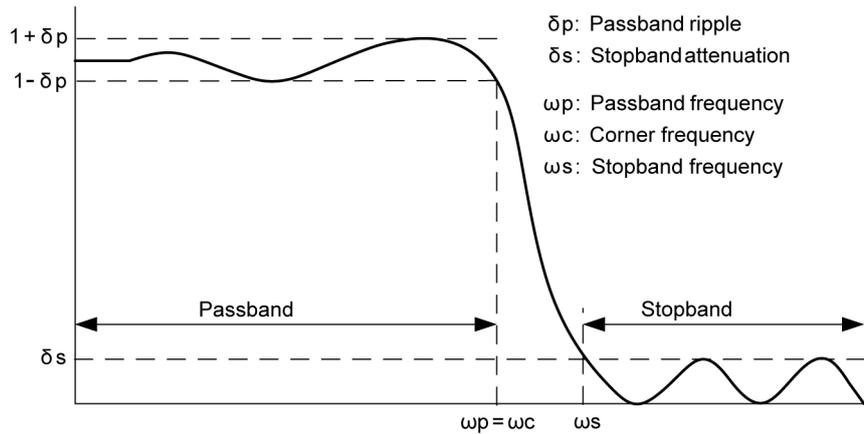
**Bessel IIR filter**

**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 20 kHz
Bessel IIR passband flatness ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to 3 kHz @ $\omega_c = 20$ kHz
Bessel IIR filter stop band attenuation ( $\delta_s$ )	-60 dB
Bessel IIR filter roll-off	-36 dB/Octave

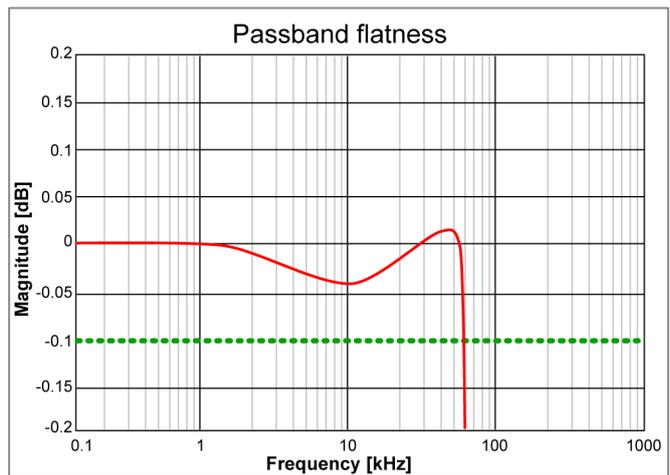
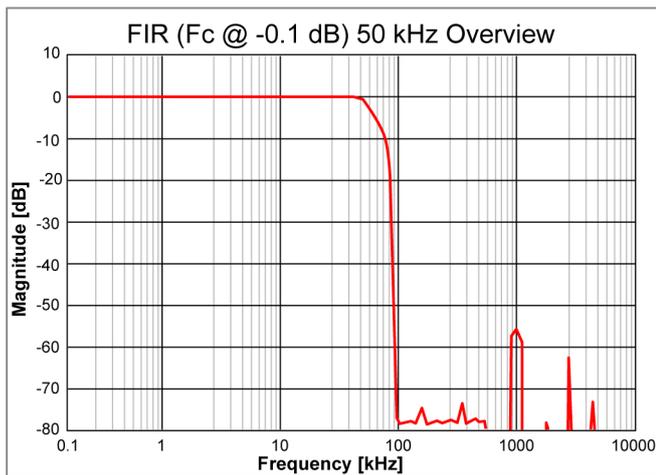

**Figure A.55:** Bessel IIR  $\omega_c = 20$  kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

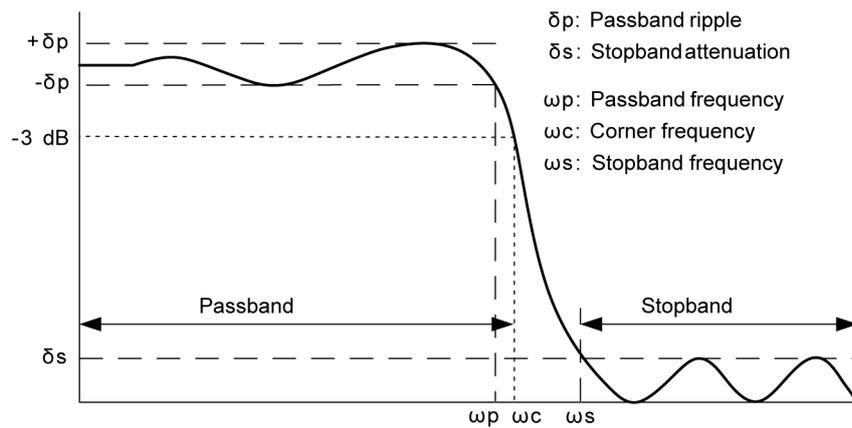
**FIR (Fc @ -0.1 dB) filter**

**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 $\pm$ 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 ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to filter bandwidth ( $\omega_c$ )
FIR (Fc @ -0.1 dB) filter stopband attenuation ( $\delta_s$ )	-60 dB
FIR (Fc @ -0.1 dB) filter roll-off	-72 dB/Octave

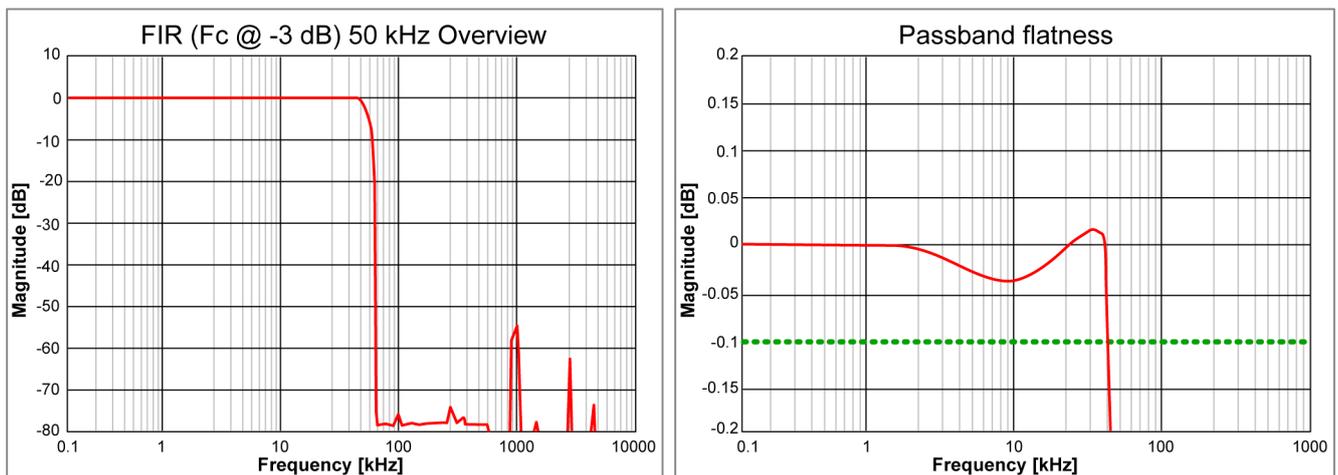

**Figure A.57:** Typical FIR (Fc @ -0.1 dB)  $\omega_c = 50$  kHz, Overview and passband flatness

(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  $\omega p$  reduced by a factor of  $\approx 1.4$  compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

Analog anti aliasing filter bandwidth	370 kHz $\pm$ 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 ( $\omega c$ )	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 ( $\omega p$ ) <sup>(1)</sup>	0.1 dB; DC to $\approx \omega c/1.4$ (Adapted FIR filter behavior)
FIR (Fc @ -3 dB) filter stopband attenuation ( $\delta s$ )	-60 dB
FIR (Fc @ -3 dB) filter roll-off	-72 dB/Octave


**Figure A.59:** Typical FIR (Fc @ -3 dB)  $\omega c = 50$  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 $\mu$ s)
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GN810 Channels within mainframe	0.4 deg (0.1 $\mu$ s)
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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 $\mu$ s)
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GN810 Channels within mainframe	0.4 deg (0.1 $\mu$ s)
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GN810 Channels across mainframes	Defined by synchronization method used (None, IRIG, GPS, Master/Slave)
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### On-board Memory

Per card	128 MB (64 MS)
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Organization	Automatic distribution amongst enabled channels
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Memory diagnostics	Automatic memory test when system is powered and not recording
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Storage sample size	16 bits, 2 bytes/sample
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### Digital Events/Timer/Counter

Digital event inputs	Not supported
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Digital event outputs	Not supported
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Timer/Counter	Not supported
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<b>Triggering</b>	
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
<b>External Trigger In</b>	
Selection per card	User selectable On/Off
Active edge	Rising/Falling mainframe selectable, identical for all cards
Minimum pulse width	500 ns
Delay	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold high: Active from first mainframe trigger to end of recording Pulse width created by mainframe
Delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; Analog triggers of all channels Logical AND; Qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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 dT : 1 to 1023 samples. dT setting shared for both levels
<b>Analog channel trigger modes</b>	
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
<b>Analog channel qualifier modes</b>	
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 Maximum holdoff time sample rate dependent
<b>Interval timer</b>	
Modes	Less then, trigger when rate is too low More then, trigger when rate is too high Between, trigger when rate between lower and upper limit 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

<b>Triggering</b>	
Event counter	Counted channel trigger events before card trigger is activated 1 to 256 trigger events

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

<b>Real-Time Analysis</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

<b>Acquisition Modes</b>	
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.

<b>Recording Mode Details</b>									
	Single Sweep Multiple Sweeps 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 Maximum 50 kS/s		
Max. continuous streaming rate	not used			0.2 MS/s 0.4 MB/s	0.4 MS/s 0.8 MB/s	1.6 MS/s 3.2 MB/s	0.05 MS/s 0.1 MB/s	0.1 MS/s 0.2 MB/s	0.8 MS/s 1.6 MB/s

<b>Single Sweep</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 6 Cycles, cycle duration 24 hours

<b>Harmonized standards for CE compliance, according to the following directives</b>	
Low voltage directive (LVD): 2006/95/EC	
Electromagnetic compatibility directive (EMC): 2004/108/EC	
<b>Electrical Safety</b>	
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
<b>Electromagnetic Compatibility</b>	
EN 61326-1 (2006)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
<b>EMISSION</b>	
EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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
<b>IMMUNITY</b>	
EN 61000-4-2	Electrostatic discharge immunity test (ESD); contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test 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 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 Dips: performance criteria A; Interruptions: performance criteria C

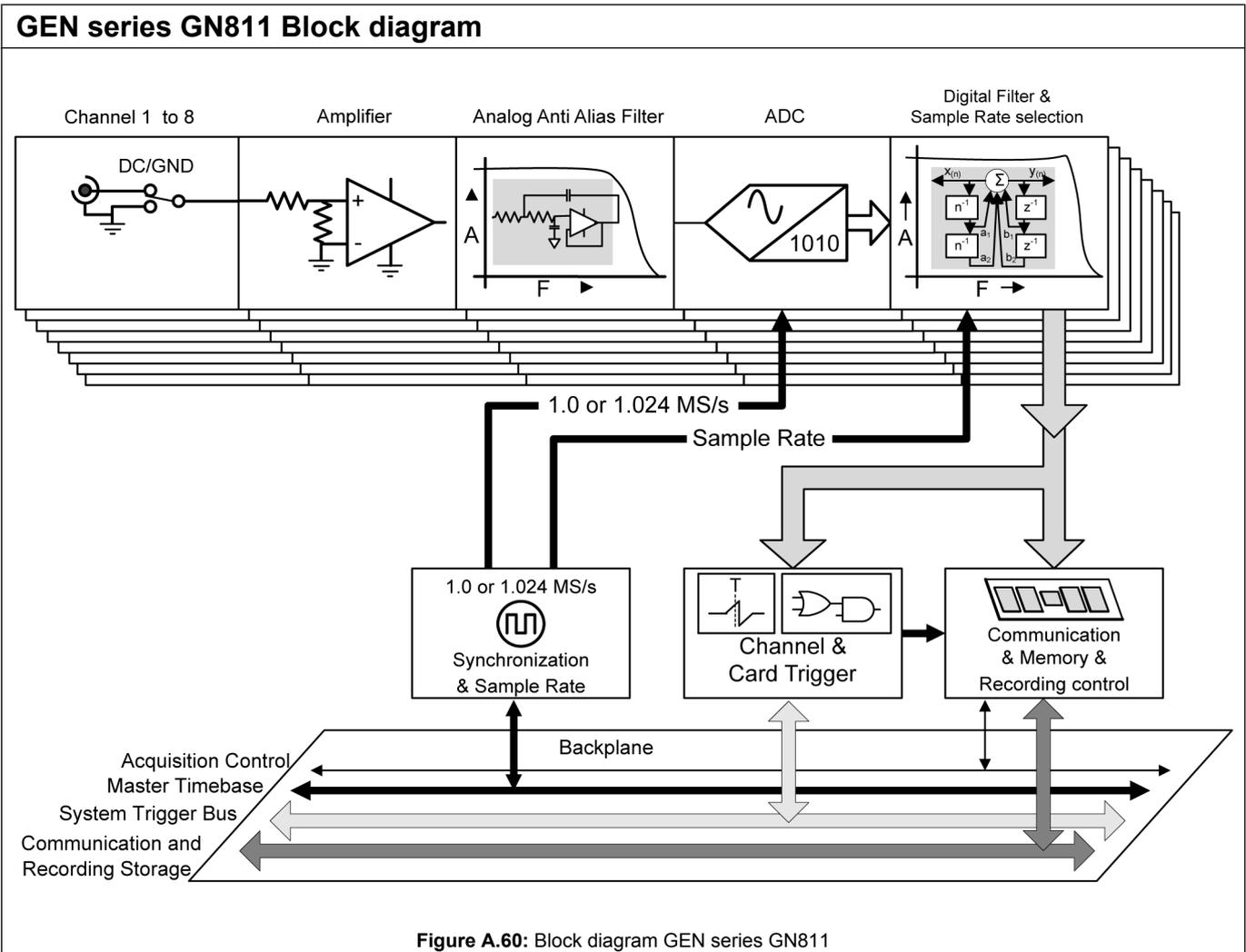
**Ordering Information<sup>(1)</sup>**

Article		Description	Order No.
Basic200k		8 Channel, 16 bits, 200 kS/s, $\pm 1$ V to $\pm 50$ 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.7 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



**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.*

<b>Analog Input Section</b>	
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 Each fixed range supports a variable gain with 1000 steps (0.1 %). Variable gain creates 1000 extra ranges between 2 fixed ranges.
Offset	± 50 % in 1000 steps (0.1 %); ± 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

<b>Analog to Digital Conversion</b>	
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 <sup>(1)</sup> ; 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

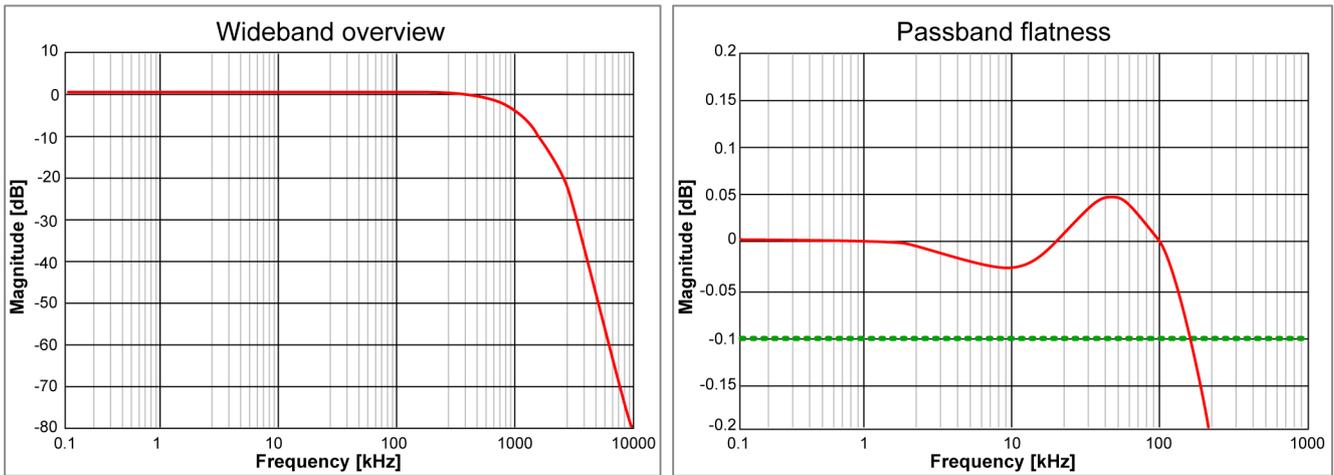
Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

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. 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. 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. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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) Supported by Perception V6.40 and higher	Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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

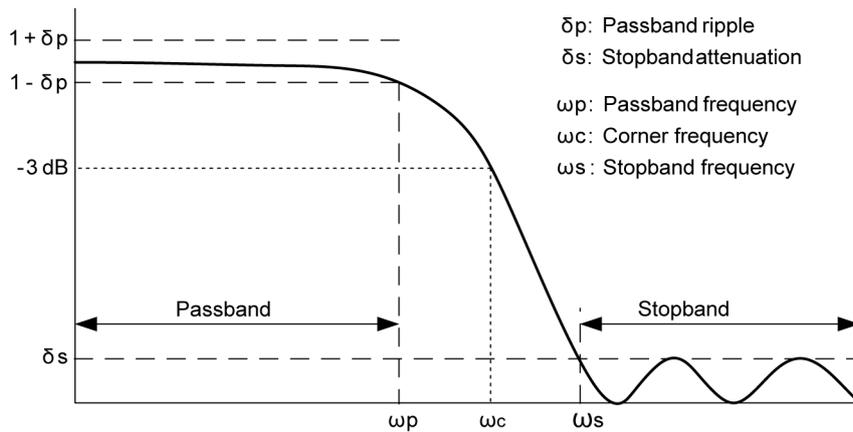
When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

Wideband bandwidth	Between 540 kHz and 690 kHz (-3 dB)
Passband flatness <sup>(1)</sup>	0.1 dB; DC to 150 kHz



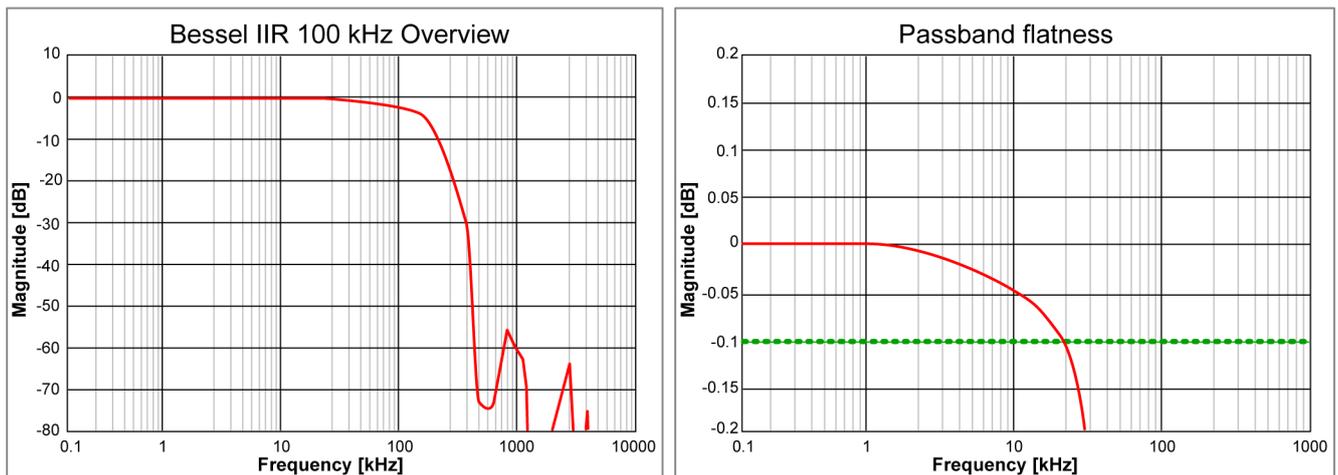
**Figure A.61:** Typical wideband overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

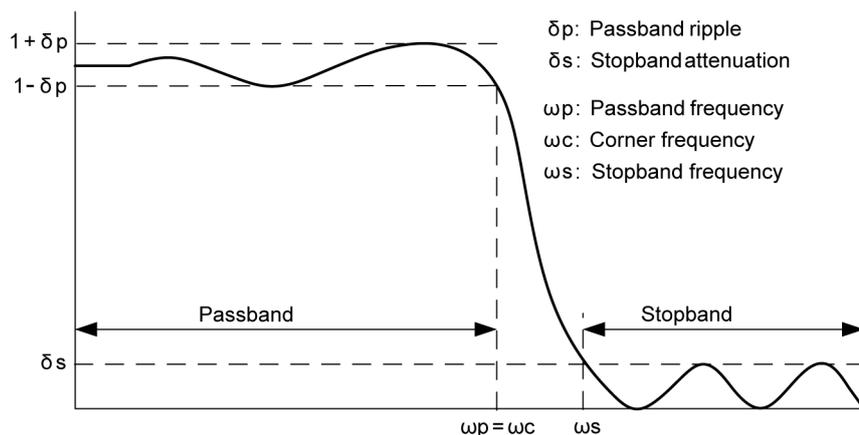
**Bessel IIR filter**

**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 100 kHz
Bessel IIR passband flatness ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to 20 kHz @ $\omega_c = 100$ kHz
Bessel IIR filter stop band attenuation ( $\delta_s$ )	-60 dB With Bessel IIR filter bandwidth selection $\omega_c = 100$ 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

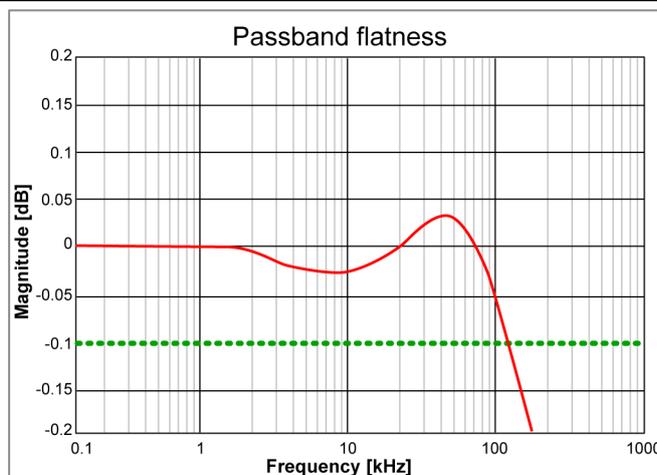
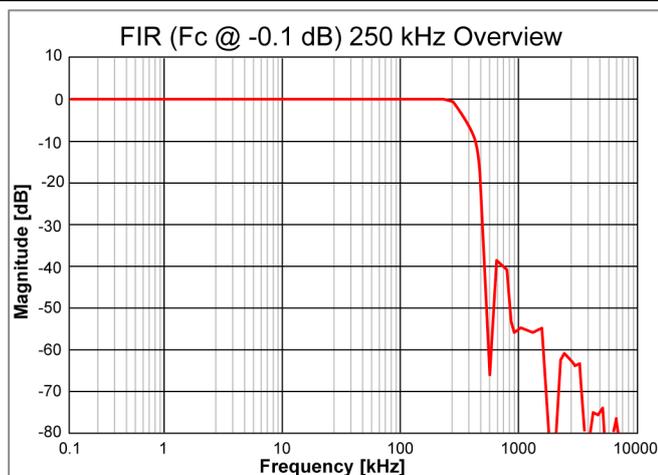

**Figure A.63:** Typical Bessel IIR  $\omega_c = 100$  kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

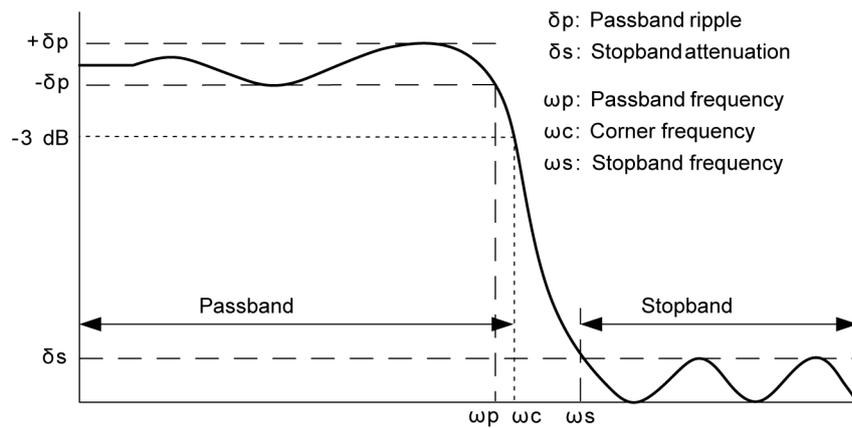
**FIR (Fc @ -0.1 dB) filter**

**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 $\pm$ 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 Divided by 40 not available for 1 MS/s & 500 kS/s sample rate User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
FIR (Fc @ -0.1 dB) filter bandwidth ( $\omega_c$ )	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 ( $\omega_p$ ) (1)	0.1 dB; DC to filter bandwidth ( $\omega_c$ ) 0.1 dB; DC to 125 kHz; FIR (Fc @ -0.1 dB) filter bandwidth selection $\omega_c = 250$ 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 ( $\delta_s$ )	-60 dB With FIR (Fc @ -0.1 dB) filter bandwidth selection $\omega_c = 250$ 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

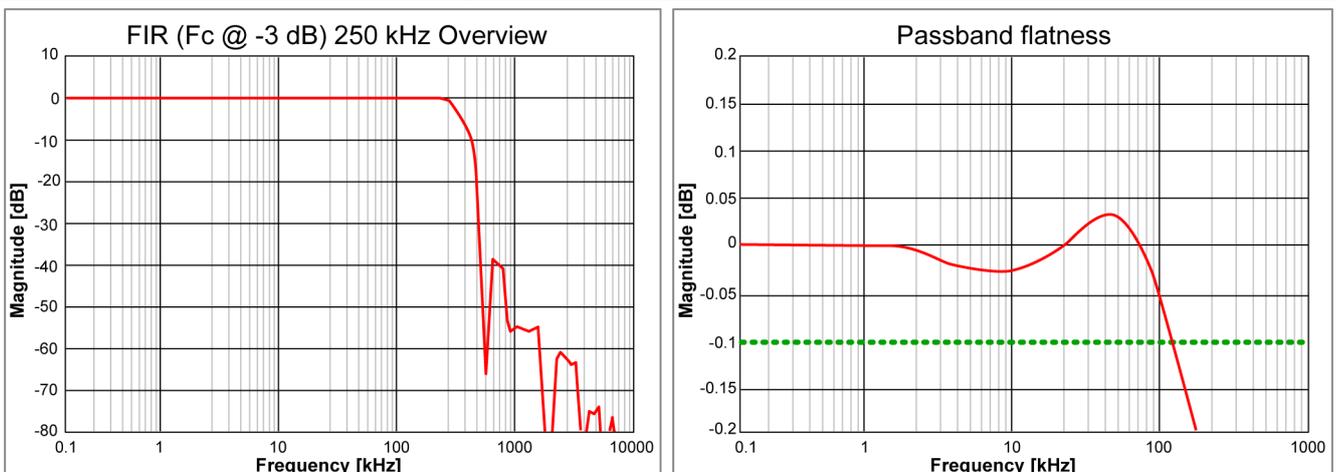

**Figure A.65:** Typical FIR (Fc @ -0.1 dB)  $\omega_c = 250$  kHz, Overview and passband flatness

(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  $\omega_p$  reduced by a factor of  $\approx 1.4$  compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

Analog anti aliasing filter bandwidth	370 kHz $\pm$ 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 Divided by 40 not available for 1 MS/s & 500 kS/s sample rate User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
FIR (Fc @ -3 dB) filter bandwidth ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to $\approx \omega_c/1.4$ (Adapted FIR filter behavior) 0.1 dB; DC to 125 kHz; FIR (Fc @ -3 dB) filter bandwidth selection $\omega_c = 250$ 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 ( $\delta_s$ )	-60 dB With FIR (Fc @ -3 dB) filter bandwidth selection $\omega_c = 250$ 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)  $\omega_c = 250$  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

<b>Triggering</b>	
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
<b>External Trigger In</b>	
Selection per card	User selectable On/Off
Active edge	Rising/Falling mainframe selectable, identical for all cards
Minimum pulse width	500 ns
Delay	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold high: Active from first mainframe trigger to end of recording Pulse width created by mainframe
Delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; Analog triggers of all channels Logical AND; Qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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 dT : 1 to 1023 samples. dT setting shared for both levels
<b>Analog channel trigger modes</b>	
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
<b>Analog channel qualifier modes</b>	
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 Maximum holdoff time sample rate dependent
<b>Interval timer</b>	
Modes	Less then, trigger when rate is too low More then, trigger when rate is too high Between, trigger when rate between lower and upper limit 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

<b>Triggering</b>	
Event counter	Counted channel trigger events before card trigger is activated 1 to 256 trigger events

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

<b>Real-Time Analysis</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

<b>Acquisition Modes</b>	
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.

<b>Recording Mode Details</b>									
	Single Sweep Multiple Sweeps 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 Maximum 50 kS/s		
Max. continuous streaming rate	not used			1 MS/s 2 MB/s	2 MS/s 4 MB/s	8 MS/s 16 MB/s	0.05 MS/s 0.1 MB/s	0.1 MS/s 0.2 MB/s	0.8 MS/s 1.6 MB/s

<b>Single Sweep</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 6 Cycles, cycle duration 24 hours

<b>Harmonized standards for CE compliance, according to the following directives</b>	
Low voltage directive (LVD): 2006/95/EC	
Electromagnetic compatibility directive (EMC): 2004/108/EC	
<b>Electrical Safety</b>	
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
<b>Electromagnetic Compatibility</b>	
EN 61326-1 (2006)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
<b>EMISSION</b>	
EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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
<b>IMMUNITY</b>	
EN 61000-4-2	Electrostatic discharge immunity test (ESD); contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test 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 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 Dips: performance criteria A; Interruptions: performance criteria C

**Ordering Information<sup>(1)</sup>**

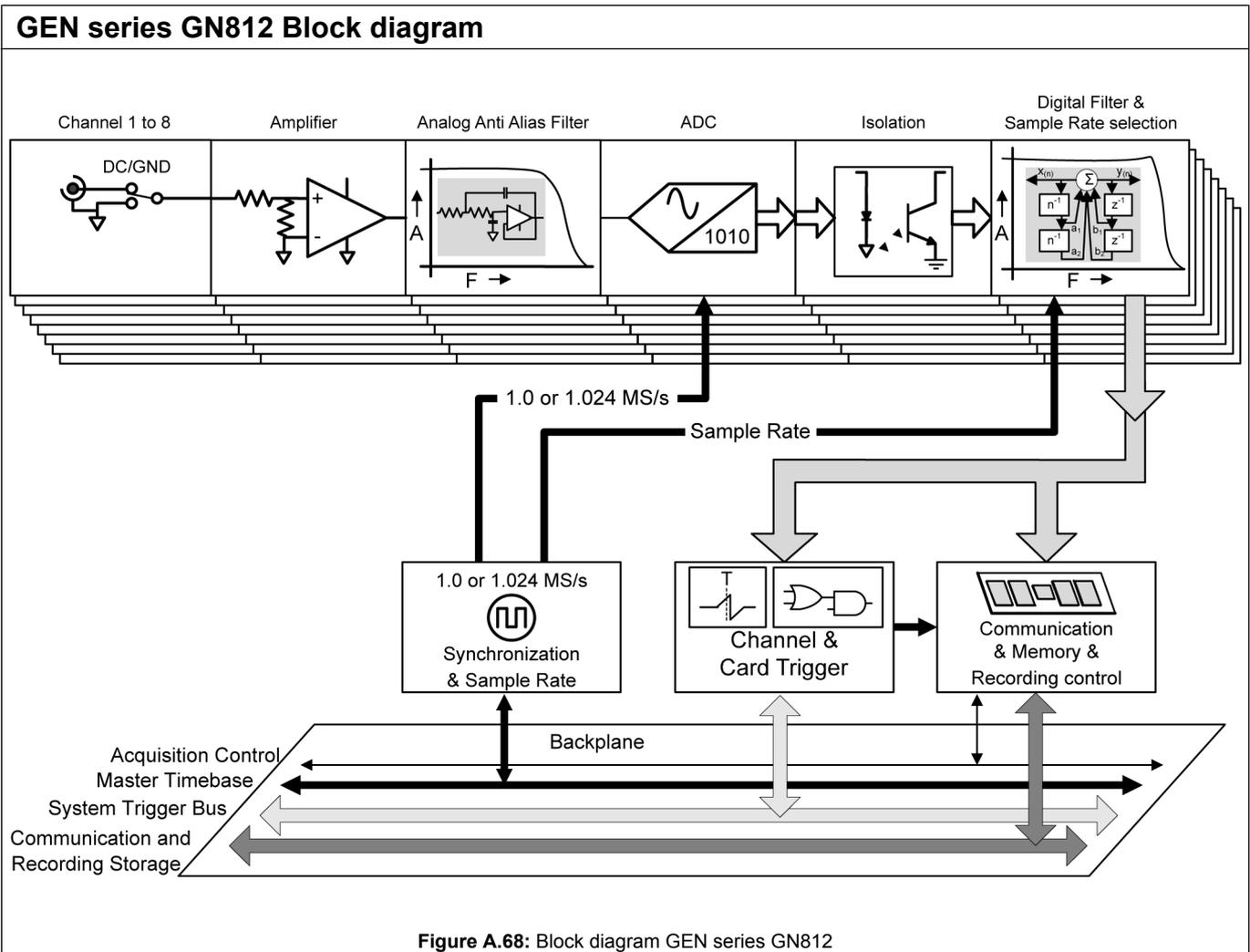
Article		Description	Order No.
Basic1M		8 Channel, 16 bits, 1 MS/s, $\pm 1$ V to $\pm 50$ V input range, 256 MB RAM (16 MS/channel), single ended, with single metal BNC for each channel	1-GN811-2

(1) All GEN series systems are intended for exclusive professional and industrial use.

