Genesis HIGH SPEED

# User Manual

English

# Isolated Digitizer

# GEN series

HBM

I2706-3.0 en HBM: public

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*References made to the Perception software are for version 6.10 or higher*

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## Table of Contents

# 1 About this Manual

## 1.1 Symbols used in this manual

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

**WARNING**

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

**WARNING**

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

**CAUTION**

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

**CAUTION**

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

**HINT/TIP**

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

## 1.2 Manual conventions

When the wording “Click Start ...” is used, this refers to the Windows® Start button. Compared to Windows® XP, 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 using this product!**

This instrument is mains or battery 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 safe. The instrument should not be used when environmental conditions exceed the instrument's specifications (e.g. damp, high humidity) or if the unit is damaged.

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

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

**Appropriate use**
This instrument and the connected transducers may be used only for measurement and directly related control tasks. 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 the instrument.

It is also essential to follow the respective legal and safety regulations for specific applications 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, please note the following information about cleaning the housing:

- 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. Using this instrument may be hazardous if it has been installed incorrectly and is operated by untrained personnel. Any person assigned to install, maintain or repair the unit or to put the unit into operation must have first read and understood the user manual, particularly the technical safety instructions.

**Residual risks**
This instrument's scope of supply and performance 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 any residual risks. Prevailing regulations must be complied with at all times. The residual risks of the measurement technology must be referenced.

**Conversions and modifications**
Neither the design nor the safety features of this instrument may be modified without our express prior written agreement. Any modification shall exclude all liability on our part for any resultant damage. In particular, any repair or soldering work on cards (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, operation of the instrument and putting the unit into service must have the appropriate qualifications. The instrument may only be installed and used by qualified personnel, in strict 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 on 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 on how to repair the automation systems. They are also authorized to activate, to ground and to label circuits and equipment in accordance with engineering safety standards. It is essential that the legal and safety requirements for the product and any accessories are complied with 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.**

**IMPORTANT**

**The Isolated Digitizer system is a combination of one or more transmitters and a receiver unit. When a reference is made to the complete system (transmitters and receiver), this is referred to as “the equipment”. If not, the transmitter and receiver unit are identified explicitly.**

## 2.3 Grounding

The instrument must be used with a protective ground connection via the protective ground conductor of the supply cable. The protective ground conductor is connected to the instrument before the line and neutral connections are made 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 connections are made.

**WARNING**

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

For protection against electric shock, all external circuits or equipment need a safe insulation. Therefore, peripheral equipment must not be connected to the system with a power supply without the SELV (Separated Extra Low Voltage) rating unless explicitly mentioned.

Signal connections to the instrument should be connected after the ground connection 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.**

**CAUTION**

**It is important when operating or handling the GN110/GN111/GN112/ GN113 transmitter, that this unit is correctly grounded via the protective ground connection.**

The primary purpose of protective grounding is to provide adequate protection against electric shock that could cause 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

A variety of symbols can be found in the system. 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 connection.

This symbol is used to denote a protective ground connection.

This symbol is used to denote a frame or chassis ground connection. This point is not a protective ground 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 pressed, the instrument state toggles between the operating and power-off mode. When the system is 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 IEC 61010-1 and the IEC 61010-2-030.
- IEC 61010-1 defines three overvoltage categories (CAT II, CAT III, and CAT IV) for the power supply of an instrument.
- IEC 61010-2-030 defines three measurement categories (CAT II, CAT III, and CAT IV) for an instrument's input measurements which can be directly connected to mains supply.
- All measurement inputs which are not specified to be connected to the mains power have no CAT rating and are referred to as O (like Others).

**Categories in accordance with IEC 61010-2-030:2010**
Electrical equipment, specifically measurement tools, can be assigned into four categories in accordance with IEC 61010-2-030:2010. These measurement categories are indicated by the terms O (previously CAT I), CAT II, CAT III and CAT IV. Originally, these categories were used to indicate the overvoltage or surge voltage that was likely to occur and could be sustained by the equipment. Currently, the category indicates the amount of energy that can be released if a short circuit occurs. 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 a mains supply. Measurements for this category are signal levels, regulated low voltage circuits or protected secondary circuits. For this category, there are no defined standard overvoltage or surge impulse levels.

**CAT II**: This category is for measurements directly connected to a low voltage mains supply. Measurements for this category are mains sockets in household applications or portable tools. This category expects a minimum of three levels of overcurrent 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. Measurements for this category are circuit breakers, wiring, junction boxes, etc. This category expects a minimum of two levels of overcurrent 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. Measurements for this category are overcurrent protection devices, ripple control units, etc. This category expects that there is a minimum of one level of overcurrent protection between the transformer and connection point of the measurement circuit. (See Figure 2.1).

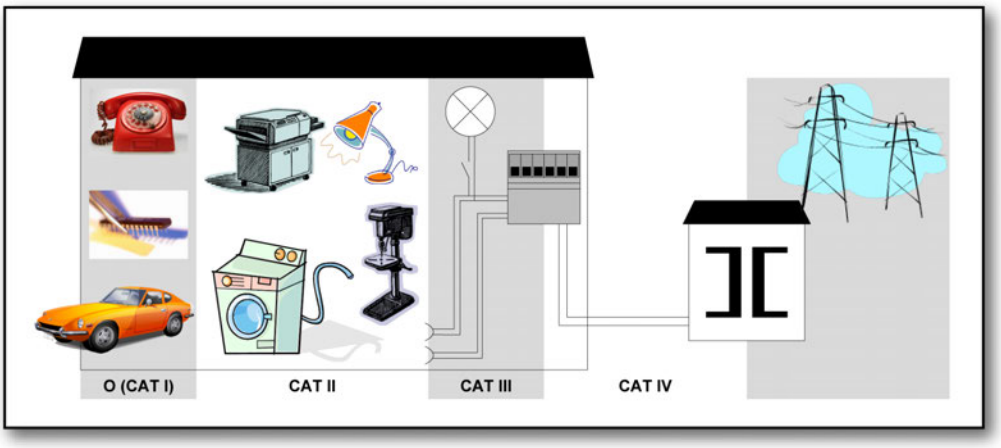



**Figure 2.1:** Category indication in accordance with IEC 61010-2-030:2010

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

*Table 2.1: Insulation test voltages in accordance with 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 | 1390 | 2210 | 1550 | 2500 | 4000 |
| > 150 ≤ 300 | 1390 | 2210 | 3310 | 2500 | 4000 | 6000 |
| > 300 ≤ 600 | 2210 | 3310 | 4260 | 4000 | 6000 | 8000 |
| > 600 ≤ 1 000 | 3310 | 4260 | 6600 | 6000 | 8000 | 12000 |

Using the table above, it can be concluded that this specification informs the user that the device passed the insulation tests; 5 sec at 2210 V RMS and impulse 4000 V. The maximum operating input voltage is 1000 V DC. This device is to be used to measure CAT II circuitry up to 600 V.

**WARNING**

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

### 2.5.2 Basic versus reinforced insulation

For reference, the basic insulation and supplementary insulation and the reinforced insulation test values for CAT II can be found below.

*Table 2.2: Test voltages for the testing electric strength of solid insulation in measuring circuits in measurement category II (IEC 61010-2-030:2010)*

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

Several means of protection can be used to protect a user from hazardous voltages. As can be seen below, basic insulation and supplementary insulation is one mean of protection, but reinforced isolation is also a means of protection. The test voltages are different for each mean of protection, as can be found in the table above.

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

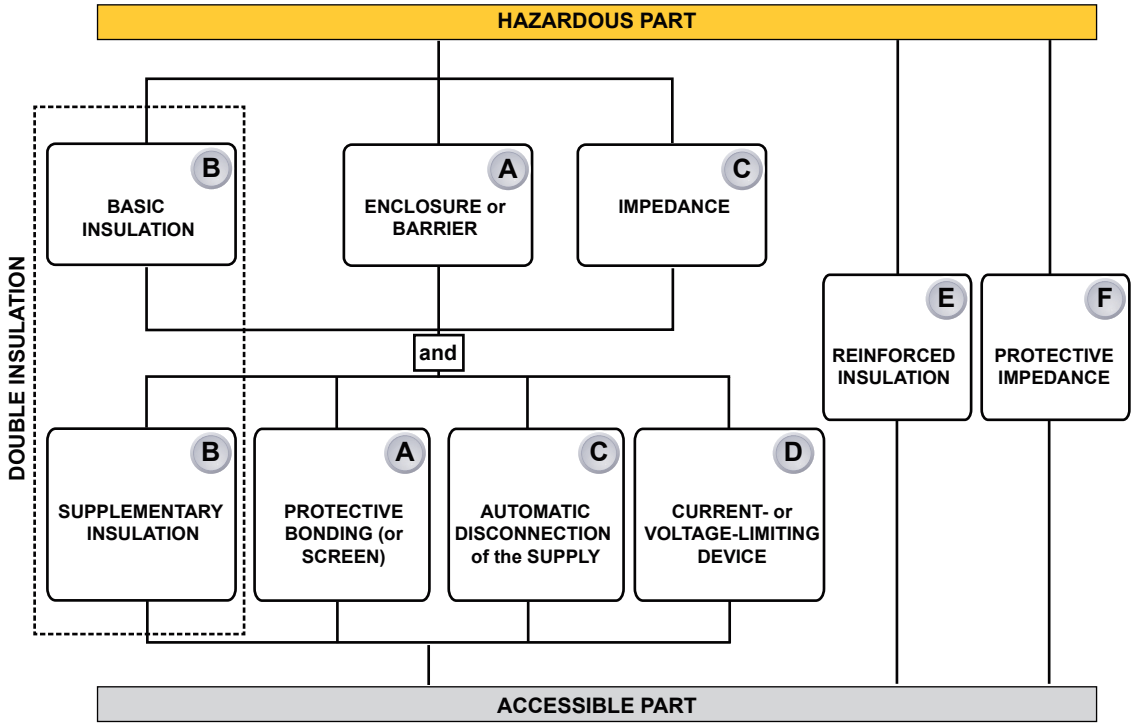



**Figure 2.2:** Acceptable arrangement of protective means against electric shock

Example: A measurement device is specified as 600 V CAT II reinforced insulation, with a maximum input voltage 1000 V DC.
Using the information above, it can be concluded that this specification informs the user that the measurement device is tested on input to chassis ground for five seconds at 3510 V RMS and impulse 6400 V. The maximum operating input voltage is 1000 V DC. This device is to be used to measure CAT II circuitry up to 600 V.

### 2.5.3 Protection

**WARNING**

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

Whenever it is likely that the protection has been impaired, the apparatus must 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 used with the equipment, such as probes.

**WARNING**

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

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

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

**WARNING**

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

**WARNING**

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

### 2.5.4 Overvoltage/current protection

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

**WARNING**

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

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

The instrument must not be operated with the covers removed.

There are no user serviceable parts inside.

### 2.5.5 Isolation

**CAUTION**

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

The GN110/GN111/N112/GN113 transmitter is designed to be used in combination with the GN1202B receiver. The fiber optic cables determine the maximum clearance distance and creepage distance between the Isolated Digitizer and the acquisition system.

**WARNING**

**The minimum clearance and creepage distance depends on the position of the GN110/GN111/N112/GN113 transmitter and the GN1202B receiver. A safety factor of at least twice of the creepage and clearance distance is required.**

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

**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 –15 °C and +50 °C for the GN110/GN111 transmitter; 0 °C and +40 °C for the GN112/GN113 transmitter and the GN1202B receiver.

The instrument is specified for use in a Pollution Degree II environment, which is normally non-conductive 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, as specified in the Pollution Degree II environment.

The equipment will operate with full specified accuracy in an environment with an ambient temperature between +15 °C and +35 °C.

Humidity should be between 0% and 80%. When moving the device from a cold to a warm environment the equipment has to be left powered 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.*

The GN110/GN111 transmitter relies on a convection air-cooling design that does not require a fan. Adequate cooling can usually be achieved by leaving a 12.5 mm (0.5") gap around the transmitter.

The GN112/GN113 transmitter has a fan installed. Leave a space around the equipment for unrestricted ventilation, especially at the front and back of the unit.

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

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

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

## 2.7 Laser Safety

The system is classified as a **Class 1 laser product**. The system uses an optical transceiver for data and command communication between GN1202B receiver and GN110/GN111/GN112/GN113 transmitter. It does not emit hazardous light but it is recommended to avoid direct exposure to the beam.

**WARNING**

**Intrabeam viewing of the laser product may produce dazzling visual effects, particularly in low ambient light. Lasers of any wavelength with sufficient output power can cause injury.**


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

The GEN series products are certified as Class 1 Laser Products and comply with US FDA regulations. These are certified by TÜV and CSA to meet the Class 1 eye safety requirements of EN (IEC) 60825 and the electrical safety requirements of EN (IEC) 60950. The devices are for use only under the specifications and ratings specified in the manual and data sheets.

**CAUTION**

**Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.**

## 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 to workers.

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

- Can one person lift this load safely, or do two people need to lift the load?
- 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 that need to be opened be encountered?
- 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 to protect hands?

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

The GN110/GN111 transmitter weighs approximately 4.6 kg maximum (each), the GN112/GN113 transmitter weighs approximately 3 kg (each):

## 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.

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

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

## Nederlands

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

De deksels mogen nooit worden verwijderd.

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

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

Suomi

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

Älä poista suojakansia.

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

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

Français

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

Ne pas déposer les panneaux de protection.

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 Gleichspannung (IEC 61010-1:2010) muss die Signalmasse angeschlossen sein.

Die Schutzabdeckung nicht entfernen.

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

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

Italiano

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

Non aprire lo strumento.

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

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

Norsk

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

Ikke fjern dekslene.

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.

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.

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

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

Español

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

No quite las tapas.

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.

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

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

English

**SAFETY WARNING**

This instrument must be operated with a protective ground (earth) connection 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.

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

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

## 日本語

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

カバーは取り外さないでください。

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

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

## 中文

**安全警告**

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

不要取下保护盖。

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.

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

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

## 안전 경고

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

덮개를 제거하지 마십시오.

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

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

## 2.10 Operation of electrical installations

Working on, with, or near electrical installations implies certain dangers. These electrical installations are designed for the generation, transmission, conversion, distribution and use of electrical power. Some of these electrical installations are permanent and fixed, such as a distribution installation in a factory or office complex, others are temporary, such as on construction sites, and others are mobile or capable of being moved either while energized or while neither energized nor charged.

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

**WARNING**

**High voltage and qualified personnel**

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

# 3 Normative Documents and Declarations

## 3.1 Electrical

### 3.1.1 Electrostatic 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 the importance of ESD preventions when handling a system, or its connections.**

**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 the electronic devices, including the system, from ESD harm. Although HBM has built protections against ESD into its products, ESD exists and, unless neutralized, could build up to levels that could harm the 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, the user may want to take extra precautions to protect the electronic equipment against ESD if ESD events are observed in the present environment.

**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 the user's 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 Electromagnetic Compatibility. The overall intention is that electronic equipment must be able to co-exist with other electronic equipment in its immediate vicinity and that the electronic equipment does not emit 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.

Whether the instrument causes interference to other equipment can be determined by turning the instrument on and off. If this instrument does cause minor harmful interference to other equipment, the user is encouraged to try reducing 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 stating that EU members now restrict the use of hazardous substances in electrical and electric equipment (Directive 2002/95/EC) and promotes the collection and recycling of such electrical equipment (Directive 2002/96/EC) has been in force.

**Statutory waste disposal mark**

The electrical and electronic devices that bear this symbol are subject to the 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. For more information about waste disposal, please contact local authorities or the dealer from whom the product was purchased. As waste disposal regulations may differ from country to country within the EU, please contact the supplier about waste disposal regulations if necessary.

**Packaging**

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

**Environmental protection**


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

### 3.3 Declaration of conformity

For information about the CE Declaration of conformity, please refer to www.hbm.com/highspeed.

# 4 Batteries

## 4.1 General

The GN110/GN111 transmitter operates on removable, rechargeable Li-ion batteries.
The GN112/GN113 transmitter has internal rechargeable Ni-MH batteries that are not serviceable.

### Battery lifetime

A battery's lifetime depends on how it is 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. If a battery is handled inappropriately, it 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 not work temporarily, 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 a spare battery is carried in a pocket or bag. Short-circuiting the terminals may damage the battery or the object that causes the short-circuiting.

**WARNING**

**If leaked battery fluid comes into contact with your eyes, immediately flush out 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.**

**WARNING**

**For protection against electric shock the transmitter may not be operated without both battery bays closed, either by a battery module installed or by a bay cover in place.**
**Make sure that input signals are detached from the transmitter before a battery module is removed.**

### 4.1.1 Li-ion battery management

The following guidelines apply for optimum Li-ion battery usage.

The most important thing to understand about Li-ion batteries is that they are **always** losing a small amount of their charge. The hotter the temperature, the faster Li-ion batteries lose their charge.

- A Li-ion battery typically provides 300-500 discharge/charge cycles.
- This battery type prefers a partial rather than a full discharge. Frequent full discharges should be avoided when possible. Instead, charge the battery more often, except before a long storage. There is no concern of memory when applying unscheduled charges, the Li-ion battery does not suffer from the "memory effect" at all.
- Li-ion batteries should be kept cool. Ideally they are stored in a refrigerator. Aging will take its toll much faster at high temperatures. The high temperatures found in cars cause Li-ion batteries to degrade rapidly. However, never freeze a battery.
- When using a device with Li-ion batteries running from fixed line power over extended periods, the battery should be removed and stored in a cool place so that it is not affected by the heat produced by the device.

**Storage temperature and charge**

- Store the battery at a 40% charge level. Never fully charge or discharge the battery before storage. The 40% charge assures a stable condition even if self-discharge robs some of the battery’s energy.
- Storing a Li-ion battery at the correct temperature and charge makes all the difference in maintaining its storage capacity. The following table shows the amount of permanent capacity loss that will occur after storage at a given charge level and temperature.

| **Storage Temperature** (Permanent Capacity Loss versus Storage Conditions) | **40% Charge** | **100% Charge** |
|---|---|---|
| **0 °C (32 °F)** | **2%** loss after 1 year | **6%** loss after 1 year |
| **25 °C (77 °F)** | **4%** loss after 1 year | **20%** loss after 1 year |
| **40 °C (104 °F)** | **15%** loss after 1 year | **35%** loss after 1 year |
| **60 °C (140 °F)** | **25%** loss after 1 year | **40%** loss after **3 months** |

*Source: www.BatteryUniversity.com*

- It is beneficial to avoid storing a Li-ion battery at full charge. A Li-ion battery stored at 40% charge will last many times longer than one stored at 100% charge, particularly at higher temperatures.
- If a Li-ion battery is stored with too low a charge, there is a risk of allowing the charge to drop below the battery's low-voltage threshold, resulting in an unrecoverably dead battery. Once the charge has dropped to this level, recharging it can be dangerous. An internal safety circuit will therefore open to prevent charging, and the battery cannot be used anymore.
- In circumstances where a second Li-ion battery is available for a given device, it is recommended that the unused battery be discharged to 40% and placed in the refrigerator to prolong its shelf life. **Batteries should be allowed to completely warm to room temperature over up to 24 hours before any discharge or charge.**

Avoid purchasing spare Li-ion batteries for later use. Observe the manufacturing date when purchasing. Do not buy old stock, even if sold at clearance prices.

Contact your battery supplier/manufacturer (or visit their web site) for more details on battery specifications, usage and maintenance.

### 4.1.2 Ni-MH battery management

The following guidelines apply for optimum Ni-MH battery usage.

The most important thing to understand about Ni-MH batteries is that they are **always** losing an amount of their charge. The hotter the temperature, the faster Ni-MH batteries lose their charge.

- The energy loss in a Ni-MH battery is asymptotical, meaning that the self-discharge is highest right after charge and then tapers off. Nickel-based batteries lose 10 to 15 percent of their capacity in the first 24 hours after charge, then 10 to 15 percent per month.

- The self-discharge on all battery chemistries increases at higher temperature and the rate typically doubles with every 10 °C (18 °F). A noticeable energy loss occurs if a battery is left in a hot environment. High cycle count and aging also increase self-discharge. Nickel-metal-hydride is good for 300-400 cycles before elevated self-discharge starts interfering with performance. The self-discharge on an older nickel-based battery can get so high that the pack loses its energy through leakage rather than normal use.
- Ni-MH batteries can be stored for about three years.
- A Ni-MH battery typically provides 300-500 discharge/charge cycles.
- Ni-MH batteries can lose electrolyte through venting due to excessive pressure during extreme charge or discharge. After repeated venting, the spring-loaded seal of the cells may not seal properly again, and the deposit of white powder around the seal opening is evidence of this. Losses of electrolyte may also occur as part of faulty manufacturing.

**Storage temperature and charge**

- Store the battery at a 40% charge level. Never fully charge or discharge the battery before storage. The 40% charge assures a stable condition even if self-discharge robs some of the battery's energy.
- Storing a Ni-MH battery at the correct temperature makes all the difference in maintaining its storage capacity. The following table shows the amount of permanent capacity loss that will occur after storage at a given temperature.

| **Storage Temperature** (Permanent Capacity Loss versus Storage Conditions) | |
|---|---|
| **0 °C (32 °F)** | **1%** loss after 1 year |
| **25 °C (77 °F)** | **3%** loss after 1 year |
| **40 °C (104 °F)** | **5%** loss after 1 year |
| **60 °C (140 °F)** | **30%** loss after 1 year |

- If a Ni-MH battery is stored with too low a charge, there is a risk of allowing the charge to drop below the battery's low-voltage threshold, resulting in an unrecoverably dead battery.

Avoid purchasing spare Ni-MH batteries for later use. Observe the manufacturing date when purchasing. Do not buy old stock, even if sold at clearance prices.

Contact your battery supplier/manufacturer (or visit their web site) for more details on battery specifications, usage and maintenance.

## 4.2 Removing and replacing

**GN112/GN113 transmitter**
The GN112/GN113 transmitter includes a non-user replaceable battery please contact HBM service if battery replacement is required.

**GN110/GN111 transmitter**
Before you can use the transmitter, a battery module must be installed. When a battery is low and needs to be charged it must be removed.

**WARNING**

**ELECTRICAL SHOCK HAZARD! Remove all cables before proceeding.**

**Removing a battery module**
To remove a battery module do the following:

1 Using a flat blade screwdriver, loosen the multi-turn screw that holds the battery module in place.
2 Pull the battery module gently out of the cabinet.


**Figure 4.1:** Battery module removal

**A** Screws

**Placing a battery module**
To place a battery module proceed as follows:

1 Place the battery module in the cabinet.
2 Push it firmly into the connector in the rear of the cabinet until you feel it snap, without using excessive force.
3 Using a flat blade screwdriver fasten the multi-turn screw to hold the battery module in position.

**Battery module**
The battery module is a battery holder with a standard Li-ion battery. The batteries can be charged and discharged hundreds of times, but will gradually wear out. When the operation time is noticeable shorter than normal, it is time to renew the batteries.

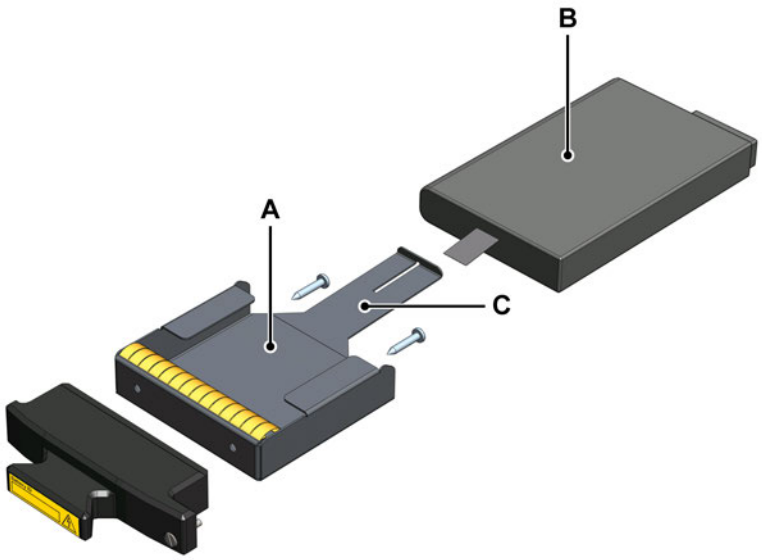



**Figure 4.2:** Battery module

**A** Battery holder

**B** Battery pack

**C** Lock strip

The battery module is designed to fit in the supplied battery charger, i.e. it is not necessary to remove the battery from its holder when charging. However, when you are using a non-standard charger it may be necessary to remove the battery from its holder before you can place the battery in a charger.