**A.8 B2634-3.0 en (GEN series GN812)**

<b>Capabilities Overview</b>	
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 <sup>(1)</sup>

(1) An unbalanced differential input can be used to do isolated single ended and differential measurements.



**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.

<b>Analog Input Section</b>	
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 Each fixed range supports a variable gain with 1000 steps (0.1 %). Variable gain creates 1000 extra ranges between 2 fixed ranges.
Offset	± 50 % in 1000 steps (0.1 %); ± 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

<b>Isolation</b>	
Channel-to-chassis	± 250 V DC
Channel-to-channel	± 500 V DC
Nondestructive, to chassis (earth)	± 250 V DC

<b>Analog to Digital Conversion</b>	
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 <sup>(1)</sup> ; 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

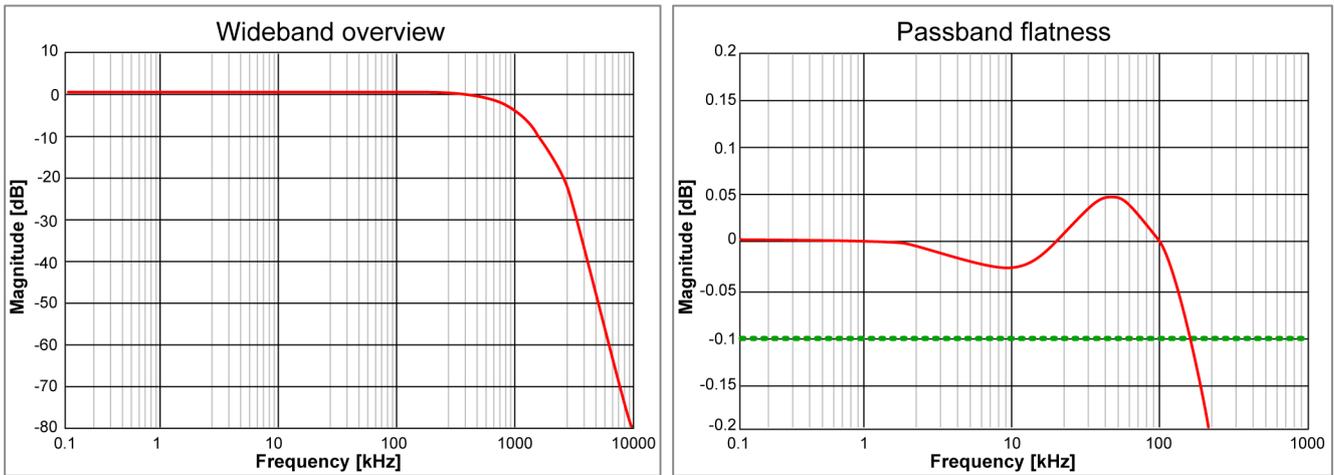
Using different filter selections (Wideband/Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

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. 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. 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. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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) Supported by Perception V6.40 and higher	Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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

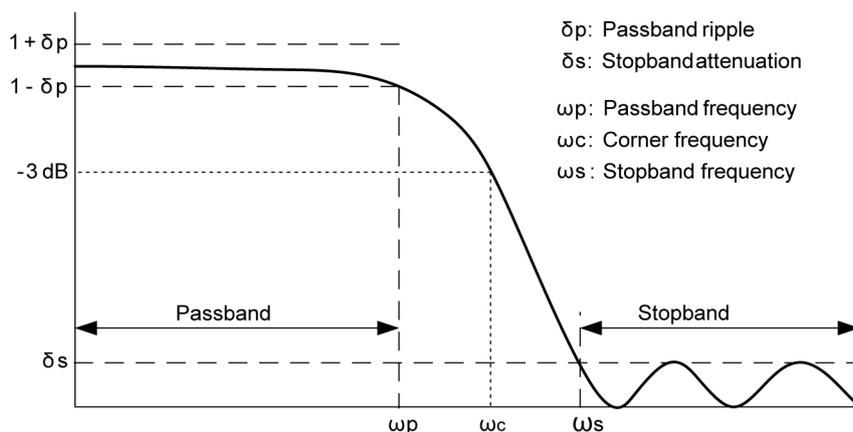
When wideband is selected there is neither an analog anti alias filter, nor any digital filter in the signal path. Therefore there is no anti alias protection when wideband is selected.

Wideband bandwidth	Between 540 kHz and 690 kHz (-3 dB)
Passband flatness <sup>(1)</sup>	0.1 dB; DC to 150 kHz



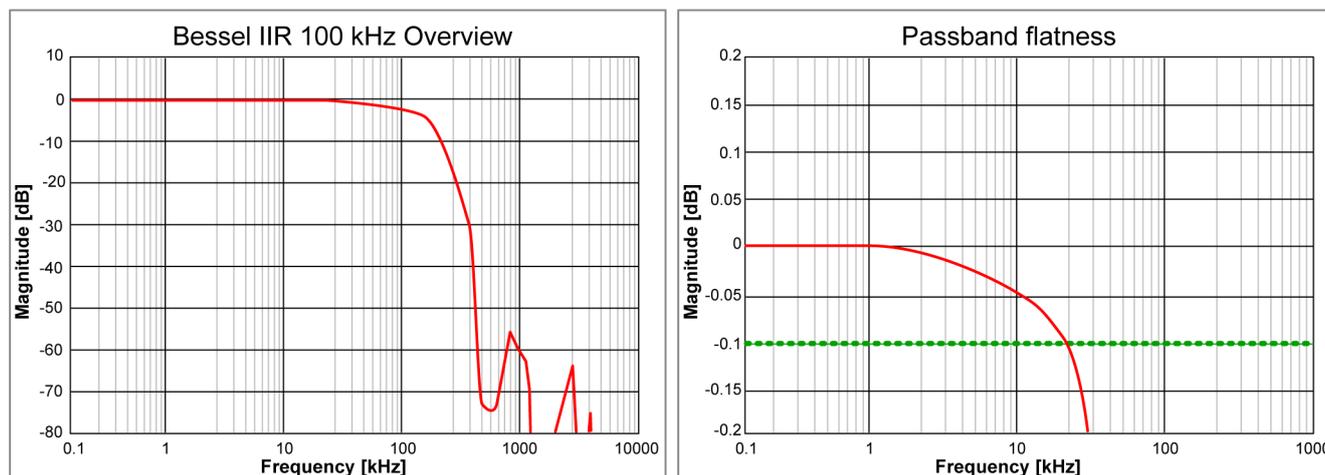
**Figure A.69:** Typical wideband overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

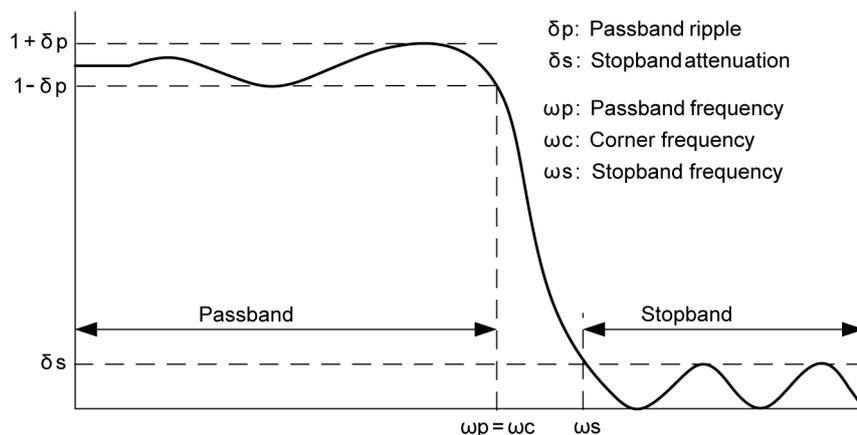
**Bessel IIR filter**

**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 100 kHz
Bessel IIR passband flatness ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to 20 kHz @ $\omega_c = 100$ kHz
Bessel IIR filter stop band attenuation ( $\delta_s$ )	-60 dB With Bessel IIR filter bandwidth selection $\omega_c = 100$ 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

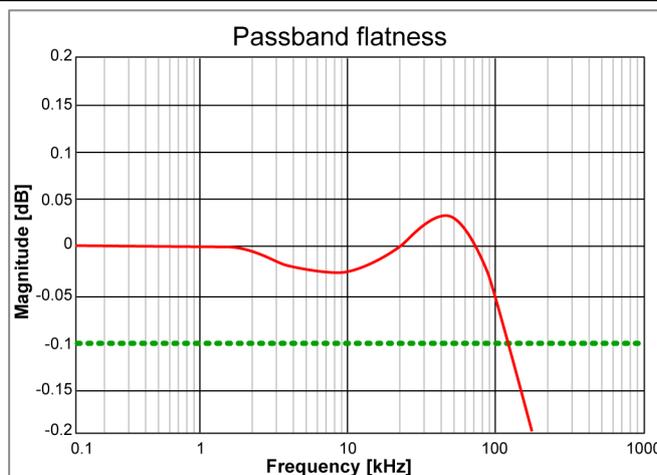
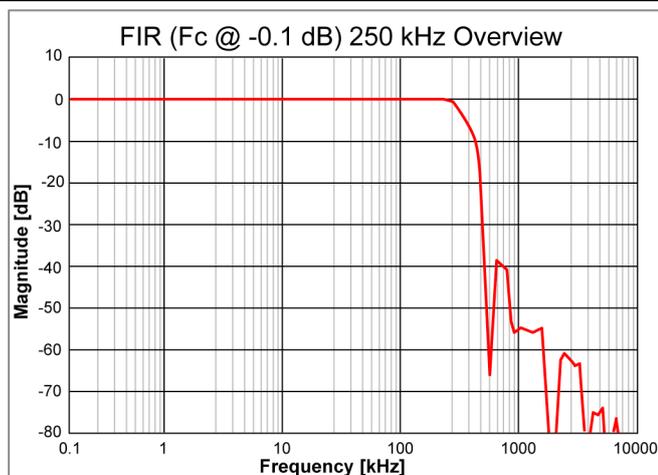

**Figure A.71:** Typical Bessel IIR  $\omega_c = 100$  kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

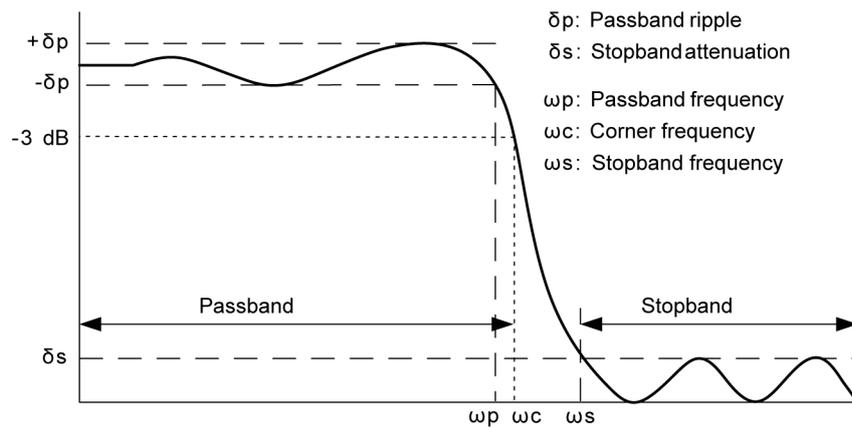
**FIR (Fc @ -0.1 dB) filter**

**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 $\pm$ 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 Divided by 40 not available for 1 MS/s & 500 kS/s sample rate User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
FIR (Fc @ -0.1 dB) filter bandwidth ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to filter bandwidth ( $\omega_c$ ) 0.1 dB; DC to 125 kHz; FIR (Fc @ -0.1 dB) filter bandwidth selection $\omega_c = 250$ 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 ( $\delta_s$ )	-60 dB With FIR (Fc @ -0.1 dB) filter bandwidth selection $\omega_c = 250$ 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

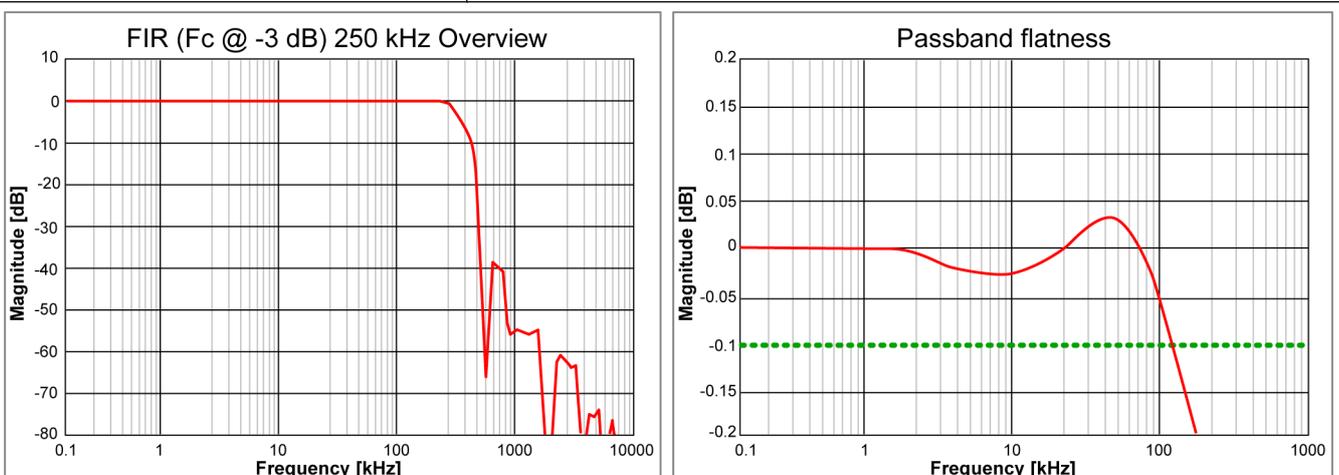

**Figure A.73:** Typical FIR (Fc @ -0.1 dB)  $\omega_c = 250$  kHz, Overview and passband flatness

(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  $\omega_p$  reduced by a factor of  $\approx 1.4$  compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

Analog anti aliasing filter bandwidth	370 kHz $\pm$ 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 Divided by 40 not available for 1 MS/s & 500 kS/s sample rate User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
FIR (Fc @ -3 dB) filter bandwidth ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to $\approx \omega_c/1.4$ (Adapted FIR filter behavior) 0.1 dB; DC to 125 kHz; FIR (Fc @ -3 dB) filter bandwidth selection $\omega_c = 250$ 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 ( $\delta_s$ )	-60 dB With FIR (Fc @ -3 dB) filter bandwidth selection $\omega_c = 250$ 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)  $\omega_c = 250$  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

<b>Triggering</b>	
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
<b>External Trigger In</b>	
Selection per card	User selectable On/Off
Active edge	Rising/Falling mainframe selectable, identical for all cards
Minimum pulse width	500 ns
Delay	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold high: Active from first mainframe trigger to end of recording Pulse width created by mainframe
Delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; Analog triggers of all channels Logical AND; Qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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 dT : 1 to 1023 samples. dT setting shared for both levels
<b>Analog channel trigger modes</b>	
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
<b>Analog channel qualifier modes</b>	
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 Maximum holdoff time sample rate dependent
<b>Interval timer</b>	
Modes	Less then, trigger when rate is too low More then, trigger when rate is too high Between, trigger when rate between lower and upper limit 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

<b>Triggering</b>	
Event counter	Counted channel trigger events before card trigger is activated 1 to 256 trigger events

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

<b>Real-Time Analysis</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

<b>Acquisition Modes</b>	
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.

<b>Recording Mode Details</b>									
	Single Sweep Multiple Sweeps 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 Maximum 50 kS/s		
Max. continuous streaming rate	not used			1 MS/s 2 MB/s	2 MS/s 4 MB/s	8 MS/s 16 MB/s	0.05 MS/s 0.1 MB/s	0.1 MS/s 0.2 MB/s	0.8 MS/s 1.6 MB/s

<b>Single Sweep</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 6 Cycles, cycle duration 24 hours

<b>Harmonized standards for CE compliance, according to the following directives</b>	
Low voltage directive (LVD): 2006/95/EC	
Electromagnetic compatibility directive (EMC): 2004/108/EC	
<b>Electrical Safety</b>	
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
<b>Electromagnetic Compatibility</b>	
EN 61326-1 (2006)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
<b>EMISSION</b>	
EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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
<b>IMMUNITY</b>	
EN 61000-4-2	Electrostatic discharge immunity test (ESD); contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test 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 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 Dips: performance criteria A; Interruptions: performance criteria C

**Ordering Information<sup>(1)</sup>**

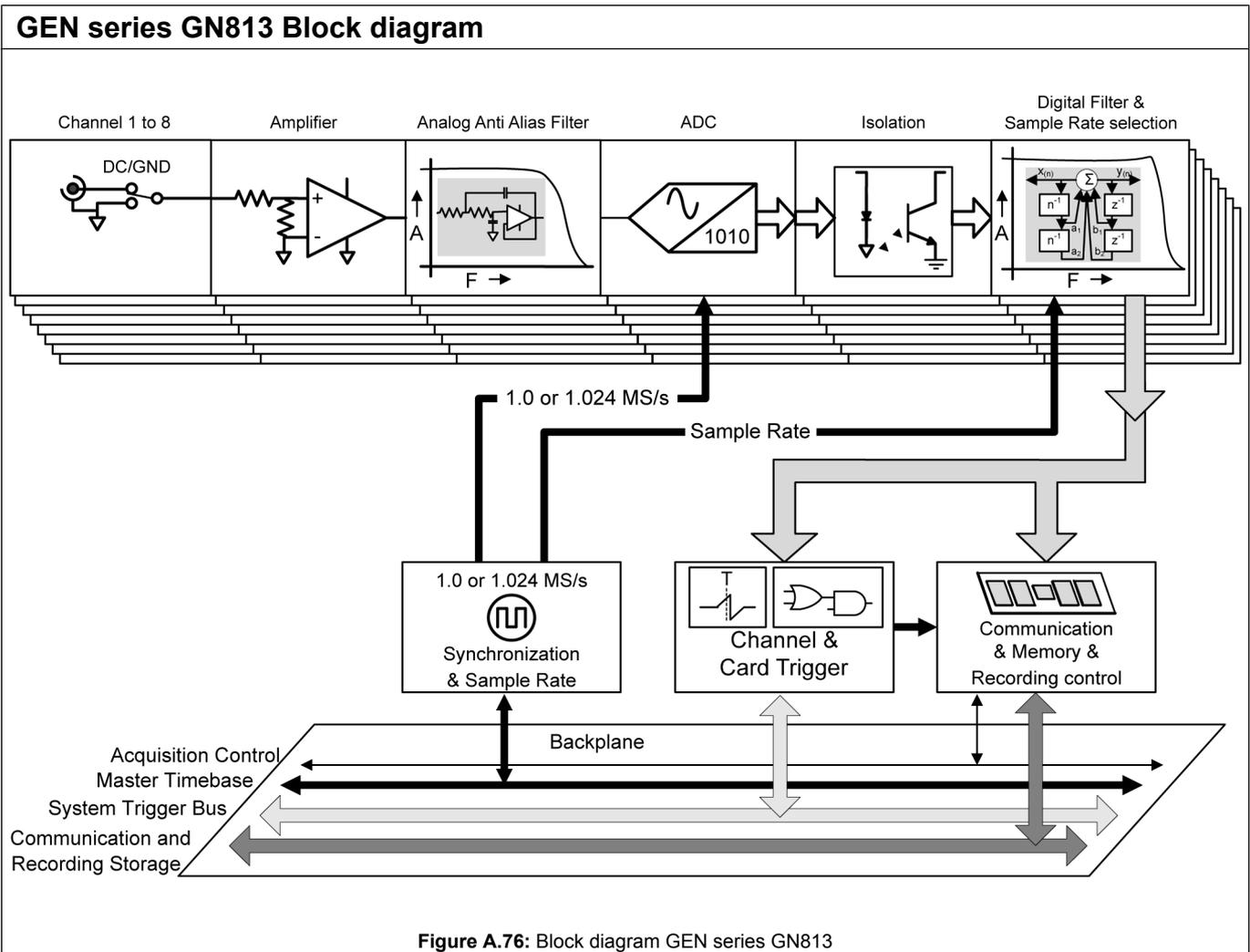
Article		Description	Order No.
Basic1M ISO		8 Channel, 16 bits, 1 MS/s, $\pm 1$ V to $\pm 50$ V input range, 512 MB RAM (32 MS/channel), isolated, unbalanced differential, with single isolated BNC for each channel	1-GN812-2

(1) All GEN series systems are intended for exclusive professional and industrial use.

**A.9 B2635-4.0 en (GEN series GN813)**

<b>Capabilities Overview</b>	
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 <sup>(1)</sup>

(1) An unbalanced differential input can be used to do isolated single ended and differential measurements.



**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.

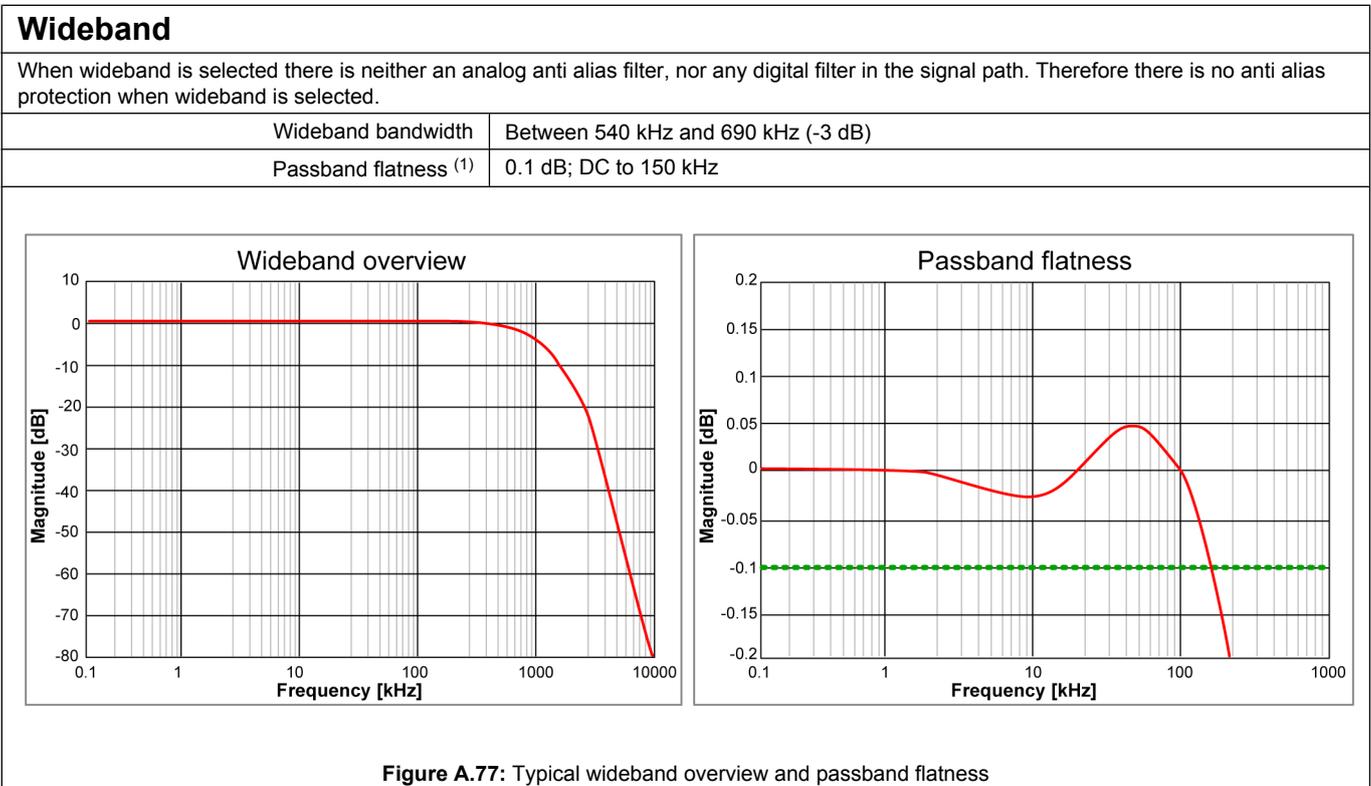
<b>Analog Input Section</b>	
Channels	8
Connectors	Fully isolated BNC (Plastic), 1 per channel
Input type	Analog isolated single ended, unbalanced differential
Input coupling	DC, GND
Impedance	1 MΩ ± 1% // 55 pF ± 10%
Ranges	± 2.0 V, ± 4.0 V, ± 10.0 V, ± 20 V, ± 40 V, ± 100 V Each fixed range supports a variable gain with 1000 steps (0.1 %). Variable gain creates 1000 extra ranges between 2 fixed ranges.
Offset	± 50 % in 1000 steps (0.1 %); ± 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

<b>Isolation</b>	
Channel-to-chassis	± 250 V DC
Channel-to-channel	± 500 V DC
Nondestructive, to chassis (earth)	± 250 V DC

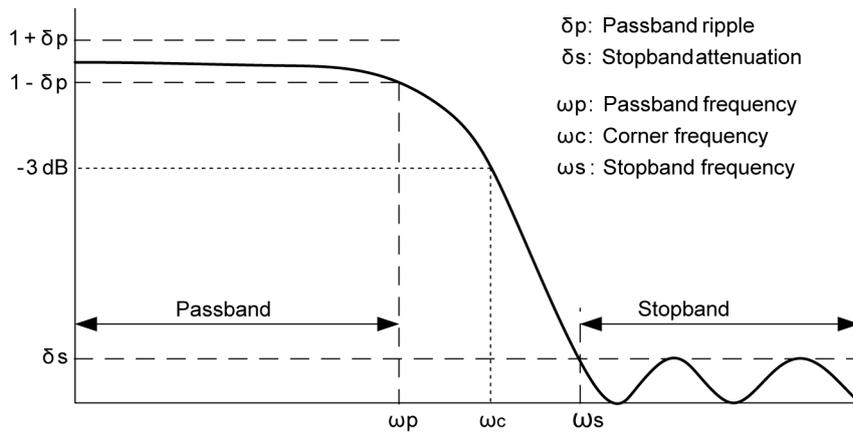
<b>Analog to Digital Conversion</b>	
Sample rate; per channel	0.1 S/s to 100 MS/s
ADC resolution; one ADC per channel	14 bit
ADC Type	CMOS pipelined multistep converter, LTC2254
Time base accuracy	Defined by mainframe: ± 3.5 ppm <sup>(1)</sup> ; aging after 10 years ± 10 ppm
Binary sample rate	Not supported
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

<b>Amplifier Bandwidth and Filtering</b>	
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. 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. 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. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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) Supported by Perception V6.40 and higher	Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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.

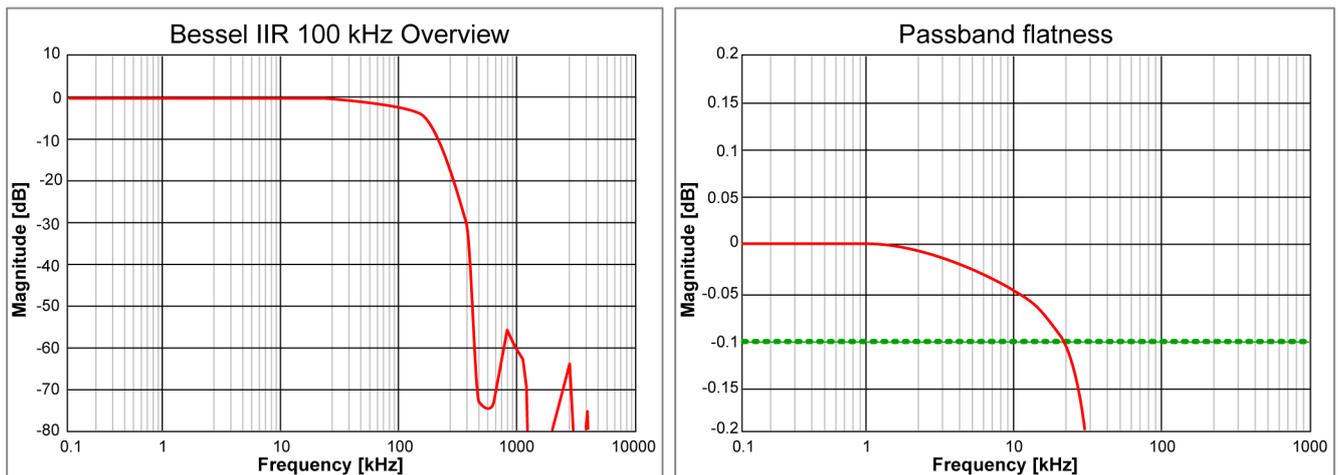


(1) Measured using Fluke 5700 calibrator, DC normalized

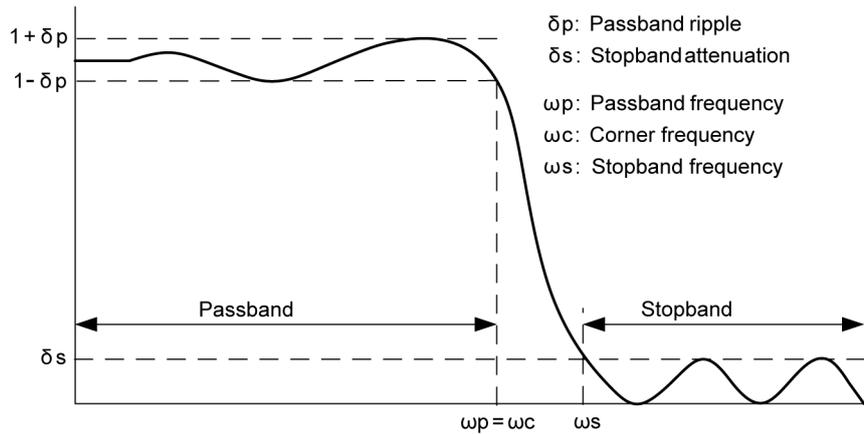
**Bessel IIR filter**

**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 100 kHz
Bessel IIR passband flatness ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to 20 kHz @ $\omega_c = 100$ kHz
Bessel IIR filter stop band attenuation ( $\delta_s$ )	-60 dB With Bessel IIR filter bandwidth selection $\omega_c = 100$ 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

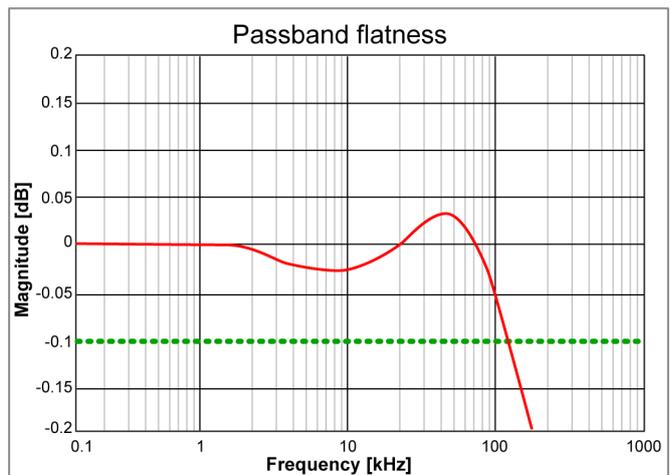
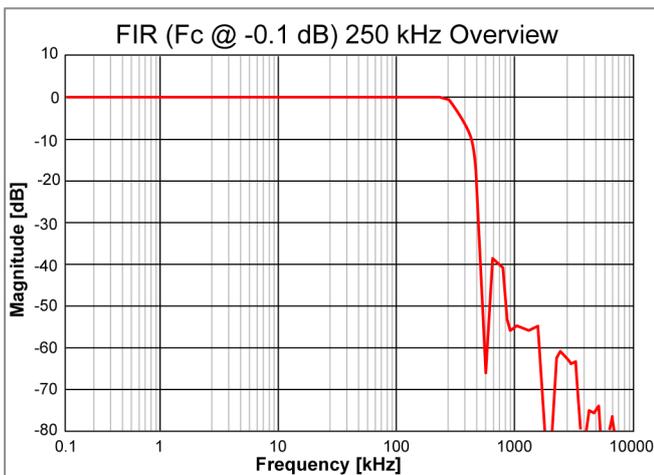

**Figure A.79:** Typical Bessel IIR  $\omega_c = 100$  kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

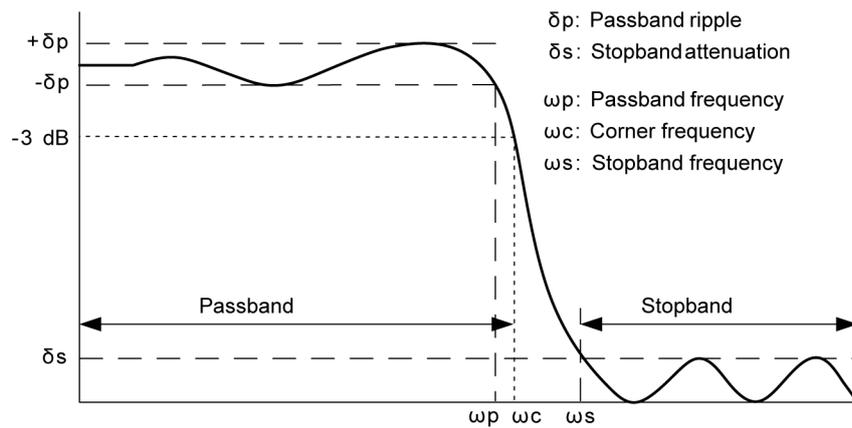
**FIR (Fc @ -0.1 dB) filter**

**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 $\pm$ 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 Divided by 40 not available for 1 MS/s & 500 kS/s sample rate User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
FIR (Fc @ -0.1 dB) filter bandwidth ( $\omega_c$ )	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 ( $\omega_p$ ) (1)	0.1 dB; DC to filter bandwidth ( $\omega_c$ ) 0.1 dB; DC to 125 kHz; FIR (Fc @ -0.1 dB) filter bandwidth selection $\omega_c = 250$ 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 ( $\delta_s$ )	-60 dB With FIR (Fc @ -0.1 dB) filter bandwidth selection $\omega_c = 250$ 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

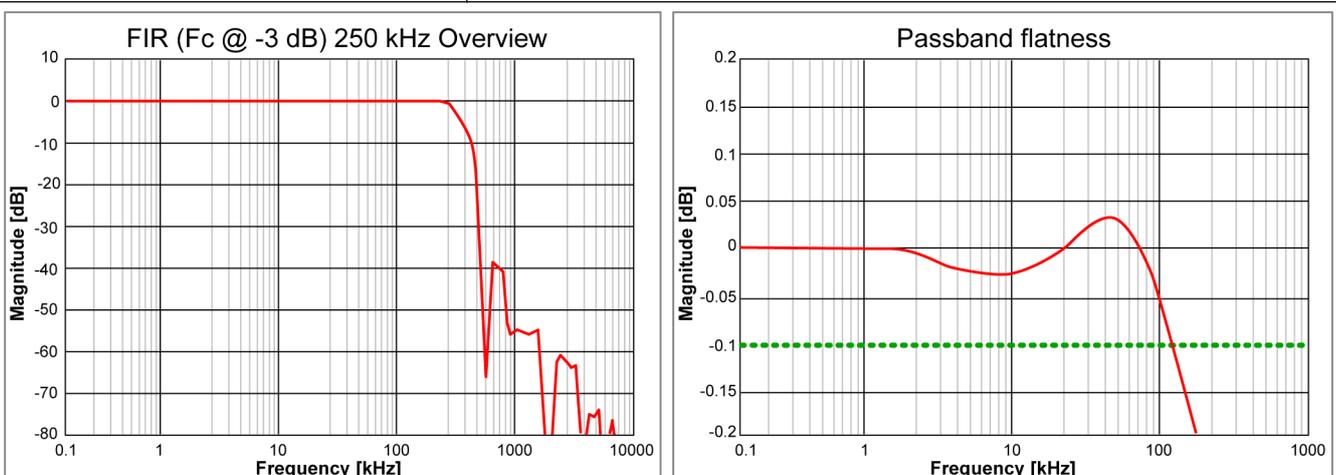

**Figure A.81:** Typical FIR (Fc @ -0.1 dB)  $\omega_c = 250$  kHz, Overview and passband flatness

(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  $\omega_p$  reduced by a factor of  $\approx 1.4$  compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

Analog anti aliasing filter bandwidth	370 kHz $\pm$ 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 Divided by 40 not available for 1 MS/s & 500 kS/s sample rate User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
FIR (Fc @ -3 dB) filter bandwidth ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to $\approx \omega_c/1.4$ (Adapted FIR filter behavior) 0.1 dB; DC to 125 kHz; FIR (Fc @ -3 dB) filter bandwidth selection $\omega_c = 250$ 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 ( $\delta_s$ )	-60 dB With FIR (Fc @ -3 dB) filter bandwidth selection $\omega_c = 250$ 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)  $\omega_c = 250$  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 $\mu$ s)
GN813 Channels within mainframe	0.7 deg (0.02 $\mu$ s)
Bessel IIR (Fc @ -3 dB), 100 kHz Filter frequency	
Channels on card	0.7 deg (0.02 $\mu$ s)
GN813 Channels within mainframe	0.7 deg (0.02 $\mu$ s)
FIR (Fc@ -0.1dB) and FIR (Fc @ -3 dB), 250 kHz Filter frequency	
Channels on card	0.7 deg (0.02 $\mu$ s)
GN813 Channels within mainframe	0.7 deg (0.02 $\mu$ s)
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

<b>Triggering</b>	
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
<b>External Trigger In</b>	
Selection per card	User selectable On/Off
Active edge	Rising/Falling mainframe selectable, identical for all cards
Minimum pulse width	500 ns
Delay	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold high: Active from first mainframe trigger to end of recording Pulse width created by mainframe
Delay	516 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s} \pm 1 \mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; Analog triggers of all channels Logical AND; Qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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 dT : 1 to 1023 samples. dT setting shared for both levels
<b>Analog channel trigger modes</b>	
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
<b>Analog channel qualifier modes</b>	
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 Maximum holdoff time sample rate dependent
<b>Interval timer</b>	
Modes	Less then, trigger when rate is too low More then, trigger when rate is too high Between, trigger when rate between lower and upper limit 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

<b>Triggering</b>	
Event counter	Counted channel trigger events before card trigger is activated 1 to 256 trigger events

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

<b>Real-Time Analysis</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

<b>Acquisition Modes</b>	
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.

<b>Recording Mode Details</b>									
	Single Sweep Multiple Sweeps 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 Maximum 50 kS/s		
Max. continuous streaming rate	not used			1 MS/s 2 MB/s	2 MS/s 4 MB/s	8 MS/s 16 MB/s	0.05 MS/s 0.1 MB/s	0.1 MS/s 0.2 MB/s	0.8 MS/s 1.6 MB/s

<b>Single Sweep</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 6 Cycles, cycle duration 24 hours

<b>Harmonized standards for CE compliance, according to the following directives</b>	
Low voltage directive (LVD): 2006/95/EC	
Electromagnetic compatibility directive (EMC): 2004/108/EC	
<b>Electrical Safety</b>	
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
<b>Electromagnetic Compatibility</b>	
EN 61326-1 (2006)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
<b>EMISSION</b>	
EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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
<b>IMMUNITY</b>	
EN 61000-4-2	Electrostatic discharge immunity test (ESD); contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test 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 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 Dips: performance criteria A; Interruptions: performance criteria C

**Ordering Information<sup>(1)</sup>**

Article	Description	Order No.
Basic1M ISO XT	 <p>8 Channel, 16 bits, 1 MS/s, <math>\pm 2</math> V to <math>\pm 100</math> V input range, 512 MB RAM (32 MS/channel), isolated, unbalanced differential, with single isolated BNC for each channel</p>	1-GN813-2

(1) All GEN series systems are intended for exclusive professional and industrial use.

**Accessories, to be ordered separately**

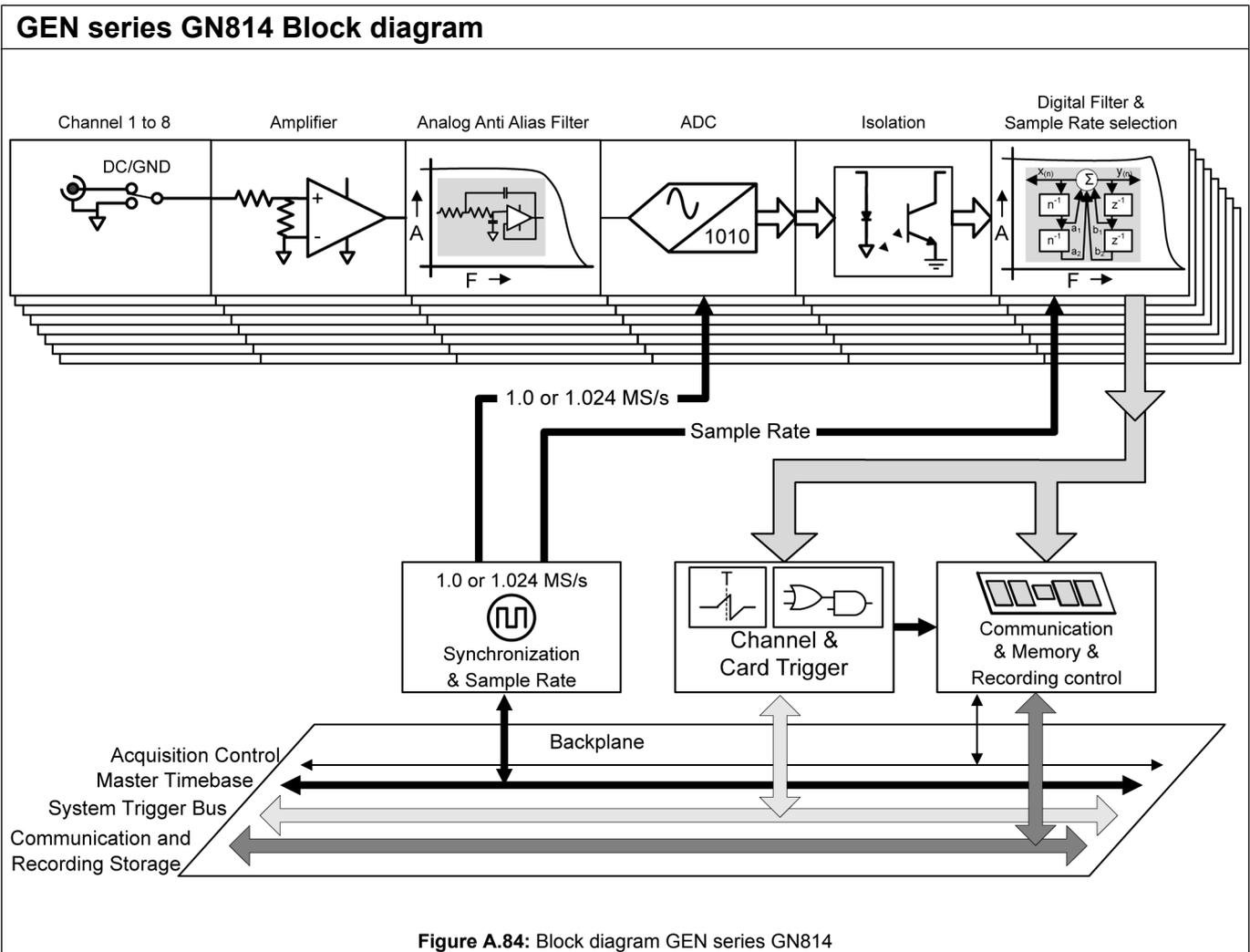
Article	Description	Order No.
1kV DC Probe <sup>(1)</sup>	<p>Probe Rack with 16 probes</p>  <p>1 : 10 Voltage divider; DC coupled, <math>\pm 1</math> kV input; for isolated Basic1M XT ISO Card with extended input range only; requires DC probe rack to be mounted; 1.25 m (49 inch) cable</p>	1-G041-2
1kV AC Probe <sup>(1)</sup>	<p>1 : 1 AC coupler probe. AC coupled, <math>\pm 100</math> V AC measurement. Input allows up to <math>\pm 1</math> kV DC with a <math>\pm 100</math> V AC modulated signal. DC part of input signal suppressed on the output. For use with Basic1M XT ISO or Basic200k XT ISO only.</p>	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.10 B2889-5.0 en (GEN series GN814)**

<b>Capabilities Overview</b>	
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 <sup>(1)</sup>

(1) An unbalanced differential input can be used to do isolated single ended and differential measurements.



**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.

<b>Analog Input Section</b>	
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 Each fixed range supports a variable gain with 1000 steps (0.1 %). Variable gain creates 1000 extra ranges between 2 fixed ranges.
Offset	± 50 % in 1000 steps (0.1 %); ± 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

<b>Isolation</b>	
Channel-to-chassis	± 250 V DC
Channel-to-channel	± 500 V DC
Nondestructive, to chassis (earth)	± 250 V DC

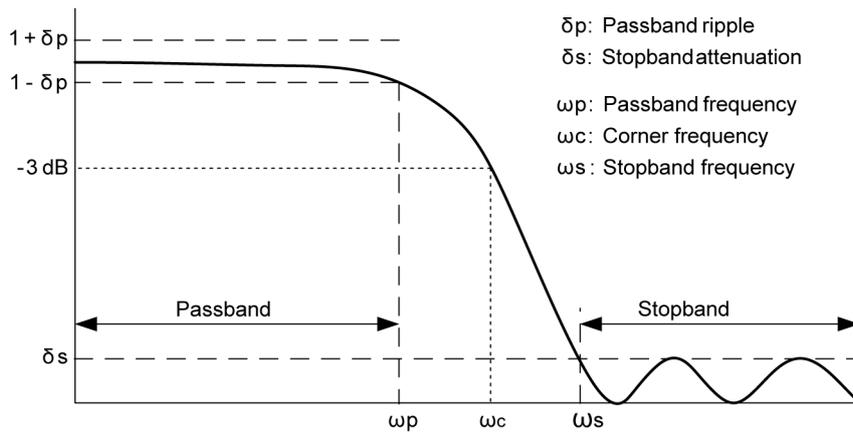
<b>Analog to Digital Conversion</b>	
Sample rate; per channel	0.1 S/s to 200 kS/s
ADC resolution; one ADC per channel	16 bit
ADC Type	Successive Approximation Register (SAR); TI ADS8401B
Time base accuracy	Defined by mainframe: ± 3.5 ppm <sup>(1)</sup> ; aging after 10 years ± 10 ppm
Binary sample rate	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

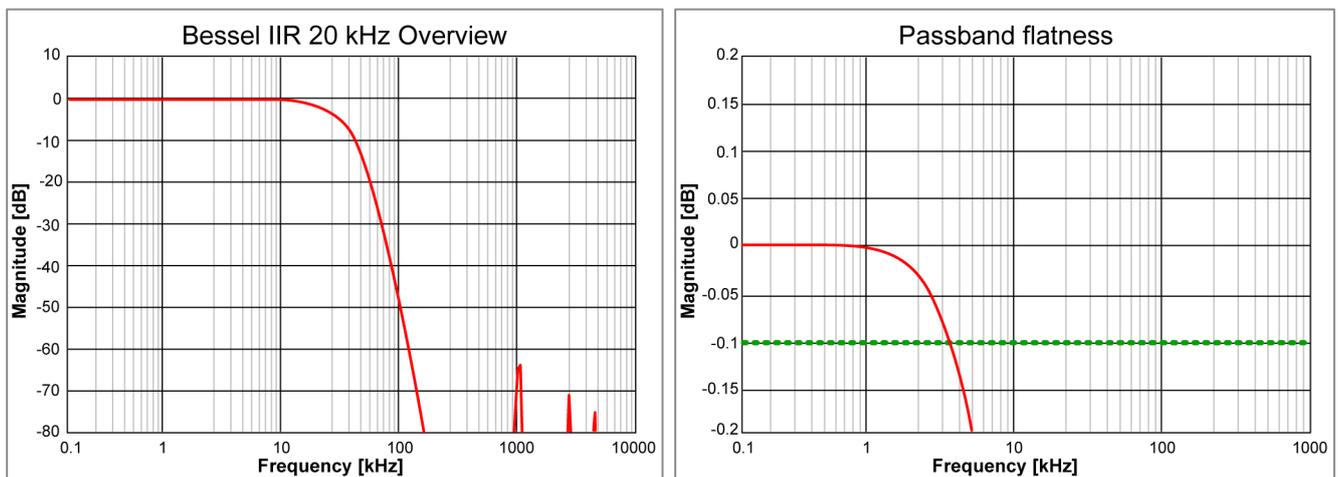
Using different filter selections (Bessel IIR/FIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.

<p>Bessel IIR (Fc @ -3 dB)</p>	<p>When Bessel IIR filter is selected, this is always a combination of an analog Bessel anti alias filter and a digital Bessel IIR filter. 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.</p>
<p>FIR (Fc @ -0.1 dB)</p>	<p>Standard FIR filter with corner frequency (Fc) defined at -0.1 dB. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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.</p>
<p>FIR (Fc @ -3 dB) Supported by Perception V6.40 and higher</p>	<p>Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB. When FIR filter is selected, this is always a combination of an analog Butterworth anti alias filter and a digital FIR filter. 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.</p>

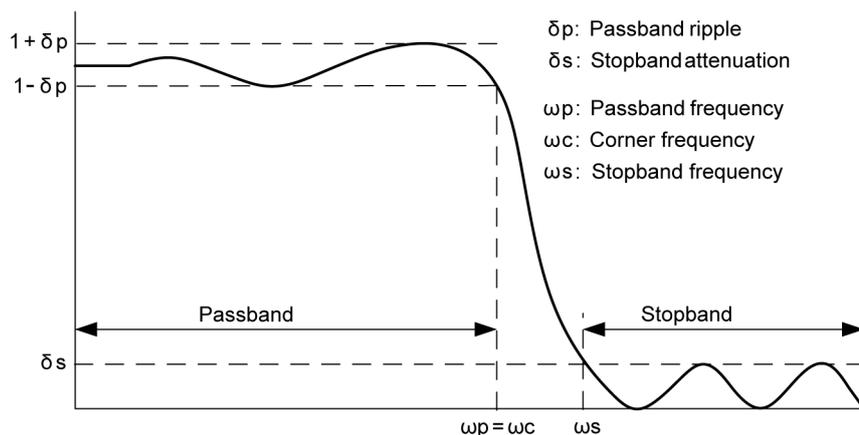
**Bessel IIR filter**

**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 $\pm$ 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 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bessel IIR filter bandwidth ( $\omega_c$ )	Auto tracking the sample rate with the selected Bessel IIR filter user selection from 0.0125 Hz to 20 kHz
Bessel IIR passband flatness ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to 3 kHz @ $\omega_c = 20$ kHz
Bessel IIR filter stop band attenuation ( $\delta_s$ )	-60 dB
Bessel IIR filter roll-off	-36 dB/Octave

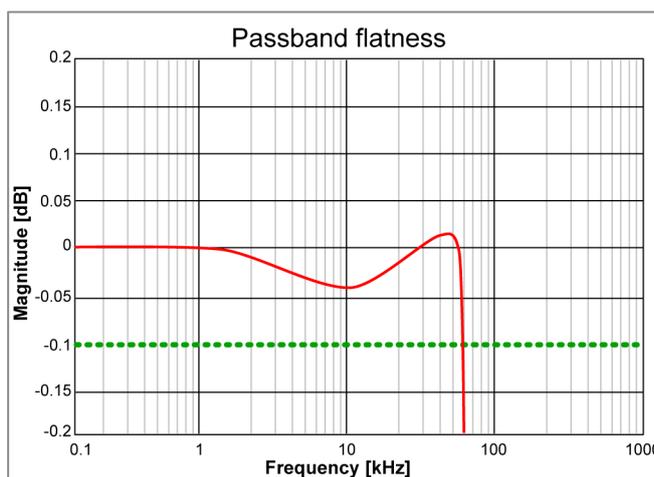
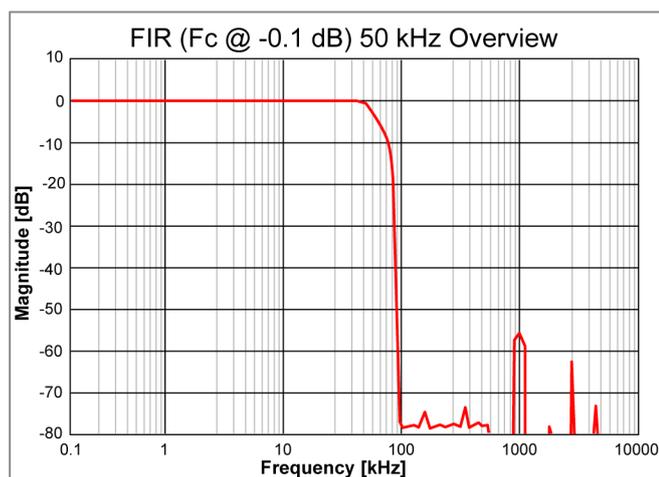

**Figure A.86:** Bessel IIR  $\omega_c = 20$  kHz, Overview and passband flatness

(1) Measured using Fluke 5700 calibrator, DC normalized

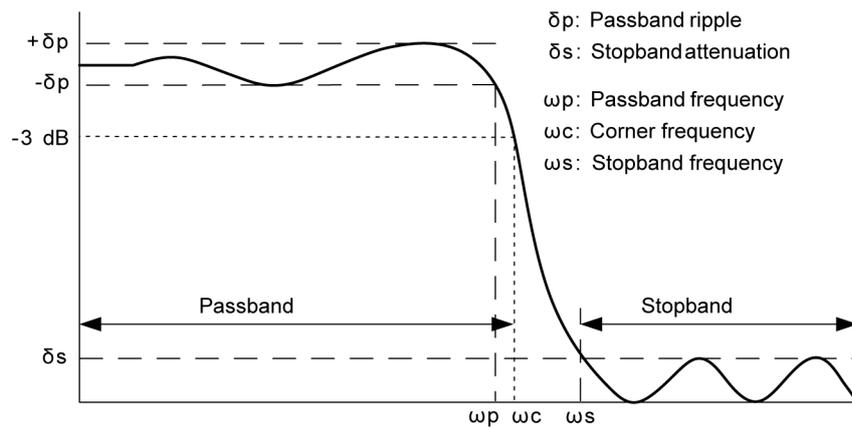
**FIR (Fc @ -0.1 dB) filter**

**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 $\pm$ 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 ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to filter bandwidth ( $\omega_c$ )
FIR (Fc @ -0.1 dB) filter stopband attenuation ( $\delta_s$ )	-60 dB
FIR (Fc @ -0.1 dB) filter roll-off	-72 dB/Octave

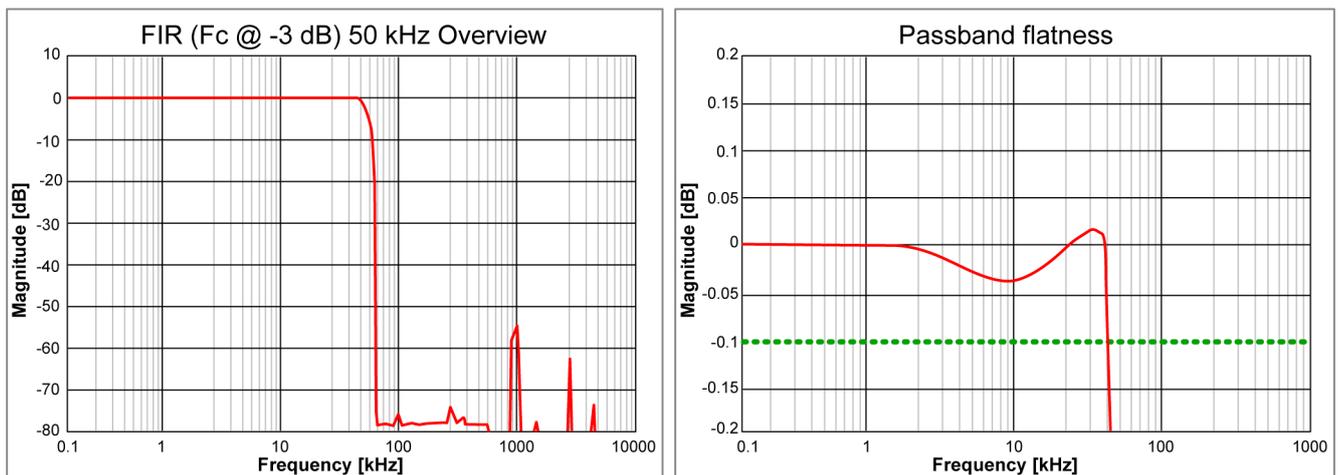

**Figure A.88:** Typical FIR (Fc @ -0.1 dB)  $\omega_c = 50$  kHz, Overview and passband flatness

(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  $\omega_p$  reduced by a factor of  $\approx 1.4$  compared to the FIR (Fc @ -0.1 dB) filter. Supported by Perception V6.40 and higher.

Analog anti aliasing filter bandwidth	370 kHz $\pm$ 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 ( $\omega_c$ )	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 ( $\omega_p$ ) <sup>(1)</sup>	0.1 dB; DC to $\approx \omega_c/1.4$ (Adapted FIR filter behavior)
FIR (Fc @ -3 dB) filter stopband attenuation ( $\delta_s$ )	-60 dB
FIR (Fc @ -3 dB) filter roll-off	-72 dB/Octave


**Figure A.90:** Typical FIR (Fc @ -3 dB)  $\omega_c = 50$  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 $\mu$ s)
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GN814 Channels within mainframe	0.4 deg (0.1 $\mu$ s)
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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 $\mu$ s)
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GN814 Channels within mainframe	0.4 deg (0.1 $\mu$ s)
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GN814 Channels across mainframes	Defined by synchronization method used (None, IRIG, GPS, Master/Slave)
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### On-board Memory

Per card	128 MB (64 MS)
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Organization	Automatic distribution amongst enabled channels
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Memory diagnostics	Automatic memory test when system is powered and not recording
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Storage sample size	16 bits, 2 bytes/sample
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### Digital Events/Timer/Counter

Digital event inputs	Not supported
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Digital event outputs	Not supported
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Timer/Counter	Not supported
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<b>Triggering</b>	
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
<b>External Trigger In</b>	
Selection per card	User selectable On/Off
Active edge	Rising/Falling mainframe selectable, identical for all cards
Minimum pulse width	500 ns
Delay	$\pm 1 \mu\text{s}$ + 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
<b>External Trigger Out</b>	
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 $\mu\text{s}$ Hold high: Active from first mainframe trigger to end of recording Pulse width created by mainframe
Delay	516 $\mu\text{s}$ $\pm$ 1 $\mu\text{s}$ + maximum 1 sample period using decimal time base 504 $\mu\text{s}$ $\pm$ 1 $\mu\text{s}$ + maximum 1 sample period using binary time base
<b>Cross channel triggering</b>	
Channels on card	Logical OR; Analog triggers of all channels Logical AND; Qualifiers of all channels
Cards in mainframe	User selectable through system trigger bus Selections: Send/Receive/Transceive (Send & Receive)
<b>System trigger bus</b>	
Connections	3 System trigger busses connecting all cards within mainframe 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 Logical AND of all qualifiers of all cards
<b>Analog channel trigger levels</b>	
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 dT : 1 to 1023 samples. dT setting shared for both levels
<b>Analog channel trigger modes</b>	
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
<b>Analog channel qualifier modes</b>	
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 Maximum holdoff time sample rate dependent
<b>Interval timer</b>	
Modes	Less then, trigger when rate is too low More then, trigger when rate is too high Between, trigger when rate between lower and upper limit 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

<b>Triggering</b>	
Event counter	Counted channel trigger events before card trigger is activated 1 to 256 trigger events

<b>Alarm Output</b>	
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 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using decimal time base 503 $\mu$ s $\pm$ 1 $\mu$ s + maximum 1 sample period using binary time base

<b>Real-Time Analysis</b>	
StatStream® Patent Number : 7,868,886	Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values Supports the real-time Live scrolling and scoping waveform displays as well as the real-time meters during recording Supports the fast displaying and zooming within extremely large recordings Supports the fast calculation of statistical channel information

<b>Acquisition Modes</b>	
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.

<b>Recording Mode Details</b>									
	Single Sweep Multiple Sweeps 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 Maximum 50 kS/s		
Max. continuous streaming rate	not used			0.2 MS/s 0.4 MB/s	0.4 MS/s 0.8 MB/s	1.6 MS/s 3.2 MB/s	0.05 MS/s 0.1 MB/s	0.1 MS/s 0.2 MB/s	0.8 MS/s 1.6 MB/s

<b>Single Sweep</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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

<b>Multiple Sweeps</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 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 trigger occurs.

<b>Slow Fast Sweep</b>	
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

<b>Continuous</b>	
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 using a streaming rate selected 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.

<b>Dual</b>	
<b>Dual Sweep Specification</b>	
Pre-trigger segment	0 % to 100 % of selected sweep length 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 recording
Maximum sweep rate	400 triggers 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 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 trigger occurs.
<b>Dual Continuous Specifications</b>	
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 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 using a streaming rate selected 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.

<b>Environmental Specifications</b>	
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 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 IEC 60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC 60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity >95/90 % RH 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
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#### EMISSION

EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement 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); contact discharge $\pm 4$ kV/air discharge $\pm 8$ kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 80 to 2700 MHz using 10 V/m, 1000 Hz AM: performance criteria A
EN 61000-4-4	Electrical fast transient/burst immunity test Mains $\pm 2$ kV using coupling network. Channel $\pm 2$ kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test Mains $\pm 0.5$ kV/ $\pm 1$ kV Line-Line and $\pm 0.5$ kV/ $\pm 1$ kV/ $\pm 2$ kV Line-earth Channel $\pm 0.5$ kV/ $\pm 1$ 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 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 Dips: performance criteria A; Interruptions: performance criteria C

**Ordering Information<sup>(1)</sup>**

Article	Description	Order No.
Basic200k ISO XT	 <p>8 Channel, 16 bits, 200 kS/s, <math>\pm 2</math> V to <math>\pm 100</math> V input range, 128 MB RAM (8 MS/channel), isolated, unbalanced differential, with single isolated BNC for each channel</p>	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 <sup>(1)</sup>	<p>Probe Rack with 16 probes</p>  <p>1 : 10 Voltage divider; DC coupled, <math>\pm 1</math> 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</p>	1-G041-2
1kV AC Probe <sup>(1)</sup>	<p>1 : 1 AC coupler probe. AC coupled, <math>\pm 100</math> V AC measurement. Input allows up to <math>\pm 1</math> kV DC with a <math>\pm 100</math> V AC modulated signal. DC part of input signal suppressed on the output. For use with Basic1M XT ISO or Basic200k XT ISO only.</p>	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 B3244-1.0 en (GEN series GN410 and GN411)**

Capabilities Overview		
Component	Value	
Model	<b>Bridge 200K ISO Digitizer</b>	<b>Bridge 1M ISO Digitizer</b>
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 %)		$\pm 2$ mV, $\pm 5$ mV, $\pm 10$ mV, $\pm 20$ mV, $\pm 50$ mV, $\pm 100$ mV, $\pm 200$ mV, $\pm 500$ mV, $\pm 1$ V, $\pm 2$ V, $\pm 5$ V, $\pm 10$ V
Offset	1000 steps		0.1 %
Coupling	AC DC, GND		-3 dB @ 0.16 Hz
Impedance			2x 10 M $\Omega$ // 130 pF
Analog bandwidth	Overall bandwidth is always limited by digital filters		20 kHz ( <b>Bridge 200k only</b> )
Maximum Static Error			
	Wideband		0.2 % of FS $\pm$ 120 $\mu$ V
	Bessel/Butterworth		0.1 % of FS $\pm$ 40 $\mu$ V
Noise	RMS		0.02 % of FS $\pm$ 30 $\mu$ V
Resolution	For each level		16 bit (= 0.0015 %)
CMRR			> 72 dB @ 100 Hz
CM voltage	To amplifier ground		$\pm 10$ V
	To chassis (earth)		$\pm 50$ 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	( $\pm 10$ V $\div$ 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	$\pm 250$ mV max
Bridge support			
	Excitation		
	Voltage excitation	Off, in 1000 steps, up to 85 mA per channel	$\pm 1.0$ V to $\pm 7.5$ 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 k $\Omega$ (0.1%)
		Quarter bridge <sup>(1)</sup>		350 $\Omega$
	Shunt resistors	2 pre-installed calibration resistors <sup>(1)</sup> one user-defined, plus external, shunt to + or – excitation		20 k $\Omega$ , 100 k $\Omega$
	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		<b>Bridge 200K XT ISO Digitizer</b>	<b>Bridge 1M XT ISO Digitizer</b>
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 Bandwidth gain (ranges $\leq \pm 20$ 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		<b>Bridge 200K XT ISO Digitizer</b>	<b>Bridge 1M XT ISO Digitizer</b>
Per card (shared by enabled channels)		64 MS (128 MB)	256 MS (512 MB)
Per Channel		16 MS	64 MS

<b>Triggering</b>			
<b>Component</b>	<b>Unit Description</b>	<b>Value</b>	
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

<b>Real-time Analysis</b>	
<b>Component</b>	<b>Description</b>
StatStream <sup>®</sup>	Each channel includes real-time extraction of Max, Min, Mean, Peak-to- Peak, and RMS values

<b>Acquisition Modes</b>	
<b>Component</b>	<b>Description</b>
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.