**Renewing a battery**

To renew a battery in the battery module do the following:

1 Remove the battery module from the cabinet and place it on a flat surface.
2 Remove the battery from the battery holder:
   - Gently bend down the strip that locks the battery into position until the battery is released.
   - Pull the battery out of the holder.
3 Place a new battery in the holder.

## 4.3 Recharging

The GN110/GN111 transmitter uses rechargeable Li-ion batteries that need to be charged in external charges.

**Precaution and warnings when charging batteries**

- Never use any charger or battery that is damaged in any way.
- Battery charging time depends on the remaining battery charge and the type of battery and charger used. The batteries can be charged and discharged hundreds of times, but will gradually wear out. When the operation time is noticeably shorter than normal, it is time to buy new batteries.
- If left unused, a fully charged battery will discharge itself over time.
- Use only HBM approved batteries and recharge your batteries only with HBM approved chargers. When a charger is not in use, disconnect it from the power source. Do not leave a battery connected to a charger for more than a week, since overcharging may shorten its life.
- Extreme temperatures will affect the charging capacity of the battery: it may require cooling or warming first.
- GN110/GN111 transmitter: Remove the batteries before charging.
- Standard Li-ion batteries cannot be charged below 0 °C (32 °F). Although the packs appear to be charging normally they will be damaged. If done repeatedly, such damage can compromise the safety of the pack. The battery will become more vulnerable to failure if subjected to impact, crush or high-rate charging.

**GN112/GN113 transmitter**

The internal batteries of the GN112/GN113 transmitter is automatically recharged when the transmitter is connected to the mains, also when the system is in operation.

**GN110/GN111 transmitter**

To recharge the batteries of the transmitter you need a suitable charger. HBM provides chargers that are targeted towards the HBM qualified batteries.


**Figure 4.3:** Example of a battery charger

To (re)charge a battery proceed as follows:

1. Remove all cables from the GN110/GN111 transmitter.
2. Remove the battery as described in "Removing a battery module" on page 53.
3. Place the battery or batteries in the charger:
   - Refer to the documentation that came with your charger for additional information.
   - Depending on the charger in use, the complete battery module may not fit in the charger. If so, remove the battery pack from the battery holder as described in "Renewing a battery" on page 55.
4. When the battery is fully loaded, replace the battery as described in "Placing a battery module" on page 54.

**Requirements**
Recharging the battery is defined by the battery in use. Check the details of the battery to match the required charge current and voltage.

When the battery is fully exhausted, it will take several hours to reach the 100% capacity again (at the typical charge rate). In practice, however, the battery will not be fully exhausted, reducing the recharge time.

**Battery low vs. recharge**
The "battery low" indication on the receiver front panel becomes active when the battery voltage has gone below the 10.5 V level, and stays active until the 9.0 V level is reached. After this the front-end will not function any more.

## 4.4 Disposal

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

**WARNING**

**Do not dispose of batteries in a fire.**

For more information about waste disposal, please contact the local authorities or the dealer from whom the product was purchased.
As waste disposal regulations may differ from country to country within the EU, please contact the supplier about waste disposal regulations if necessary.

# 5 Mains Power

## 5.1 Power and frequency requirements

The **GN110/GN111** transmitter is battery-powered. Refer to the various sections in this document on batteries, their usage, storage, charging and power management for more information. The GN110/GN111 transmitter use 6 VA typical, 8 VA maximum.

The **GN112/GN113** transmitter uses up to 12 VA and operates from line voltages of 115 V AC or 230 V AC at 47-63 Hz.

The power connections of the GN112/GN113 transmitter is via a standard IEC 320 EN 60320 C14 (male) appliance inlet, 2-pole, 3-wire designed for 250 V @ 10A. Access to the AC supply fuse(s) and voltage selector can only be made if the AC supply connector is removed.Two 250 mA fuses must always be used. Refer to "Fuse replacement" on page 60 for details.

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.

The GN112/GN113 transmitter must be used with a ground connected via the conductor of the supply cable. This is to ensure all Electro Magnetic Compatibility (EMC) requirements are met.

## 5.2 Fuse replacement

The **GN110/GN111** transmitter has no additional fuses.

The **GN112/GN113** transmitter is equipped with a replaceable fuse. The fuse arrangement stated here must be followed and, additionally, in the UK a fuse should be fitted in the line supply plug.

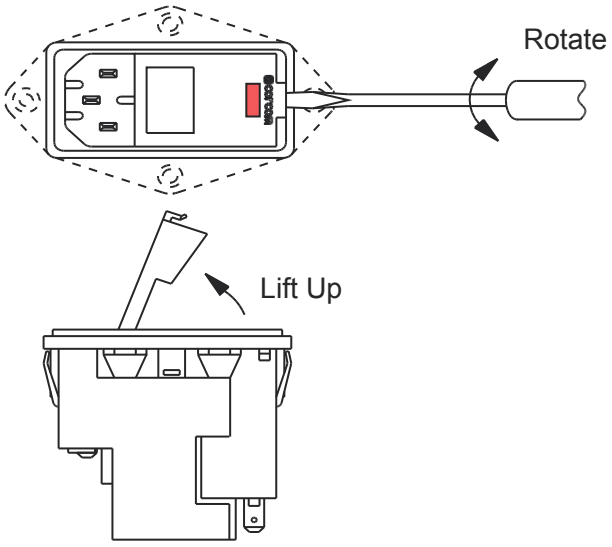
The fuse must be a 5 x 20 mm slow blow (T) fuse with a rating of 250 mA.

**WARNING**

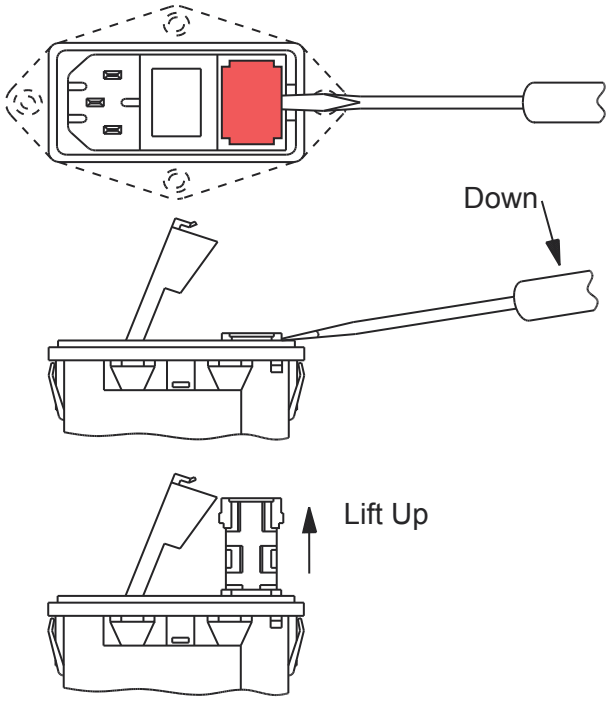
**Inspect the voltage selector at the rear of the transmitter cabinet for the correct setting before applying power. If necessary see the section for instructions on changing the voltage selector.**

To gain access to the fuses proceed as follows:

1. Unplug the power cord.
2. Using a pocket screwdriver, insert the screwdriver in the slot under the fuse door and gently rotate the screwdriver to unlatch the door. When unlatched, raise the fuse door.



3 With the door in the raised position, gently position the screwdriver at the slot in the end of the fuse holder and gently lever to raise the fuse holder and remove it from the housing.




**Replacing the fuses**

The fuse holder is equipped with two identical fuses.

**WARNING**

**Replace both fuses at the same time with correct type and rating as indicated on the rear of the GN112/GN113 transmitter and in this manual.**

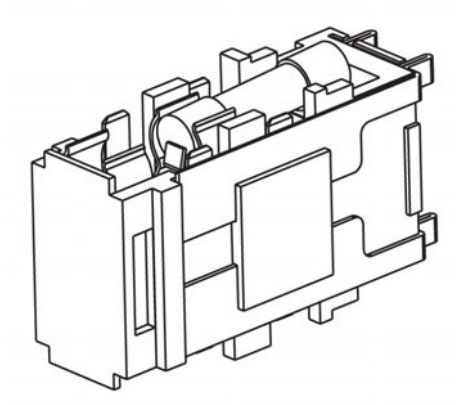


**Figure 5.1:** Fuse holder shown with 5x20 mm fuse

To replace the fuses proceed as follows:

1 Remove the fuses from their fixture and insert new fuses.
2 When done re-insert the fuse holder and close the fuse door.

**Note** *The fuse holder has two fuses installed. Replace both fuses at the same time.*

## 5.3 Mains voltage selector

**WARNING**

**Inspect the voltage selector for the correct setting before applying power. Using a wrong voltage selection could result in unrecoverable internal system damage.**

**Changing the voltage selection for GN112/GN113 transmitter**
To change the voltage selection do the following:

1. Turn the fuse holder.
2. Re-insert the fuse holder and close the fuse door.
3. The correct voltage must now be visible from the outside of the power entry housing.

Re-insertion of the fuse holder should go smoothly. Do not use excessive force. Verify proper placement of fuses as well as the position of the unit if it won't snap into place easily.

# 6 Introduction

## 6.1 Introduction to Isolated Digitizers

Successful operation of any laboratory, whether independent or manufacturer-owned, relies on disturbance-free and accurate measurements, also when the object under test has a failure: high frequency oscillating currents flow to ground and cause a high potential shift of the ground point. The resulting problems of grounding and power supply connection are less when galvanic isolation from the test area is achieved by means of fiber optic links.

There are two principal ways of transmitting signals via fiber optic links: analog or digital. With a digital link the measured signal is digitized with an A-to-D converter close to the test object, transmitted via the fiber optics, processed directly in digital form, and converted back to an analog signal with a D-to-A converter. Digital fiber optic systems do not have drift or noise problems and surpass their analog counterparts when it comes to dynamic accuracy.

Bringing the A-to-D converters close to the test object, however, means that extra care must be taken to shield the equipment from strong electromagnetic fields. The power for the A-to-D converters must be supplied from batteries to avoid any coupling with the environment.

The Isolated Digitizer eliminates the use of floating scopes, protecting both operator and instrument even where high voltage and high EMI are involved. The Isolated Digitizer offers remote operation, excellent signal fidelity and elimination of ground problems.

**Features and advantages**

- Complete single-channel isolated analog input to analog output system
- Rugged enclosure for use in EMI-hostile environments
- Digital fiber optic data transmission for excellent DC stability
- Wide dynamic range and unsurpassed dynamic accuracy

### 6.1.1 Configuration

The Isolated Digitizers are available in four different configurations. There are two mechanical variants, one for use in medium and one for use in high voltage environments. Each model is available with 25 MS/s or 100 MS/s digitizing speed per channel.

- The GN110/GN111 transmitter version is single layer shielded and exclusively battery powered. The removable batteries run for a minimum of 24 hours, with a software controlled “sleep mode” that extends the standby time significantly. Hot swappable batteries (not when acquiring data, see ("Batteries" on page 49) allow for continuous deployment: while charging one set, the unit operates on a spare set. Standardized Lithium-Ion batteries are used to ensure proper operation in various environments.
- The GN112/GN113 transmitter version is single layer shielded and use AC power. This GN112/GN113 transmitter version can be used for isolated measurements up to 1.8 kV while being powered by AC power. When higher isolation is required, the GN112/GN113 transmitter version can be disconnected from the AC power and run from internal battery for 5 minutes. When it is reconnected to AC power, the internal battery will be recharged.
- The GN1202B receiver is the standard GEN series acquisition card for receiving data from the transmitters, it can receive up to twelve data signals. These signals are then recorded digitally by the acquisition card.

### 6.1.2 Functional description

A **system** always consists of one (or more) Isolated Digitizer transmitters and one (or more) receiver cards. One GEN series receiver card serves up to four transmitters.

For each data channel the system has a front-end (the Isolated Digitizer), a twin fiber optic link, data channel receiver and storage unit. The data channel receiver and storage unit is part of a GEN series four-channel receiver card.

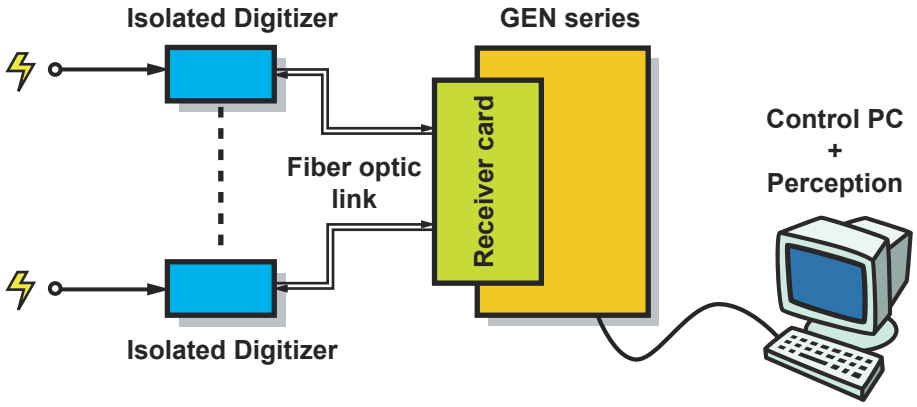



**Figure 6.1:** System block diagram

The transmitter comprises a high-fidelity programmable amplifier with anti-aliasing (AA) filter, an A-to-D converter, control logic, fiber optic interfacing and a battery power management system.

For technical specifications refer to "B4770-1.0 en (GEN series GN1202B Optical Fiber Islolated 100 MS/s Input Card)" on page 84.

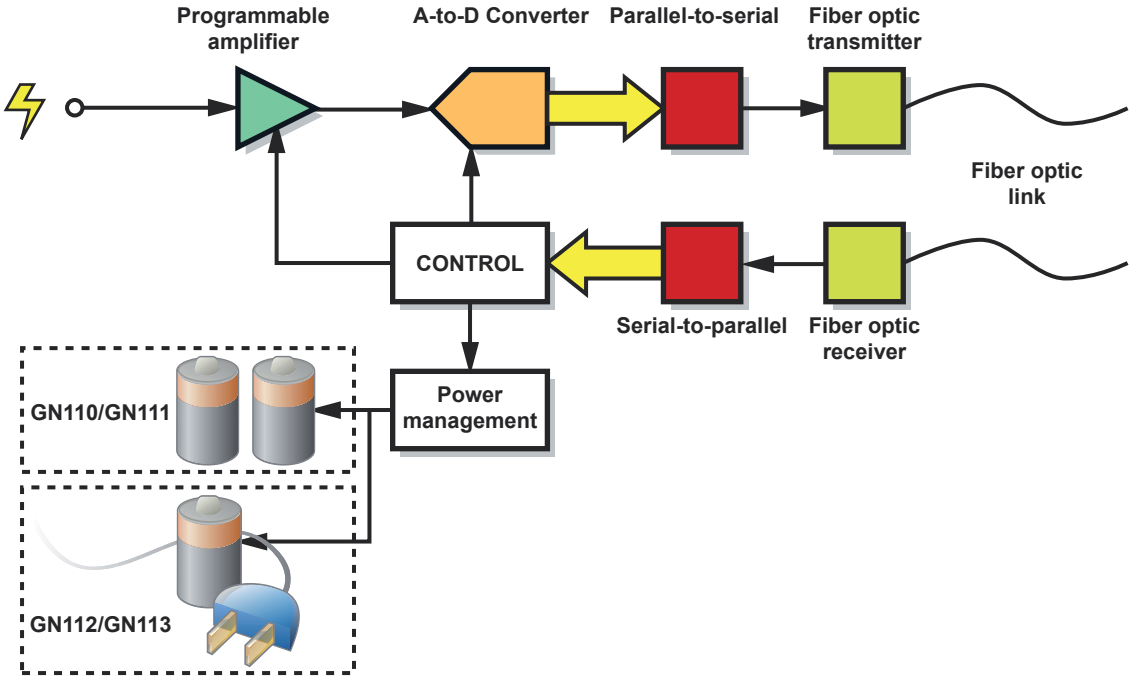



**Figure 6.2:** Block diagram - Transmitter

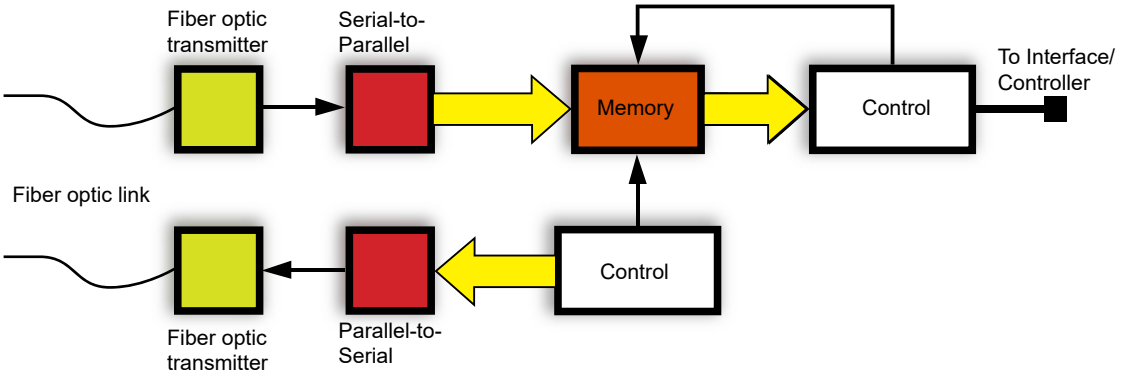



**Figure 6.3:** GN1202B block diagram - Receiver

Data emerging from the A-to-D converter is serialized before transmission. Therefore only one fiber optic cable is required for data transmission. This approach reduces cost and increases reliability and ease of handling.

The data-receiving end of the system consists of fiber optic interfacing and deserializing, digital trigger circuitry, buffer memory for local data storage and control logic. It provides all standard functions of a GEN series subsystem. The fiber optic isolation is fully transparent to the user.

## 6.2 Unpacking

For transportation the Isolated Digitizer units are sealed in a polyethylene bag and cushioned in its box by shock-absorbent material. Accessories are separately sealed in polyethylene bags and included in the box.

### 6.2.1 Unpacking and inspection

Unpack the equipment carefully and examine it thoroughly to ascertain whether or not damage has occurred in transit. Report immediately any such damage to the agent or manufacturer.

Retain the packing materials and box for use if further transportation is necessary. Also be sure to keep all documents supplied with the equipment; some may be addenda or update bulletins applicable to the manual or equipment.

### 6.2.2 Equipment checklist

Check that the equipment contained in the transportation box complies with the packing list. It typically includes:

- GN1202B receiver typically installed in a GEN series mainframe
- One or more GN110/GN111/GN112/GN113 transmitter(s)
- Fiber optic cables as ordered
- User Manual that you are reading now
- Charger as ordered (GN110/GN111 only)
- Power cords
- Batteries for GN110 and GN111 models
- Calibration certificates
- Miscellaneous documents

# 7 Start using the equipment

## 7.1 Connecting power

The AC power inlet of the GN112/GN113 transmitter is located on the rear of the transmitter cabinet.

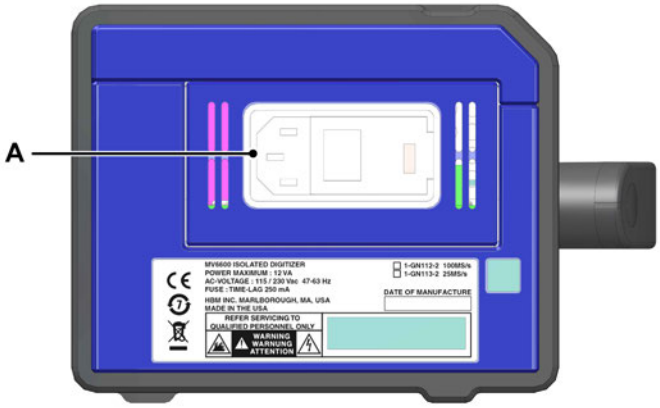



**Figure 7.1:** GN112/GN113 transmitter rear view with AC power inlet

**A - Power inlet** The power connections of the GN112/GN113 transmitter is via a standard IEC 320 EN 60320 C14 (male) appliance inlet, 2-pole, 3-wire designed for 250 V @ 10 A.

**WARNING**

**Inspect the voltage selector at the rear of the transmitter cabinet for the correct setting before applying power. If necessary see the section for instructions on changing the voltage selector.**

The GN112/GN113 transmitter is delivered with a standard power cord that should be inserted into this socket and must be connected to a suitable AC power outlet. According to the standards utilized in your country, you may be required to purchase a different power cord.

To disconnect the instrument from the AC supply, unplug the IEC connector on the rear of 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.

## 7.2 Connector locations

This section describes the location of the various connectors on the GN110/ GN111/GN112/GN113 transmitters.

### 7.2.1 Transmitter I/O connectors

Refer to the following diagrams for the position of the signal input and fiber optic connectors on the front-end cabinets.

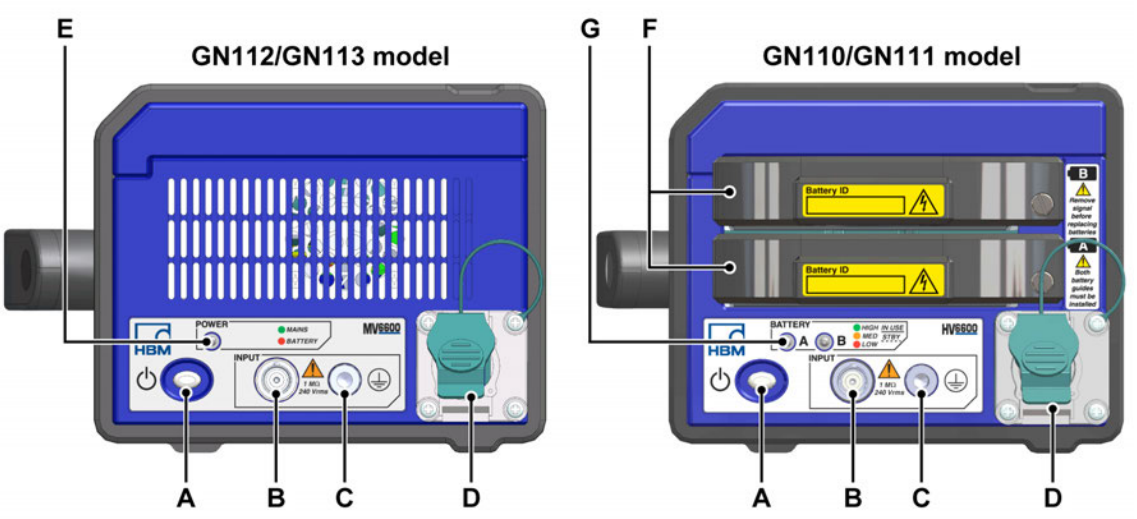



**Figure 7.2:** Front-end I/O connectors, switches and indicators

**A** Power standby switch

**B** Isolated signal input BNC connector

**C** Protective ground

**D** Fiber optic connector

**E** LED power status indicator

**F** Removable batteries

**G** LED battery status indicators

**A - Power switch** The power switch on the instrument is not a disconnecting device. When the instrument is connected to the mains or when batteries are installed, some power will be consumed. To disconnect the MV model from the AC supply, unplug the IEC connector on the rear of the instrument.