<b>Storage Modes</b>	
<b>Component</b>	<b>Description</b>
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		<b>200kS, 128M</b> 4 Channel, 200 kS/s Bridge Card, 128 MB RAM (16 MS/ch), isolated	1-GN410-2
Bridge 1M ISO XT		<b>1MS, 512M</b> 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.12 B3250-1.0 en (GEN series GN440 and GN441)**

Capabilities Overview		
Component	Value	
Model	<b>Universal 200 iso CARD</b>	<b>Universal 1M iso CARD</b>
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	$\pm 10$ mV to $\pm 100$ V in 1, 2, 5 steps	$\pm 10$ mV, $\pm 100$ mV, $\pm 200$ mV, $\pm 400$ mV, $\pm 1$ V, $\pm 2$ V, $\pm 4$ V, $\pm 10$ V, $\pm 20$ mV, $\pm 40$ V, $\pm 100$ V, $\pm 200$ 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 Full Scale, with a maximum of $\pm 50$ % in the $\pm 100$ V range		0.1% 50 % Maximum
Coupling	AC DC, GND		(-3 dB @ 1.6 Hz)
Impedance			2 x 1 M $\Omega$ // 100 pF
Maximum Static Error <sup>(2)</sup>			$\pm 0.1$ % of Full Scale $\pm 100$ $\mu$ V
Gain Error <sup>(2)</sup>			$\pm 0.1$ % of Full Scale $\pm 100$ $\mu$ V
Offset Error <sup>(2)</sup>			$\pm 0.02$ % full scale $\pm 100$ $\mu$ V
Noise (RMS)			0.02 % + 116 $\mu$ V
Analog Bandwidth			20 kHz (-3 dB)
CMRR	Typical @ 80 Hz for all ranges		< -80 dB
CM voltage	Ranges < $\pm 2$ V Ranges $> = \pm 20$ V Other ranges; all referred to amplifier ground		< 10 V <sub>peak</sub> < 250 V <sub>peak</sub> < 100 V <sub>peak</sub>
Measurement Overrange			5 % above/below Full Scale
Recovery time	to 0.03 % after a 200 % Full Scale overload		$\leq 10$ $\mu$ s
Isolation			
	Channel – channel	Peak isolation	250 V <sub>peak</sub>
	Channel – chassis	Peak isolation	250 V <sub>peak</sub>
	Maximum input voltage	Ranges < $\pm 2$ V Ranges $\geq \pm 2$ V	$\pm 100$ V $\pm 250$ V
	Maximum common mode voltage	250 Volt peak with isolated common floating	+ 250 V <sub>peak</sub>

## General Specifications

### Analog Input Section

Component	Unit Description	Value
IEPE amplifier support <sup>(1)</sup>		
Ranges	7 ranges from in 1, 2, 5 steps	$\pm 0.2 \text{ V}$ to $\pm 20 \text{ V}$
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	$\pm 50 \text{ mA}$ to $\pm 1 \text{ A}$
Accuracy <sup>(2)</sup>		$\leq 0.2 \% \text{ of FS } \} \pm 300 \mu\text{A}$
Measurement Shunt		$0.2 \Omega \pm 1 \%$
Maximum Current		1 A
Overload Protection	Resettable fuse, $0.1 \Omega \pm 20 \%$	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	<b>Universal 200 ISO CARD</b>	<b>Universal 1M ISO CARD</b>
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	$< \pm 0.2 \text{ V}$ : 185 kHz (-3 dB) $\geq \pm 0.2 \text{ V}$ : 220 kHz (-3 dB)
Frequency Domain	7-pole Butterworth, extended frequency response	
	20 kHz	$< \pm 0.2 \text{ V}$ : 300 kHz (-3 dB) $\geq \pm 0.2 \text{ V}$ : 350 kHz (-3 dB)
IIR or FIR filter specifics		
Digital	IIR or FIR	
Frequency domain	12-pole FIR at sample rate divided by: 4, 10, 20, 40	12-pole FIR at sample-rate divided by: 4, 10, 20, 40
Time domain	6-pole Bessel style IIR, sample rate divided by: 10, 20, 40, 100	6-pole Bessel style IIR, sample rate divided by: 10, 20, 40, 100

### On-board Memory

Component	Value	
Model	<b>Universal 200 ISO CARD</b>	<b>Universal 1M ISOCARD</b>
Per card (Mega Samples)	64 MS shared by enabled channels	256 MS shared by enabled channels
Per channel	16 MS per channel	64 MS

<b>Triggering</b>		
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

<b>Real-time Analysis</b>	
Component	Description
StatStream <sup>®</sup>	Each channel includes real-time extraction of Max, Min, Mean, Peak-to- Peak, and RMS values

<b>Acquisition Modes</b>	
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.

<b>Storage Modes</b>	
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

<b>Ordering Information</b>		
Model	Unit Description	Order number
Uni 200kS, 128M		4 Channel, 200 kS/s Universal Card, 128 MB RAM (16 MS/ch)
Uni 1MS, 512M		4 Channel, 1 MS/s Universal Card, 512 MBRAM (64 MS/ch) isolated

**A.13 B3240-2.0 en (GEN series GN1610 and GN3210)**

<b>Capabilities Overview</b>			
<b>Component</b>		<b>Value</b>	
		<b>GN3210</b>	<b>GN1610</b>
Model		250 kS/s	250 kS/s
Sample rate max		1800 MB	1800 MB
Memory per card		16/24 bits	16/24 bits
ADC resolution <sup>(1)</sup>		32	16
Analog channels		16	16
Digital event channels <sup>(2)</sup>		yes	yes
Timer/Counter support <sup>(2)(3)</sup>			
Input type			
	Analog	yes	yes
	IEPE	yes	yes
	Charge	yes	yes
	TEDS support <sup>(4)</sup>	yes	yes

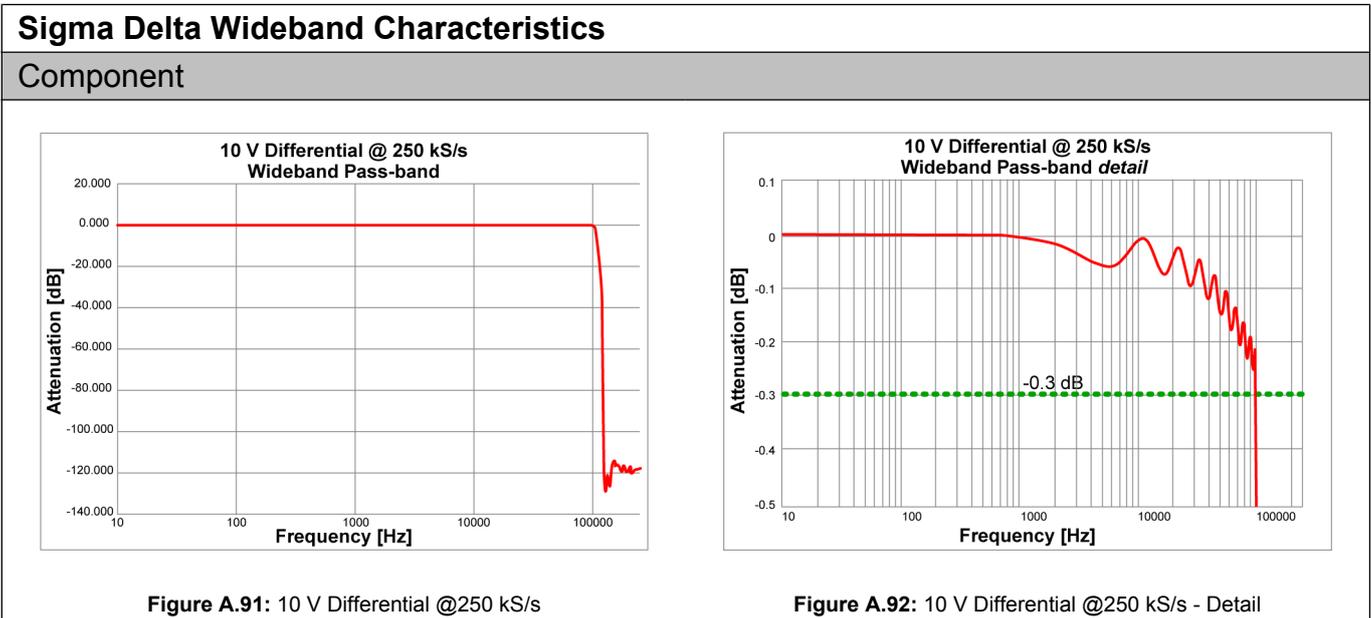
- (1) Software selectable
- (2) When supported by mainframe
- (3) When in 24-bit mode
- (4) When IEPE selected

**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.*

<b>General Specifications</b>					
<b>Analog and Global</b>					
<b>Component</b>		<b>Unit Description</b>		<b>Value</b>	
				<b>GN3210</b>	<b>GN1610</b>
Channels				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 V <sub>peak</sub>	
		In range ≥4 V		± 50 V <sub>peak</sub>	
Input protection		Transient free		± 50 V <sub>peak</sub>	

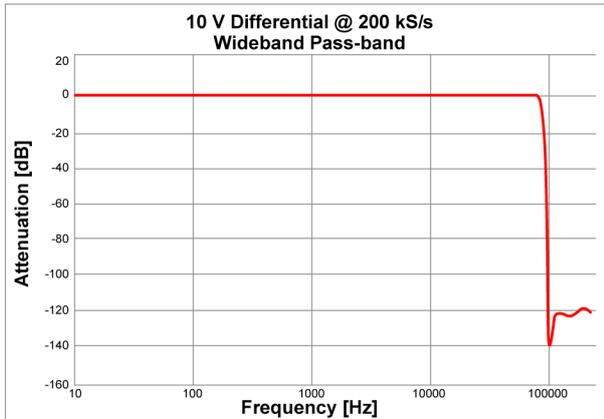
General Specifications		
Analog and Global		
Component	Unit Description	Value
Sample rate	High rates	10 S/s to 250 kS/s
	Low rates (Low rate = High rate / n, where n is an integer $\geq 2$ )	1 S/s to 125 kS/s
Binary sample rate	Supported	Yes
External time base	Supported	Yes
Filter selection		
Bandwidth	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 $\geq 4$ V +0.2 dB/-0.4 dB
Digital Decimation Filters		
Time Domain	12 <sup>(1)</sup> -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.

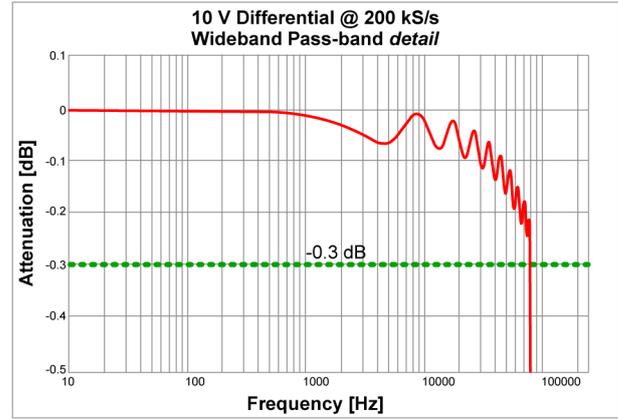


## Sigma Delta Wideband Characteristics

### Component



**Figure A.93:** 10 V Differential @200 kS/s



**Figure A.94:** 10 V Differential @200 kS/s - Detail

## IEPE Amplifier

Component	Unit Description	Value
Input ranges		$\pm 10$ mV, $\pm 20$ mV, $\pm 50$ mV, $\pm 100$ mV, $\pm 200$ mV, $\pm 500$ mV, $\pm 1$ V, $\pm 2$ V, $\pm 5$ V, $\pm 10$ V, $\pm 20$ V
Over voltage protection		-1 V to 22 V
IEPE gain error	All ranges	$\pm 0.1$ % $\pm 300$ $\mu$ V
IEPE gain error drift		$\pm 10$ ppm/ $^{\circ}$ C
Sensor compliance voltage		22 V
Sensor excitation current	Software selectable	2 mA, 4 mA, 6 mA and 8 mA
	Excitation accuracy	$\pm 5$ %
	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		$\pm 10$ pC, $\pm 20$ pC, $\pm 50$ pC, $\pm 100$ pC, $\pm 200$ pC, $\pm 0.5$ nC, $\pm 1$ nC, $\pm 2$ nC
Over voltage protection		$\pm 30$ V <sub>peak</sub>
Charge gain error		$\pm 2$ %
Charge gain error drift		$\pm 30$ ppm/ $^{\circ}$ C
Lower bandwidth limit		-3 dB @ 1 Hz
Upper bandwidth limit	1 nF source capacity	-3 dB @ 10 kHz

<b>Digital Functionality</b>			
<i>Only available when the mainframe provides a complementary connector</i>			
<b>Component</b>		<b>Unit Description</b>	<b>Value</b>
Event inputs			
	Number of Levels	User can invert value in software	16 High (1)/Low (0)
Event/Status outputs			
	Number of Status output	Acquisition status	2 High when active
	Event output	Trigger or Alarm; user programmable	
Event out			
	Duration		Pulse of 12.8 $\mu$ s
	Delay		200 $\mu$ s $\pm$ 1 $\mu$ s $\pm$ 1 sample
Timer/counter functionality			
		Uses three event input channels. You can use timer/counter functionality in parallel with the used event input channels	<ul style="list-style-type: none"> <li>Counter</li> <li>Frequency counter</li> <li>Quadrature decoder</li> </ul>
Counter			
	Functionality	Up/down counter with reset	
	Inputs	<ul style="list-style-type: none"> <li>Count</li> <li>Up/down</li> <li>Reset</li> </ul>	
	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: <ul style="list-style-type: none"> <li>Software controlled (manual)</li> <li>On Start of Acquisition</li> <li>On external trigger once</li> <li>Always on external trigger</li> </ul>	
Frequency counter			
	Functionality	Frequency and RPM measurement with external direction input and reset	
	Inputs	<ul style="list-style-type: none"> <li>Measure</li> <li>Direction</li> <li>Reset</li> </ul>	
	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: <ul style="list-style-type: none"> <li>Software controlled (manual)</li> <li>On Start of Acquisition</li> <li>On external trigger once</li> <li>Always on external trigger</li> </ul>	
Quadrature decoder			
	Functionality	Quadrature decoding with reset	
	Inputs	<ul style="list-style-type: none"> <li>Signal A</li> <li>Signal B</li> <li>Reset</li> </ul>	
	Frequency	Maximum input frequency	5 MHz
	Accuracy	The number of edges in the input signals used per cycle to determine position.	1: Single precision 2: Dual precision 4: Quadruple precision
	Count	Maximum count equals counter width divided by precision 'N'	32 bit/N
	Reset	One of four modes: <ul style="list-style-type: none"> <li>Software controlled (manual)</li> <li>On Start of Acquisition</li> <li>On external trigger once</li> <li>Always on external trigger</li> </ul>	

## Digital Functionality

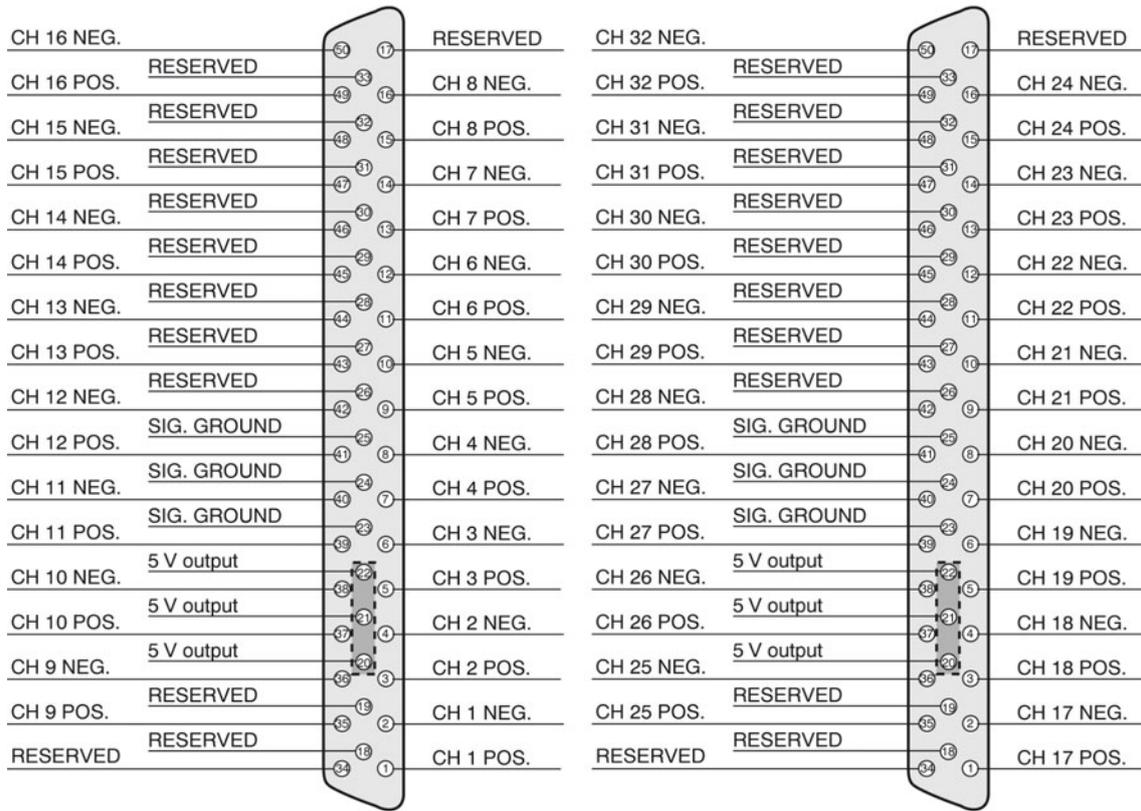
*Only available when the mainframe provides a complementary connector*

Component	Unit Description	Value
Status output		
Functionality	Outputs status. One event for "Acquisition active" and one for "Trigger" or "Alarm" under user control	
Outputs	<ul style="list-style-type: none"> <li>Acquisition active</li> <li>Trigger/alarm</li> </ul>	
Acquisition active	Active high when recording. Low in idle and pause mode	Level
Pulse width	Trigger output pulse	12.8 $\mu$ s
Delay	Delay from actual event to output	200 $\mu$ s $\pm$ 1 $\mu$ s $\pm$ 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	

<b>Acquisition and Storage Modes</b>		
<b>Component</b>	<b>Unit Description</b>	<b>Value</b>
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.
When acquiring 24 bit data and/or using counter timer channels.		32 bit/sample
Acquisition		
	Sample memory	1800 MB

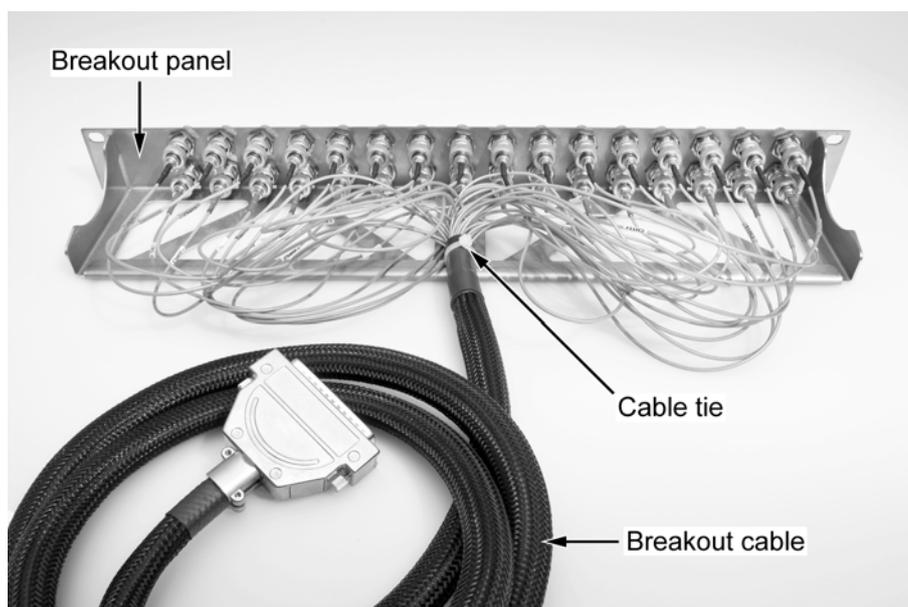
**Front View**


**Figure A.95:** 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.96:** 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.14 B3264-2.0 en (GEN series GN1611 and GN3211)**

<b>Capabilities Overview</b>			
<b>Component</b>		<b>Value</b>	
Model		<b>GN3211</b>	<b>GN1611</b>
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 <sup>(1)</sup>		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.*

<b>General Specifications</b>					
<b>Analog and Global</b>					
<b>Component</b>		<b>Unit Description</b>		<b>Value</b>	
Channels				<b>GN3211</b>	<b>GN1611</b>
				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 V <sub>peak</sub>	
		In range ≥4 V		± 50 V <sub>peak</sub>	
Input protection		Transient free		± 50 V <sub>peak</sub>	
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
	Frequency Domain	12-pole Butterworth style IIR, sample rate divided by 4, 10, 20 and 40
		Minimum filter frequency
Measurement category	IEC 61010	CAT 1

## Wideband (20 kHz) Characteristics

### Component

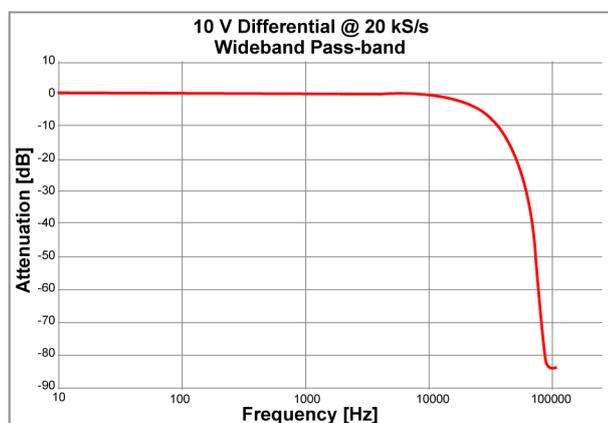


Figure A.97: 10 V Differential @ 20 kS/s

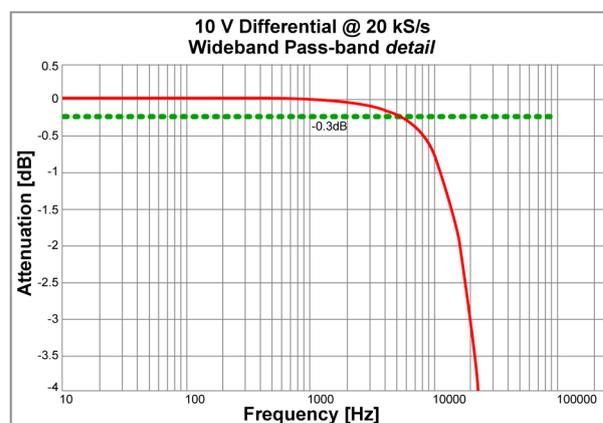


Figure A.98: 10 V Differential @ 20 kS/s - Detail

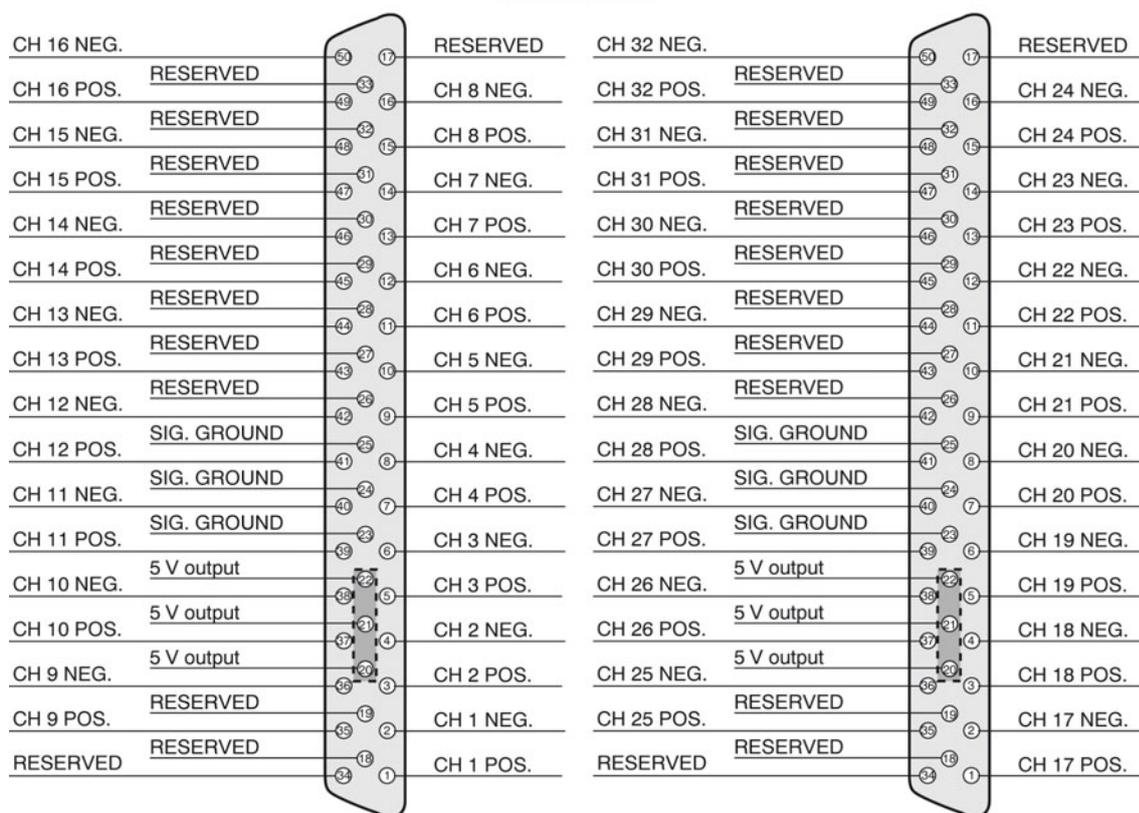
## Digital Functionality

*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
Event/Status outputs		
	Number of	2
	Status output	Acquisition status
	Event output	Trigger or Alarm; user programmable
Event out		
	Duration	Pulse of 12.8 $\mu$ s
	Delay	200 $\mu$ s $\pm$ 1 $\mu$ s $\pm$ 1 sample

<b>Triggering</b>			
<b>Component</b>	<b>Unit Description</b>	<b>Value</b>	
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

<b>Acquisition and Storage Modes</b>			
<b>Component</b>	<b>Unit Description</b>	<b>Value</b>	
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

**Front View**


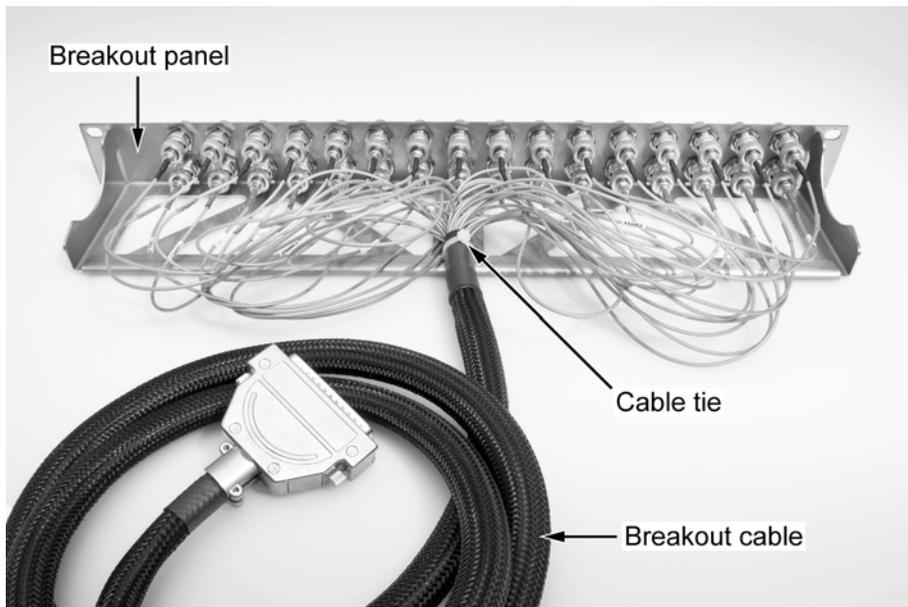
**Figure A.99:** Pin diagram for top 16 Ch Connector (left), Bottom 16 Ch connector (right, 32 Ch Card only)

**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 digi- tizer, 200 MB RAM per card, 16 bit.
GN1611		16 Channel 20 kS/s per channel Differential digi- tizer, 200 MB RAM per card, 16 bit.


**Figure A.100:** 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
KAB172		16 ch differential break out cable, HDSUB to 32x BNC, 2 m; for use with GEN DAQ 16/32 ch input card
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
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
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

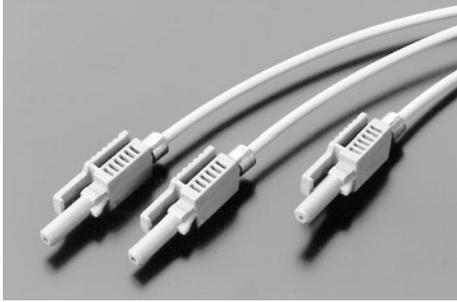
**A.15 B3246-1.0 en (GEN series GN4070)**

<b>General Specifications</b>		
<b>Analog Input Section</b>		
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

<b>Analog to Digital Conversion</b>		
Component	Unit Description	Value
Sample rate	Maximum	1 MS/s

<b>Digital Input Section</b>			
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	
<b>Figure A.101: Logic threshold voltage levels</b>			
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
			
<b>Figure A.102: Fiber optic cables</b>			
<b>Conditional functionality</b>			
	Modes	Trigger, Qualifier, Alarm	
	Trigger		
	Modes	Off, rising edge active, falling edge active	
	Combination	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	
<b>Functionality</b>			
	General		
	Number of Channels		3
	Pins per channel		3
	Function	<ul style="list-style-type: none"> <li>• Clock</li> <li>• Direction</li> <li>• Reset</li> </ul>	
	Sample size		64 Bits (8 Bytes)
	Operation modes	<ul style="list-style-type: none"> <li>• Counter</li> <li>• Quadrature counter</li> <li>• RPM</li> <li>• Frequency</li> </ul>	
	Counter mode		
	Count size		64 bits
	Maximum frequency		10 MHz
	Direction	External	Up/down
	Reset to "0"	<ul style="list-style-type: none"> <li>• Manual by user</li> <li>• At start of recording</li> <li>• By reset pin once after start of recording</li> <li>• By reset pin always</li> </ul>	
	Quadrature mode		
	Count size		64 bits
	Maximum frequency		10 MHz
	Direction	External	Up/down

<b>Digital Input Section</b>				
<b>Component</b>		<b>Unit Description</b>		<b>Value</b>
		Reset to "0"	<ul style="list-style-type: none"> <li>Manual by user</li> <li>At start of recording</li> <li>By reset pin once after start of recording</li> <li>By reset pin always</li> </ul>	
	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	

<b>On-board Memory</b>				
<b>Component</b>		<b>Unit Description</b>		<b>Value</b>
	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

<b>Acquisition Modes</b>	
<b>Component</b>	<b>Description</b>
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.

<b>Storage Modes</b>	
<b>Component</b>	<b>Description</b>
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)	5 V @ 0.5 A
	Typical @ 60 °C (ambient PCB)	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.16 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
<b>Figure A.103: Logic threshold voltage levels</b>		
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	<ul style="list-style-type: none"> <li>• Clock</li> <li>• Direction</li> <li>• Reset</li> </ul>	

Digital Input Section		
Component	Unit Description	Value
	Sample size	64 Bits (8 Bytes)
	Operation modes	<ul style="list-style-type: none"> <li>● Counter</li> <li>● Quadrature counter</li> <li>● RPM</li> <li>● Frequency</li> </ul>
Counter mode		
	Count size	64 bits
	Maximum frequency	10 MHz
	Direction	External
	Reset to "0"	<ul style="list-style-type: none"> <li>● Manual by user</li> <li>● At start of recording</li> <li>● By reset pin once after start of recording</li> <li>● By reset pin always</li> </ul>
Quadrature mode		
	Count size	64 bits
	Maximum frequency	10 MHz
	Direction	External
	Reset to "0"	<ul style="list-style-type: none"> <li>● Manual by user</li> <li>● At start of recording</li> <li>● By reset pin once after start of recording</li> <li>● By reset pin always</li> </ul>
RPM mode		
	Count size	64 bits
	Maximum frequency	10 MHz
	Direction	External
	Gate time	User selectable in 1, 2, 5 steps
	Inaccuracy	Gate time
	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
	Gate time	User selectable in 1, 2, 5 steps
	Inaccuracy	Gate time
	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

<b>Acquisition Modes</b>	
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.

<b>Storage Modes</b>	
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

<b>Miscellaneous</b>		
Component	Unit Description	Value
Output power	Typical @ 20 °C (ambient PCB) Typical @ 60 °C (ambient PCB)	5 V @ 0.5 A 5 V @ 0.35 A

<b>Ordering Information</b>		
Model	Unit Description	Order number
GN6470	 <p><b>1 MS TTL Card</b> 64 binary channels, 1 MS/s Digital Input Card, 512 MB RAM, TTL Level, 4 SubD input connectors.</p>	1-GN6470-2

## B Maintenance

### B.1 Preventive maintenance

Regularly scheduled HBM preventative 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 specified capacity and therefor the instrument 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 GEN5i system is factory calibrated as delivered to the customer. Swapping, replacing or removing of boards may result in minor deviations to the original calibration.

HBM recommends that every GEN5i system should be tested and if necessary, calibrated, at one year intervals or after any major event that may effect 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 GEN5i 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](http://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 boards 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 effect 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 to be isolated – which is wrong.

#### Single ended

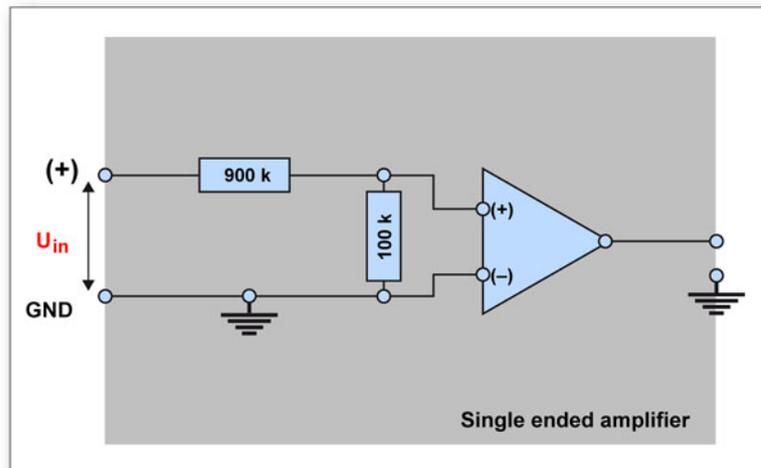
An amplifier where one input is fixed to (measurement) ground.

**Note** *A differential amp can be turned into a single ended one by connecting the -Ve input to ground.*

#### Isolated

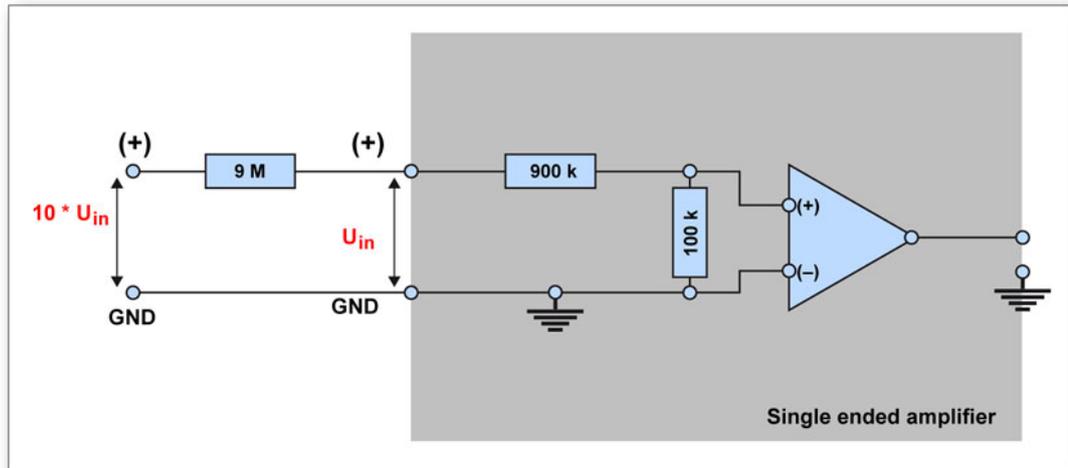
An amplifier where both inputs are isolated from (earth) ground or has infinite resistance to ground.

**Note** *Isolation can be combined with any of the above mentioned amplifier variants.*



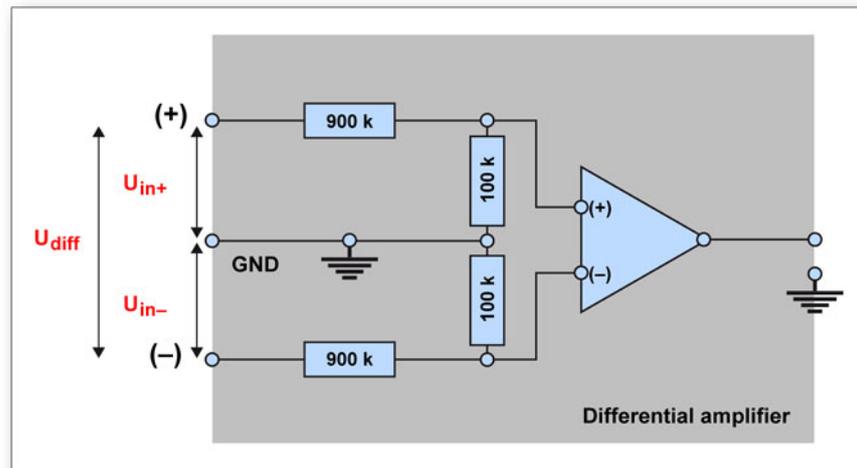
**Figure D.1:** Single ended or unbalanced, grounded amplifier

- 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)



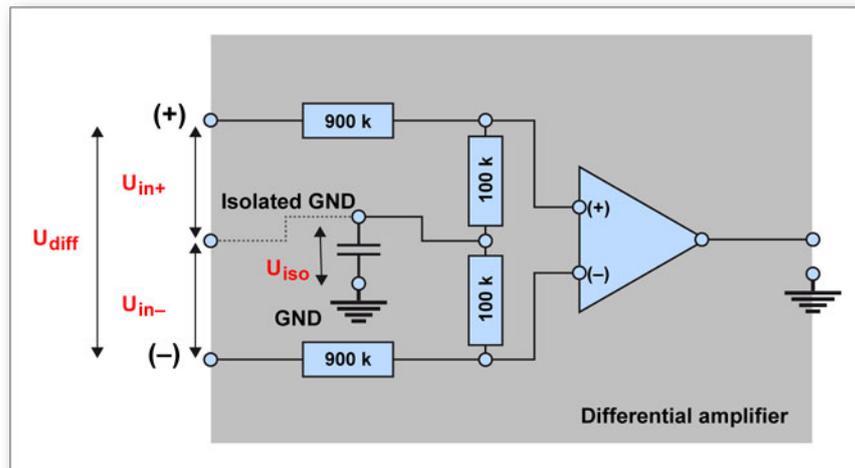
**Figure D.2:** Single ended or unbalanced, grounded amplifier with passive probe

- An inline resistor acts as a voltage divider with the input resistance of the amplifier
- The amplifier itself sees only  $U_{in}$ ; the **total** input range is  $10 * U_{in}$
- 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
- They need compensation → **C** compensation range needs to match input amplifiers capacitance range



**Figure D.3:** Differential or balanced, grounded 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

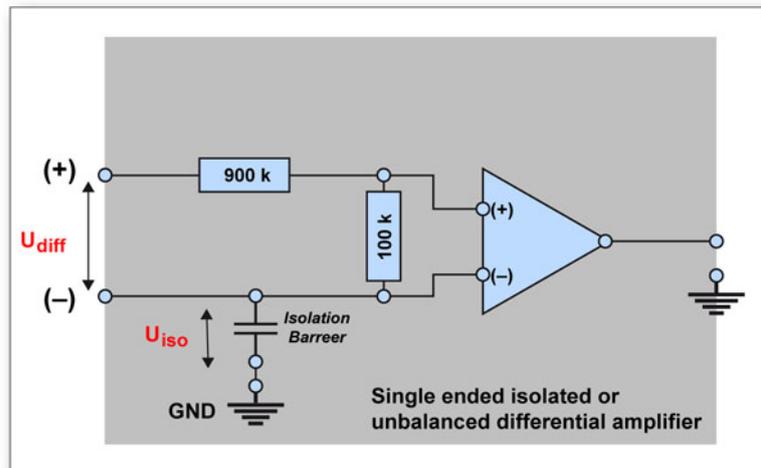


**Figure D.4:** Differential or balanced, grounded amplifier

- Resistance / Capacitance from each terminal to ground is identical
- There is an ISOLATED GROUND
  - Used in GEN DAQ Universal amplifier
  - Typically identified by using 2 or 3 (isolated) connectors per channel

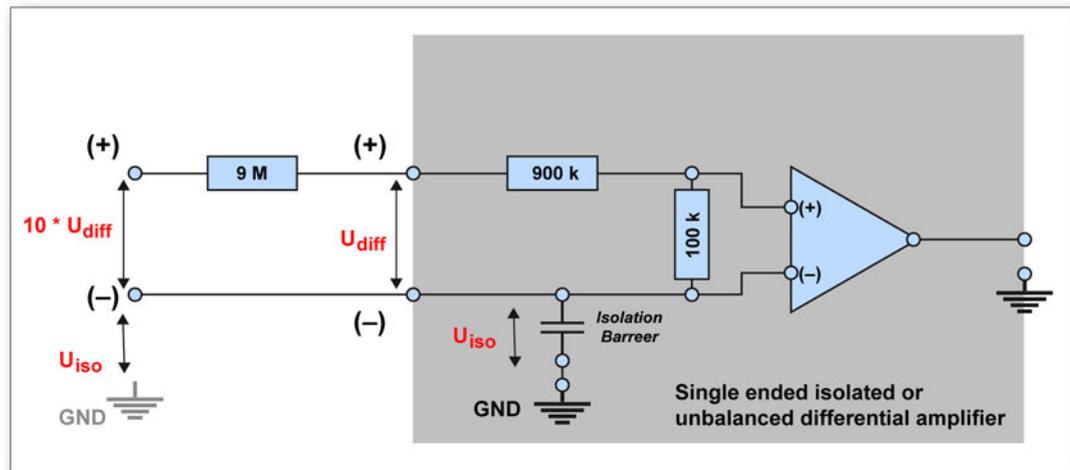
**Note** *The isolated ground is not accessible in some designs*

- Cannot be used with probes as there is no ground reference for probes to divide the voltage down



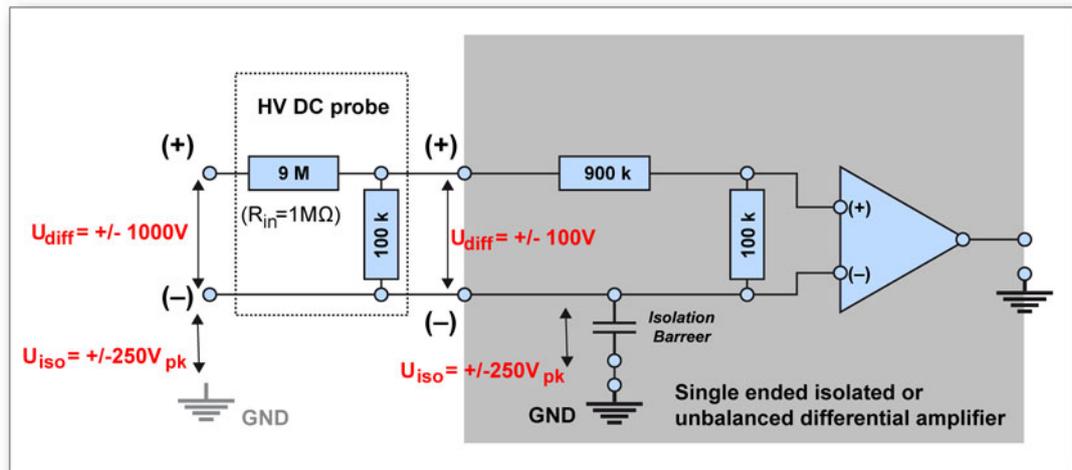
**Figure D.5:** Single ended, isolated amplifier

- 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.6:** Single ended, isolated 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 board with external Isolated passive probe



**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.

**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**

- Save
- Expensive and large
- Good CMRR, best CMV
- VERY difficult to use with probes

**Single ended (to ground) amplifiers**

- Liberty 8 ch DC, ICP
- GEN DAQ Basic DC board

**Single ended isolated amplifier – unbalanced differential**

- ISOBE 5600 and Isolated Digitizers 6600
- GEN DAQ Basic DC ISO board

**Differential amplifier (with common ground)**

- Liberty 16 ch DC & Bridge
- GEN DAQ Fast differential input boards

**Differential amplifier with isolated common**

- GEN DAQ Bridge amplifier and GEN DAQ Universal amplifier

## D.2 Overview of probes

HBM offers a variety of probes for use with the Genesis Highspeed and ISOBE5600 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, but 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, but they typically decrease the overall accuracy of the amplifier.

It is also important to understand that they increase the range only, but 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, but not the isolation voltage.

- **Matched differential, passive voltage probes**

These probes increase the input range of a differential amplifier, but 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, but 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, but their performance typically is limited. Also, as they usually operate from batteries, this causes some inconvenience.

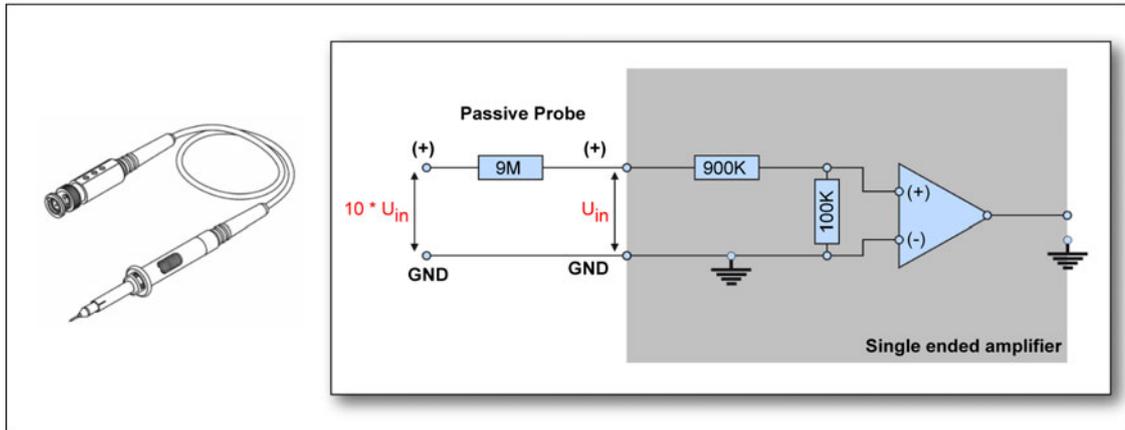
- **Current clamps**

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 <sup>(1)</sup>	x1/x10 switchable	1X: 55 V AC rms 10X: 300 V AC rms

Part number	Divider factor	Maximum input voltage
<b>1-G902-2(1)</b>	x1/x10 switchable	1X: 55 V AC rms 10X: 300 V AC rms
<b>1-G903-2(1)</b>	x100	1000 V AC rms
<b>1-G904-2(1)</b>	x100	2 kV AC rms 3 kV DC incl. AC pk
<b>1-G906-2(1)</b>	x1000	20 kV DC 14 kV AC rms 50/60 Hz) 40 kV pulse (derating)
<b>1-G027-2(2)</b>	1X/10X switchable	1X: 55 V AC rms 10X: 300 V AC rms

- (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**

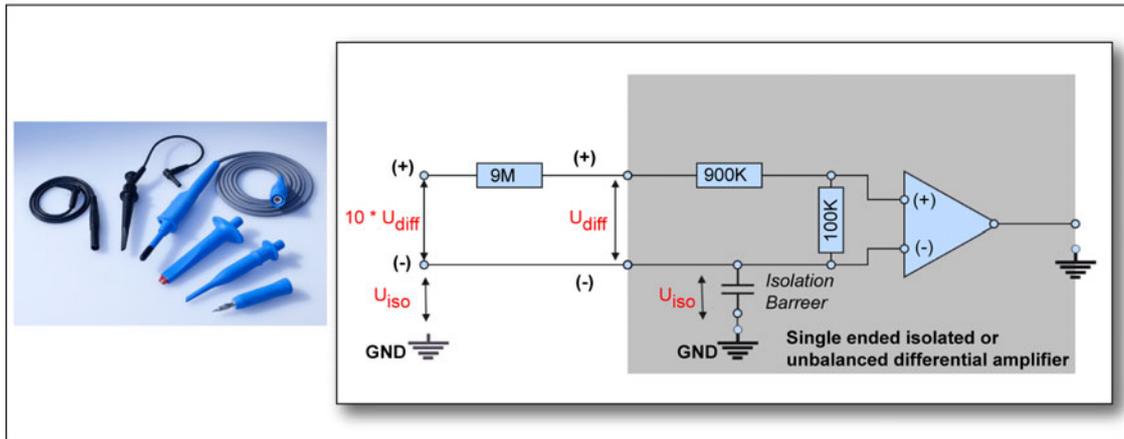
*Table C.2: Voltage probes overview table (Part 2)*

Part number	Compensation range	Cable length	Bandwidth
<b>1-G901-2(1)</b>	7 - 75 pF	1.2 m	1X: 12 MHz 10X: 200 MHz
<b>1-G902-2(1)</b>	7 - 75 pF	3 m	1X: 6 MHz 10X: 100 MHz
<b>1-G903-2(1)</b>	7 - 45 pF	1.2 m	400 MHz
<b>1-G904-2(1)</b>	10 - 50 pF	2 m	300 MHz
<b>1-G906-2(1)</b>	10 - 50 pF	3 m	100 MHz
<b>1-G027-2(2)</b>	100 – 140 pF	3 m	1X: 2 MHz 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**

### 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
<b>1-G057-2</b> (1)	x100	3540 V CAT I 1000 V CAT II 600 V CAT III

- (1) Suitable instruments and input amplifiers:  
 GEN DAQ Basic Iso card **GN812**  
 GEN DAQ Basic XT cards **GN813 & GN814**

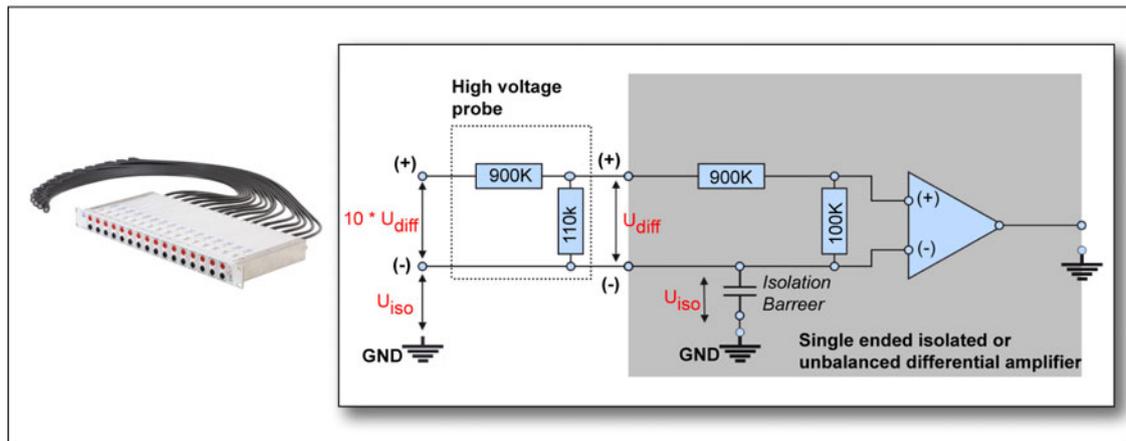
*Table C.4: Voltage probes for ISOLATED amplifiers overview table (Part 2)*

Part number	Compensation range	Cable length	Bandwidth
<b>1-G057-2</b> (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, but 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
<b>1-G041-2(1)</b> Must use suitable rack 1-G019-2	x10	1 kV
<b>1-G042-2(1)</b> Must use suitable rack 1-G020-2	x1 AC coupled	100 V AC CMV: 1 kV DC

(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.*

*Table C.6: High accuracy voltage probes for isolated amplifiers overview table (Part 2)*

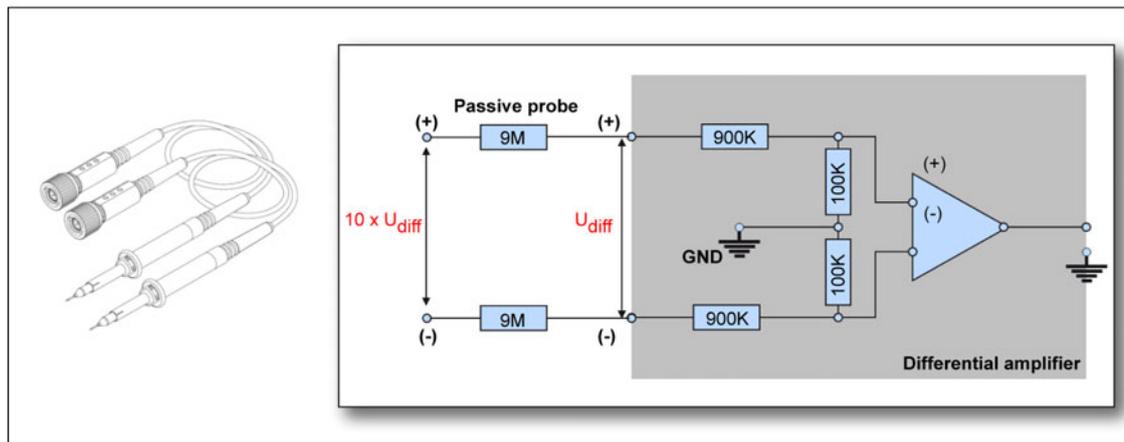
Part number	Accuracy	Cable length	Bandwidth
<b>1-G041-2(1)</b> Must use suitable rack 1-G019-2	0.2 %, 0.1 % typical	1.2 m	250 kHz
<b>1-G042-2(1)</b> Must use suitable rack 1-G020-2	0.2 %, 0.1 % typical	1.2 m	250 kHz

(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
<b>1-G025-2</b> (1) One pair	x200	2.8 kV AC rms 4 kV DC incl. AC pk
<b>1-G026-2</b> (1) One pair	x10	400 V rms CAT I 300 V rms CAT II
<b>1-G907-2</b> (2) One pair	x10	300 V rms CAT II

- (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.*

*Table C.8: Passive differential voltage probes overview table (Part 2)*

Part number	Compensation range	Cable length	Bandwidth
<b>1-G025-2</b> (1) One pair	100 – 140 pF	3 m	20 MHz
<b>1-G026-2</b> (1) One pair	105 – 140 pF	3 m	100 MHz
<b>1-G907-2</b> (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, but their performance typically is limited. Also, as they usually operate from batteries, this causes some inconvenience 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 <sup>(1)</sup>	20X/200X switchable	+/- 1.4 kV DC or +/- 1000 V rms

- (1) Suitable instruments and input amplifiers:  
 All GEN DAQ Basic cards **GN810 & GN811 & GN812 & GN 814**  
 GEN DAQ High speed cards **GN412 & GN413**

*Table C.10: Passive differential voltage probes overview table (Part 2)*

Part number	Accuracy	Cable length	Bandwidth
1-G909-2 <sup>(1)</sup>	+/- 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)
<b>Basic200k</b> (1) <b>Basic1M</b> (1)	<b>1-GN810-2</b> <b>1-GN811-2</b>	Single ended	32 pF
<b>Basic1M iso</b> (2)	<b>1-GN812-2</b>	Isolated unbalanced	65 pF
<b>BasicXT200k iso</b> (3) <b>BasicXT1M iso</b> (3)	<b>1-GN814-2</b> <b>1-GN813-2</b>	Isolated unbalanced	55 pF
<b>Uni200k iso</b> (4) <b>Uni1M iso</b> (4)	<b>1-GN410-2</b> <b>1-GN411-2</b>	Differential isolated	100 pF
<b>HighSpeed25M</b> (5) <b>HighSpeed100M</b> (5)	<b>1-GN412-2</b> <b>1-GN413-2</b>	Differential	21/25 pF; pending from range
<b>6600 HV 100M</b> (6) <b>6600 HV 25M</b> (6) <b>6600 MV 100M</b> (6) <b>6600 MV 25M</b> (6) <b>7600</b> (6)	<b>1-GN110-2</b> <b>1-GN111-2</b> <b>1-GN112-2</b> <b>1-GN113-2</b> <b>1-GN114-2</b>	Isolated unbalanced	38 pF
<b>ISOBE5600 HV</b> (7) <b>ISOBE5600 MV</b> (7)	<b>1-GENIS-1T</b> <b>1-GENIS-1TM</b>	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**

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 6600MV	GN114, 100M 7600	GENIS-1T, 5600HV	GENIS-1TM, 5600MHV
<b>Probe type</b>																
<b>passive, single ended</b>																
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							✓*	✓*								
<b>passive, for isolated amplifiers</b>																
1-G057-2, x100, iso			✓	✓	✓											
1-G041-2, x10, iso				✓	✓											
1-G042-2, x10, iso AC				✓	✓											
<b>passive differential, matched</b>																
1-G025-2, x200							✓	✓								
1-G026-2, x10							✓	✓								
1-G907-2, x10 **																
<b>active differential</b>																
1-G909-2, x20/x200	✓	✓	✓	✓	✓	✓										
<b>current clamps</b>																
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 Part number	Type	Probe factor	Old LDS 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, matched	x200	869-929500
1-G026-2	Differential, matched	x10	869-929600
1-G027-2	Passive voltage	x1/x10	869-929700
1-G907-2	Differential, matched	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)**

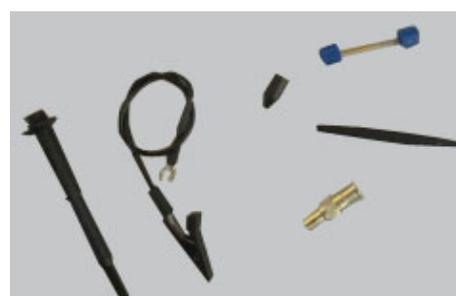
Probe tip adapters with 4 mm safety-shrouded banana plugs. Includes tip and ground lead adapters and two alligator clips with 1" jaw opening. Use on probes G901 and G902 only.



#### 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 x10: 400 V rms CAT I x10: 300 V rms CAT II	x1: 12 MHz 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 x10: 400 V rms CAT I x10: 300 V rms CAT II	x1: 6 MHz x10: 100 MHz	x10: +/- 2 % at DC
1-G903-2	passive, single ended	PMK	PHV1000-145	x100	7 ...45 pF	1.2 m	1000 V rms CAT I 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 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 14 kV AC rms (50/60 Hz) 40 kV pulse (derating)	100 MHz	
1-G907-2	passive, single ended, isolated	Multi-Contact	Isoprobe II 100:1 55pF	x100	30 ...70 pF	1.2 m	3540 V CAT I 1000 V CAT II 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 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 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 x10: 400 V rms CAT I x10: 300 V rms CAT II	x1: 2 MHz 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 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 VDC or 140 V rms x200: +/-1.4 kVDC or 1 kV rms	25 MHz	+/- 2 %

**D.3 General on probes**

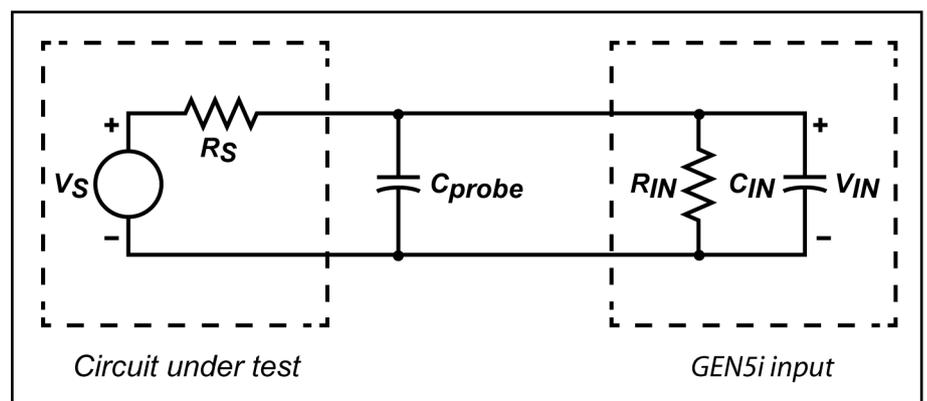
Due to the high capacitive load of the input of the universal amplifier, special care must be taken when selecting a probe for measurements. This section describes some related issues.

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.

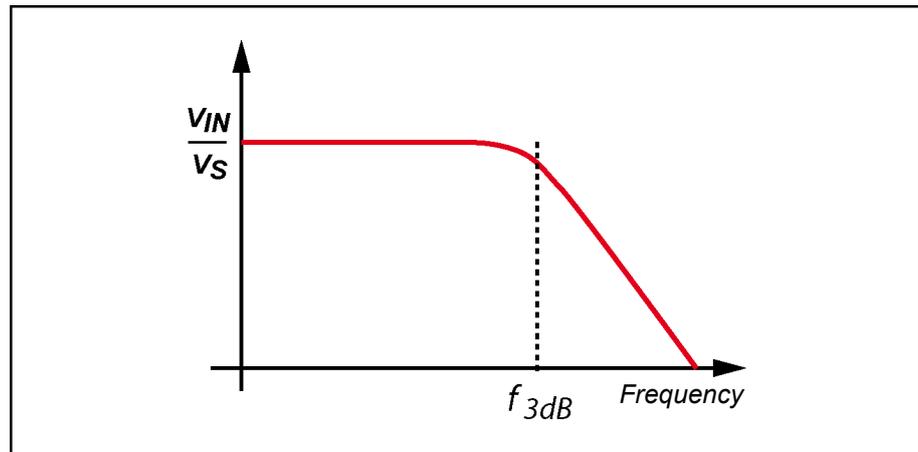
**D.4 1X Probes**

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, but 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)**

$$f(-3db) = \frac{1}{2\pi(R_s \parallel R_{IN})(C_{IN} + C_{probe})}$$

$$= 1 / (6.28 \times 500 \text{ E}+3 \times 150 \text{ E}-12) \approx 2 \text{ kHz}$$

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)**

$$V_{IN} = V_S \left( \frac{R_{IN}}{R_{IN} + R_S} \right)$$

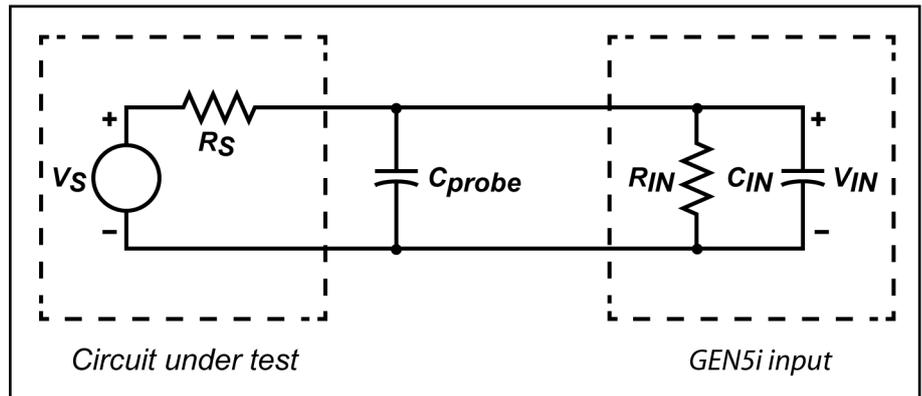
The effect of the capacitive loading is more complex and results in an exponential response in the voltage:

**(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

If  $R_1C_1 = R_2C_2$ , 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  $V_S$  to  $V_{IN}$  is:

(EQ 4)

$$V_{IN} = V_S \left( \frac{R_2}{R_1 + R_2} \right)$$

$R_2$  is the input resistance of the instrument's high input impedance (1 M $\Omega$ ) and  $R_1 = 9R_2$ . 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  $R_1 + R_2 = 10 \text{ M}\Omega$ , 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. Use the filter to reduce the bandwidth to a physically relevant value.