**B - Signal input** This BNC connector is the analog input connector. Connect the signal to be recorded to this plug. The BNC connector is isolated. For connection of a signal to the isolated BNC input of the instrument use isolated BNC connectors only.

**C - Protective ground**

**D - Fiber optic connector** This connector is used in combination with a fiber optic plug connector SCRJ (in accordance with IEC 61754-24), IP67, duplex, with quick connection method. As seen from the front, the left-most fiber optic link transmits the data (Data Output) and the right-most fiber optic link receives the commands (Command Input). Also fiber optic plug connectors SCRJ-IP20 can be used.

The receiver side of the system is equipped with an LC duplex connector.

**Figure 7.3:** Example of a duplex SCRJ connectors (IP67 and IP20)

The optical link is used to transfer digitized data from the front-end to the receiver unit and to transfer control commands from the GEN series to the front-end.

**E - LED Power status indicator** This indicator shows the power status of the GN112 and GN113:

- When OFF: transmitter is switched off.
- When ON - GREEN: transmitter is active and working from the mains power supply.
- When ON - RED: transmitter is active and running on internal batteries.

When the LED is GREEN and BLINKING, the transmitter is in use, but there is no valid communication between the transmitter and the GN1202B, e.g. the cable is not connected.

**F - Removable batteries** For more details refer to "Removing a battery module" on page 53.

**G - LED battery status indicators** There are two LED indicators on the GN110 and GN111, one for each battery. The LED's can have one of the following states:

- When OFF: transmitter is switched off, or battery is not installed.
- When BLINKING: battery is not in use.
- When ON: battery is in use.
- When GREEN: battery capacity is high.
- When ORANGE: battery capacity is medium.
- When RED: battery capacity is low. You should replace the battery.

Any combination of ON/BLINKING and GREEN/ORANGE/RED is possible. E.g. an orange blinking LED indicates that the corresponding battery is not in use and has a medium capacity.

When both LED's are GREEN and BLINKING, the transmitter is in use, but there is no valid communication between the transmitter and the GN1202B, e.g. the cable is not connected.

### 7.2.2 Receiver connectors and indicators

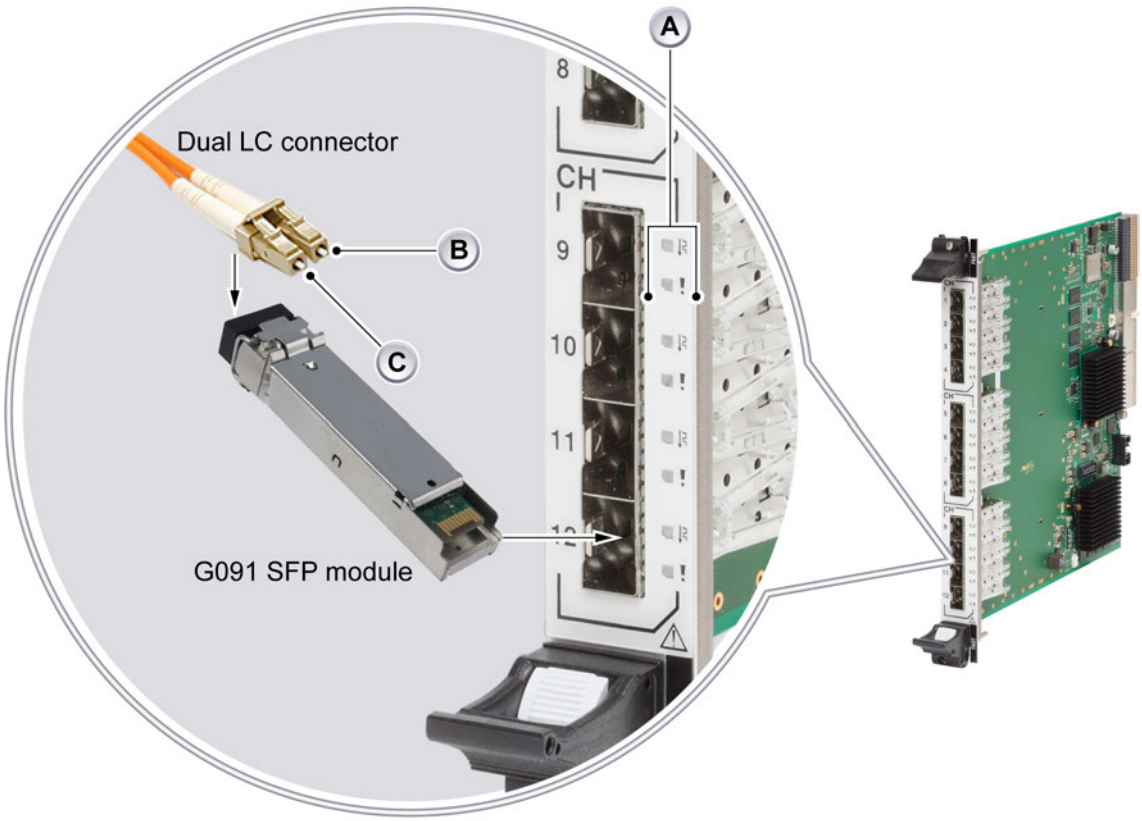



**Figure 7.4:** GN1202B reciever

**A** Status LEDs

**B** Command output fiber optic

**C** Data input fiber optic

The GN1202B receiver is a card that is inserted in the GEN series Data Acquisition System. One receiver card serves up to 12 transmitters. Each channel uses an optional SFP module (HBM pn: G091) to receive the optical signal.

**Note** *The G091 must be ordered separately per receiver channel used.*

**Note** *Unused channels should be covered using the supplied dust cover.*

**WARNING**

**Use HBM approved transceivers only.**

For more information, please refer to "Installing the SFP module on GN1202B" on page 76.

**A-** The LED indicators are used to give a visual indication of the fiber-link / transmitter status.

**Note** *The following table gives the function of the two LEDs ( and ).*

*Table 7.1: Front panel LED indicators*

| GN1202B Front panel LEDs | | | |
|---|---|---|---|
| **Link** | **Alerts** | **State** | **Description** |
| Orange | Orange | Booting | Booting/Minimum mode |
| Off | Off | No SFP | The SFP slot is empty |
| Off | Off | Mounting SFP | Software is reading the SFP type |
| Orange | Off | Power Off | The user disabled the channel in Perception |
| Orange *BLINKING* | Off | Wait link | The system waits until the link is stable |
| Orange *BLINKING* | Red | Incompatible transmitter | The connected transmitter is not supported |
| Red | Off | Unsupported SFP | The SFP is not an HBM approved part |
| Green | Red *BLINKING* | Battery low, Temperature high | Two problems |
| Green | Red | Battery low | Battery is low |
| Green | Orange | Temperature high | Temperature is high |
| Green | Green *BLINKING* | Warming up | Artificial state to let the transmitter warm up |
| Orange | Orange *BLINKING* | Thermal shutdown | The transmitter is switched off because it got too hot |
| Green | Green | Online | Channel is online, everything OK |

**B- Command output** This connector provides the command and timing output and must be connected using fiber optic cable with the “Optical Link - Command” connector on the transmitter cabinet.

The Command Output and Data Input are combined in a dual LC® connector.

**C- Data input** This connector is the data input connector and must be connected using fiberoptic cable with the “Optical Link - Data” connector on the front-end cabinet.

The Command Output and Data Input are combined in a dual LC® connector.

**Figure 7.5:** Example of a dual LC connector

### 7.2.3 Installing the SFP module on GN1202B

**Introduction**

This section explains how to install and remove the Small Form Factor Pluggable (SFP or SFP+) transceiver device from any interface that supports SFP or SFP+ modules.

**Warnings**

Before installing this device, please read and make sure that you have understood the following warnings, which are specific for this device.

**Description of Electrostatic Discharge (ESD)**

**CAUTION**

**Electrostatic discharge (ESD) can cause damage to electronic devices if discharged into 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 the importance of ESD preventions when handling a system, or its connections.**

**WARNING**

**Laser Safety**
**The system is classified as a Class 1 laser product. The SFP uses an 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 that the mainframe unit is switched off. Then locate the available SFP slot and remove the plastic plug (if inserted).

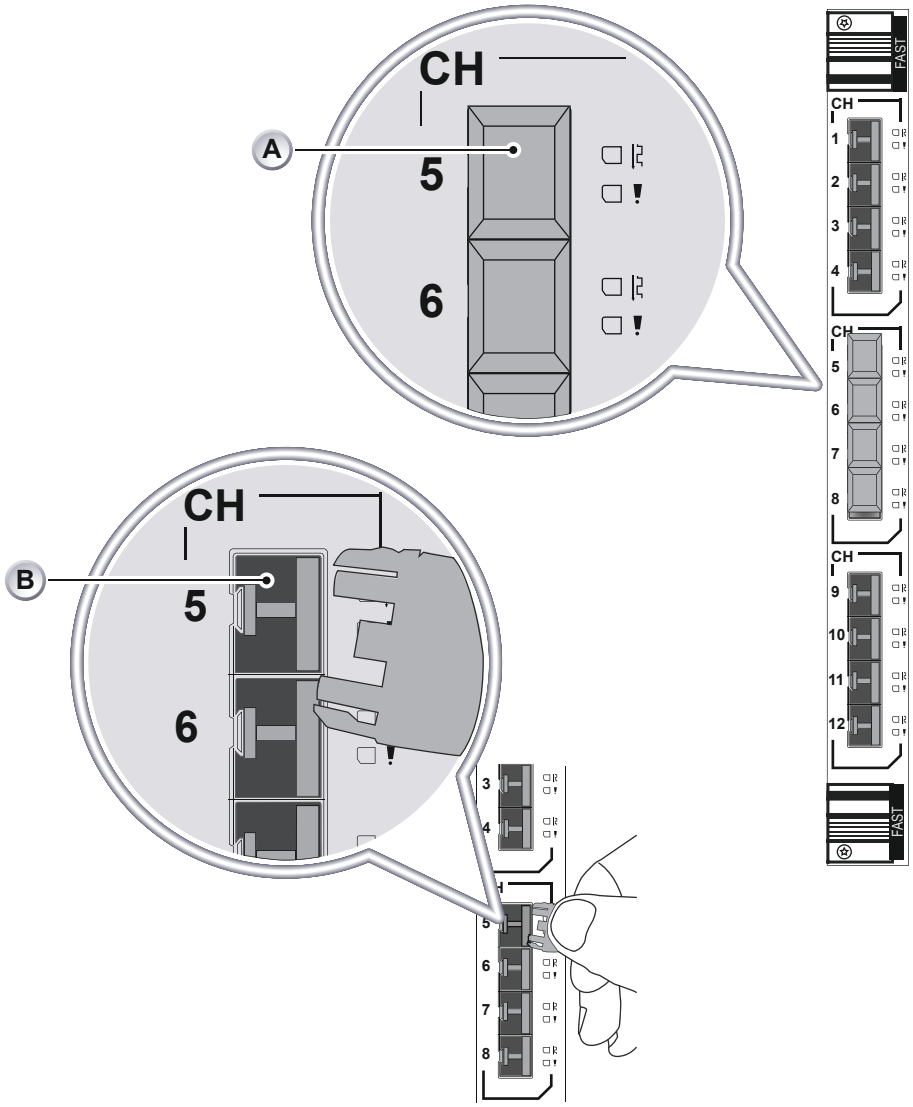



**Figure 7.6:** Interface/Controller SFP location

**A** Interface/Controller SFP location

**B** Remove cap

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

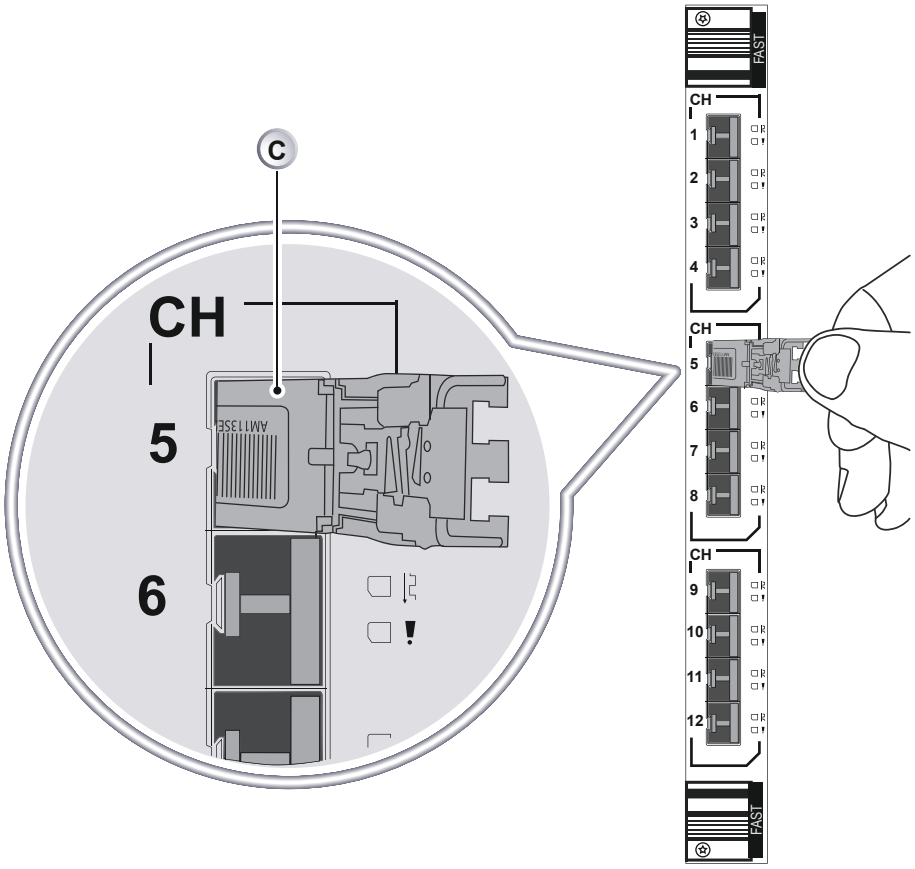



**Figure 7.7:** Insert device in SFP slot

**C** Insert device

3 Embedded software detects the device and automatically connects to it when the mainframe is powered on.

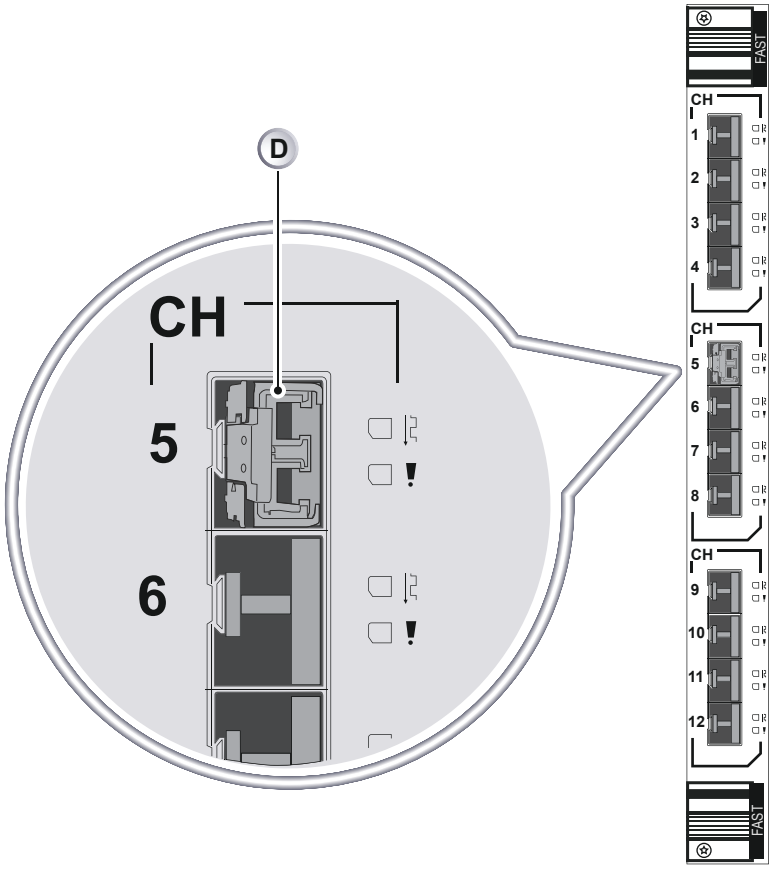



**Figure 7.8:** SFP slot with device

**D** Device being inserted

4 To remove the module from the mainframe, first make sure that the mainframe is powered off. Then grasp the small black removal bar and pull it away and out from the mainframe. The spring-loaded removal bar releases the SFP from the front panel.

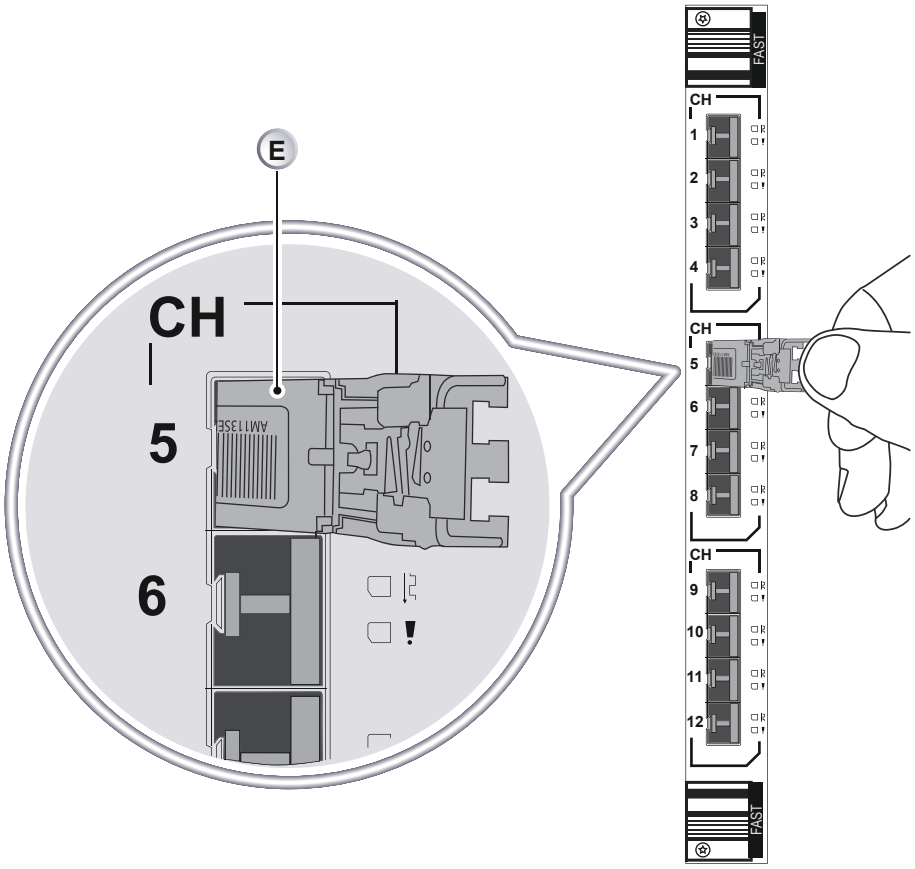



**Figure 7.9:** SFP slot - Remove device

**E** Remove device

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

## 7.3 System connections

Connect the transmitter and receiver by means of a fiber optic cable. The fiber optic cable must be a dual-core cable. One side has a dual SCRJ connector, the other end has a dual LC connector. Cables supplied by HBM are already correctly configured.

**Figure 7.10:** Fiber optic cable with LC (left) and SCRJ (right) connectors

Using the fiber optic cable, connect the dual LC connector to the receiver card (select any of the four ports). The other end of the cable with the SCRJ connector goes to the front-end.

### LC connector

Insert the plug into the receiver. Refer to "Receiver connectors and indicators" on page 73 for details. Make sure the lock mechanism is positioned to the right. You hear a ´click´ when the lock mechanism locks the cable. To disconnect the LC connector, push the lock mechanism and gently pull the connector out of the port on the receiver. Do not use excessive force to pull out the plug.

### SCRJ connector

Insert the plug into the front-end. Refer to Figure 7.2 for details. On the connector there is a notch. Make sure the notch is pointing downwards. You hear a ´click´ when the lock mechanism locks the cable.

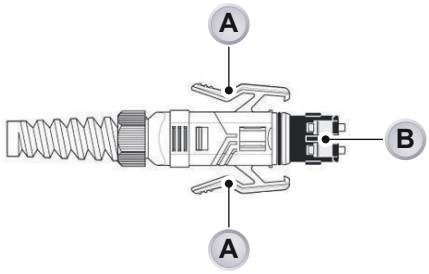



**Figure 7.11:** SCRJ connector latches and notch

**A** Press latches to release connector

**B** Notch

To disconnect the SCRJ connector, press both latches and pull the connector out of the port on the front-end.

Insertion and removal of the SCRJ connector require some force.

When you are using your own fiber optic cables make sure that the COMMAND and DATA lines are connected correctly: command-out of the receiver to the command-in of the front-end; data-out of the front-end to the data-in of the receiver.

## 7.4 Initial check-out

For an initial check-out of the system verify as follows:

- GN110/GN111 transmitter: make sure that both batteries are in place and charged.
- GN112/GN113 transmitter: make sure the voltage selector is set to the correct voltage and the power cord is connected.
- Check the fiber optic cabling between the front-end and the receiver card in the GEN series mainframe.
- Is the mainframe installed properly: fuses, power selection, power cord connected?

**This completes the installation.**

For a functional check-out of the system verify as follows:

1. Connect a fiber optic cable from the transmitter to the optical-input ‘1’ on the receiver.
2. Turn power on for both the receiver and the transmitter.
3. Connect a signal generator to the transmitter input.
4. Set input span on receiver to 20 V.
5. Set a generator to 10 V(peak-peak) 50 Hz AC.
6. Using Perception Software check the signal of channel 1.