# E Trouble Shooting

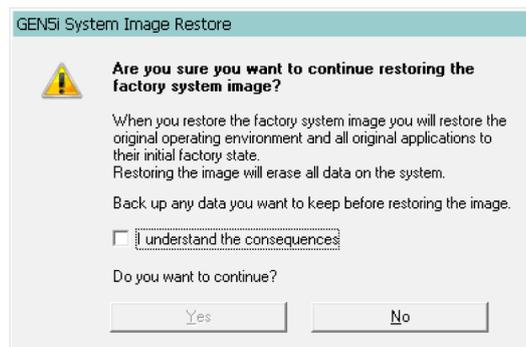
## E.1 Restoring the GEN5i

Your GEN5i comes with a System Image Restore DVD. This DVD contains a complete software image of the system as delivered.

You might need to restore the original image because Windows won't boot, or because your system drive died, or for one of a million other possible reasons.

**To restore the image proceed as follows:**

- 1 Insert the GEN5i System Image Restore DVD into the DVD drive.
- 2 Turn on the system and press the F11 key on the keyboard until the Boot Device selection window is shown.
- 3 From the list of devices select the MATSHITA DVD-RAM drive and press the Enter key to continue.
- 4 When the message "Press any key to boot from CD or DVD" appears, press the Enter key. The system will now boot from the DVD which will take a few minutes.
- 5 When the DVD is booted the following dialog is shown:



**Figure E.1:** Image restore dialog

Read the text carefully and select the "I understand the consequences" check box to enable the Yes button. Click **Yes** to restore the image. To cancel the process click **No**. Wait until the image is restored.

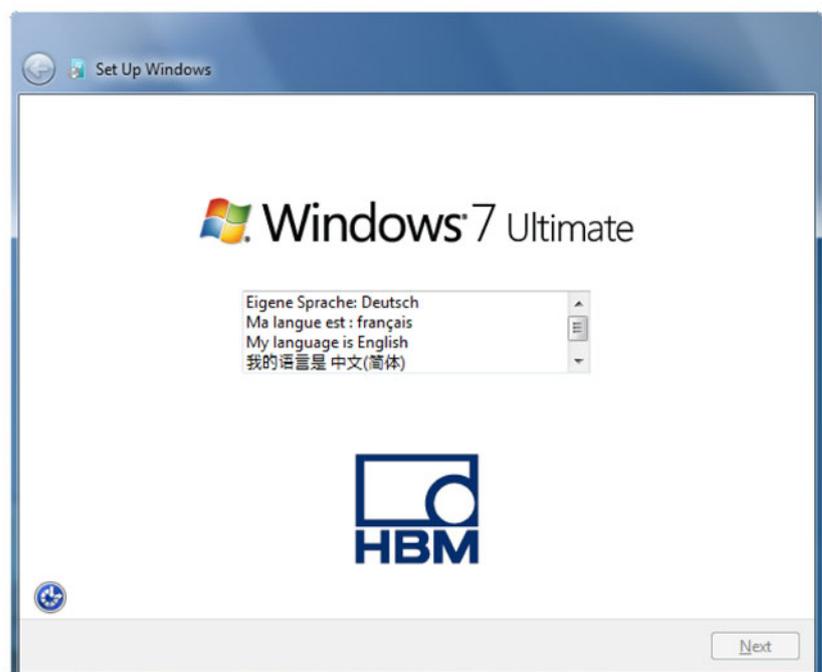

**WARNING**

**Do not turn off or reboot the system while restoring the image.**

- 6** After the image has been restored, remove the DVD from the drive and press any key to reboot the system.

After the system has rebooted, the system will automatically continue to finalize the restore process. The following is the list of steps to complete.

- 1 Language** From the dialog, select the appropriate user interface language and click **Next**.



**Figure E.2:** Language selection dialog

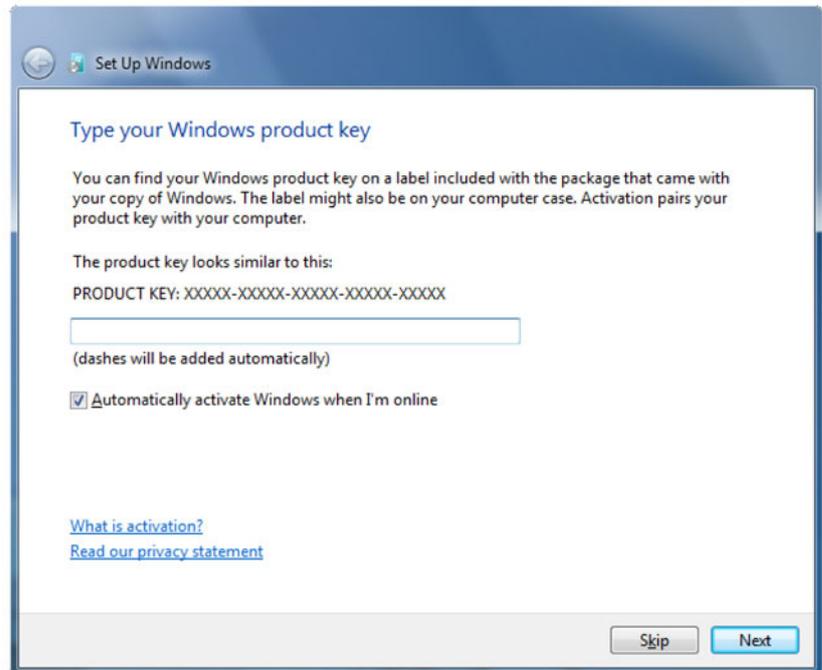
- 2 **Regional and keyboard** The regional and keyboard settings must be selected.



**Figure E.3:** Regional and keyboard dialog

Select the correct settings from each of the drop-down combo boxes and click **Next** to proceed.

- 3 Activation** In the next step, the Windows 7 product key must be entered. The product key sticker is attached to the back of the system.

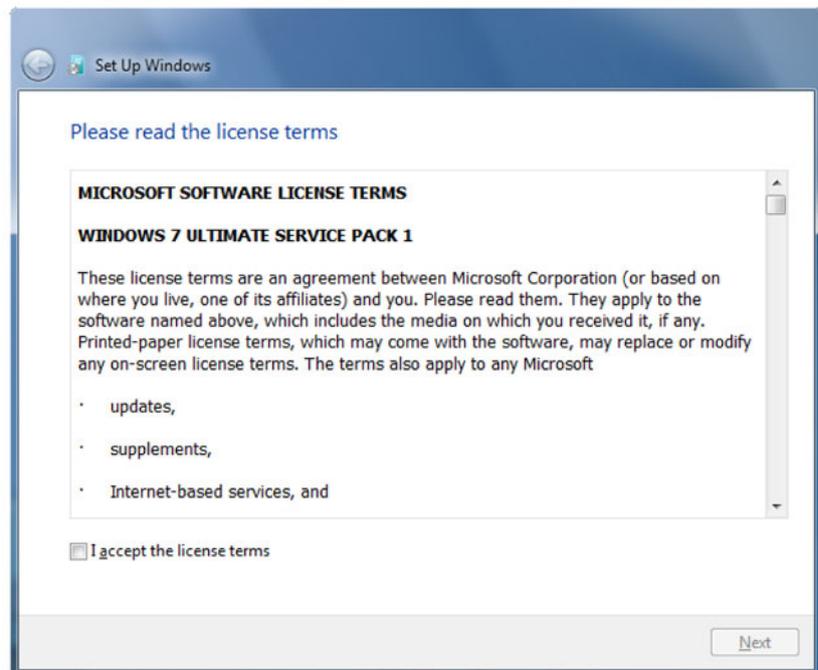


**Figure E.4:** Activation dialog

Enter the key and click **Next** to continue.

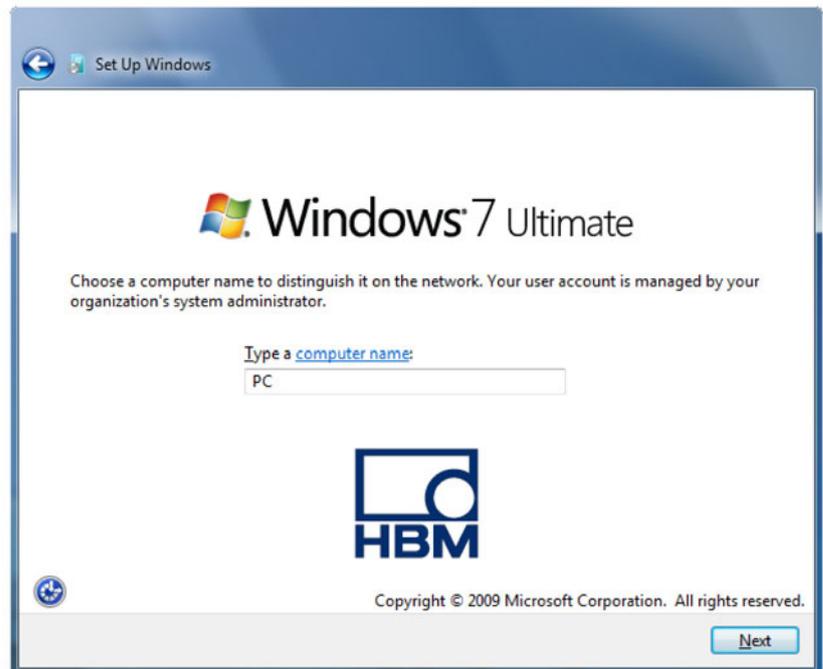
When you re-image the GEN5i, the system hard disk is erased. Therefore you need to activate the current copy of your Microsoft Windows 7 again. You can activate either online or by phone. To activate online you need an Internet connection. Activating by phone requires interacting with an automated phone system. When you have an Internet connection, activation will be done automatically after the re-image process.

- 4 **License** In the next step, the license terms are shown. You must accept these before the system can continue.



**Figure E.5:** License dialog

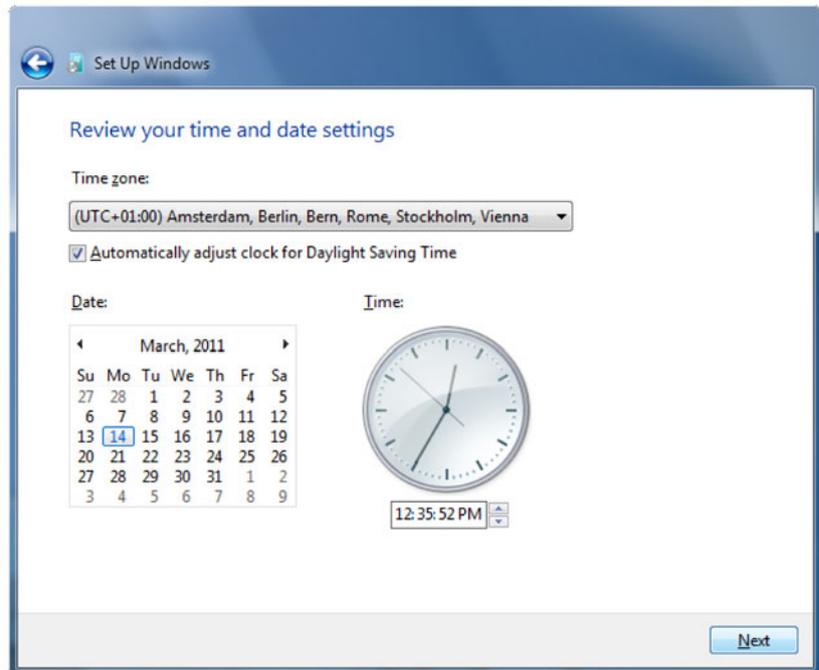
**5 Computer name** Enter the name of the GEN5i system.



**Figure E.6:** Computer name dialog

The original system name is the serial number of the system which starts with IEX and can be found on the back of the system.

- 6 **Review** The last configuration step is used to review and configure the time and date settings.



**Figure E.7:** Time and date settings dialog

Verify the date and the time and select the correct time zone from the **Time zone** box. Click **Next** to continue.



**WARNING**

Using the incorrect time zone results in incorrect date and time information in the recordings.

**7 Setup Wireless network** You can now join a wireless network.



**Figure E.8:** Select and join a network dialog

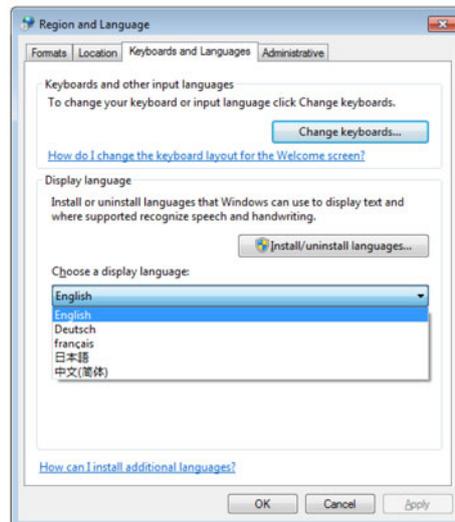
Select a network and click **Next** to continue or click **Skip** to skip this procedure.

**8 Ready** The system is now ready to be used. Windows will start to check the computer's performance. This will take approximately 2-3 minutes.

## E.2 Language Setting Windows 7 Ultimate

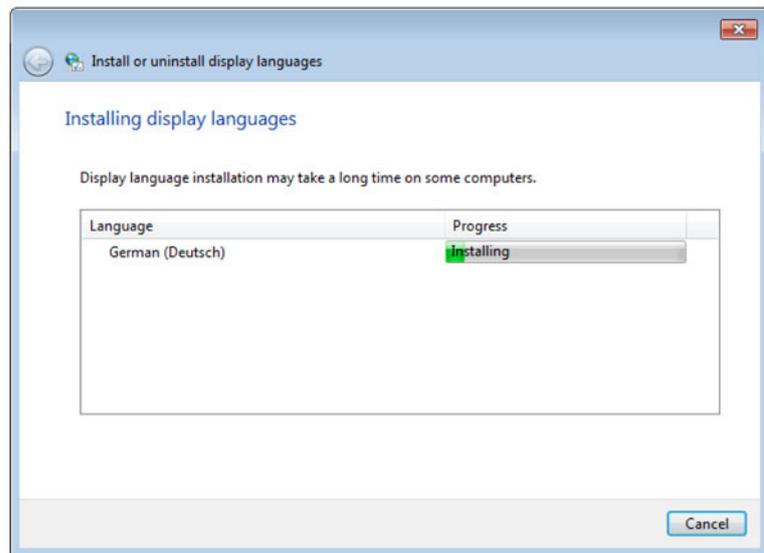
### How to change the Windows 7® Display Language

- 1 Go to **Start** ► **Control Panel** ► **Clock, Language, and Region** / **Change the display language**.
- 2 Switch the display language in the **Choose a display language** dropdown menu.



**Figure E.9:** Choose a display language

- 3 Click **OK**.
- 4 Windows® 7 will install the language, as shown in Figure E.10.



**Figure E.10:** Installing display languages

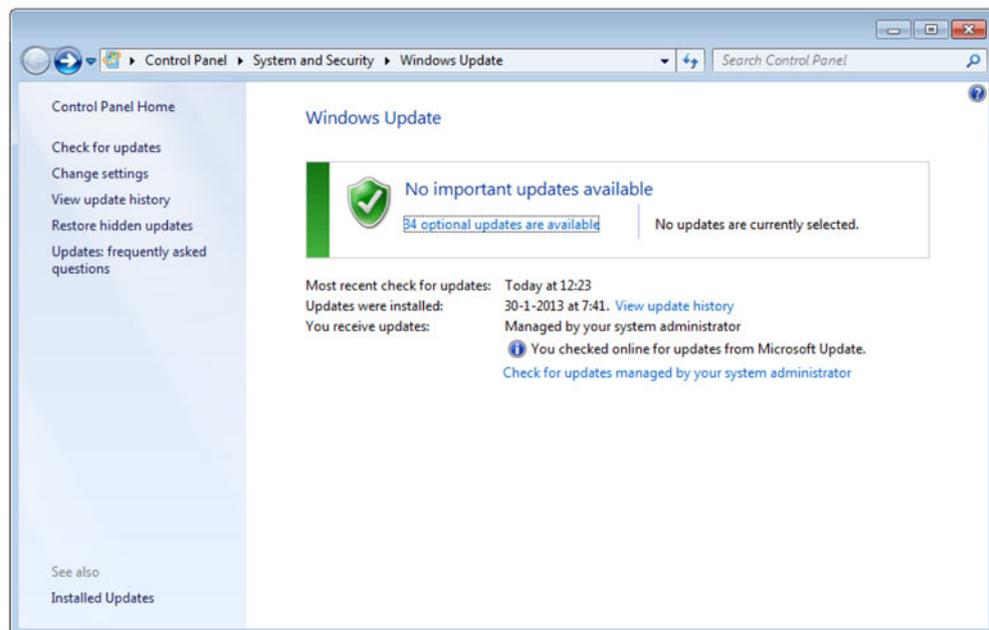
- 5 Log off for the changes to take effect (this will affect only the user profile under which you are currently logged on).

**Note** *If the required language is not listed, install the require language as described in "Install Language Pack in Windows 7 Ultimate" on page 544.*

### E.2.1 Install Language Pack in Windows 7® Ultimate

**Note** *Make sure the GEN5i has access to an internet connection. Windows® update needs access to Microsoft® servers to download the selected language pack.*

- 1** Go to **Start ► All Programs ► Windows Update ► Optional Updates**.
- 2** Open optional updates and go to the section **Windows 7 Language Packs**.



**Figure E.11:** Optional Updates

3 Select the check box of the desired Language Pack and confirm with **OK**.

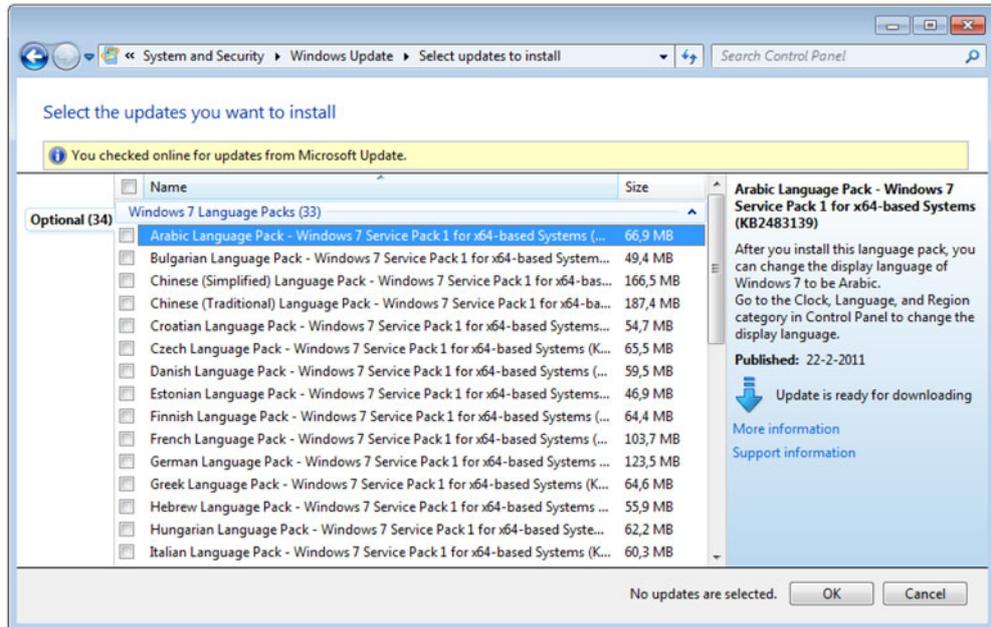


Figure E.12: Windows® 7 Language Packs

4 Proceed with **Install updates**.

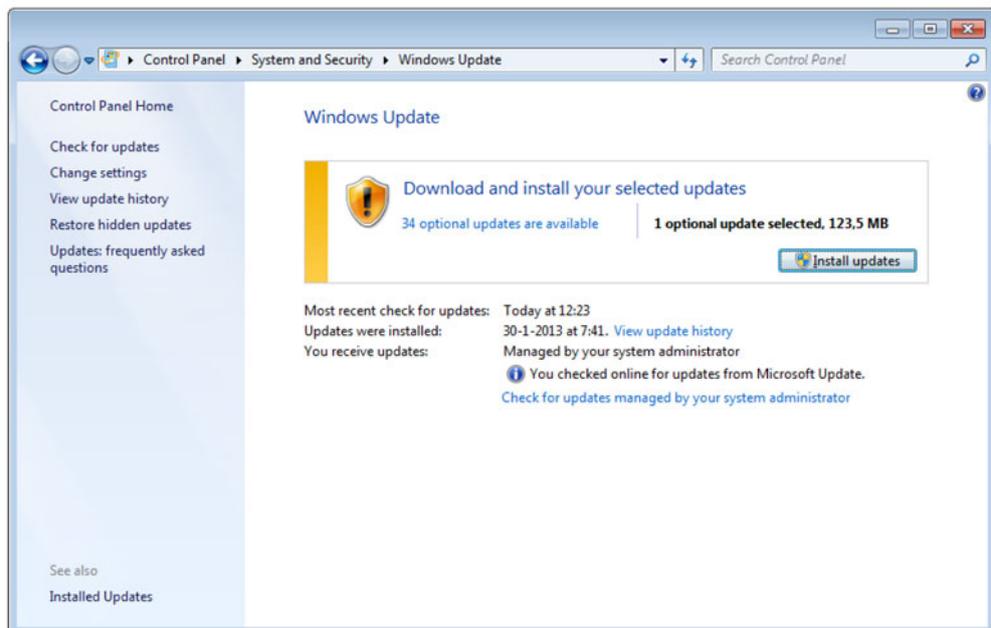


Figure E.13: Install updates

5 Windows® 7 will download the Language Pack.

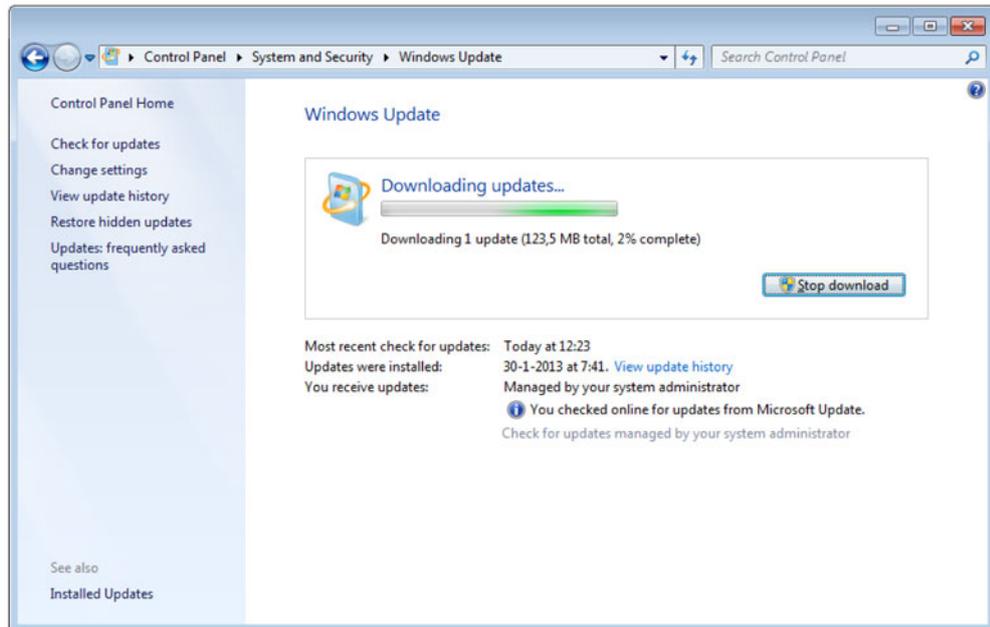


Figure E.14: Downloading update

6 Automatic install will be initiated after download.

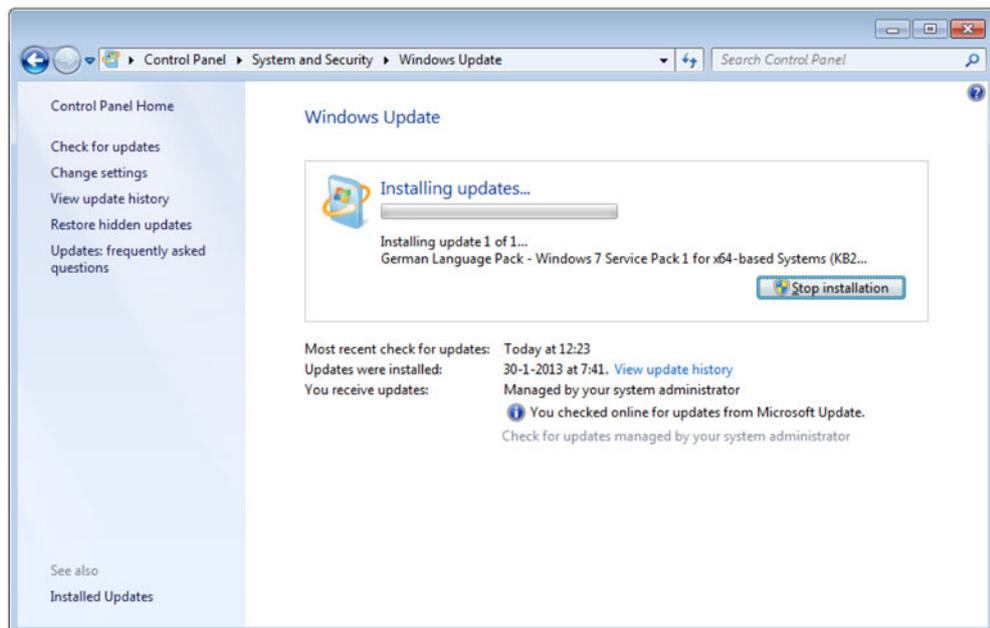


Figure E.15: Installing update

# F Rack Mount Instructions

## F.1 Mount GEN5i in a 19-inch rack

A 19-inch rack is a standardized (EIA 310-D, IEC 60297 and DIN 41494 SC48D) system for mounting various electronic units in a rack, 19 inches (482.6 mm) wide. Equipment designed to be placed in a rack is described as rack-mount or a rack-mounted system.

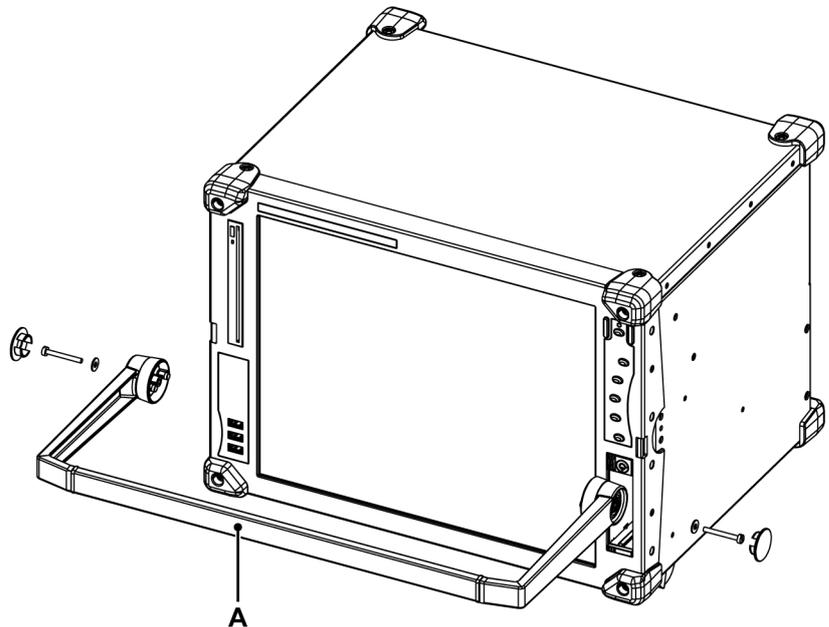
The GEN5i by itself cannot directly be mounted into a 19-inch rack. For this you need to use the optional 19-inch rack mount kit.

How to install the GEN5i rack mount kit:

### Handle removal

To remove the handle do the following:

- 1 Remove the plastic buttons on both sides.
- 2 Remove the 2 screws and rivets.
- 3 Pull the handle carefully outwards and take the handle off towards the front.



**Figure F.1:** GEN5i Handle removal

**A** Handle

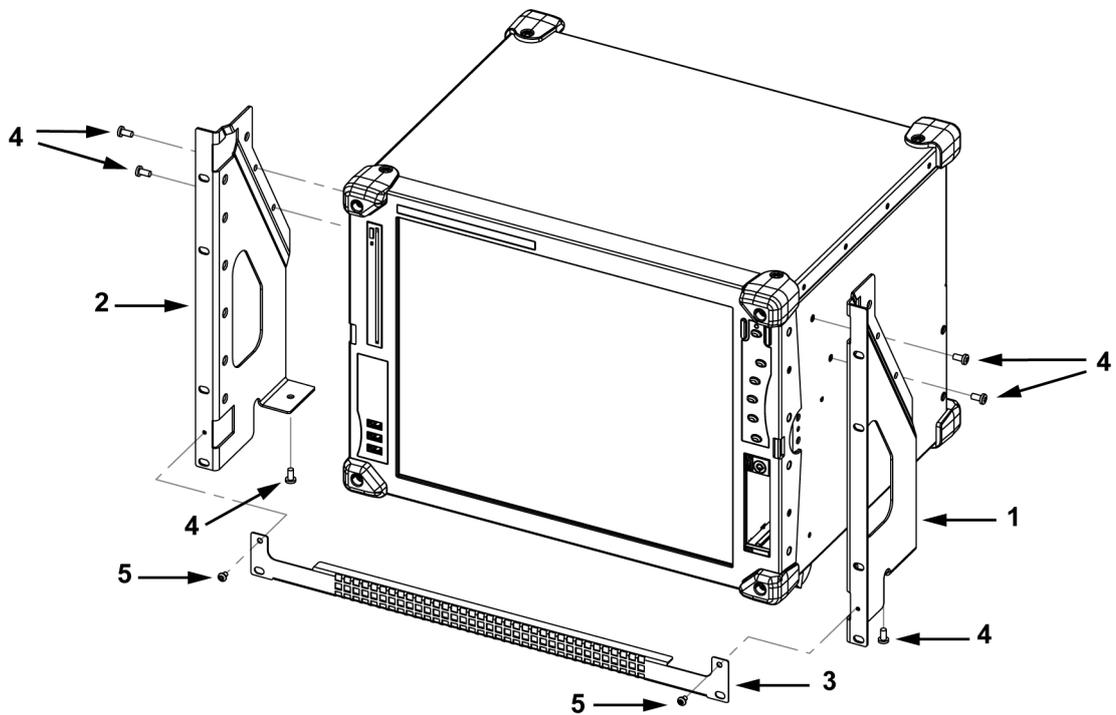

**HINT/TIP**

If the handle is removed install a M4 nut on the screws to keep the handle complete.