# A Specifications

## A.1 B4770-1.0 en (GEN series GN1202B Optical Fiber Islolated 100 MS/s Input Card)

- **12 transmitters per receiver card**
- **Digital fiber optic connection, noise/error and drift free**
- **Cable length up to 1000 m**
- **Automatic cable length phase compensation**
- **Battery powered transmitter**
- **Continuous powered transmitter with 1.8 kV RMS isolation**
- **1 isolated, unbalanced differential input per transmitter**
- **± 20 mV to ± 100 V input ranges**
- **Analog/digital anti-alias filters**
- **Calibration values stored in transmitter**
- **25 MS/s or 100 MS/s transmitter**
- **15 or 14 bit resolution**
- **Metal BNC input on transmitter**

The optical fiber isolated system consists of up to 12 transmitter units (GN110, GN111, GN112 or GN113) connected to the GN1202B receiver card built into a GEN series mainframe using a fiber optic cable.
By converting the analog signal into a digital signal and transmitting the signal to the receiver card via fiber optic cable, the transmission does not add any drift or error to the measured signal. The automatic cable length compensation phase matches all fiber optic isolated channels to any standard analog input channel. The GN112 and GN113 offer continuous powered isolation at 1.8 kV RMS, while the GN110 and GN111 offer higher isolation options using battery power with a continuous operation time of 30 hours. Optimum anti-alias protection is achieved by the 6-pole analog anti-alias filter combined with a fixed sample rate Analog-to-Digital converter. At lower sample rates the digital anti-alias filters allow for a large range of $8^{th}$ order Bessel IIR filters with precise phase match and ultra low noise output. Using the full transient and data recorder feature set of the GN1202B with the powerful Perception software eliminates the need to use separate data acquisition hardware or software.

| Capabilities Overview | |
|---|---|
| Receiver model | GN1202B |
| Transmitter models | GN110, GN111, GN112 and GN113 |
| Maximum sample rate per channel | 100 MS/s<br>When either GN111 or GN113 is connected, the maximum sample rate for all channels will be limited to 25 MS/s |
| Memory per receiver | 8 GB (4 GS) |
| Analog channels | 1 input per transmitter (GN110, GN111, GN112 or GN113) |
| Anti-alias filters | Fixed bandwidth analog AA-filter combined with sample rate tracking digital AA-filter |
| ADC resolution | 14 bit<br>GN111 and GN113: 15 bit using four time over sampling |
| Isolation | Transmitter to receiver and transmitter to earth |
| Input type | Isolated, unbalanced differential inputs |
| Passive voltage/current probes | Passive, single-ended voltage probes |
| Sensors | Not supported |
| TEDS | Not supported |
| Real-time cycle based calculators | Not supported at release of this card |
| Real-time formula database calculators (option) | Not supported at release of this card |
| EtherCat® output | Not supported at release of this card |
| Digital Event/Timer/Counter | 16 digital events and 2 Timer/Counter channels.<br>Due to technical implementation limits, some sample rates do not support Digital Event/ Timer/Counters (Supported from Perception 7.20 onwards) |
| Standard data streaming (up to 200 MB/s) | Not supported |
| Fast data streaming (up to 1 GB/s) | Supported |
| Slot width | 1 |

## Block Diagram

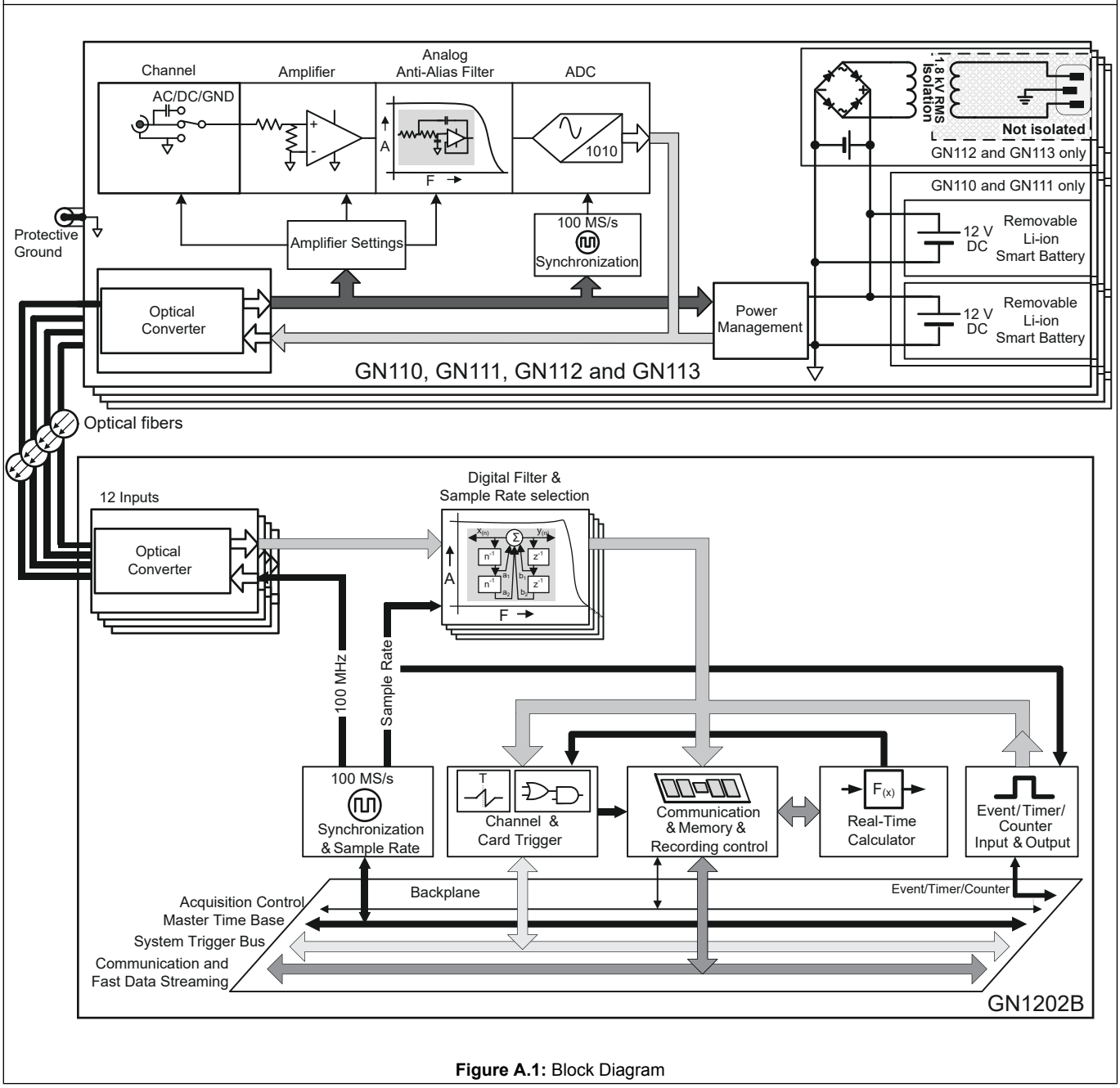



**Figure A.1:** Block Diagram

**Note** *Each transmitter is calibrated independent from the receiver card. Calibration details are stored inside the transmitter to ensure calibrated measurements and traceability. The use of the optical fiber cable allows the use of any length of cable without effecting the calibration results.*

| Analog Input GN110, GN111, GN112 and GN113 (Transmitter) | |
|---|---|
| Channels | 1 |
| Connector | 1; metal BNC |
| Input type | Isolated, unbalanced differential inputs (BNC connected to isolated common) |
| Input Coupling | |
| Coupling modes | AC / DC / GND |
| AC coupling frequency | 1.6 Hz (±10%); - 3 dB |

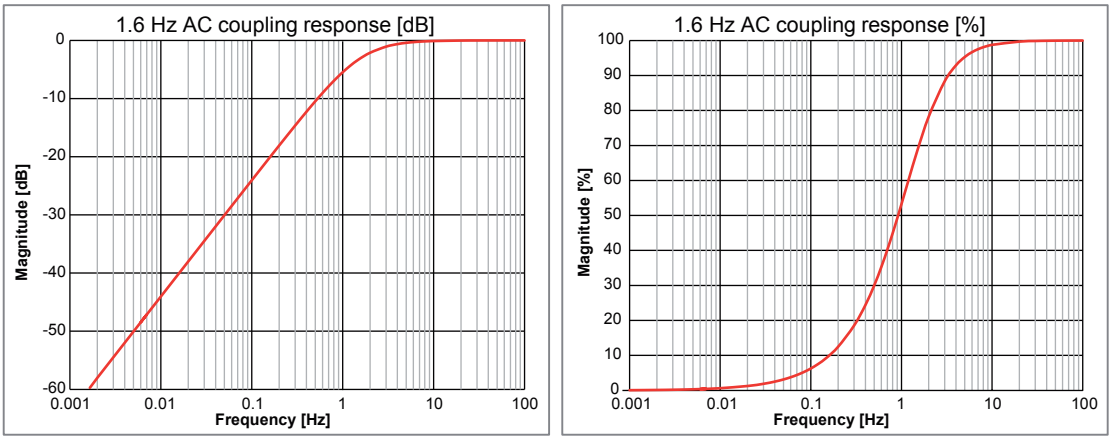



**Figure A.2:** Representative AC coupling response

| | |
|---|---|
| Impedance | 1 MΩ (± 2%) // 38 pF (± 5%) |
| Ranges | ± 20 mV, ± 50 mV, ± 100 mV, ± 200 mV, ± 500 mV, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50V and ± 100 V |
| Offset | ± 50% in 1000 steps (0.1%)<br>± 100 V range has fixed 0% offset |
| DC Offset error | |
| Wideband | 0.1% of Full Scale ± 50 µV |
| Bessel filter | 0.1% of Full Scale ± 50 µV |
| Offset error drift | GN110 and GN111: ±(60 ppm + 10 µV)/°C (±(36 ppm + 6 µV)/°F)<br>GN112 and GN113: ±(100 ppm + 10 µV)/°C (±(60 ppm + 6 µV)/°F) |
| DC Gain error | |
| Wideband | 0.1% of Full Scale ± 50 µV |
| Bessel filter | 0.1% of Full Scale ± 50 µV |
| Gain error drift | GN110 and GN111: ±100 ppm/°C (± 60ppm/°F)<br>GN112 and GN113: ±(100 ppm + 10 µV)/°C (±(60 ppm + 6 µV)/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.1% of Full Scale ± 50 µV |
| Bessel filter | 0.1% of Full Scale ± 50 µV |
| RMS Noise (50 Ω terminated) | |
| Wideband | 0.05% of Full Scale ± 100 µV |
| Bessel filter | 0.05% of Full Scale ± 100 µV |
| Common mode (referred to ground while protective ground is not connected)<br>Requires a protected LAB environment and EN50191:2000 compliant work procedures | |
| Rejection (CMR) | > 72 dB @ 80 Hz (GN110 and GN111: > 100 dB typical) |
| Maximum common mode voltage | 1.8 KV RMS (GN112 and GN113)<br>>1.8 kV RMS (GN110 and GN111); Limits set by fiber cable and transmitter air gap isolation |
| Input bias current | < 2 nA |
| Rise time | 14 ns |

| Analog Input GN110, GN111, GN112 and GN113 (Transmitter) | |
|---|---|
| Input overload protection | |
| Overvoltage impedance change | The activation of the overvoltage protection system results in a reduced input impedance. The overvoltage protection is not active for as long as the input voltage remains less than 200% of the selected input range or 250 V, whichever value is the smallest. |
| Maximum nondestructive voltage | ± 125 V DC; Ranges < ± 2 V<br>± 250 V DC; Ranges ≥ ± 2 V |
| Overload recovery time | Restored to 0.1% accuracy in less than 50 ns after 200% overload<br>Restored to 10% accuracy in less than 10 ns after 200% overload |

| Analog to Digital Conversion | |
|---|---|
| Sample rate per channel | 1 S/s to 100 MS/s |
| ADC resolution; one ADC per channel | 14 bit |
| ADC type | CMOS pipelined multi step flash converter, LTC2254 |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm; 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 (See GEN series Isolated Digitizer manual for calculation details) |
| External time base level | TTL |
| External time base minimum pulse width | 100 ns |

## Anti-Alias Filters

Note on phase matching channels. Every filter characteristic and/or filter bandwidth selection comes with it's own specific phase response. Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths can result in phase mismatches between channels.

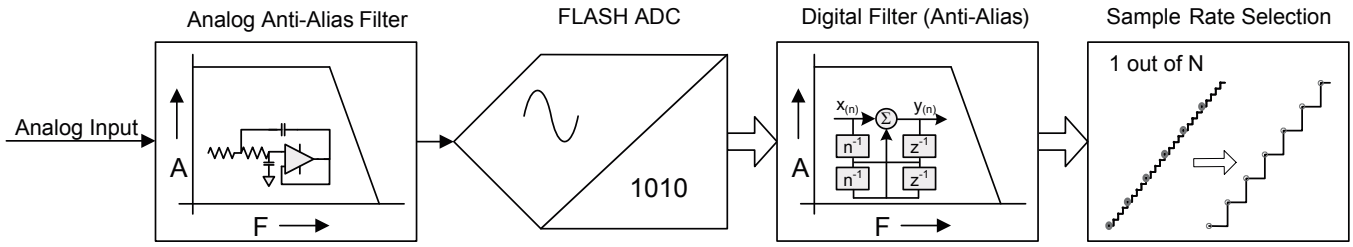



**Figure A.3:** Combined analog and digital anti-alias filter block diagram

Aliasing is prevented by a steep, fixed frequency analog anti-alias filter in front of the Analog to Digital Converter (ADC). The ADC always samples at a fixed sample rate. The fixed sample rate of the ADC avoids the need for different analog anti-alias filter frequencies.
Directly behind the ADC, the high precision digital filter is used as anti-alias protection before the digital downsampling to the desired user sample rate is performed. The digital filter is programmed to a fraction of the user sample rate and automatically tracks any user sample rate selection. Compared to analog anti-alias filters, the programmable digital filter offers additional benefits like higher order filter with steep roll-off, a larger selection of filter characteristics, noise-free digital output and no additional phase shifts between channels that use the same filter settings.

| | |
|---|---|
| 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 should not be used if working in a frequency domain with recorded data. Using wideband, enhanced resolution is not supported at lower sample rates. |
| Bessel (Fc @ -3 dB) | This analog Bessel filter can be used to reduce the higher bandwidth signals. Bessel filters are typically used when looking at signals in the time domain. They are best used for measuring transient signals or sharp edge signals like square waves or step responses. Using the Bessel filter, enhanced resolution is not supported at lower sample rates. |
| 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 to prevent aliasing at lower sample rates. Bessel filters are typically used when looking at signals in the time domain. They are best used for measuring transient signals or sharp edge signals like square waves or step responses. Enhanced resolution is supported by using oversampling combined with a digital filter at the following sample rates: 15 bit resolution at 25 MS/s and lower, 16 bit resolution at 10 MS/s and lower. |
| Butterworth IIR (Fc @ -3 dB) | When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti-alias filter and a digital Butterworth IIR filter to prevent aliasing at lower sample rates. This filter is 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. Enhanced resolution is supported by using oversampling combined with a digital filter at the following sample rates: 15 bit resolution at 25 MS/s and lower, 16 bit resolution at 10 MS/s and lower. |

## Wideband (No Anti-Alias Protection)

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) |
| 0.1 dB passband flatness (1) | DC to 3 MHz |

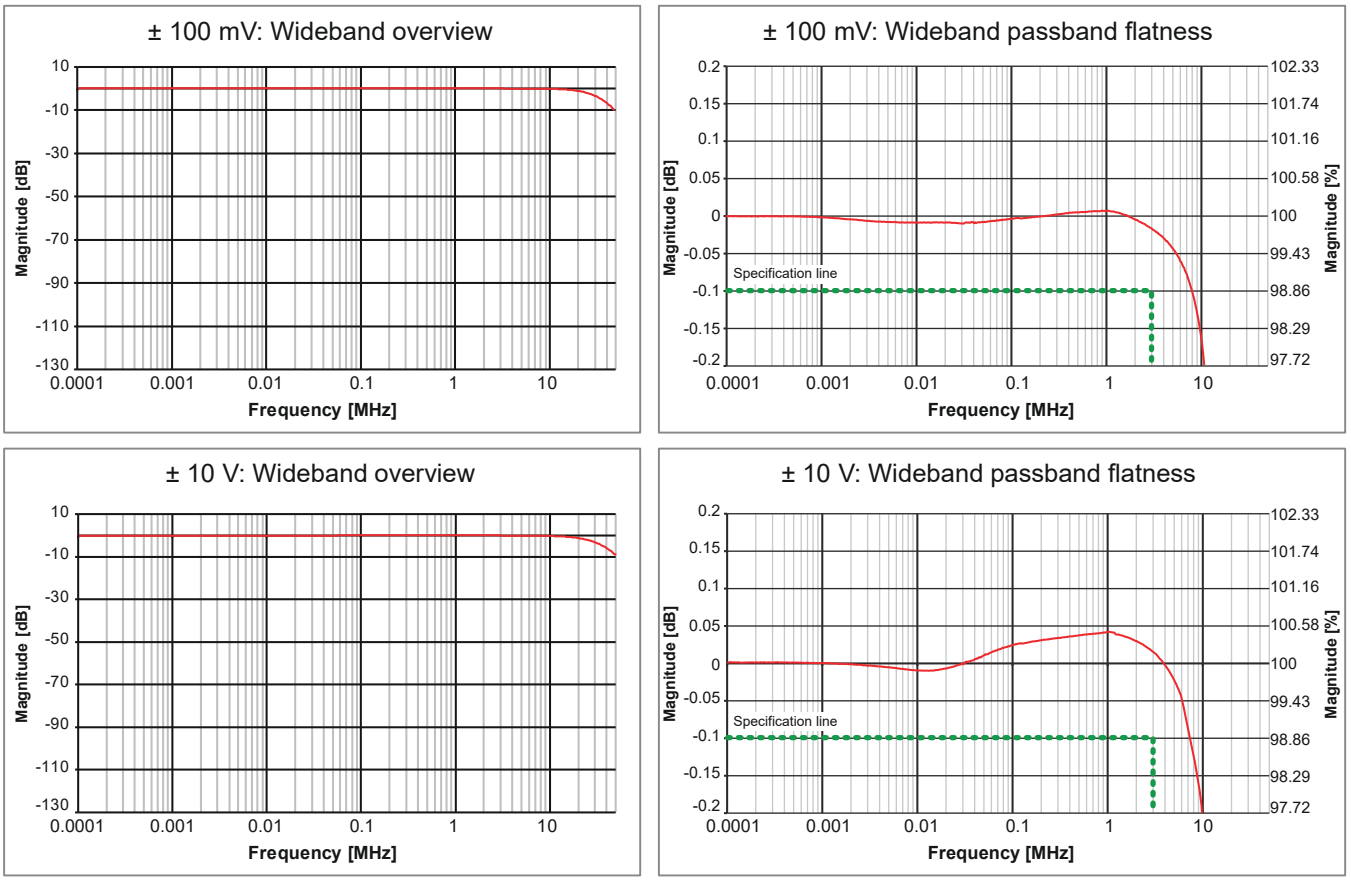
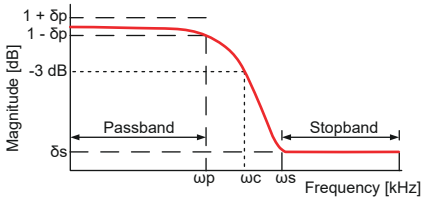



**Figure A.4:** Representative Wideband examples

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

## Bessel Filter (Analog Anti-Alias)

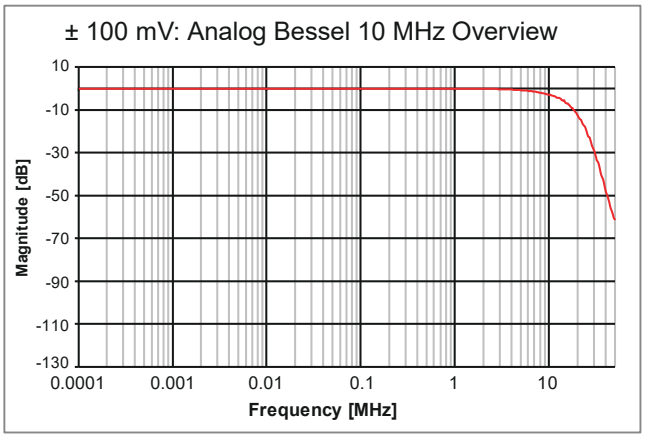


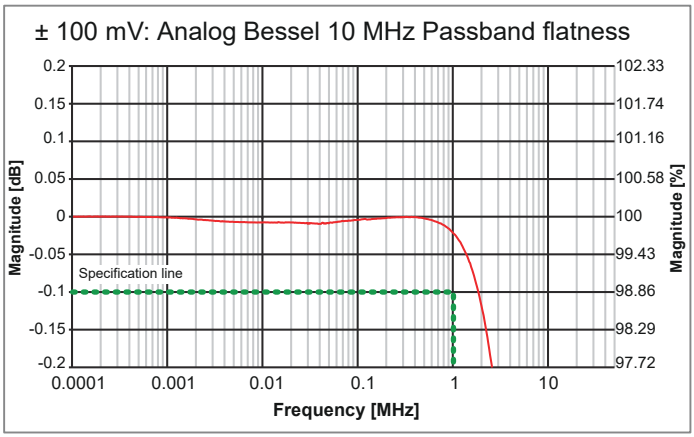

δp: Passband ripple
δs: Stopband attenuation

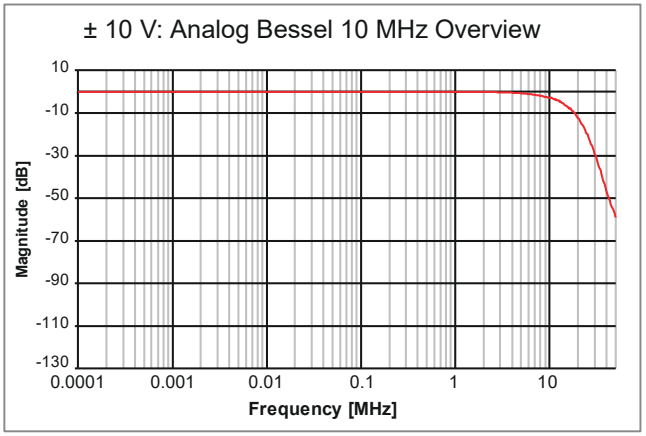
ωp: Passband frequency
ωc: Corner frequency
ωs: Stopband frequency

**Figure A.5:** Analog Bessel Filter

| Analog Bessel filter | |
|---|---|
| Bandwidth | 10 MHz ± 1 MHz (-3 dB) |
| Characteristic | 6-pole Bessel, optimal step response |
| 0.1 dB passband flatness (ωp)(1) | DC to 1 MHz |
| Stopband (δs) | -50 dB at ωs = 60 MHz |
| Analog Bessel filter roll-off: | -30 dB/Octave |



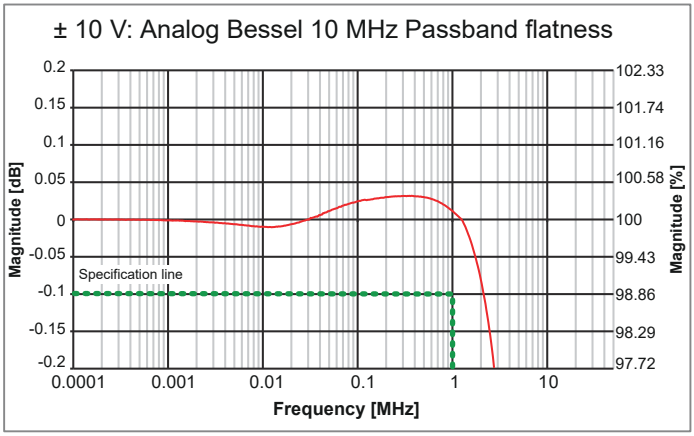
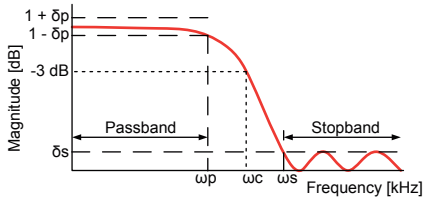




**Figure A.6:** Representative analog Bessel examples

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

## Bessel IIR Filter (Digital Anti-Alias)




δp: Passband ripple
δs: Stopband attenuation

ωp: Passband frequency
ωc: Corner frequency
ωs: Stopband frequency

**Figure A.7:** 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-alias filter | Bessel |
| Bessel IIR filter | |
| Characteristic | 8-pole Bessel style IIR |
| User selection | Auto tracking for sample rate divided by: 10, 20, 40, 100<br>The user selects a division factor from the current sample rate; software then adjusts the filter when the sample rate is changed. |
| Bandwidth (ωc) | User selectable from 50 Hz to 5 MHz |
| 0.1 dB passband (ωp)(1) | DC to 0.16 * ωc |
| Stopband (δs) | -60 dB |
| Roll-off | -48 dB/Octave |

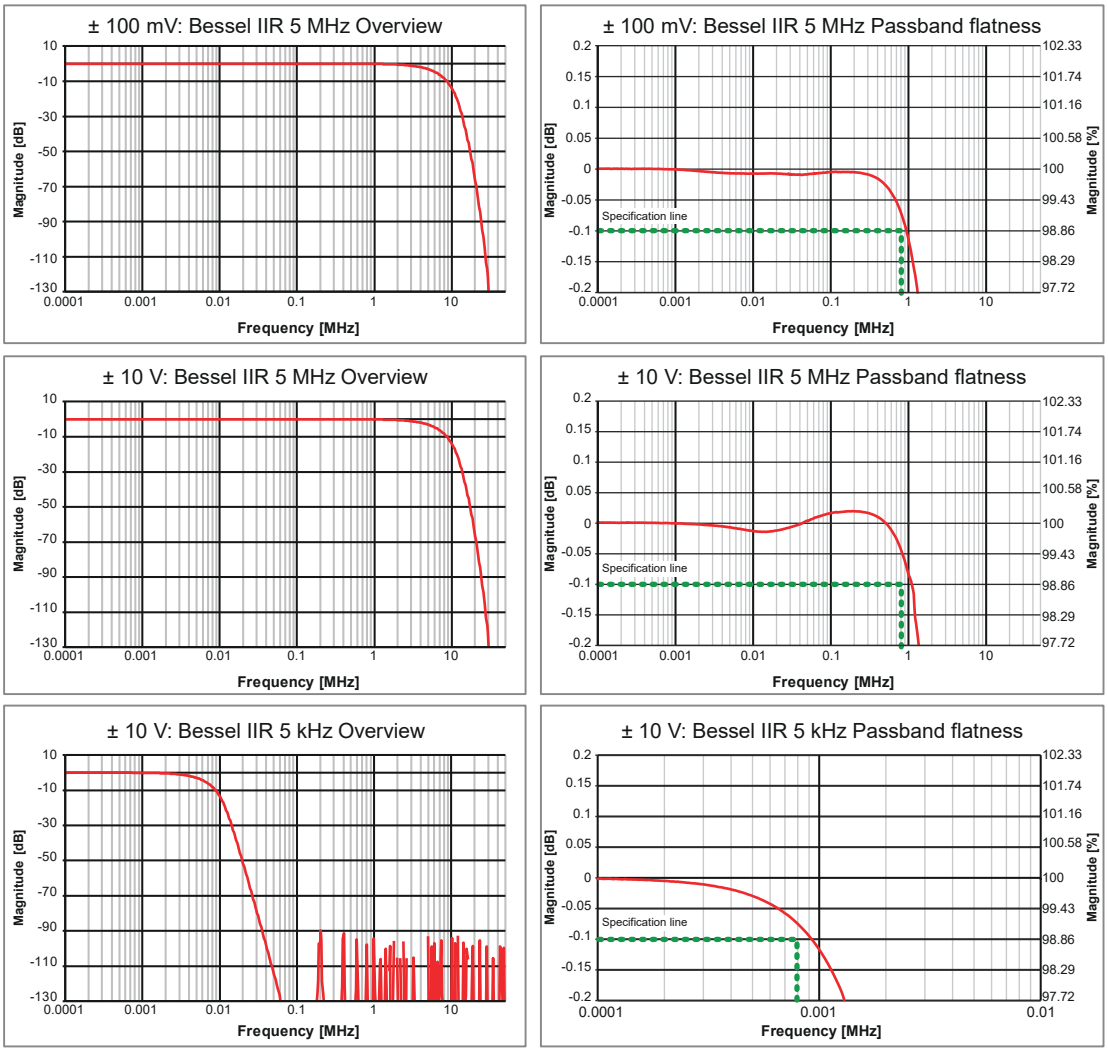
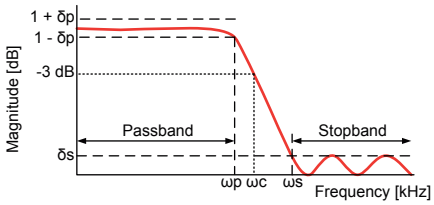



**Figure A.8:** Representative Bessel IIR examples

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

## Butterworth IIR Filter (Digital Anti-Alias)




δp: Passband ripple
δs: Stopband attenuation

ωp: Passband frequency
ωc: Corner frequency
ωs: Stopband frequency

**Figure A.9:** Digital Butterworth IIR Filter

When Butterworth IIR filter is selected, this is always the combination of the analog Bessel anti-alias filter and a digital Butterworth IIR filter.

| | |
|---|---|
| Analog anti-alias filter | Bessel |
| Butterworth IIR filter | |
| Characteristic | 8-pole Butterworth style IIR |
| User selection | Auto tracking for sample rate divided by: 4, 10, 20, 40<br>The user selects a division factor from the current sample rate; software then adjusts the filter when the sample rate is changed |
| Bandwidth (ωc) | User selectable from 125 Hz to 5 MHz |
| 0.1 dB passband (ωp)(1) | DC to 0.7 * ωc (for ωc > 1 MHz, DC to 0.3 * ωc, due to analog anti-alias filter bandwidth) |
| Stopband (δs) | -60 dB |
| Roll-off | -48 dB/octave |

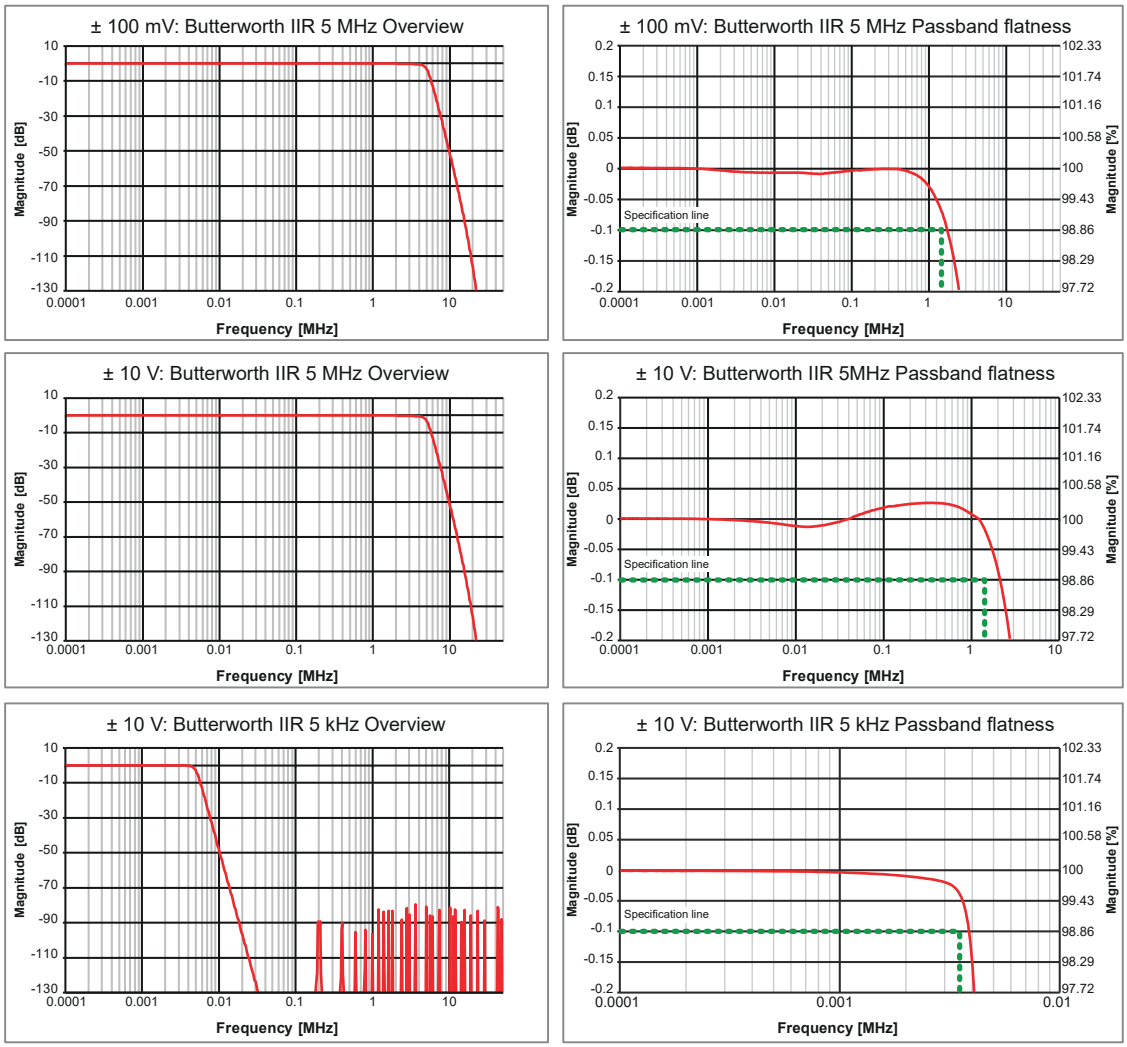



**Figure A.10:** Representative Butterworth IIR examples

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

| Channel to Channel Phase Match | |
|---|---|
| Using different filter selections (Wideband/Bessel/Bessel IIR/Butterworth IIR) or different filter bandwidths results in phase mismatches between channels. | |
| Channel to channel phase difference | Typical ± 10 ns with the same filter selections applied (≥ 100Hz) |
| Fiber cable length compensation | Yes, automatic when optical communication is established<br>Optical cable delay is compensated to phase match standard GEN DAQ channels. |
| Typical fiber cable delay mismatch | ± 20 ns |
| Fiber cable delay | 5 ns/m; delay compensated by cable length compensation |

| On-Board Memory | |
|---|---|
| Per card | 8 GB (4 GS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered on but not recording |
| Storage sample size analog and digital event channels | 16 bits, 2 bytes/sample |
| Storage sample size Timer/Counter channels | 32 bits, 4 bytes/sample |

| Digital Event/Timer/Counter | |
|---|---|
| The Digital Event/Timer/Counter input connector is located on the mainframe. For exact layout and pinning see mainframe data sheet. | |
| Card Sample rate | Digital Event/Timer/Counter sample rate |
| ≤10 MS/s | Sample rate |
| 12.5 MS/s | Not supported |
| 20 MS/s | Sample rate |
| 25 MS/s | Not supported |
| 40 MS/s | Not supported |
| 50 MS/s | Not supported |
| 100 MS/s | 20 MS/s |
| Digital input events | 16 per card |
| Levels | TTL input level, user programmable invert level |
| Inputs | 1 pin per input, some pins are shared with Timer/Counter inputs |
| Digital output events | 2 per card |
| 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 any channel trigger of this card only)<br>12.8 µs minimum pulse width<br>200 µs ± 1 µs ± 1 sample period pulse delay |
| Alarm | High when alarm condition is activated, low when not activated (alarm conditions of this card only)<br>200 µs ± 1 µs ± 1 sample period alarm event delay |
| Recording active | High when recording, low when in idle or pause mode<br>Recording active output delay of 450 ns |
| Set High or Low | Output set High or Low; can be controlled by Custom Software Interface (CSI) extensions; delay depends on specific software implementation |
| Timer/Counter | 2 per card |
| Levels | TTL input levels |
| Inputs | 3 pins: signal, reset and direction<br>All pins are shared with digital event inputs |
| Input coupling | Uni-directional, Bi-directional and ABZ incremental encoder (Quadrature) |
| Measurement modes | Count, Angle, Frequency and RPM |

## Input Coupling Uni- and Bi-directional

Uni- and bi-directional input coupling is used when the direction signal is a stable signal.

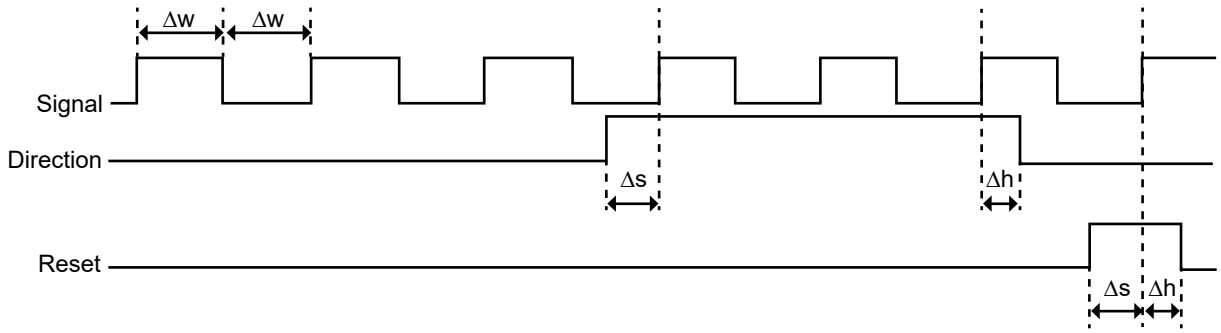



**Figure A.11:** Uni- and Bi-directional timing

| | |
|---|---|
| Inputs | 3 pins: signal, reset and direction (only used in bi-directional count) |
| Maximum input signal frequency | 5 MHz |
| Minimum pulse width (Δw) | 100 ns |
| Reset input | |
| Level sensitivity | User selectable invert level |
| Minimum setup time prior to signal edge (Δs) | 100 ns |
| Minimum hold time after signal edge (Δh) | 100 ns |
| Reset options | |
| Manual | Upon user request by software command |
| Start recording | Count value set to 0 at Start of recording |
| First reset pulse | After the recording is started, the first reset pulse sets the counter value to 0. The next reset pulses are ignored. |
| Each reset pulse | On each external reset pulse, the counter value is reset to 0. |
| Direction input | |
| Input Level sensitivity | Only used when in bi-directional mode<br>Low: increment counter/positive frequency<br>High: decrement counter/negative frequency |
| Minimum setup time prior to signal edge (Δs) | 100 ns |
| Minimum hold time after signal edge (Δh) | 100 ns |

## Input Coupling ABZ Incremental Encoder (Quadrature)

Typically used for tracking rotating/moving devices using a decoder with two signals that are always 90 degree phase shifted. E.g. allow for direct interfacing to HBM torque and speed transducers.

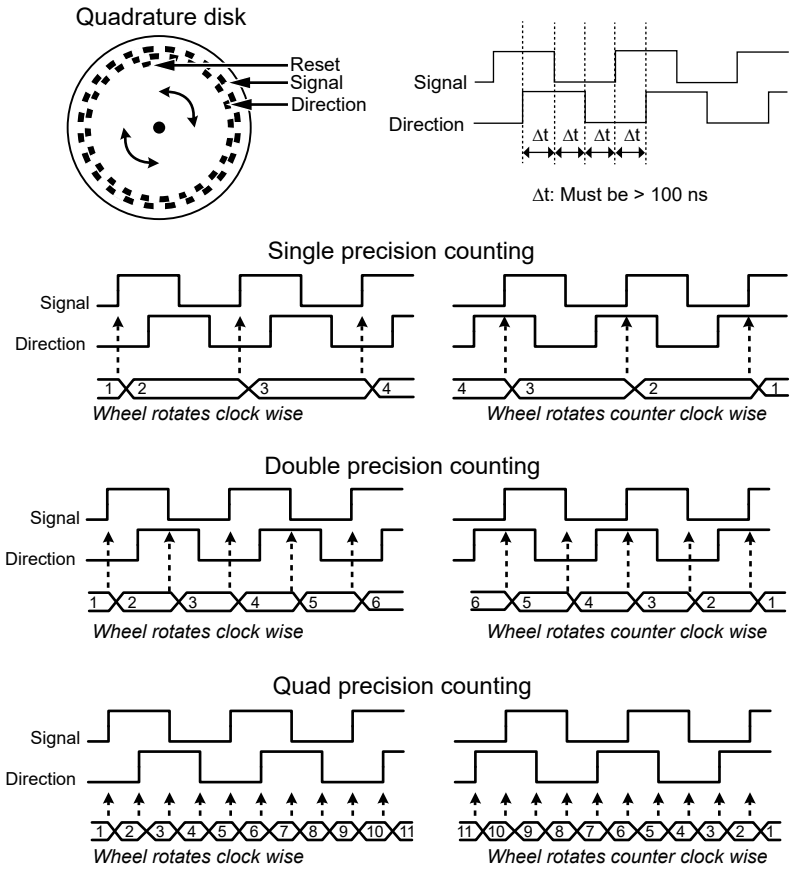



**Figure A.12:** Bi-directional quadrature count modes

| | |
|---|---|
| Inputs | 3 pins: signal, direction and reset |
| Maximum input signal frequency | 2 MHz |
| Minimum pulse width | 200 ns (2 * Δt) |
| Minimum setup time | 100 ns (Δt) |
| Minimum hold time | 100 ns (Δt) |
| Accuracy | Single (X1), dual (X2) or quad (X4) precision |
| Input coupling | ABZ incremental encoder (Quadrature) |
| Reset input | |
| Level sensitivity | User selectable invert level |
| Minimum setup time prior to signal edge (Δt) | 100 ns |
| Minimum hold time after signal edge (Δt) | 100 ns |
| Reset options | |
| Manual | Upon user request by software command |
| Start recording | Count value set to 0 at Start of recording |
| First reset pulse | After the recording is started, the first reset pulse sets the counter value to 0. The next reset pulses are ignored. |
| Each reset pulse | On each external reset pulse, the counter value is reset to 0. |

| Measurement Mode Angle | |
|---|---|
| In angle measurement mode the counter will use a user defined maximum angle and revert back to zero when this count value is reached. Using the reset input the measured angle can be synchronized to the mechanical angle. The real-time calculators can extract the RPM from the measured angle independent from the mechanical synchronization. | |
| Angle options | |
| Reference | User selectable. Enables the use of the reset pin to reference the mechanical angle to the measured angle |
| Angle at reference point | User defined to specify mechanical reference point |
| Reset pulse | Angle value is reset to user defined "angle at reference point" value |
| Pulses per rotation | User defined to specify the encoder/count resolution |
| Maximum pulses per rotation | 32767 |
| Maximum RPM | 30 * sample rate (Example: Sample rate 10 kS/s means maximum 300 k RPM) |

| Measurement Mode Frequency/RPM | |
|---|---|
| Used to measure any kind of frequency like engine RPM, or active sensors with proportional frequency output signal. | |
| Accuracy | 0.1%, when using a gate measuring time of 40 µs or more.<br>With lower gate measuring times, the real-time calculators or Perception formula database can be used to enlarge the measuring time and improve the accuracy more dynamically e.g. based on measured cycles. |
| Gate measuring time | Sample period (1 / sample rate) to 50 s. Minimum gate measuring time is 50 ns.<br>Can be selected by user to control update rate independent of sample rate |

| Measurement Mode Uni- and Bi-directional Count | |
|---|---|
| Counter mode is typically used for tracking movement of device under test. When possible use the quadrature modes as these are less sensitive to counting errors. | |
| Counter range | 0 to $2^{31}$; uni-directional count<br>$-2^{31}$ to $+2^{31} - 1$; bi-directional count |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent per channel, software selectable either trigger or qualifier |
| Pre- and post-trigger length | 0 to 1 GS |
| Maximum trigger rate | 400 triggers per second |
| Maximum delayed trigger | 1 GS after a trigger occurred |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per mainframe | User selectable On/Off |
| Trigger In edge | Rising/Falling mainframe selectable |
| Minimum pulse width | 500 ns |
| Trigger In delay | ± 1 µs + maximum 1 sample period |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per mainframe | User selectable On/Off |
| Trigger Out level | High/Low/Hold High; mainframe selectable |
| Trigger Out pulse width | High/Low: 12.8 µs<br>Hold High: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe; For details, please refer to the mainframe datasheet |
| Trigger Out delay | Selectable (83 µs to 516 µs) ± 1 µs + maximum 1 sample period using decimal time base<br>Default 516 µs for decimal time base, compatible with standard behavior.<br>Minimum selectable delay is the smallest delay available for all acquisition cards used within the mainframe |
| Cross channel triggering | |
| Measurement channels | Logical OR of triggers from all measured signals<br>Logical AND of qualifiers from all measured signals |
| Calculated channels | Logical OR of triggers from all calculated signals (RTC and RT-FDB)<br>Logical AND of qualifiers from all calculated signals (RTC and RT-FDB) |
| Analog channel trigger levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015%) for each level |
| Direction | Rising/Falling; single direction control for both levels based on selected mode |
| Hysteresis | 0.1 to 100% of Full Scale; defines the trigger sensitivity |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; two individual levels, logical OR |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/Disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/Disable trigger with dual level |
| Event channel trigger | |
| 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 |

| Alarm Output | |
|---|---|
| Selection per card | User selectable On/Off |
| Alarm modes | Off, 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 | Selectable (83 µs to 516 µs) - 1 µs +/-1 µs + max 1 sample period |

| Real-time Statstream® | |
|---|---|
| Patent Number : 7,868,886<br>Real-time extraction of basic signal parameters.<br>Supports real-time live scrolling and scoping waveform displays as well as real-time meters while recording.<br>During recording reviews, it enhances speed for displaying and zooming extremely large recordings and it reduces the calculation time for statistical values on large data sets. | |
| Analog channels | Real-time extraction of Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values |
| Event/Timer/Counter channels | Real-time extraction of Maximum, Minimum and Peak to Peak values |

## Real-Time Cycle Based Calculators (Not Available at Release)

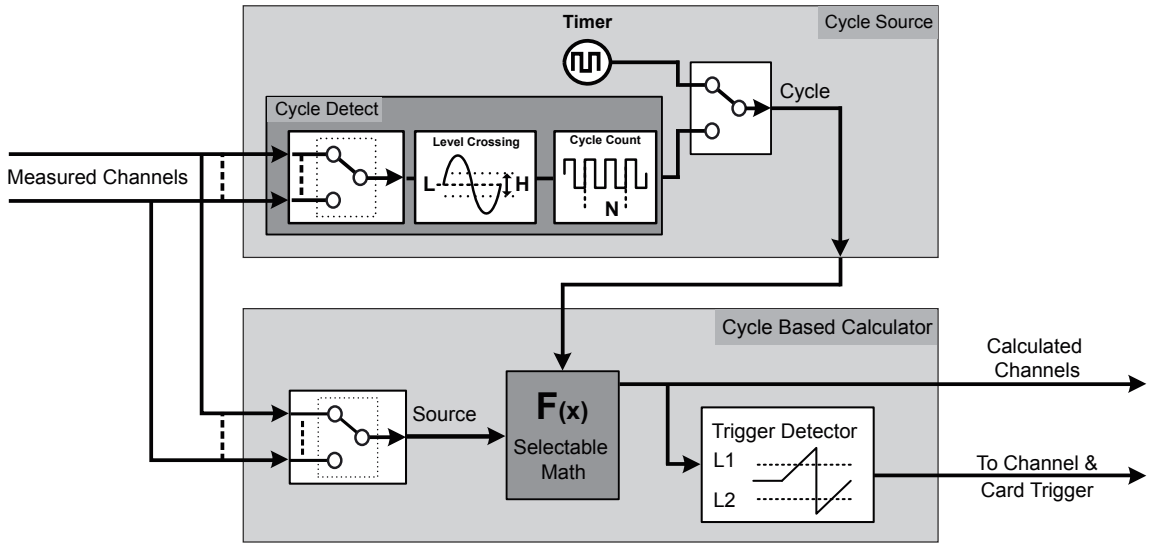



**Figure A.13:** Real-time cycle based calculators

| | |
|---|---|
| Cycle Source | Determines the periodic real-time calculation speed by either setting a timer or using a real-time cycle detect |
| Cycle Source: Timer | |
| Timer duration | 1.0 ms (1 kHz) to 60 s (0.0167 Hz) |
| Cycle Source: Cycle detect | |
| Level crossing | Real-time monitors one input channel using a signal level, hysteresis and direction to determine the cyclic nature of the signal |
| Cycle count | Sets the counted number of cycles used for periodic calculation output |
| Cycle period(1) | Maximum Cycle period that can be detected: 0.25 s (4 Hz)<br>Minimum Cycle period that can be detected: 0.91 ms (1.1 kHz)<br>Calculations are stopped when the Cycle period exceeds its maximum Cycle period (0.25 s).<br>Cycle count is temporarily increased when Cycle period becomes shorter than minimum Cycle period (0.91 ms).<br>Time event notifications in the channel data indicate when the Cycle period has been exceeded or when the automatic Cycle count is increased |
| Cycle based calculator | |
| Number of calculators | 32; at sample rates 200 kS/s or lower. At higher sample rates, the number of calculators is reduced to match the available DSP power |
| DSP load | Each calculator can perform 1 calculation. Not every calculation uses the same DSP power. Selecting a calculation with the highest computation power could result in a reduction in the total number of calculators. Different combinations require different computation power. The effects of selected combinations is reflected in Perception software |
| Cycle Source calculations | Cycle and Frequency |
| Analog channel calculations | RMS, Minimum, Maximum, Mean, Peak-to-Peak, Area and Energy |
| Timer/Counter channel calculations | Frequency (to enable triggering), RPM of Angle |
| Cycle | Square wave signal, 50% duty cycle.<br>Represent Cycle Source; rising edge indicates start of new calculation period |
| Frequency | Detected cycle interval is converted to a frequency (1/cycle time of input signal) |
| Trigger detector | |
| Number of detectors | 32; One per real-time calculator |
| Trigger level | Defined by the user for each detector. Generates trigger when the calculated signal crosses the level |
| Trigger output delay | Triggers are delayed by 100 ms on calculated signals. The trigger time is corrected internally so that the sweep triggering is correct. An additional pre-trigger length of 100 ms is added to enable the trigger time correction. This reduces the maximum sweep length by 100 ms |