**19-inch brackets installation**

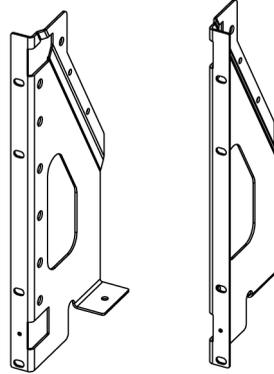
To install a 19-inch bracket do the following:

- 1 Install both side brackets
- 2 Install frontpanel bracket

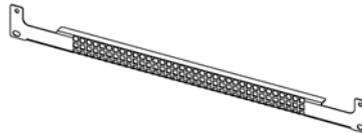


**Figure F.2:** 19-inch brackets installation

- 1 and 2** 011-959500  
BRKT/INT GEN 19INCH L+R



- 3** 011-960800  
BRKT/INT GEN BTTM RACK MOUNT



**Note**

*Make sure that the unit is not positioned above equipment that produces much heat.*

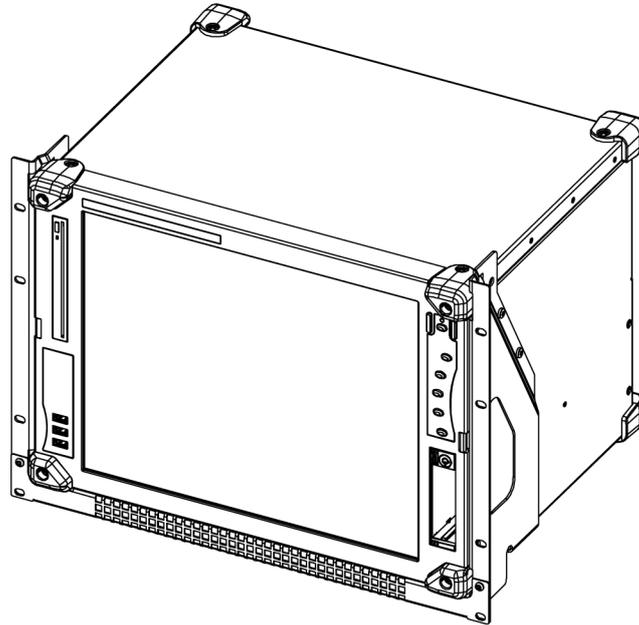
*Make sure that the unit has more than 25 mm free space on the left side for air inlet.*

- 4** 227-M0500100  
SCR/M5x0.80 010 PAN PH SS  
(6x)



- 5** 227-M0400062  
SCR/M4x0.70 006 PAN PH SS  
(2x)





**Figure F.3:** GEN5i with installed 19-inch brackets

# G Application Specific Usage

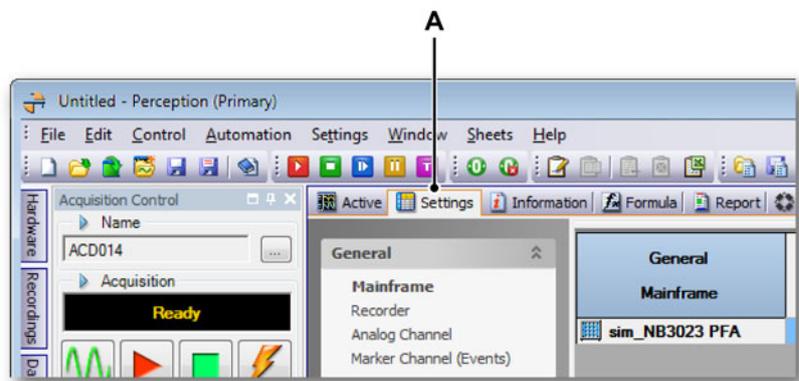
## G.1 Rotational External Clock

GEN DAQ systems allow extensive setups for rotating external clock measurements. This document attempts to explain how to use the settings to get the job done.

### G.1.1 GEN DAQ settings explained

All settings shown in this document can be found in the Perception software.

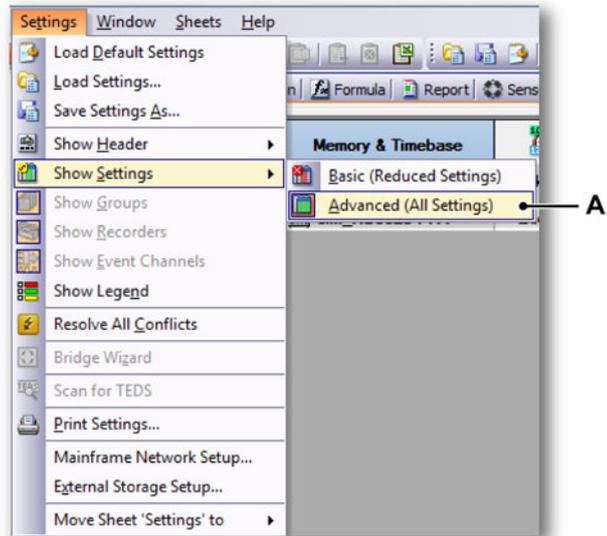
In Perception activate the settings sheet as shown in Figure G.1.



**Figure G.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)**



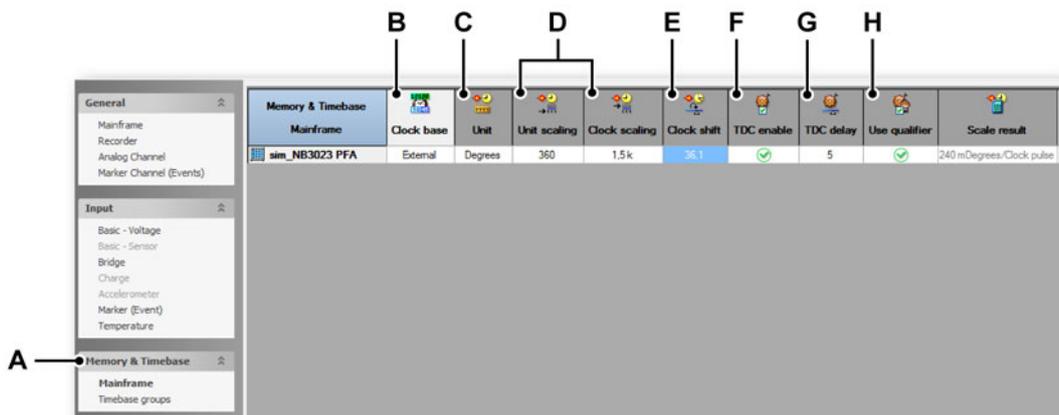
**Figure G.2:** Settings menu

**A** Advanced (All Settings)

## G.1.2 Memory and Time base

### Mainframe

Within the settings sheet select **Memory & Time base** ► **Mainframe**. The Mainframe setting sheet should look like Figure G.3.



**Figure G.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 from 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 establish 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, eg. 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<sup>th</sup> 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 than measuring the qualification signal by one of the analog channels.

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. Default 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 as the external clock signal supplied.*

### G.1.3 Calculating sample limits for external time base use

External sample rates are limited per board type. See the individual specification sheets of the different acquisition boards for details. Make sure and check not to exceed the maximum external sample rate. Exceeding the sample rate will result 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 eg. 500 kS/s (all boards having a maximum sample rate of 1 MS/s) the maximum pulses per rotation are:

$$500\,000 / 100 = 5\,000 \text{ pulses per rotation maximum}$$

However it is advisable not to exceed 10 % of the maximum sample rate of the acquisition board 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.

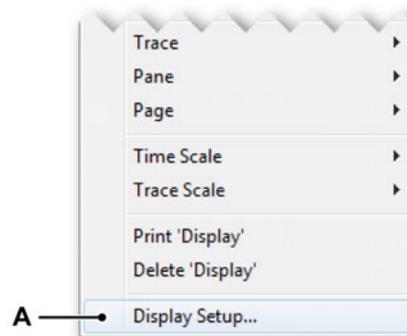
Using a 1 MS/s acquisition boards an external clock at 500 kS/s would appear to contain jitter of up to 1  $\mu$ s. The jitter then is 50 % of the external clock time period, (1/500 kS/s = 2  $\mu$ s).

**Note** *One way to overcome exceeding the maximum external sample rate of the board 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 allow 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.*

**G.1.4 Perception Display settings explained**

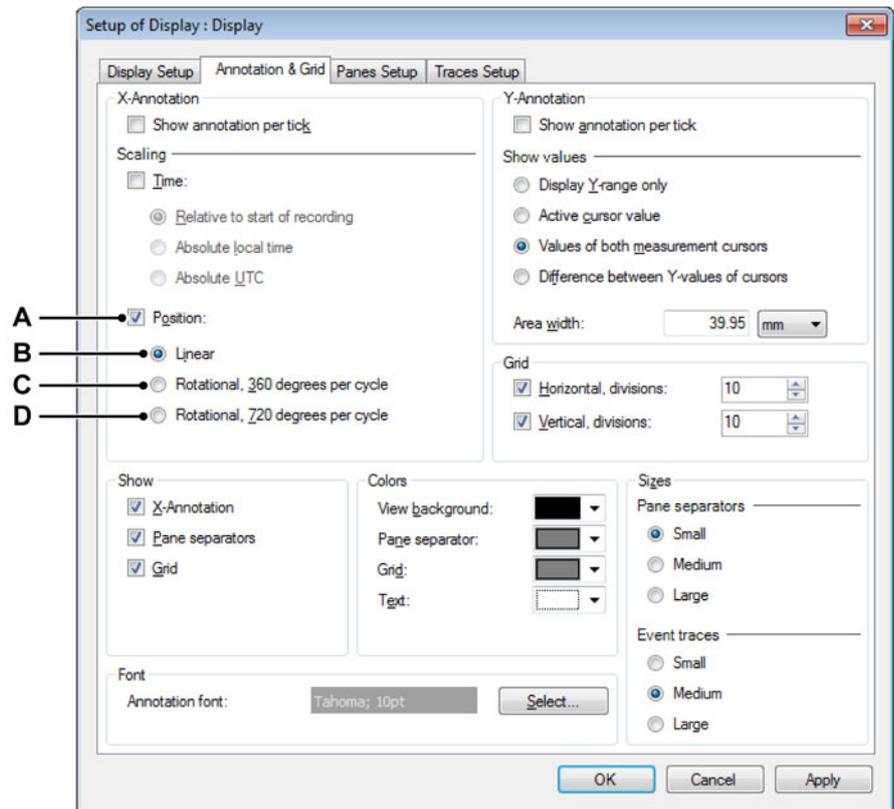
The Perception displays are capable of handling external time base recordings in different ways. The setup is controlled using the display’s X-Annotation Scaling settings.

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 G.4:** Perception - 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 G.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.

Eg. 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.

Eg. 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.

Eg. 1200 degrees will show as 1:480, means 1 Cycle and 480 Degrees.

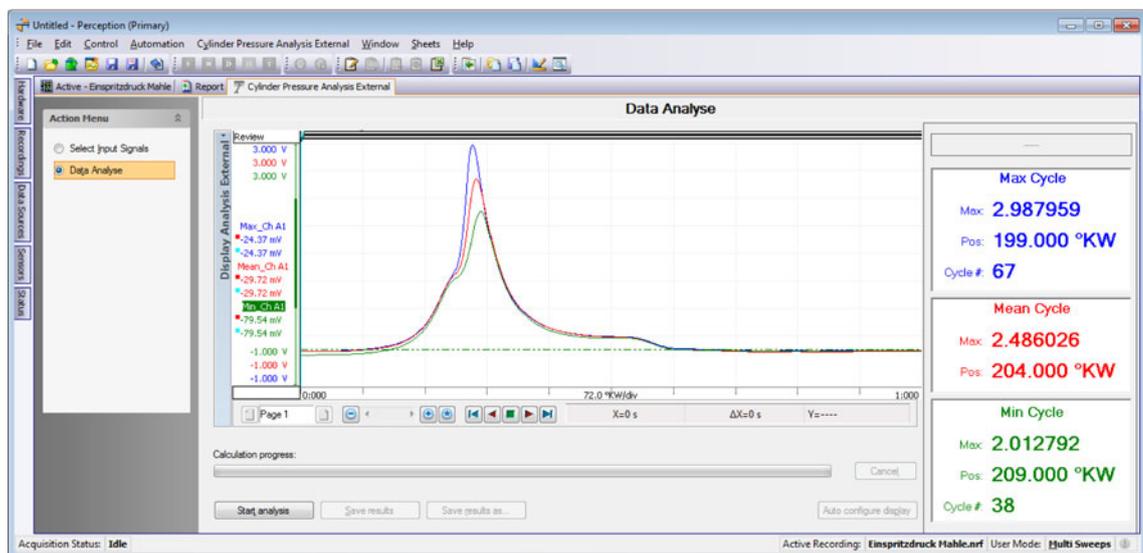
Perception will use the TDC setup process to determine the proper 0 degree point. (See "TDC Enable" and "TDC qualifier" (Figure G.3 "Memory and Time base" on page 553) how to use these settings).

### G.1.5 Cylinder Pressure Analysis option package

HBM offers a special custom software package on Perception to analyze some parameters on 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 G.6:** Cylinder Pressure Analysis dialog

### G.1.6 Cylinder Pressure Analysis customer evaluation

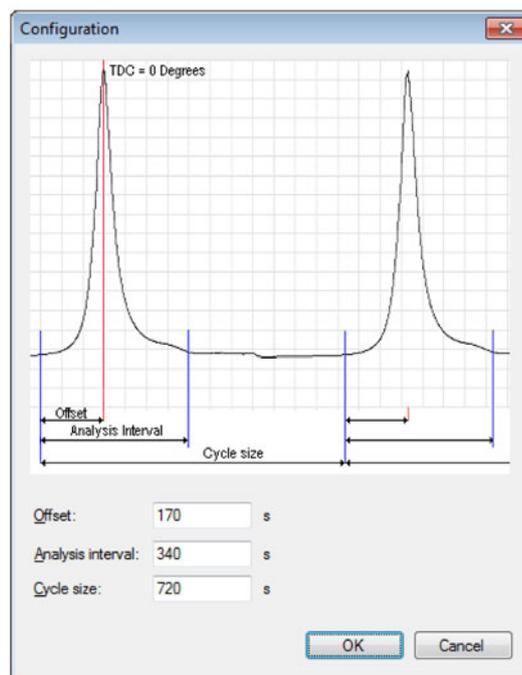
HBM offers a 30 day evaluation version of this special software to see if this meets the requirements.

Special wishes can be adapted as cost option after consulting our CSI programmer.

### G.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 G.7.



**Figure G.7:** Cylinder Pressure Analysis Configuration

## G.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 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 you a change in the amplifier settings is required to be able to actually generate a trigger for you. Say amplifier is set to 100 V range and dY of 110 V can never be measured with this sensitivity. However 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 be recalculated to 55 V/5 ms. What choice should Perception make here 11 V/1 ms would also be possible. But this leads to completely different trigger behavior as the noise sensitivity goes down from 110 V to 11 V and this might not be what you want.

**dT:** Specified in seconds, used in samples. Setting is samplerate dependant. Maximum dT in samples is 1023. For user convenience we allow entry in time. But the hardware works in samples. Therefore changing samplerates might make your setting unusable. Eg. 1023 ms is OK as long as the samplerate is 1 kS/s. At 1 MS/s the maximum dT time is 1.023 ms.

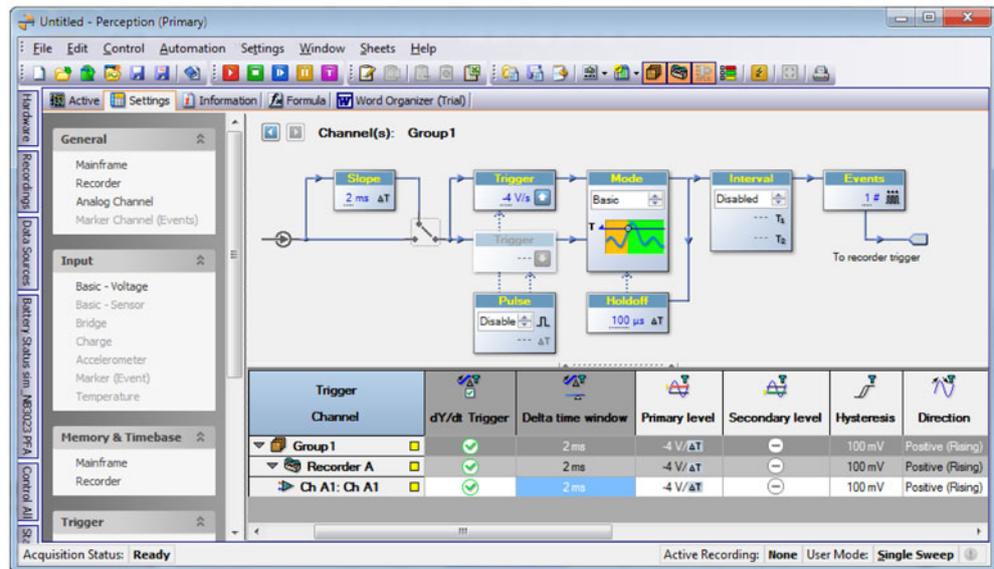
Whenever a dT is not useable with the selected samplerate the background of this setting will turn yellow within Perception (Perception indicates this setting is not valid with the current settings that are dependant for this setting).

### 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 G.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 send to the trigger unit.

- Next sample recorded (sample of blue cursors, see Figure G.9)
- Difference is -2.451 V
- dY not met, no trigger

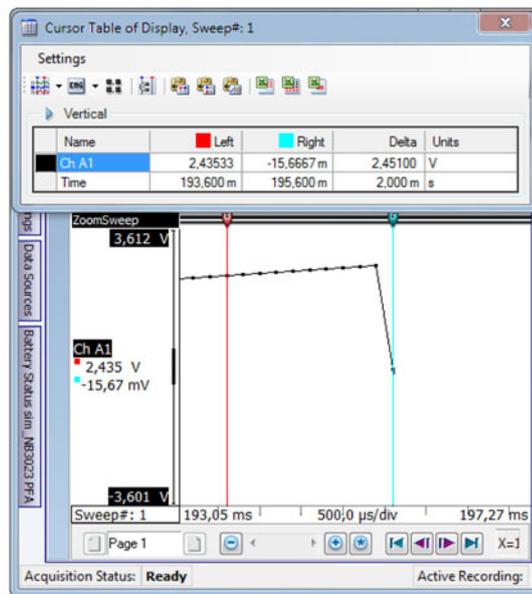


Figure G.9: Sample recording 1

- Next sample recorded (sample of blue cursors, see Figure G.10)
- Difference now is -3.81633 V
- dY not met, no trigger

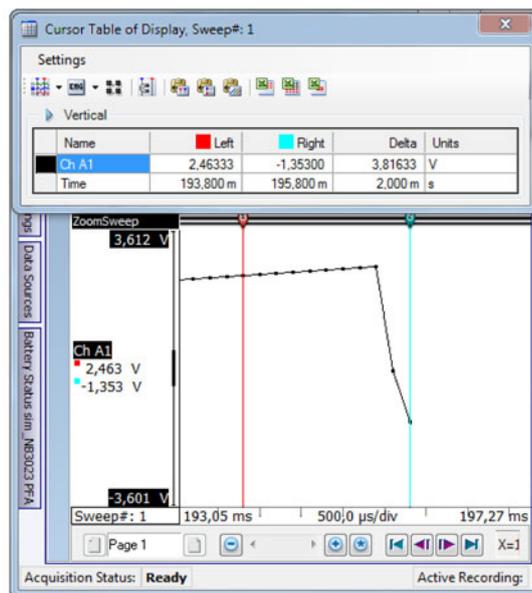
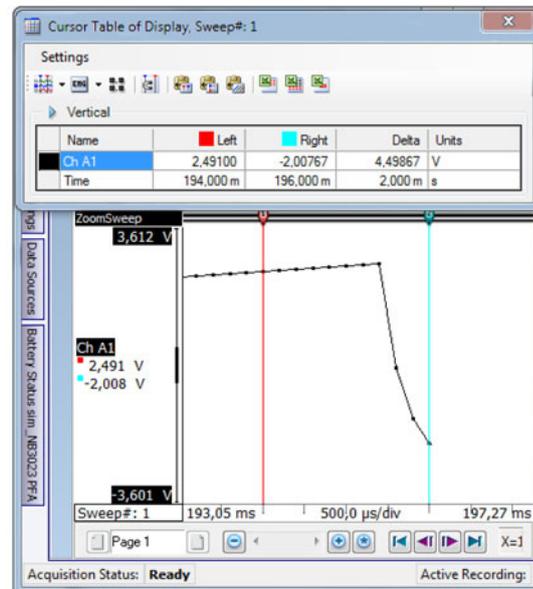


Figure G.10: Sample recording 2

- Next sample recorded (sample of blue cursors, see Figure G.11)
- Difference now is -4.49867 V
- dY met
- As previous dY was higher value, this is a falling edge: trigger



**Figure G.11:** Sample recording 3

**Note** *Trigger edge in this case is the edge of the differentiated signal. Not the signal itself.*

# H Using Fiber Optic Cables

## H.1 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 = Multimode 62.5/125 μm	850 nm	8 dB	-3.5 dB/km	-0.75 dB	200 MHz*km
OM2 = Multimode 50/125 μm	850 nm	8 dB	-3.5 dB/km	-0.75 dB	500 MHz*km
OM3 = Multimode 50/125 μm laser optimized fiber	850 nm	8 dB	-3.5 dB/km	-0.75 dB	2000 MHz*km
OM4 = Multimode 50/125 μm laser optimized fiber	850 nm	8 dB	-3.5 dB/km	-0.75 dB	4700 MHz*km
OS1 = Singlemode 9/125 μm	1310 nm	10 dB	-1 dB/km	-0.75 dB	N/A
OS2 = Singlemode 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 singlemode 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 multimode 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)

$$L_{BW} = \frac{BW}{1000MHz} (km)$$

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

# I 10 GB Ethernet Windows settings

## I.1 Introduction

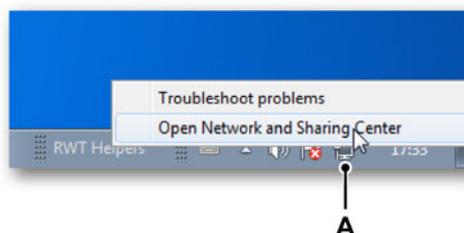
To help achieve the highest possible speed rating for the 10 Gbit Ethernet card the following settings can be made to the network adaptor in Windows® 7.

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**.



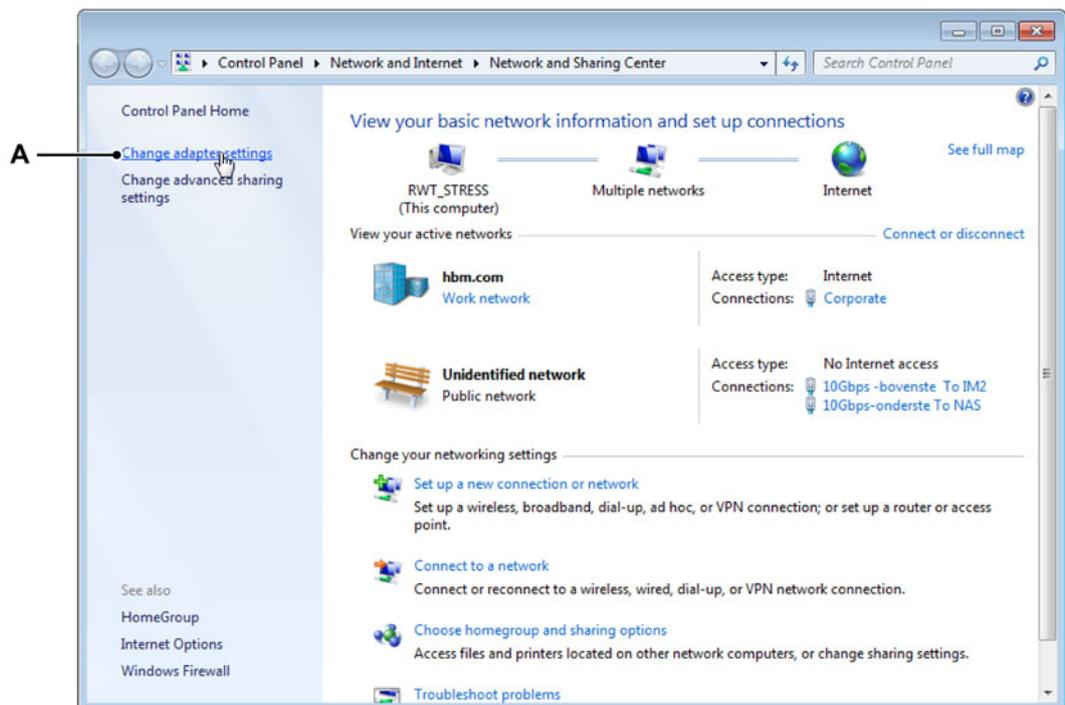
**Figure I.1:** Windows® 7 Network and Sharing Centre tooltip

**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.

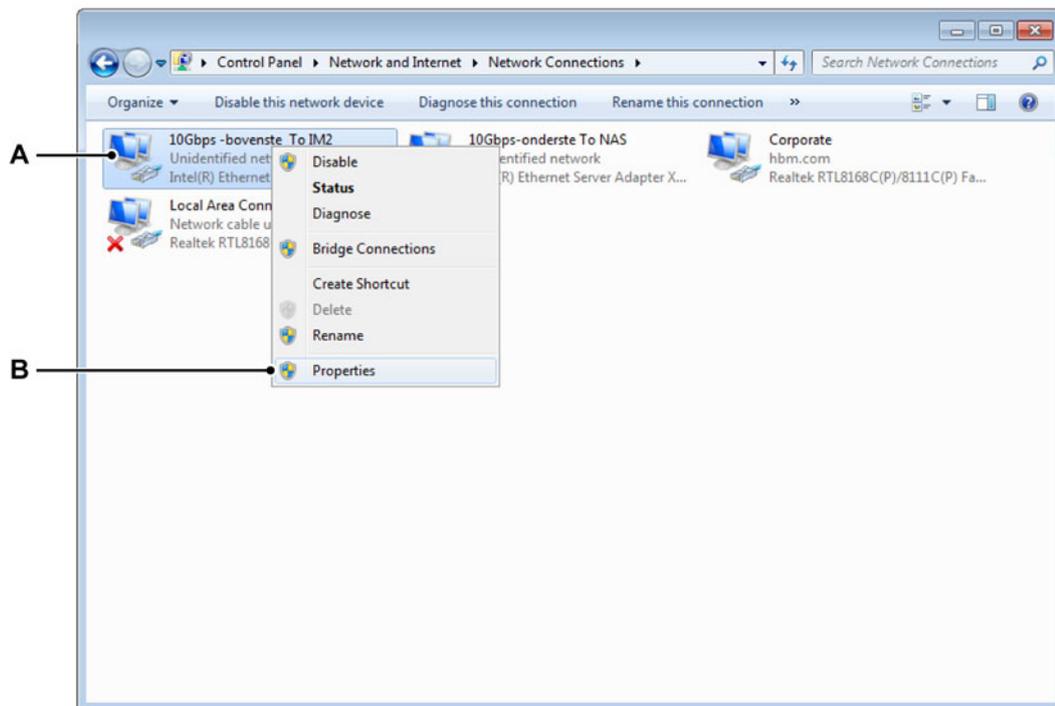


**Figure I.2:** Windows® 7 Network and Sharing Center

**A** Change adapter settings

Click **Change adaptor settings**

- 3 The available adaptors in **Network Connections** should be shown as in the following Figure I.3.

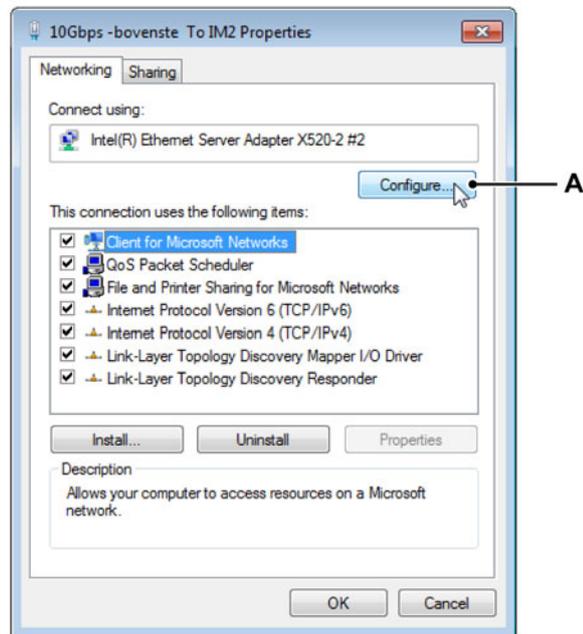


**Figure I.3:** Network Connections

- A Adaptor
- B Properties

Right click the 10 Gbit Ethernet adaptor connected to the IM2 board, In the pop-up menu select **Properties**.

4 The following properties dialog will appear.

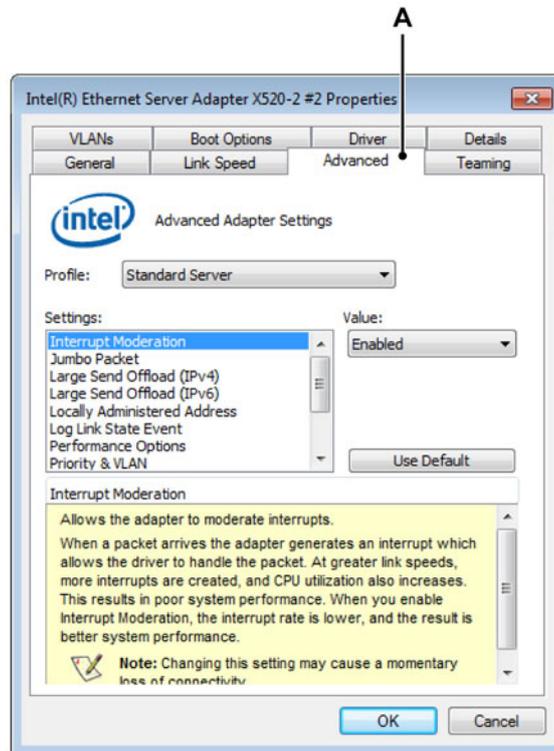


**Figure I.4:** Networking properties dialog

**A** Configure

Click **Configure...**

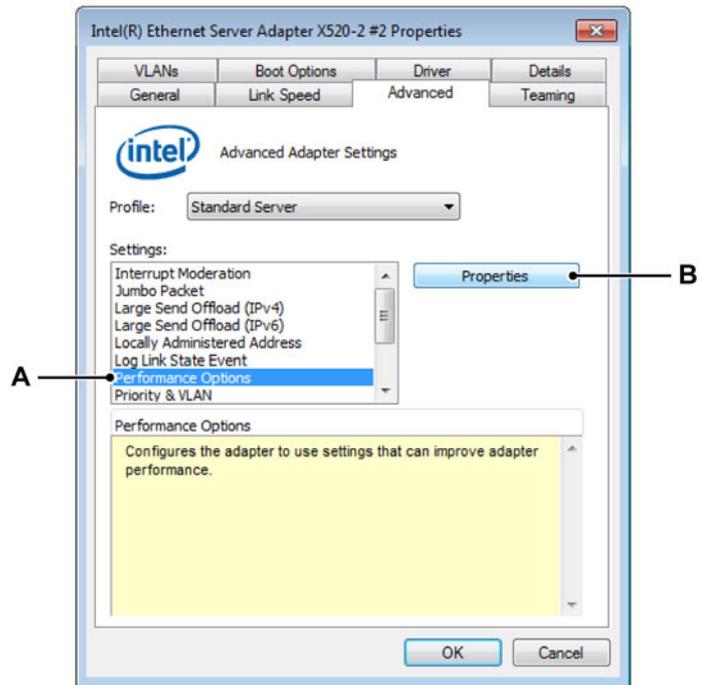
- 5 The Ethernet Server Adaptor properties dialog for your specific adaptor will appear.



**Figure I.5:** Ethernet Server Adaptor properties dialog (Part 1)

**A** Advanced tab

Click the **Advanced** tab.

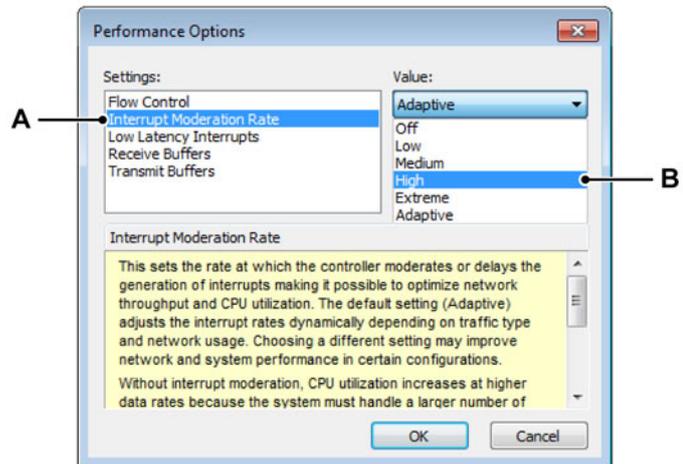


**Figure I.6:** Ethernet Server Adaptor properties dialog (Part 2)

- A** Settings/Performance Option
- B** Properties

Scroll down in the settings menu to **Performance Options** and then click **Properties** on the right hand side.