(1) Cycle period range depends on signal wave shape and hysteresis setting. Specified for Sine wave with 25% Full Scale hysteresis.

| Acquisition Modes | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| 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 depend 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 depend on Ethernet speed, PC used and data storage media used.<br>In Dual mode the RT-FDB calculators sample based results are only calculated for the sweep sections of the recorded data. Due to the asynchronous nature of cycle based results, all cycle based results are continuously stored and used in both the sweep as well as the continuous sections of the recording. |

| Single Sweep | |
|---|---|
| Pre-trigger segment | 0% to 100% of selected sweep length<br>If trigger occurs before the pre-trigger segment is recorded, the pre-trigger segment is truncated to recorded data only. |
| Delayed trigger | Maximum 1 GS after a trigger occurred. The sweep is recorded immediately after a delayed trigger time with 100% post-trigger after this time point. |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep restarts the post-trigger length. If, upon the detection of a new trigger, the extended post-trigger does not fit within the sweep memory, sweep stretch does not happen. The maximum sweep stretch rate is 1 sweep stretch per 2.5 ms. |

| Single sweep | 1 channel | 2 channels | 3 channels | 4 channels | 5 channels | 6 channels | 7 channels | 8 channels | 9 channels | 10 channels | 11 channels | 12 channels | 12 channels 1 Timer/Counter | 12 channels 2 Timer/Counters | 12 channels 2 Timer/Counters Digital events |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum sweep memory | 1000 MS | 1000 MS | 1000 MS | 950 MS | 750 MS | 620 MS | 525 MS | 450 MS | 395 MS | 350 MS | 310 MS | 280 MS | 235 MS | 205 MS | 190 MS |
| Maximum sample rate | 100 MS/s | | | | | | | | | | | | | | |

| Multiple Sweeps | |
|---|---|
| Pre-trigger segment | 0% to 100% of selected sweep length<br>If trigger occurs before the pre-trigger segment is recorded, the pre-trigger segment is truncated to recorded data only. |
| Delayed trigger | Maximum 1 GS after a trigger occurred. The sweep is recorded immediately after a delayed trigger time with 100% post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep restarts the post-trigger length. If, upon the detection of a new trigger, the extended post-trigger does not fit within the sweep memory, sweep stretch does not happen. The maximum sweep stretch rate is 1 sweep stretch per 2.5 ms. |
| Sweep storage | Sweep storage is started immediately after the trigger for this sweep has been 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 are stored one by one, starting with the first recorded sweep. |
| Sweep storage rate | Determined by the total number of selected channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. For details, please refer to the mainframe datasheet. |
| Exceeding sweep storage rate | Trigger event markers are stored in a recording. No sweep data is stored. New sweep data is recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |

| Multi sweep | 1 channel | 2 channels | 3 channels | 4 channels | 5 channels | 6 channels | 7 channels | 8 channels | 9 channels | 10 channels | 11 channels | 12 channels | 12 channels 1 Timer/Counter | 12 channels 2 Timer/Counters | 12 channels 2 Timer/Counters Digital events |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum sweep memory | 1000 MS | 1000 MS | 1000 MS | 950 MS | 750 MS | 620 MS | 525 MS | 450 MS | 395 MS | 350 MS | 310 MS | 280 MS | 235 MS | 205 MS | 190 MS |
| Maximum sample rate | 100 MS/s | | | | | | | | | | | | | | |

## Continuous

| | |
|---|---|
| Continuous modes supported | Standard, Circular recording, Specified time and Stop on trigger |
| Standard | User starts and stops recording. Recording is stopped when the storage media is full |
| Circular recording | User specified recording history on storage media. All recorded data is stored on the storage media as quickly as possible. As soon as the selected history time is reached, older recorded data is overwritten. Recording can be stopped by the user or any system trigger. |
| Specified time | Recording is stopped after the time specified or when the storage media is full |
| Stop on trigger | Recording is stopped after any system trigger or when the storage media is full |
| Continuous FIFO memory | Used by enabled channels to optimize the continuous streaming rate |
| Maximum recording time | Until storage media filled or user selected time or unlimited when using circular recording |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters. For details, please refer to the mainframe datasheet |
| Exceeding aggregate streaming rate | When a streaming rate higher than the aggregate streaming rate of the system is selected, the continuous memory acts as a FIFO. As soon as this FIFO fills up, the recording is suspended (no data is recorded temporarily). During this period, the internal FIFO memory is transferred to a storage medium. When internal memory is completely empty again, the recording is automatically resumed. User notifications are added to the recording file for post recording identification of storage overrun. |

| Continu-ous | 1 channel | 2 channels | 3 channels | 4 channels | 5 channels | 6 channels | 7 channels | 8 channels | 9 channels | 10 channels | 11 channels | 12 channels | 12 channels 1 Timer/Counter | 12 channels 2 Timer/Counters | 12 channels 2 Timer/Counters Digital events |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum FIFO | 3800 MS | 1800 MS | 1200 MS | 900 MS | 720 MS | 600 MS | 510 MS | 450 MS | 400 MS | 360 MS | 320 MS | 280 MS | 230 MS | 210 MS | 190 MS |
| Maximum sample rate | 25 MS/s | | | | | | | | | | | | 20 MS/s (Timer/Counter limitation) | | |
| Maximum aggregate streaming rate | 25 MS/s | 50 MS/s | 75 MS/s | 100 MS/s | 125 MS/s | 150 MS/s | 175 MS/s | 200 MS/s | 225 MS/s | 250 MS/s | 275 MS/s | 300 MS/s | 280 MS/s | 320 MS/s | 340 MS/s |

## Dual

| Dual Sweep Specification | |
|---|---|
| Pre-trigger segment | 0% to 100% of selected sweep length.<br>If trigger occurs before the pre-trigger segment is recorded, the pre-trigger segment is truncated to recorded data only. |
| Delayed trigger | Maximum 1 GS after a trigger occurred. The sweep is recorded immediately after a delayed trigger time with 100% post-trigger after this time point. |
| Maximum number of sweeps | 200 000 per recording |
| Maximum sweep rate | 400 sweeps per second |
| Sweep re-arm time | Zero re-arm time, sweep rate limited to 1 sweep per 2.5 ms |
| Sweep stretch | User selectable On/Off.<br>When enabled, any new trigger event occurring in the post-trigger segment of the sweep restarts the post-trigger length. If, upon the detection of a new trigger, the extended posttrigger does not fit within the sweep memory, sweep stretch does not happen. The maximum sweepstretch rate is 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 is started immediately after the trigger for this sweep has been 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 are stored one by one, starting with the first recorded sweep. |
| Sweep storage rate | Determined by the continuous sample rate, total number of channels and mainframes, mainframe type, Ethernet speed, PC storage medium and other PC parameters. For details, please refer to mainframe datasheet. |
| Exceeding sweep storage rate | Continuous recorded data is not stopped, trigger event markers are stored in recording and no new sweep data is stored. A new sweep is recorded as soon as enough internal memory is available to capture a full sweep when a trigger occurs. |
| **Dual Continuous Specifications** | |
| Continuous FIFO memory | Used by enabled channels to optimize the continuous streaming rate |
| Maximum recording time | Until storage media filled or user selected time |
| Maximum aggregate streaming rate per mainframe | Determined by mainframe, Ethernet speed, PC storage medium and other PC parameters. For details, please refer to the mainframe datasheet.<br>When the average aggregate streaming rate is exceeded, the sweep storage speed is automatically reduced to increase the aggregate streaming rate until the sweep storage is stopped completely. |
| Exceeding aggregate storage rate | When a streaming rate higher than the aggregate streaming rate of the system is selected, the continuous memory acts as a FIFO. As soon as this FIFO fills up, the recording is suspended (no data is recorded temporarily). During this period, the internal FIFO memory is transferred to the storage medium. When the internal memory (Continuous and Sweep memory) is completely empty, the recording is automatically resumed. User notifications are added to the recording file for post recording identification of storage overrun. |

| Dual | 1 channel | 2 channels | 3 channels | 4 channels | 5 channels | 6 channels | 7 channels | 8 channels | 9 channels | 10 channels | 11 channels | 12 channels | 12 channels 1 Timer/Counter | 12 channels 2 Timer/Counters | 12 channels 2 Timer/Counters Digital events |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum sweep memory | 1000 MS | 1000 MS | 1000 MS | 760 MS | 595 MS | 490 MS | 410 MS | 355 MS | 310 MS | 275 MS | 245 MS | 220 MS | 185 MS | 160 MS | 148 MS |
| Maximum sweep sample rate | 100 MS/s | | | | | | | | | | | | | | |
| Maximum FIFO | 800 MS | 400 MS | 260 MS | 180 MS | 144 MS | 120 MS | 103 MS | 89 MS | 75 MS | 68 MS | 61 MS | 55 MS | 46 MS | 40 MS | 37 MS |
| Maximum continous sample rate | 25 MS/s | | | | | | | | | | | | 20 MS/s (Timer/Counter limitation) | | |
| Maximum aggregate streaming rate | 25 MS/s | 50 MS/s | 75 MS/s | 100 MS/s | 125 MS/s | 150 MS/s | 175 MS/s | 200 MS/s | 225 MS/s | 250 MS/s | 275 MS/s | 300 MS/s | 280 MS/s | 320 MS/s | 340 MS/s |

| G091: 2 Gbit Optical SFP Module Multi Mode 850 nm (Option to be ordered seperately) | |
|---|---|
| Small Form-factor Pluggable (SFP) optical transceiver for GN1202B | |
| **WARNING**<br>**Use HBM approved transceivers only.** | |
| Data rate | 2.125 Gbps |
| Wavelength | 850 nm |
| Input connector | LC |
| Form factor | SFP |
| Operating temperature range | -20 °C to +85 °C |
| Laser class | 1 |
| Original manufacturer's part number | Finisar FTLF8519P3BNL |
| To fulfill the laser class requirements, the transceiver must be used under the following conditions: | |
| Storage temperature | -40 °C to +85 °C |
| Case operating temperature | -20 °C to +85 °C |

| Fiber Optic Link | |
|---|---|
| Light source | Class 1 laser product |
| Transfer rate | 2.125 Gbit/s |
| Wavelength | 850 nm |
| Connector | LC duplex on GN1202B<br>SCRJ/IP67 duplex on GN110, GN111, GN112 and GN113 |
| Cable | |
| Isolation | $10^{15}$ Ω/m |
| Type | Duplex Multi Mode, 50/125 µm, ISO/IEC 11801 type OM2, OM3 or OM4 |
| Coupler | LC duplex or SCRJ/IP67 duplex |
| Maximum cable length<br>For every extra coupler used subtract 200 m (656 ft). Refer to the GEN series Isolated Digitizer manual for details on maximum length calculations. | |
| ISO/IEC 11801 type OM2 | 500 m (1640 ft) no extra cable couplers used<br>300 m (984 ft) 1 additional cable coupler used |
| ISO/IEC 11801 type OM3 | 1000 m (3280 ft) no extra cable couplers used<br>800 m (2624 ft) 1 additional cable coupler used |

| Power Requirement GN110 and GN111 (Transmitter) | |
|---|---|
| Battery powered | Maximum 2 removable batteries possible<br>**Note** *Use HBM approved batteries only. See option G034 for approved battery details.* |
| Power consumption | 6 VA typical, 8 VA maximum |
| Operation Time (using G034 batteries) | 30 hours; 2 batteries installed (15 hours; 1 battery installed)<br>Perception software can activate a low power sleep mode to extend the operation time |

| Power Requirement GN112 and GN113 (Transmitter) | |
|---|---|
| Power supply | 115/230 V AC @ 47 - 63 Hz (manual voltage selector) |
| Power consumption | 12 VA maximum |
| Power supply isolation | |
| Protective ground connected | 0 V, both sides grounded |
| Protective ground not connected | 1.8 kV RMS (IEC 61010-1:2010)<br>Requires a protected LAB environment and EN50191:2000 compliant work procedures |
| Fuse(s) | 2 x 250 mA; Slow blow |
| Battery | 12 V @ 300 mAh; Internal, rechargeable, NiMH |
| Battery back-up time | 5 minutes (with new and fully charged battery) |

| Physical, Weight and Dimensions GN110 and GN111 | |
|---|---|
| Weight | 4.6 kg (10 lb) including two batteries |
| Dimensions including handles | 175 mm (6.89") x 277 mm (10.91") x 119 mm (4.69") (W x D x H) |
| Battery carrier | 2 (batteries need to be ordered separately) |
| Shielding and casing | Single metal shielding in plastic housing. Correct operation has been verified by placing the transmitter cabinet within 1 meter of an EMC field created by a 80 kA current |
| Cooling fans | 0 |
| Handle | One carrying handle |
| Protective ground | M6 screw terminal |

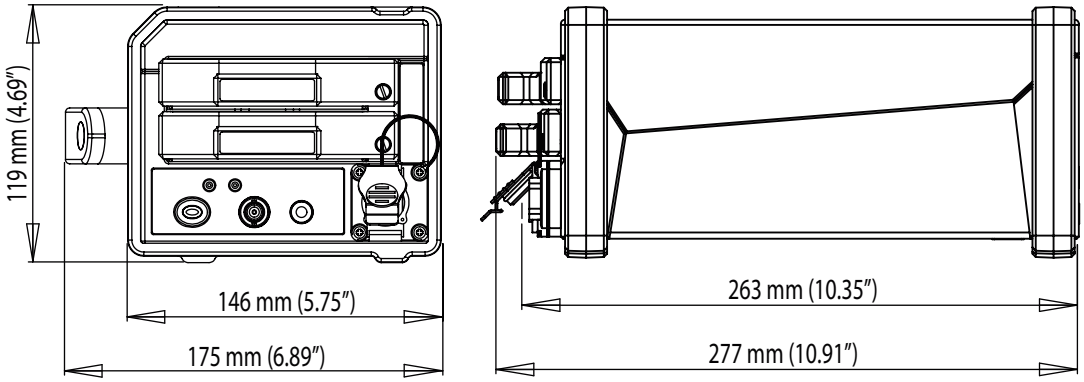



**Figure A.14:** Dimensions GN110 and GN111 transmitter

| Physical, Weight and Dimensions GN112 and GN113 | |
|---|---|
| Weight | 3 kg (6.6 lb) |
| Dimensions including handles | 175 mm (6.89”) x 267 mm (10.51”) x 119 mm (4.69”) (W x D x H) |
| Shielding and casing | Single metal shielding in plastic housing. Correct operation has been verified by placing the transmitter cabinet within 1 meter of an EMC field created by a 80 kA current |
| Cooling fans | 1 |
| Handle | One carrying handle |
| Protective ground | M6 screw terminal |

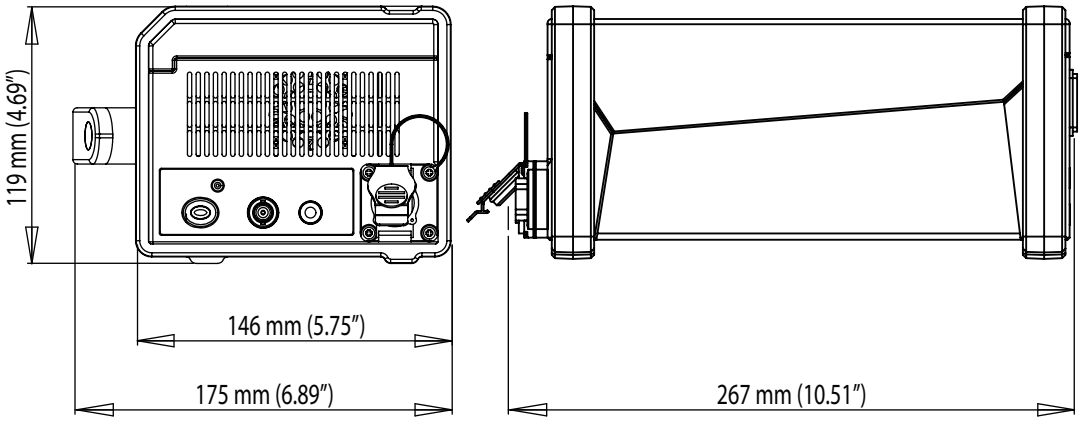



**Figure A.15:** Dimensions GN112 and GN113 transmitter

| Environmental Specifications | |
|---|---|
| Temperature Range | |
| Operational | GN110 and GN111: -15 °C to +50 °C (+5 °F to +122 °F)<br>GN112 and GN113: 0 °C to +40 °C (+32 °F to +104 °F)<br>GN1202B: 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0% to 80%; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft) above sea level; 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 60068-2-64 | |
| 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)<br>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<br>6 cycles, cycle duration 24 hours |

| Harmonized Standards for CE Compliance, According to the Following Directives<br>Low Voltage Directive (LVD): 2014/35/EU<br>Electromagnetic Compatibility Directive (EMC): 2014/30/EU | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2011) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2011) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (2013) | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| **Emission** | |
| EN 55011 | Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement<br>Conducted disturbance: class B; Radiated disturbance: class A |
| EN 61000-3-2 | Limits for harmonic current emissions: class D |
| EN 61000-3-3 | Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems |
| **Immunity** | |
| EN 61000-4-2 | Electrostatic discharge immunity test (ESD);<br>contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B |
| EN 61000-4-3 | Radiated, radio-frequency, electromagnetic field immunity test;<br>80 MHz to 2.7 GHz using 10 V/m, 1000 Hz AM: performance criteria A |
| EN 61000-4-4 | Electrical fast transient/burst immunity test<br>Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B |
| EN 61000-4-5 | Surge immunity test<br>Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth |

| Harmonized Standards for CE Compliance, According to the Following Directives | |
|---|---|
| | Low Voltage Directive (LVD): 2014/35/EU<br>Electromagnetic Compatibility Directive (EMC): 2014/30/EU |
| EN 61000-4-6 | Immunity to conducted disturbances, induced by radio-frequency fields<br>150 kHz to 80 MHz, 1000 Hz AM; 10 V RMS @ mains, 10 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## G034, G301: Rechargeable Li-ion SM202 Battery (Option, to be ordered separately)

Option G034 is battery only. Option G301 is a combination of the battery (G034) and the battery carrier (see Figure A.16)

**Note** *Shipment regulations don't allow HBM to import batteries to all countries. These regulations change almost yearly and are increasingly becoming more strict. Check with the local HBM office before ordering the battery from HBM.*
*Use only HBM approved batteries to avoid unexpected failures and/or specification deviations.*
Standard G034 batteries have almost all world-wide approvals and are available for purchase locally in most countries.
For more information please refer to the following website: www.rrc-ps.com

| | |
|---|---|
| Chemical system | Lithium Ion (Li-Ion) |
| Battery voltage | 11.25 V |
| Typical weight | 490 g (1.1 lb) |
| Nominal capacity | 8850 mAh |
| Mechanical form factor | SM202 |
| Dimensions | 149 mm (5.86”) x 89 mm (3.50”) x 19.7 mm (0.77”) (D x W x H) |
| Smart battery | SMbus & SBDS revision 1.1 Compliant |
| Maximum charge voltage | 13.0 V |
| Recommended charge current | 4.0 A |
| Typical charging time | 3 hours @ a charging current of 4 A |
| Discharge temperature | -20 °C to +55 °C (-4 °F to +131 °F) |
| Charge temperature | +0 °C to +40 °C (+32 °F to +104 °F) |
| Storage temperature | -20 °C to +50 °C (-4 °F to +122 °F). Recommended -20 °C to +25 °C (-4 °F to +77 °F) |
| Original manufacturer's part number | RRC power solutions RRC2020 |
| Compliance information | CE / UL 2054 / UL1642 / FCC / IEC 62133 / EN 60950 / RoHS / UN 38.3 / PSE / RCM / CQC / BIS IS160346 |
| Availability | Available in most countries worldwide |
| Recycling | Registered with most recycling systems worldwide |


**Figure A.16:** G034 battery (left) and G301 battery with carrier (right)

## G109: Li-ion Battery Charger (Option, to be ordered separately)

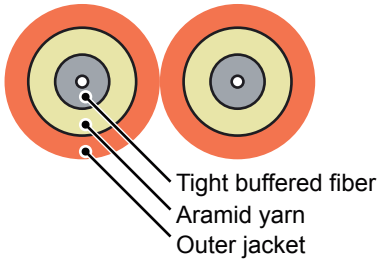
Li-ion ten-bay and two-bay battery chargers

| | |
|---|---|
| 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 | Simultaneous for two batteries. |


**Figure A.17:** Two-bay Li-ion battery charger

## KAB277: Fiber Cables (Option, to be ordered separately)

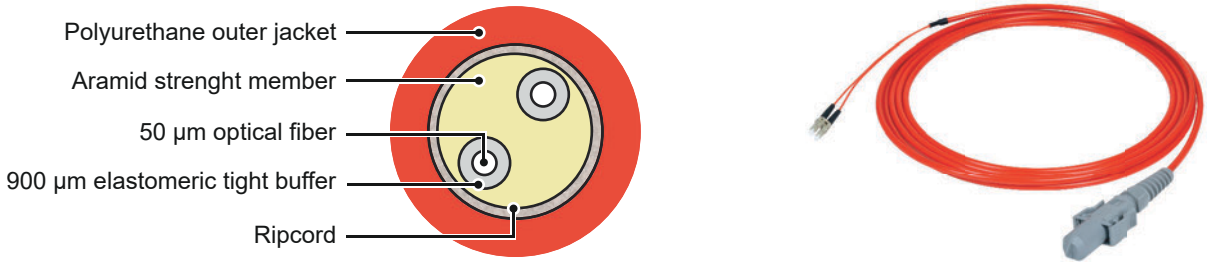
Standard fiber optic duplex cable (1-KAB277-xxx)




| | |
|---|---|
| Connector type | LC - SCRJ |
| Glass rating | OM2; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size | 2 mm (0.08") |
| Jacket rating | Low-smoke zero-halogen |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 10, 20, 50 and 100 m (33, 66, 164 and 328 ft) |
| Operating temperature | -40 °C to +80 °C |