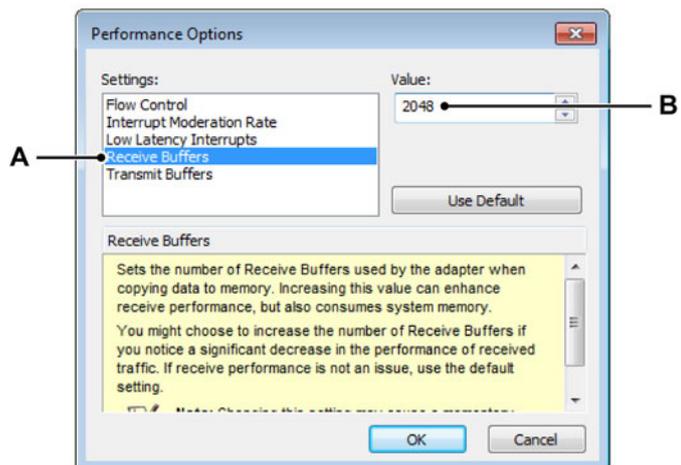
6 The **Performance Options** properties dialog will appear



**Figure I.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.



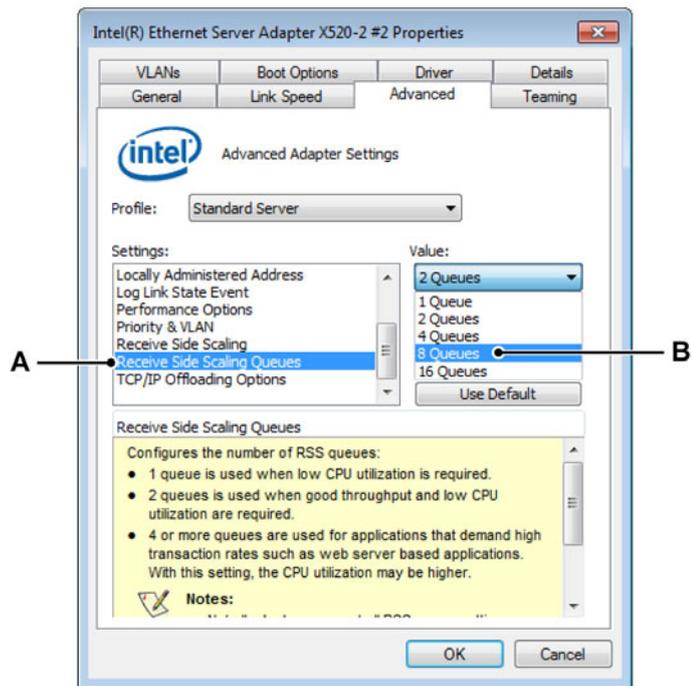
**Figure I.8:** Performance Options (Part 2)

- 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 I.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.

# J Setting up the iSCSI with Synology NAS

## J.1 Introduction

### Setting up the iSCSI with Synology® NAS

For further tutorials please see:

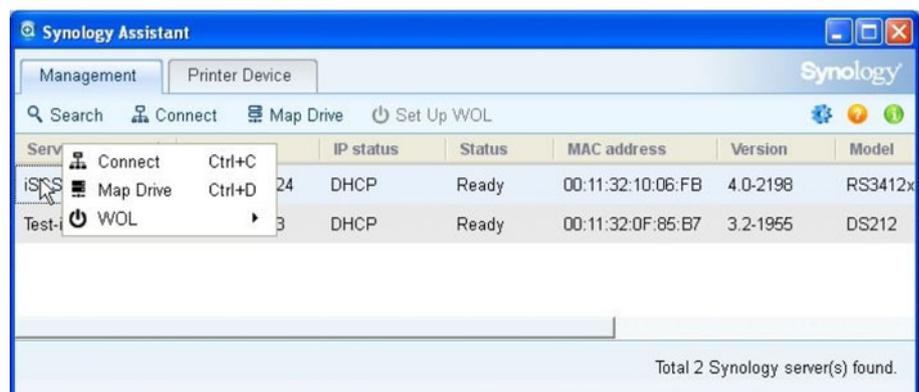
[www.synology.com/tutorials/tutorials.php](http://www.synology.com/tutorials/tutorials.php)

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](http://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 J.1:** Synology Assistant

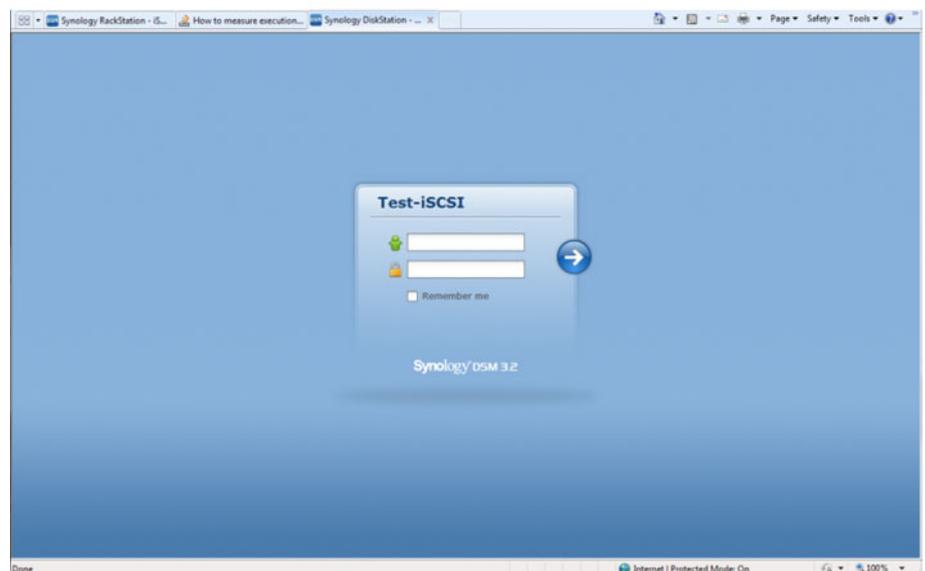
Select or right click an iSCSI device and then click **Connect**.

Your web browser should open to **DSM Synology® RackStation** 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.

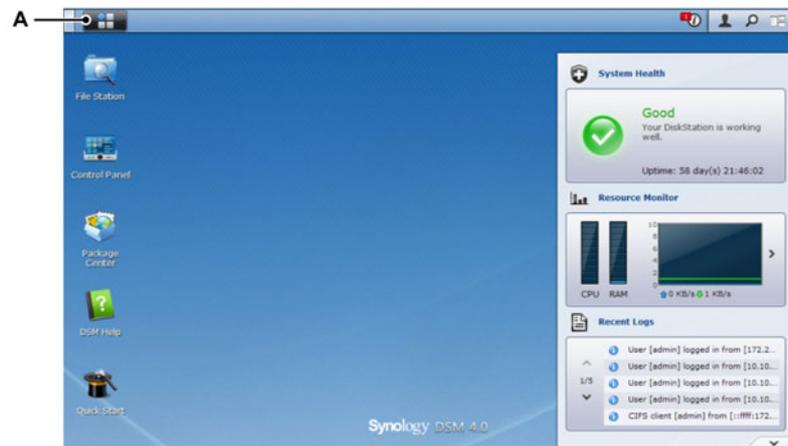
If you see a log in screen you need to log in with the details that were used to setup the NAS the first time it was used. Please refer to the manufacturers guide if you need more information.

Please see the Synology® manual for the start up procedure and how to create log-in details.



**Figure J.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 J.3.



**Figure J.3:** Home screen

**A** Main-menu icon

6 A quick launch window will open.

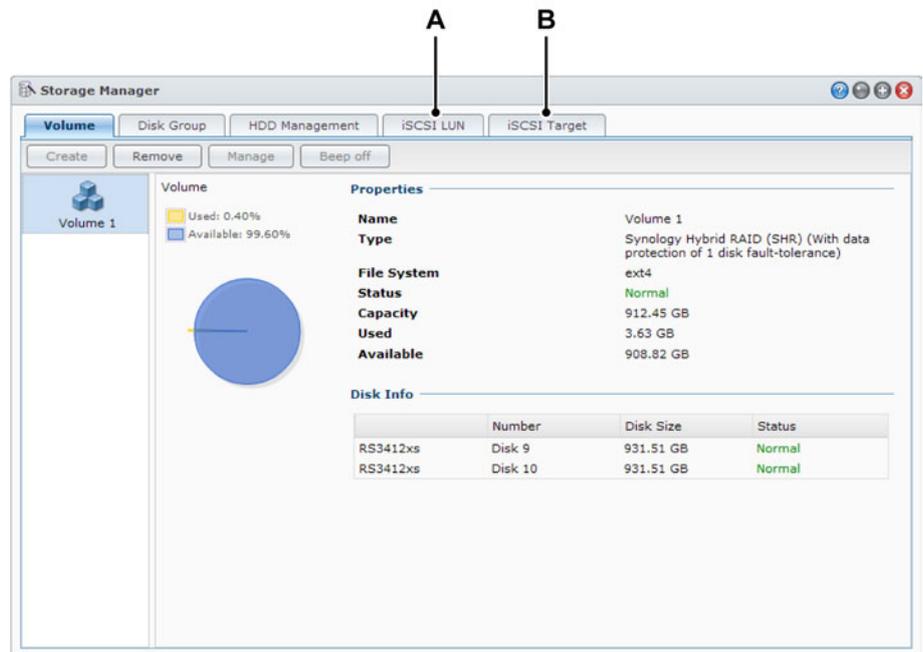


**Figure J.4:** Quick launch window

**A** Storage Manager

Click the **Storage Manager** icon.

7 The **Storage Manager** dialog opens.



**Figure J.5:** Storage Manager dialog

**A** iSCSI LUN

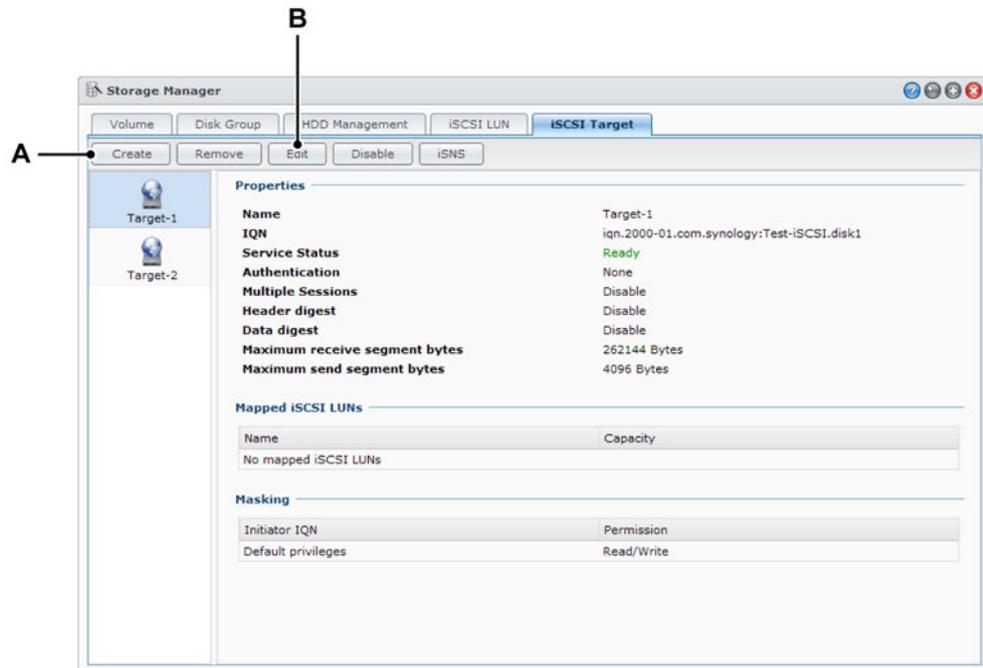
**B** iSCSI Target

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 J.8 "Create a new iSCSI LUN target dialog" on page 582.

8 Click the tab **iSCSI Target**:



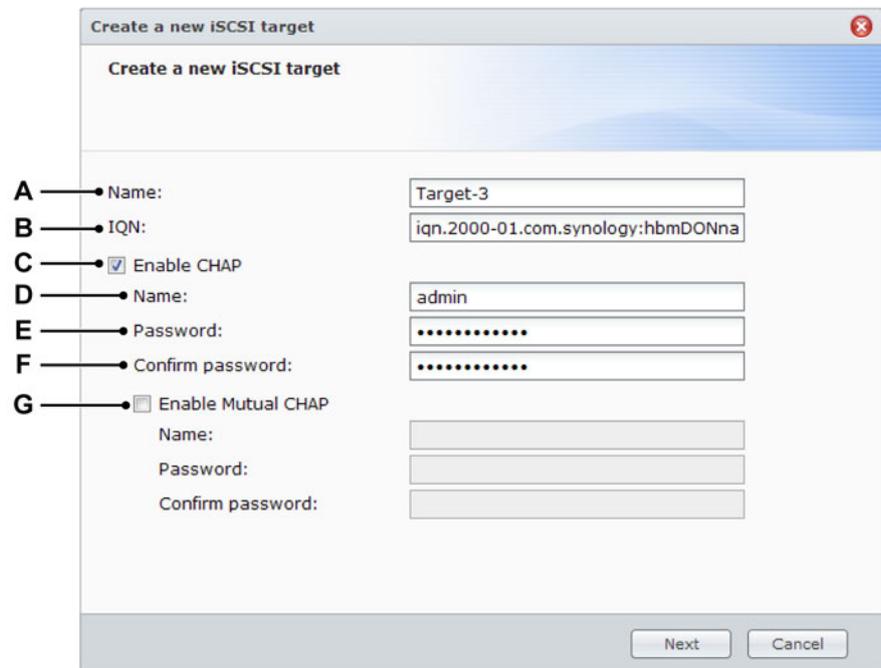
**Figure J.6:** iSCSI Target window dialog

**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 J.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 J.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 J.6 (B)) and then click **Edit**.

- A **Name:** Enter a name for target mapping.  
Recommended Format: iqn.yyyy-mm.domain:device.ID

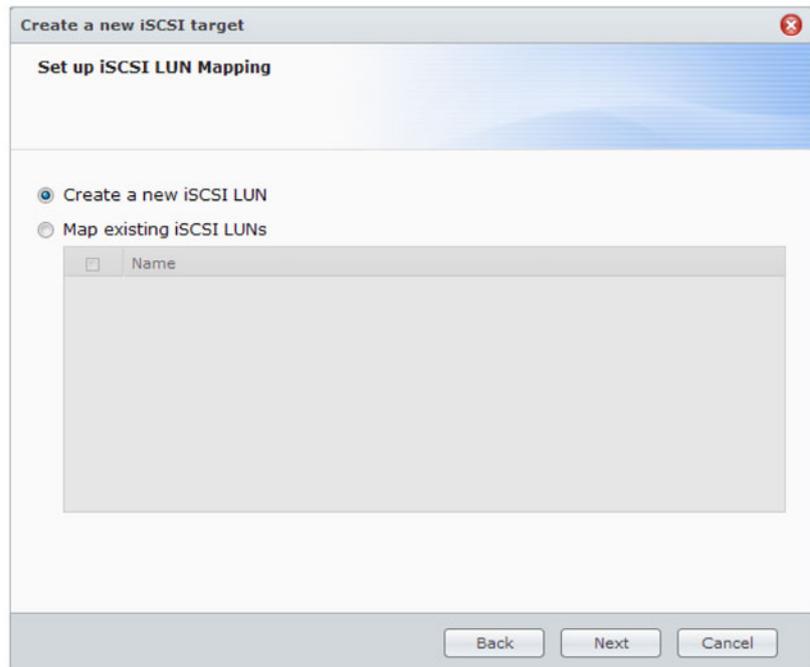
- B IQN:** Enter the actual iSCSI IQN name here.  
Recommended Format: iqn.yyyy-mm.domain:device.ID  
This IQN name is the same name used in Perception dialog **External storage setup: iSCSI Target - Target name** (see Figure 11.6 "External Storage Setup dialog" on page 153 **(C1)** for an example).
- 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.

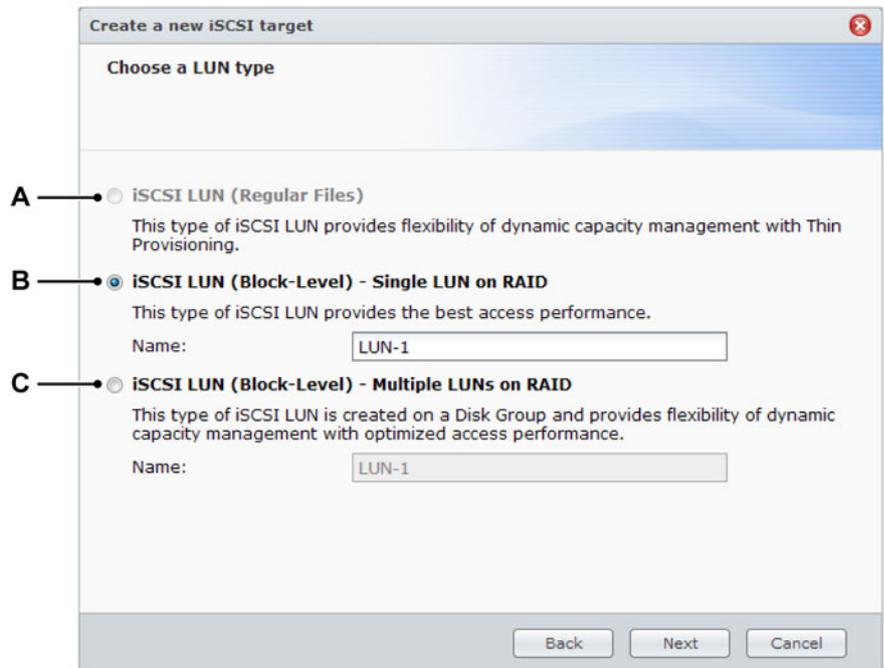


**Figure J.8:** Create a new iSCSI LUN target dialog

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 J.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.

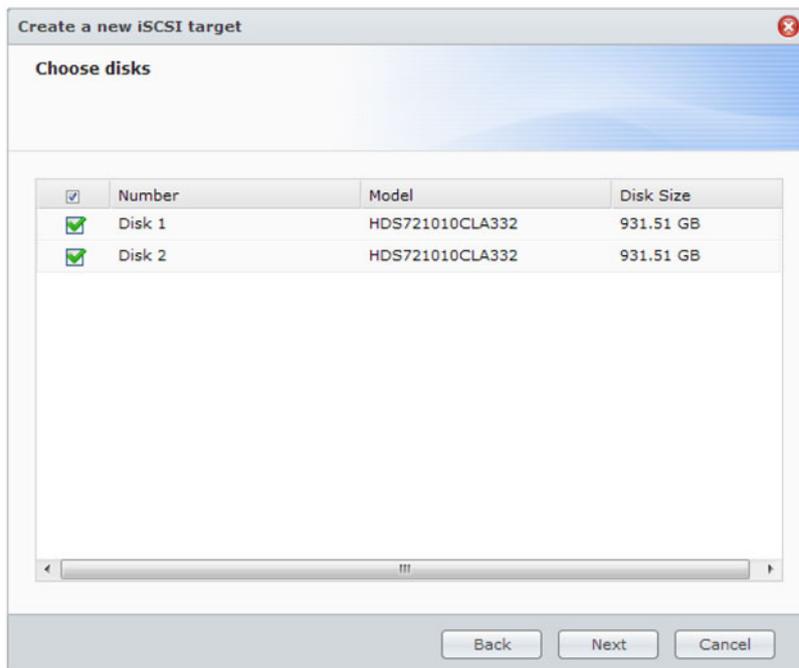
For the following options:

- **iSCSI LUN (Regular files) (A)**
- **iSCSI LUN (Block-level) - Multiple LUN on RAID (C)**

Please see manufacturers description online:  
[www.synology.com/tutorials](http://www.synology.com/tutorials)

Click the **Next** button.

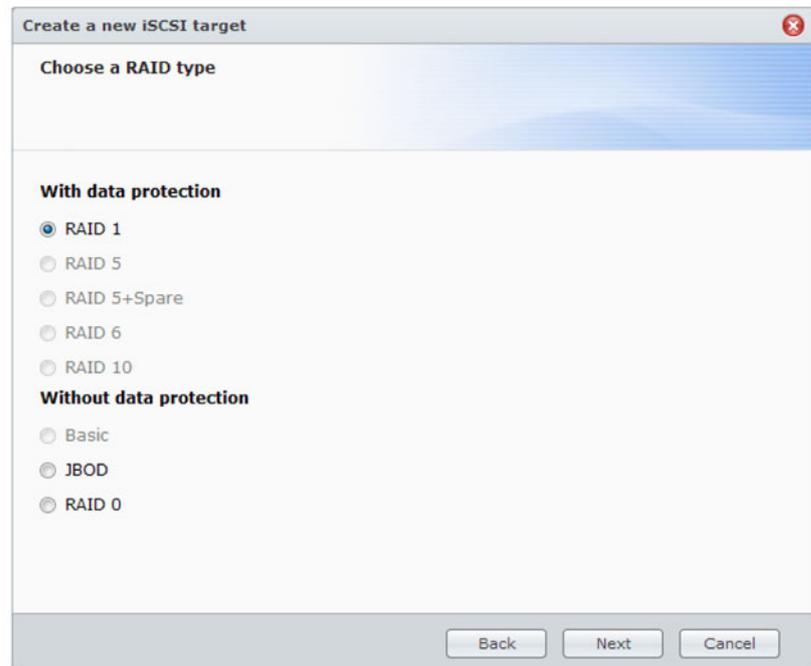
**12** The **Create a new iSCSI target - Choose disks** dialog appears.



**Figure J.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 iSCSI target - Choose RAID type** dialog appears.



**Figure J.11:** Create a new iSCSI LUN target - Choose a RAID type

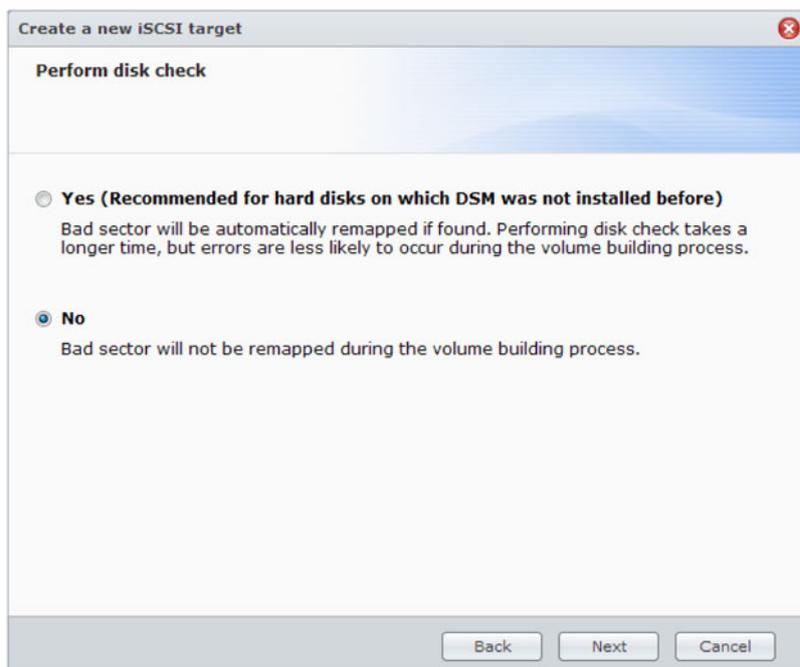
Select the RAID configuration you require.

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](http://forum.synology.com/wiki/index.php)

Click the **Next** button.

- 14 The **Create a new iSCSI target - Perform disk check** dialog appears.

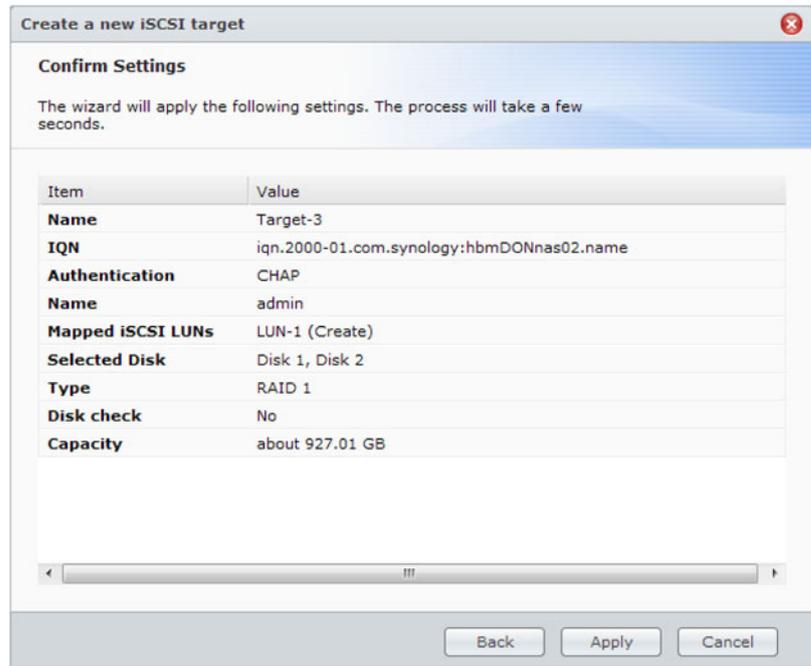


**Figure J.12:** Create a new iSCSI LUN target - Perform disk check dialog

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 iSCSI target - Confirm Settings** dialog appears.



**Figure J.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**.

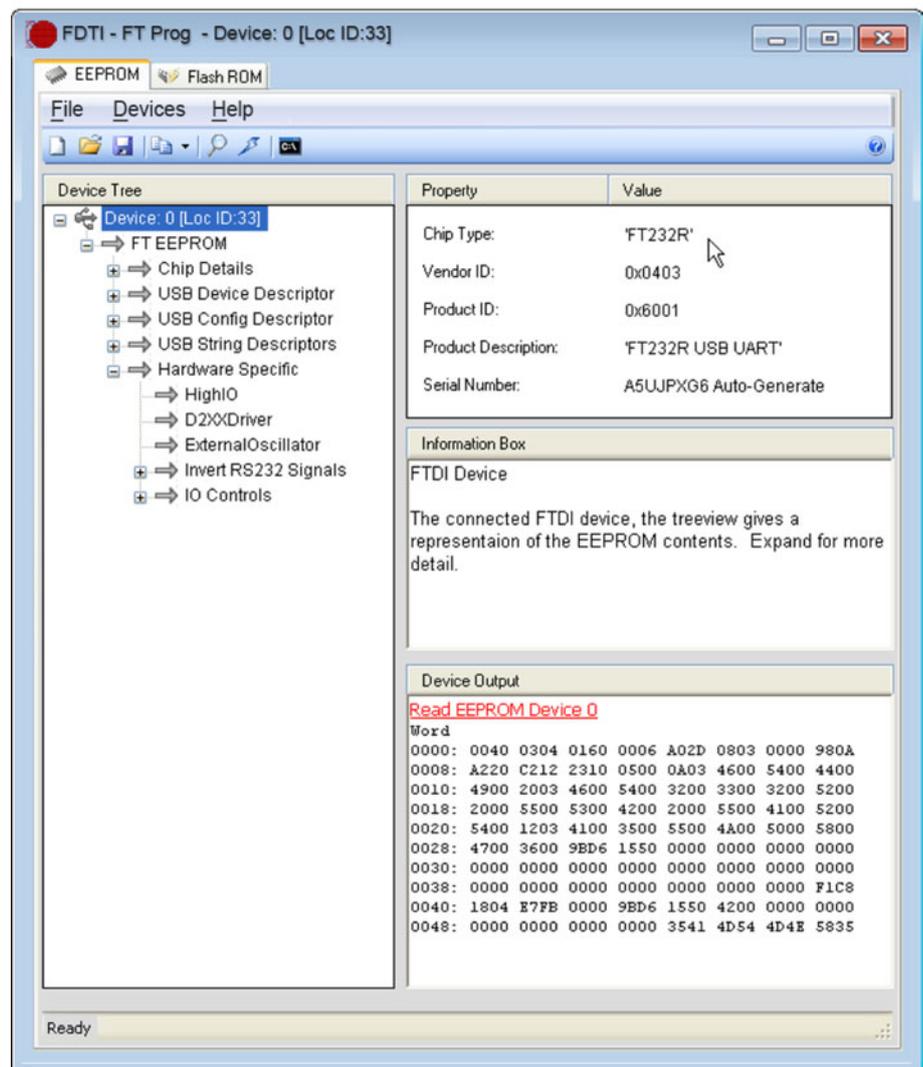
When the dialog box closes a new iSCSI Target/LUN will appear in the iSCSI Target and/or LUN tab of the Synology® software.

**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.*

# K BE3200 USB to Optical RS232 Convertor

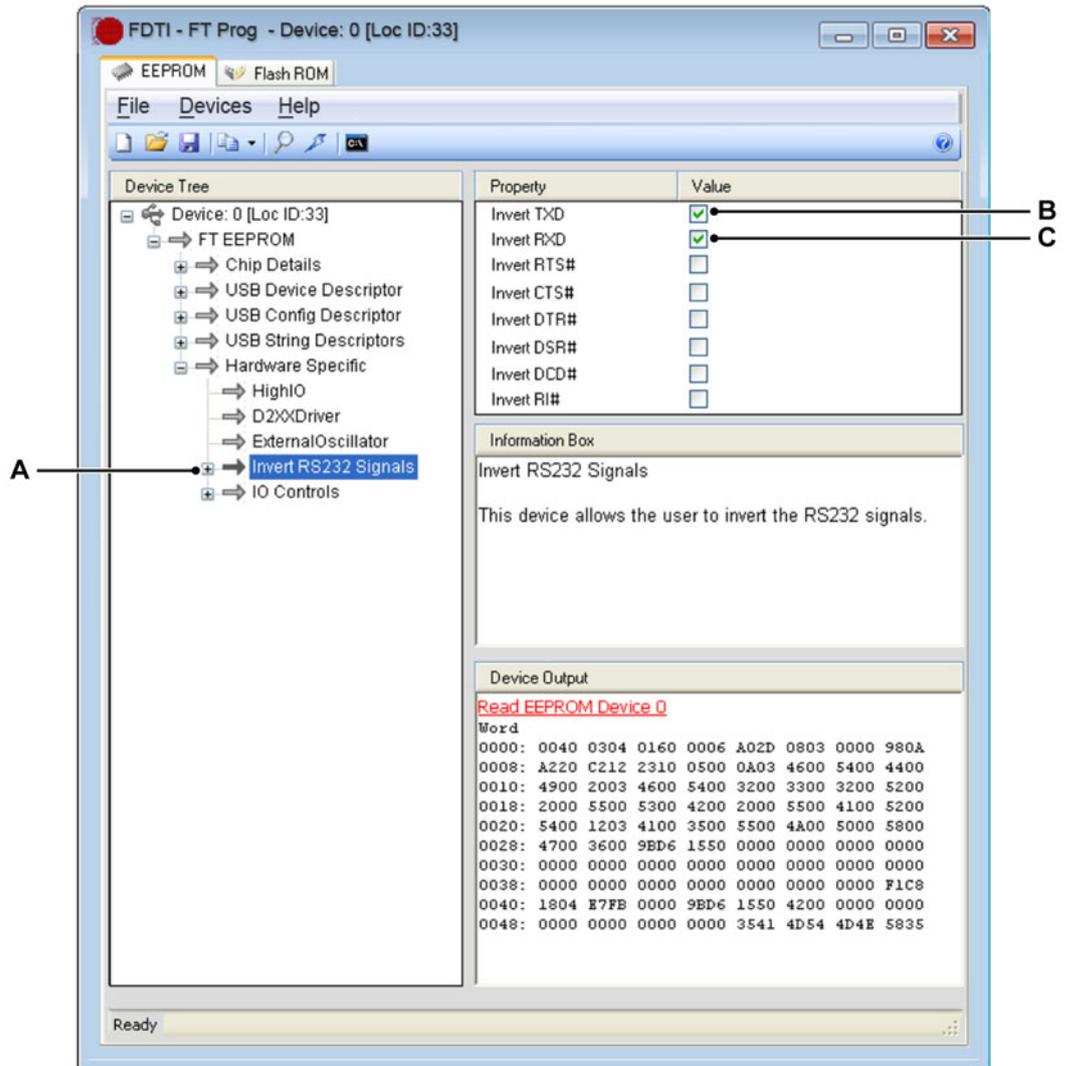
## K.1 Re-programming of the USB-RS232 (opt. 650nm) converter to work with BE3200

- 1 Download the „FT-Prog“ from:  
[www.ftdichip.com/Support/Utilities.htm](http://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 K.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 K.2).
- 5 In the **Property** column select **Invert TXD** and **Invert RXD** check boxes (see Figure K.2):



**Figure K.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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