## KAB278: 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 |

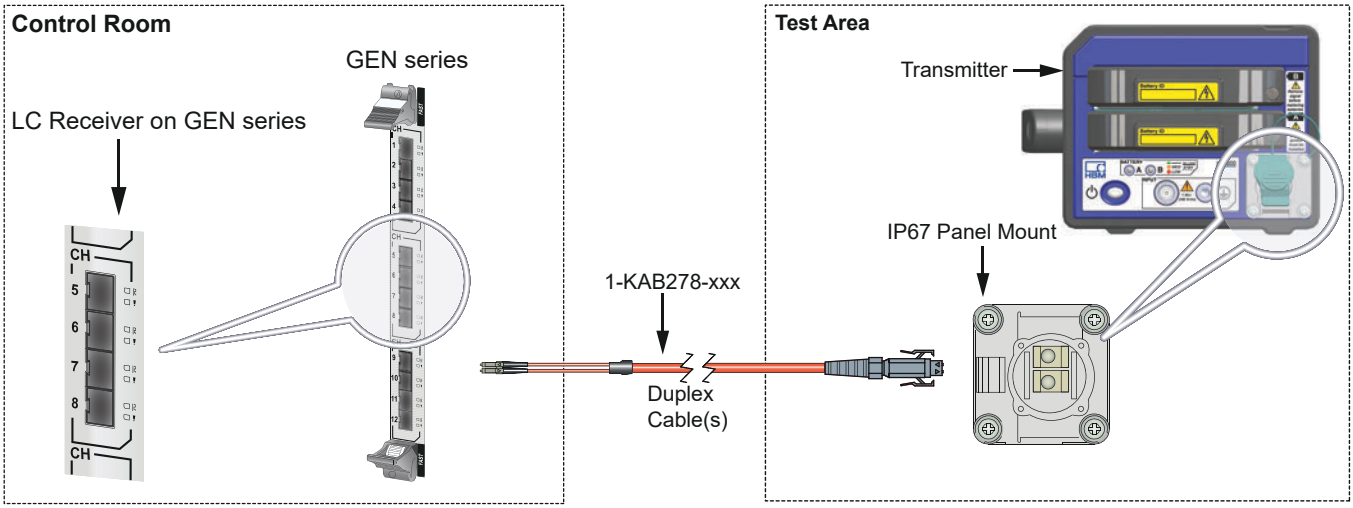
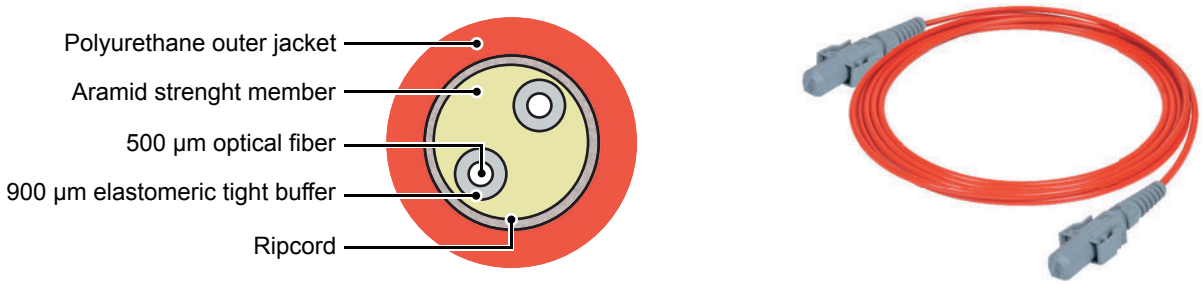



**Figure A.18:** Application area of a fiber optic duplex cable (Example 1)

## KAB279: Fiber Cables (Option, to be ordered separately)

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




| | |
|---|---|
| Connector type | SCRJ/IP67 - SCRJ/IP67 |
| Glass rating | OM2; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size | 6 mm (0.24") |
| Jacket rating | Polyurethane, halogen free, non-corrosive |
| Jacket coating | High chemical resistance against acids/alkalis |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 20 and 50 m (66 and 164 ft) |
| Operating temperature | -40 °C to +80 °C |

## KAB280: Fiber Cable Standard MM LC-LC (Option, to be ordered separately)

Standard zipcord fiber optic duplex Multi Mode patch cable


**Figure A.19:** Block diagram and image

| | |
|---|---|
| Connector type | LC - LC |
| Glass rating | OM3; Multi Mode |
| Core/Cladding diameter | 50/125 µm |
| Jacket size/diameter | Typically 2 mm (0.08") single core |
| Jacket rating | Low-smoke zero-halogen |
| Attenuation | ≤ 2.7 dB/km @ 850 nm |
| Available lengths | 3, 10, 20 and 50 m (10, 33, 66 and 164 ft) |
| Bend radius | 30 mm (1.2") |
| Weight | Typically 14 kg/km (9 lb/1000 ft) |
| Operating temperature | -40 °C to +80 °C |

## KAB280: Fiber Cable Standard MM LC-LC (Option, to be ordered separately)

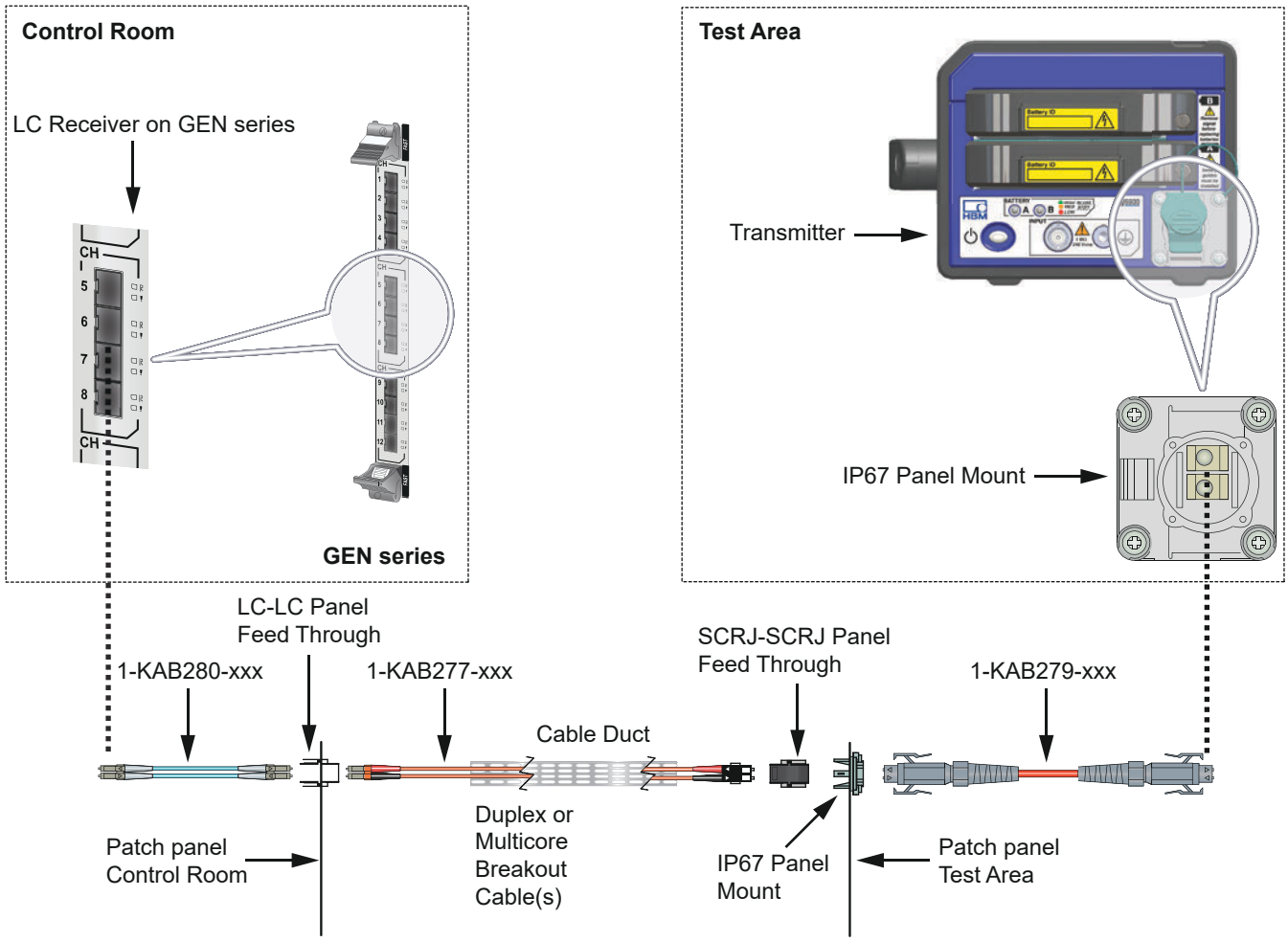



**Figure A.20:** Application area of a fiber optic duplex cable (Example 2)

## Ordering Information[1]

| Article | | Description | Order No. |
|---|---|---|---|
| GN110<br>1 ch Transmitter |  | GN110 optical isolated transmitter HV, 100 MS/s, 14 bit, 25 MHz bandwidth, two Li-ion battery holders, SCRJ/IP67 connector.<br>**Note** *Batteries need to be ordered separately. Check the import restrictions before ordering batteries from HBM. Use only HBM approved batteries to avoid unexpected failures and/or specification deviations.* | 1-GN110-2 |
| GN111<br>1 ch Transmitter |  | GN111 optical isolated transmitter HV, 25 MS/s, 15 bit, 10 MHz bandwidth, two Li-ion battery holders, SCRJ/IP67 connector.<br>**Note** *Batteries need to be ordered separately. Check the import restrictions before ordering batteries from HBM. Use only HBM approved batteries to avoid unexpected failures and/or specification deviations.* | 1-GN111-2 |
| GN112<br>1 ch Transmitter |  | GN112 optical isolated transmitter MV, 100 MS/s, 14 bit, 25 MHz, built-in power supply with 1.8 kV RMS isolation, SCRJ/IP67 connector. | 1-GN112-2 |
| GN113<br>1 ch Transmitter |  | GN113 optical isolated transmitter MV, 25 MS/s, 15 bit, 10 MHz, built-in power supply with 1.8 kV RMS isolation, SCRJ/IP67 connector. | 1-GN113-2 |
| GN1202B<br>12 ch Receiver |  | GN1202B optical isolated receiver, 12 channels, 12 x LC in, 2 GB memory<br><br>**Note** *When mixing 100 MS/s and 25 MS/s transmitters, the maximum receiver sample rate is limited to 25 MS/s for all 12 channels.* | 1-GN1202B-2 |
| 2 Gbit Optical SFP module MM<br>850 nm |  | GEN DAQ 2Gbit Ethernet SFP, 850 nm Multi Mode.<br>Up to 600 m optical cable length supported, LC connector support.<br>The 2 Gbit SFP cannot be used for 1 or 10 Gbit SFP requirements. | 1-G091-2 |

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

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| Li-ion SM202 Battery |  | Rechargeable Li-ion battery unit for GN110/ GN111 and ISOBE5600t<br>The battery is compliant with CE / UL 2054 / UL1642 / FCC / IEC 62133 / EN 60950 / RoHS / UN 38.3 / PSE / RCM / CQC / BIS IS 160346<br>**Note** *Check the import restrictions before ordering batteries from HBM.* | 1-G034-2 |
| Li-ion SM202 Battery with carrier |  | Rechargeable Li-ion battery unit with carrier for GN110/GN111 and ISOBE5600t<br>The battery is compliant with CE / UL 2054 / UL1642 / FCC / IEC 62133 / EN 60950 / RoHS / UN 38.3 / PSE / RCM / CQC / BIS IS 160346<br>**Note** *Check the import restrictions before ordering batteries from HBM.* | 1-G301-2 |
| 2 bay Li-ion battery charger |  | Li-ion two bay battery charger for GN110/GN111 and ISOBE5600t batteries. Accepts two batteries without removing the carrier. | 1-G109-2 |
| Fiber cable standard MM LC-SCRJ |  | GEN DAQ standard fiber optic duplex Multi Mode 50/125 µm cable, 2.7 dB/km loss (or 3.5 dB/km for general specification ISO/IEC 11801), LC-SCRJ connectors, orange, ISO/IEC 11801 type OM2. Typically used for fixed cable routing or LAB environments.<br>Lengths: 10, 20, 50 and 100 meter (33, 66, 164 and 328 ft) | 1-KAB277-10<br>1-KAB277-20<br>1-KAB277-50<br>1-KAB277-100 |
| Fiber cable heavy duty MM LC-SCRJ |  | GEN DAQ heavy duty fiber optic duplex Multi Mode 50/125 µm cable, 2.7 dB/km loss (or 3.5 dB/ km for general specification ISO/IEC 11801), LC-SCRJ/IP67 connectors, orange, ISO/IEC 11801 type OM2. Typically used for test cell environments.<br>Lengths: 10, 20, 50, 100, 150 and 300 meter (33, 66, 164, 328, 492 and 984 ft) | 1-KAB278-10<br>1-KAB278-20<br>1-KAB278-50<br>1-KAB278-100<br>1-KAB278-150<br>1-KAB278-300 |
| Fiber cable heavy duty MM SCRJ-SCRJ |  | GEN DAQ heavy duty fiber optic duplex Multi Mode 50/125 µm cable, 2.7 dB/km loss (or 3.5 dB/ km for general specification ISO/IEC 11801), SCRJSCRJ/ IP67 connectors, orange, ISO/IEC 11801 type OM2. Typically used for test cell environments as patch panel to transmitter connections.<br>Lengths: 20 and 50 meter (66, 164 ft) | 1-KAB279-20<br>1-KAB279-50 |
| Fiber cable standard MM LC-LC |  | GEN DAQ standard zipcord fiber optic duplex Multi Mode 50/125 µm cable, 3.0 dB/km loss, LC-LC connectors, aqua, ISO/IEC 11801 type OM3. Typically used for fixed cable routing or LAB environments.<br>Lengths: 3, 10, 20 and 50 meters (10, 33, 66 and 164 ft) | 1-KAB280-3<br>1-KAB280-10<br>1-KAB280-20<br>1-KAB280-50 |

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

# B Maintenance

## B.1 Cleaning

To clean the instrument, disconnect all power sources. Lightly wipe the surfaces with a clean, soft cloth dampened with water.

The GN110/GN111/GN112/GN113 transmitter cabinet or the GN1202B receiver do not require additional routine cleaning.

# 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 local sales person for more information. For local contact information, visit www.hbm.com/support.

If servicing is 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 and the accompanying paperwork to the unit.

During the warranty period, the customer pays for shipping to HBM. HBM pays to return the equipment in the same fashion as it was received. Outside of the warranty period, a quote for the shipping costs is issued. 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 the frequent shipping of some products, HBM offers hard shipping containers specifically designed for frequent transportation.

## C.2 Preventive maintenance

Except for the batteries, the instrument is a maintenance-free product; no preventive maintenance is required.

Inspect the instrument's batteries at least twice a year, but preferably every month. Damaged batteries and batteries with reduced capacity should be replaced to meet the batteries' specified capacity and consequently the instrument's specified run-time using the battery. The main benefit of this inspection will result in reliable use of the instrument.

If the instrument has been stored for four weeks or longer, first inspect the battery before putting the instrument back to use.

# D Understanding inputs and usage of probes

## D.1 GEN series inputs

**Note** *Every manufacturer uses different names for similar or even identical types of inputs. Some of the terminology used is described in this section.*

**Balanced Vs Unbalanced**
A balanced input describes an input stage where both input terminals exhibit the same electrical behavior, such as 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.
A differential amplifier is often treated as an isolated amplifier, which is incorrect.

**Single-ended**
A single-ended amplifier is a type of electronic amplifier that has the negative input connected to (measurement) ground.

**Note** *A differential amplifier can be turned into a single-ended one by connecting the negative input to ground.*

**Isolated**
An isolated amplifier is a type of electronic amplifier where both inputs are isolated from (earth) ground or which has infinite resistance to ground.

**Note** *Isolation can be combined with any of the amplifier variations mentioned above.*

### D.1.1 Single-ended input

A single-ended input is not isolated and uses unbalanced inputs.

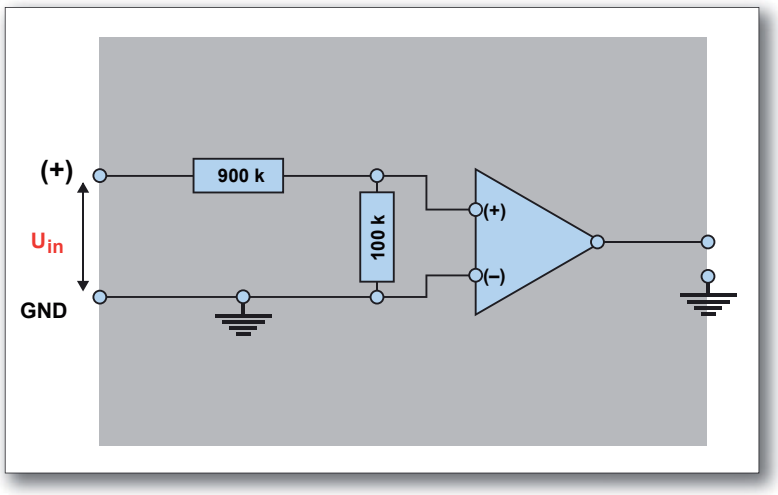



**Figure D.1:** Single-ended amplifier

- One input is connected to ground
- Resistance / Capacitance from each terminal to ground is different
- Amplifier is typically found in oscilloscopes
  - Also used in GEN DAQ Basic amp, Liberty 8ch DC amp
  - Often identified by the use of a single METAL BNC connector per channel
- Can be used with standard passive probes (as with oscilloscopes)

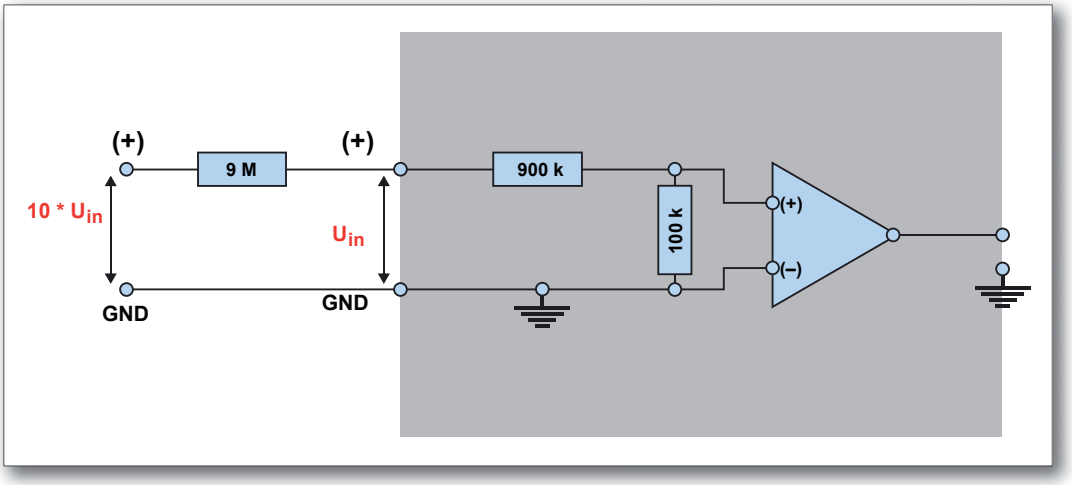



**Figure D.2:** Single-ended amplifier with passive probe

- An inline resistor acts as a voltage divider using the input resistance of the amplifier
- The amplifier itself measures only $\mathbf{U_{in}}$; the **total** input range is $\mathbf{10 * U_{in}}$
- This can be done with any oscilloscope or the GEN DAQ Basic Amp
  - Oscilloscope probes are typically only +/- 2% to +/- 5% accurate
- The probes used need compensation. The compensation range needs to match the input amplifier's capacitance range.

### D.1.2 Balanced differential input

A balanced differential input is not isolated and uses balanced inputs.

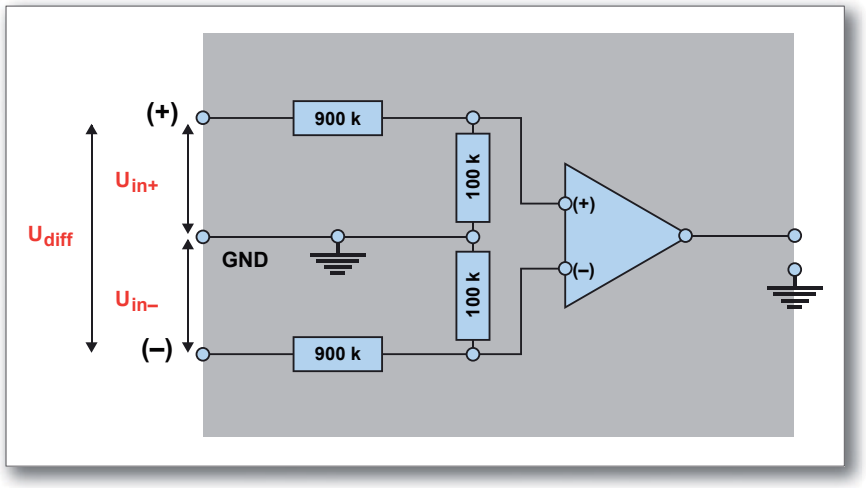



**Figure D.3:** Balanced differential amplifier

- Resistance / Capacitance from each terminal to ground is identical
- There is NO ISOLATION
  - Used in some of the GEN DAQ acquisition cards
  - Often identified by the use of two METAL BNC connectors per channel
- Can be used with matched pair of probes only
  - Works with the same limitations as single probes, but is more tricky due to the necessary **balance** between probes
- The probes used need compensation. The compensation range needs to match the input amplifier's capacitance range

### D.1.3 Isolated single-ended or Isolated unbalanced differential input

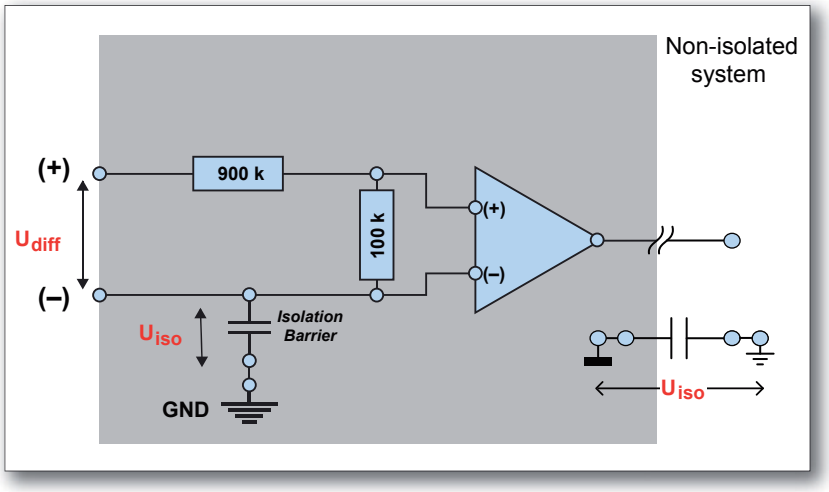



**Figure D.4:** Isolated single-ended or Isolated unbalanced differential amplifier

- Also referred to as **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 perform *DIFFERENTIAL MEASUREMENTS with different limitations and options, compared to a differential grounded amplifier*.

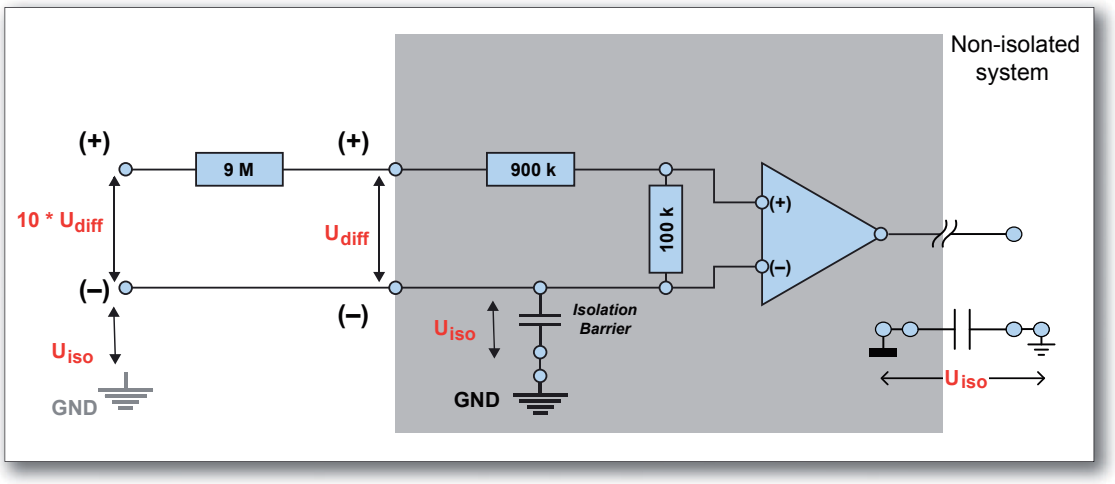



**Figure D.5:** Isolated single-ended or Isolated unbalanced differential amplifier with passive probe

- Also referred to as **unbalanced**, **isolated** or **unbalanced differential** amplifier with probe
- None of the inputs are connected to ground
- The positive (system) input accepts ten times the input voltage of the amplifier
- The negative input has NOT CHANGED AT ALL
- The measurement range is increased from + to - inputs,
  BUT the isolation voltage from (-) to ground remains unchanged
  - Example is the GEN DAQ Basic XT Iso card with external Isolated passive probe
- The probes used need compensation. The compensation range needs to match the input amplifier's capacitance range

### D.1.4 Isolated balanced differential input

An isolated balanced differential input is isolated and uses balanced inputs. Isolated measurement ground is not often available.

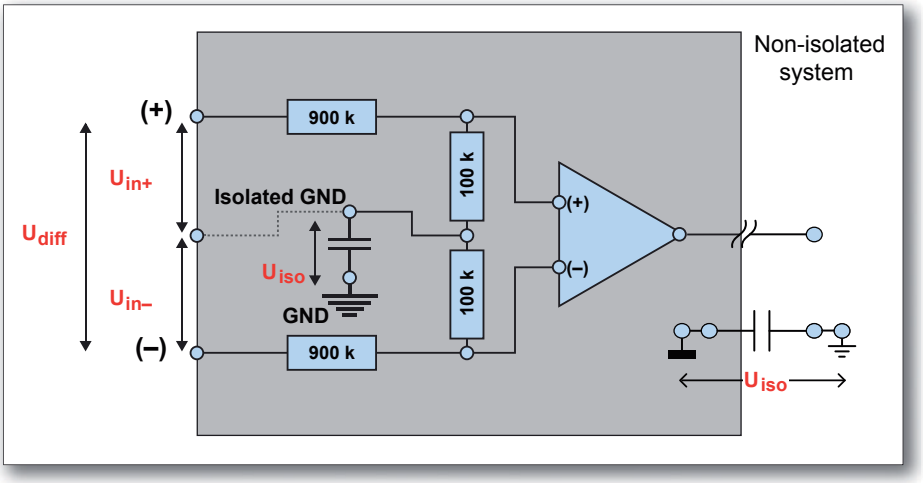



**Figure D.6:** Isolated balanced differential amplifier

- Resistance / Capacitance from each terminal to isolated measurement ground is identical
- There is an ISOLATED MEASUREMENT GROUND
  - Used in GEN DAQ Universal amplifier
  - Typically identified by using two or three (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

**Different amplifiers – Pros and Cons**

**Single-ended (to ground) amplifiers**

- Cost effective and small
- High bandwidth
- Easy to use with probes
- Potential ground problems
- No safety problems
- No CMRR and no CMV

**Single-ended isolated amplifier – unbalanced differential**

- Can perform differential measurements
- Expensive and large
- Difficult to use with probes
- Limited CMRR, best CMV
- Avoids ground loops
- High level of safety

**Differential amplifier (with common ground)**

- Widely used in DAQ
- Good CMRR, limited CMV
- No (safety) isolation and potential ground loops will remain present

**Differential amplifier with isolated common**

- Safe
- Expensive and large
- Good CMRR, best CMV
- More difficult to use with probes

## D.2 GEN series voltage probe types

HBM offers a variety of probes. 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.

- **Passive, single-ended voltage probes**
  These probes can be used with single-ended or differential non-isolated amplifiers and increase the input range of the amplifier only in single-ended mode. They typically decrease the overall accuracy of the amplifier.
- **Passive, single-ended isolated voltage probes**
  These probes can be used with single-ended or differential isolated amplifiers and increase the input range of an isolated amplifier only in single-ended mode. They typically decrease the overall accuracy of the amplifier.
  It is important to understand that they increase only the range, not the isolation voltage.
- **Passive, differential matched isolated voltage probes**
  These probes can be used with differential isolated amplifiers and increase the input range of the amplifier in differential mode. They typically decrease the overall accuracy and the CMRR of the amplifier.
  They work with isolated and non-isolated variations of differential amplifiers.
  When used with isolated amplifiers, they increase only the range, not the isolation voltage.
- **Active differential voltage probes**
  These probes are self-contained, differential amplifiers to be used in front of an instrument using any amplifier in single-ended mode.
  The input range and accuracy depend on the type of active differential probe used and have no relation to the amplifier used. They usually operate from batteries; this causes some inconvenience.
- **Current clamps**
  Current clamps function more as transducers than probes, as they convert one physical quantity (current) into another one (usually voltage). They are used to perform non-invasive current measurements. This allows the current in a circuit to be measured without disturbing the circuit.

**Note** *There are other possibilities to measure current as well (current shunts, or Rogowski coils).*

### D.2.1 Passive, single-ended voltage probes

Voltage probes divide a single-ended input signal by a specific factor.

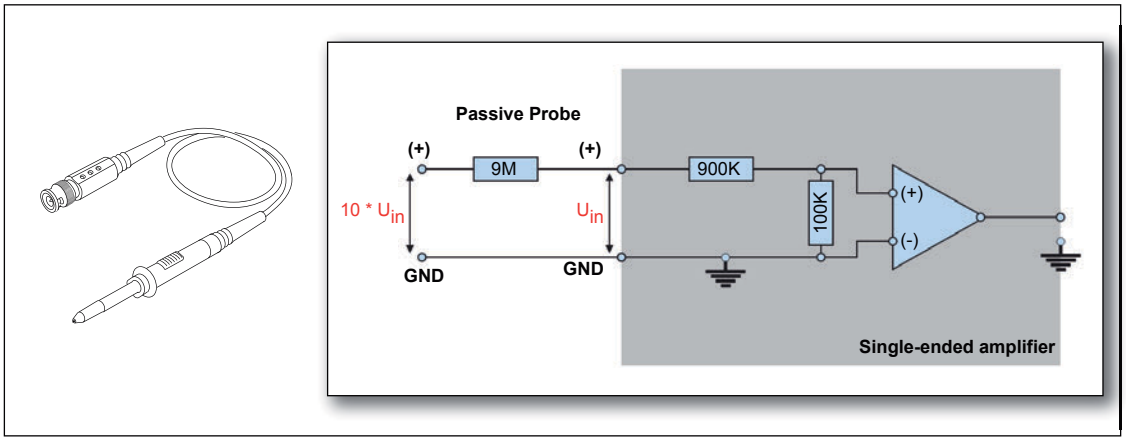



**Figure D.7:** Typical example of a voltage probe

Theoretically, voltage probes are simply passive in-line resistors in series with 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 series with the amplifier itself is divided. 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 increases so that large input ranges can be achieved. Voltage probes do not provide or add either isolation or common mode voltage rejection. These probes can only be used in series with 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 D.1: Voltage probes overview table*

| Part number | Capacitive compensation range | Cable length | Divider factor | Bandwidth | Maximum input voltage |
|---|---|---|---|---|---|
| **1-G901-2** | 7 - 75 pF | 1.2 m | 1 ± 2% | 12 MHz | 55 V RMS |
| | | | 10 ± 2% | 200 MHz | 300 V RMS |
| **1-G902-2** | 7 - 75 pF | 3 m | 1 ± 2% | 12 MHz | 55 V RMS |
| | | | 10 ± 2% | 200 MHz | 300 V RMS |
| **1-G903-2** | 7 - 45 pF | 1.2 m | 100 ± 2% | 400 MHz | 1 kV RMS |
| **1-G904-2** | 10 - 50 pF | 2 m | 100 ± 2% | 300 MHz | 2 kV RMS<br>3 kV DC<br>3 kV pulse |
| **1-G906-2** | 10 - 50 pF | 3 m | 1000 ± 2% | 100 MHz | 14 kV RMS<br>20 kV DC<br>40 kV pulse |
| **1-G027-2** | 100 – 140 pF | 3 m | 1 ± 2% | 2 MHz | 55 V RMS |
| | | | 10 ± 2% | 50 MHz | 300 V RMS |

*Table D.2: Passive, single-ended voltage probe overview*

| Input card | 1-G901-2 | 1-G902-2 | 1-G903-2 | 1-G904-2 | 1-G906-2 | 1-G027-2 |
|---|---|---|---|---|---|---|
| GN110/GN111 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| GN112/GN113 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| GN114 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| GN610B/GN611B | | | | | | |
| GN815/GN816 | | | | | | |
| GN840B | | | | | | |
| GN1640B | | | | | | |
| GN3210/GN3211 | ✓ | ✓ | | | | |
| GENIS-1T/GENIS-1TM | ✓ | ✓ | ✓ | ✓ | ✓ | |

### D.2.2 Passive, single-ended isolated voltage probes

Passive, single-ended isolated voltage probes divide an isolated input signal by a specific factor. They are designed in an “isolated way” (like plastic BNCs to prevent users from touching the connection) so they can be used in series with an isolated unbalanced amplifier. They are called “isolated voltage probes”, although the amplifier and not the probe adds the isolation.

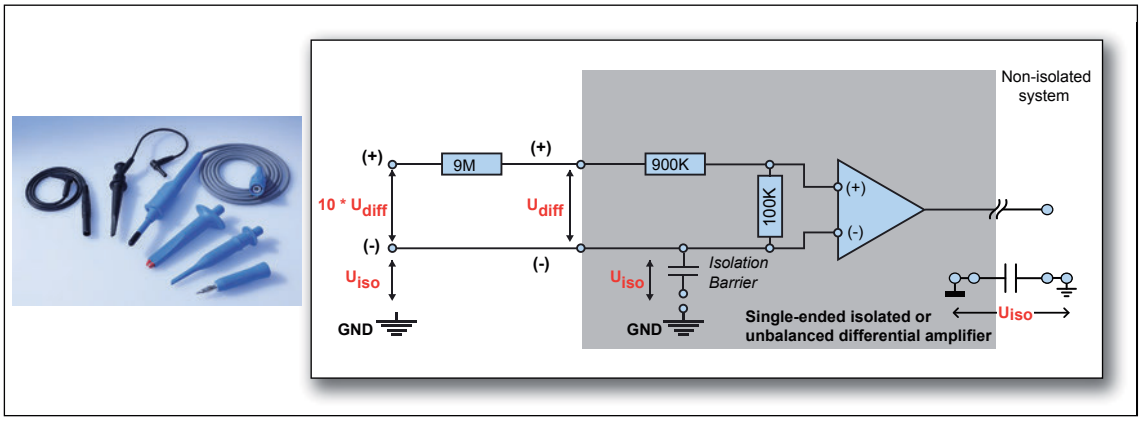



**Figure D.8:** Typical example of an isolated voltage probe

Theoretically, voltage probes for isolated amplifiers are simply passive in-line resistors in series with the positive input of an isolated unbalanced amplifier as well.

Together with the input resistor of the amplifier, they form a voltage divider so that the voltage in front of the amplifier itself is divided. 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.

However, as the division only applies to the positive side of the amplifier input, the input range is increased while the isolation voltage remains the same as without a probe.

These probes can only be used in series with 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 D.3: Voltage probes for ISOLATED amplifiers overview table*

| Part number | Capacitive compensation range | Cable length | Divider factor | Bandwidth | Maximum input voltage |
|---|---|---|---|---|---|
| **1-G057-2** | 30 - 70 pF | 1.2 m | 100 ± 2% | 50 MHz | 3.5 kV RMS<br>1 kV RMS CAT II<br>600 V RMS CAT III |

### D.2.3 Passive, differential matched isolated voltage probes

Passive, differential matched isolated voltage probes are used in series with differential amplifiers and divide a differential input signal by a specific factor.

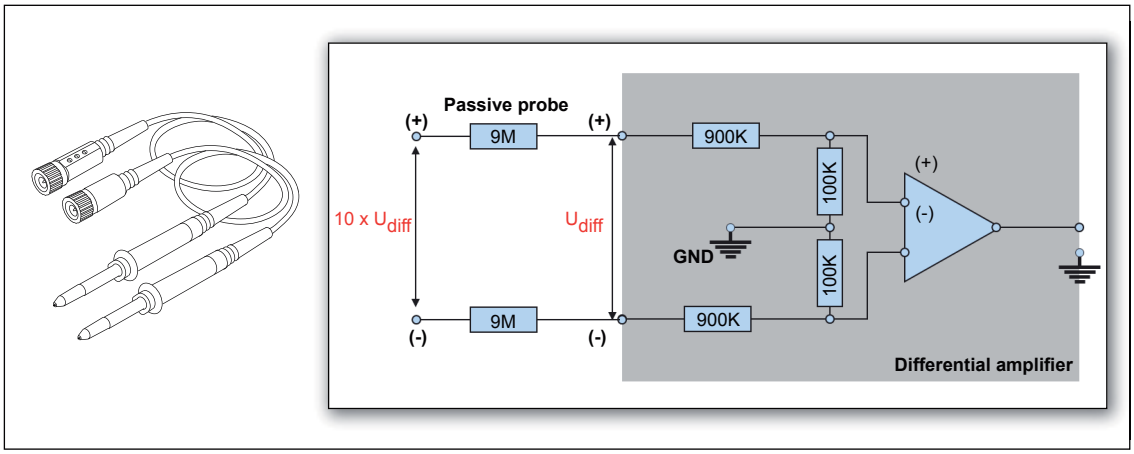



**Figure D.9:** Typical example of a passive differential voltage probe

Passive, differential matched isolated voltage probes are – in theory – simply a pair of “normal” voltage probes.

They add passive in-line resistors in series with both the positive and 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 series with the amplifier itself is divided. 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 themselves need to “match” as closely as possible. Otherwise, the two input terminals are divided differently. Therefore, the probes are typically manufactured (and sold) in pairs and called “matched”. By selecting higher resistance probes, the divider ratio increases so that large input ranges are possible. Passive, differential matched isolated voltage probes typically decrease the overall accuracy and the CMRR of the system.

*Table D.4: Passive differential voltage probes overview table*

| Part number | Capacitive compensation range | Cable length | Divider factor | Bandwidth | Maximum input voltage |
|---|---|---|---|---|---|
| **1-G025-2** | 100 – 140 pF | 3 m | 200 ± 2% | 20 MHz | 2.8 kV RMS<br>4 kV DC |
| **1-G026-2** | 105 – 140 pF | 3 m | 10 ± 2% | 100 MHz | 400 V RMS<br>300 V RMS CAT II |
| **1-G907-2** | 35 – 70 pF | 3 m | 10 ± 2% | 100 MHz | 300 V RMS CAT II |

*Table D.5: Passive, single-ended isolated voltage probe overview*

| Input card | 1-G025-2 | 1-G026-2 | 1-G907-2 |
|---|---|---|---|
| GN110/GN111 | | | |
| GN112/GN113 | | | |
| GN114 | | | |
| GN610B/GN611B | | | |
| GN815/GN816 | | | |
| GN840B | | | |
| GN1640B | | | |
| GN3210/GN3211 | | | ✓ |
| GENIS-1T/GENIS-1TM | | | |

### D.2.4 Active differential voltage probes

Active differential voltage probes are battery-powered, differential amplifiers in series with any input amplifier in single-ended mode.

**Figure D.10:** Typical example of an active differential voltage probe

The achievable input range and accuracy depends on which active differential probe is used. Active differential probes can be used in series with virtually any amplifier, their performance typically is limited. The fact that they are usually battery-powerd may cause some inconvenience, as battery maintenance is required.

Active differential voltage probes typically decrease the overall accuracy of the system. The active output enables the use of the probe with (almost) any type of input.

*Table D.6: Active differential voltage probes*

| Part number | Capacitive compensation range | Cable length | Divider factor | Bandwidth | Maximum input voltage |
|---|---|---|---|---|---|
| **1-G909-2** | n/a | 0.9 m | 20 ± 2% | 25 MHz | 140 V RMS<br>140 V DC |
| | | | 200 ± 2% | 25 MHz | 1.0 kV RMS<br>1.4 kV DC |

### D.2.5 Probe accessories

**Probe accessories**
**1-G910-2 (LDS 040-747900)**
Probe tip adapters with 4 mm safety-shrouded banana plugs. Include tip and ground lead adapters and two alligator clips with 1" jaw opening.
Use on probes G901 and G902 only.

**G911 Probe Accessory Kit**
**1-G911-2 (LDS 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.

## D.3 Probe bandwidth calibration

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.3.1 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. Figure D.11 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) introduces 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.

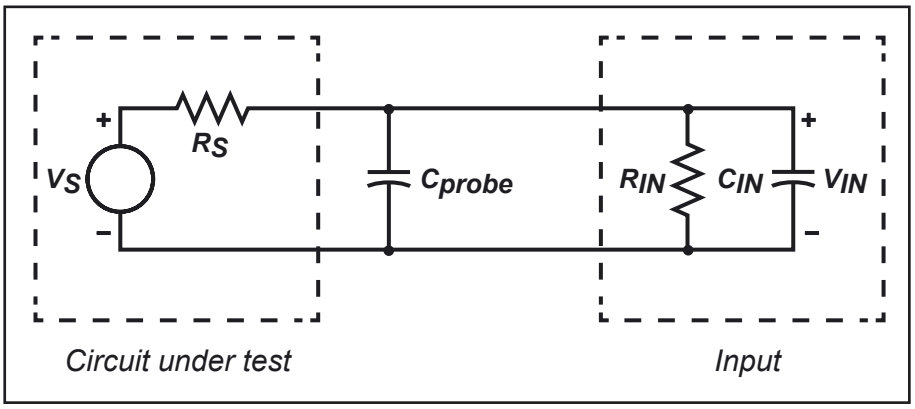



**Figure D.11:** Input connection using a 1X probe

The impedance of the circuit and the input impedance of the instrument 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 reduces the voltage detected by the instrument. Figure D.12 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.

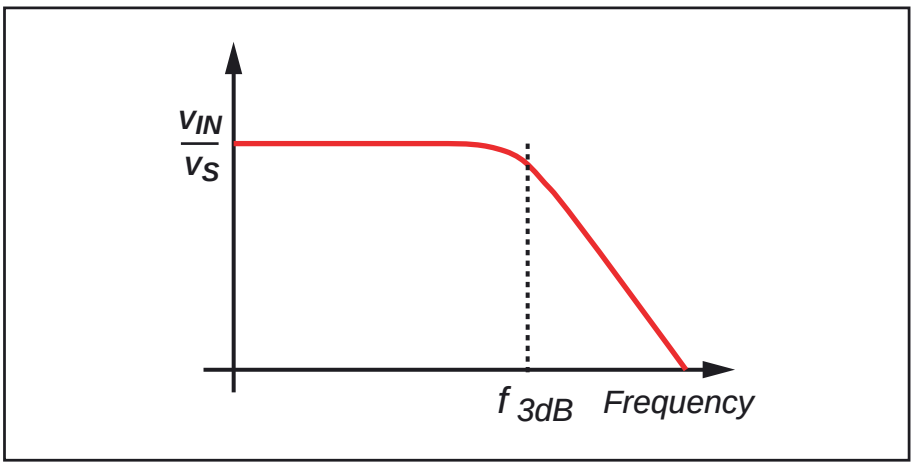



**Figure D.12:** Frequency response with 1X probe

Example: Assuming that the voltage source has a 1 MΩ resistance and the 1X probe has a 50 pF capacitance (a 1X probe has no resistance by itself ), the universal amplifier input would have a 1 MΩ resistance and a 100 pF capacitance.

This yields a -3dB point at:

**(EQ1)**

$$f(\text{-}3db) = \frac{1}{2\pi(R_s \| R_{IN})\ (C_{IN}+C_{probe})}$$

= 1 / (6.28 x 500 E+3 x 150 E-12) ≈ 2 kHz

The loading due to the input impedance of the instrument and the probe capacitance is twofold: resistive loading and capacitive loading.

The resistive loading actually reduces the voltage delivered to the instrument:

**(EQ2)**

$$V_{IN} = V_S\left(\frac{R_{IN}}{R_{IN}+R_S}\right)$$

The effect of the capacitive loading is more complex and results in an exponential response in the voltage:

**(EQ3)**

$$V_{IN}(t) = V_{MAX}\left[1 - e^{-t/(R_S C_{in\ +\ probe})}\right]$$

### D.3.2 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.13 shows the circuit diagram for the 10X probe connected to a high-impedance input of an instrument.

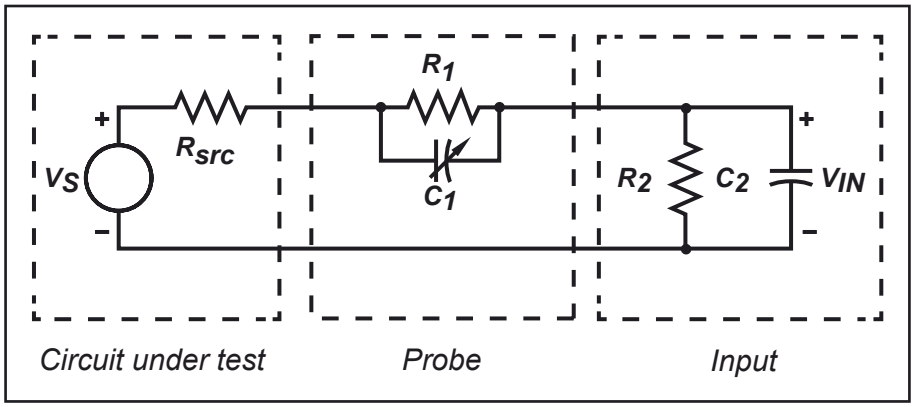



**Figure D.13:** Input connection using a 10X probe

Assuming that $R_{src}$ is low compared to $R_1$ and that $R_1 * C_1 = R_2 * C_2$, then the effect of both capacitors cancel each other out in this circuit. The capacitor is usually adjustable and can be tweaked for a nearly perfect match. In these conditions, the relationship of VS to VIN 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 MΩ) and $R_1 = 9 * R_2$. Using the previous equation, this results in:

**(EQ 5)**

$$V_{IN} = \left(\frac{1}{10}\right)V_S$$

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 measures only one-tenth of the original voltage (hence the name 10X probe). The circuit being measured is affected with a load impedance of $R_1 + R_2 = 10$ MΩ, which is much higher than with the 1X probe.

**IMPORTANT**

**To perform the compensation correctly, both impedances must have the same value, i.e. $R_1 * C_1 = R_2 * C_2$. In practice, $R_1 * C_1$ will never be equal to $R_2 * C_2$, but the values can be approximated. The probe's compensation capacitor is usually 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, the compensation cannot be performed 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.3.3 Probes and differential measurements

Connecting the differential amplifier or probe to the signal source is generally a major source of error. To maintain the input match, both paths should be as identical as possible. Any cabling should be the same length for both inputs. If individual probes are used for each signal line, they should be the same model and have the same 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 is impossible to balance their attenuation precisely. 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 the 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.4 Current 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 the low voltage signal lines from the 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.

**CAUTION**

**Keep in mind that very strong magnetic fields can influence the amplifier setting relays!**

**HINT/TIP**

Note that the GN110/GN111/GN112/GN113 transmitter has a relatively high bandwidth of 25 MHz. As a result of this high bandwidth, high frequency transients might show that have never been shown before. Use the filter to reduce the bandwidth to a physically relevant value.

# E Troubleshooting

## E.1 Overview

**Transmitter does not start after completely discharged**

| Symptoms: | Solution |
|---|---|
| When the GN112/ GN113 transmitter(s) was running without mains connection and (nearly) fully discharged the internal battery, the unit becomes inoperable and will not awake when the mains cord is connected again. | This is normal behavior. The GN112/GN113 transmitter(s) need first to be powered off by the On/ OFF switch before you connect the mains power cord. Then turn the unit on again. |

If the Troubleshooting tips don't help, use the information in chapter "General - Service Information" on page 116 to get in touch with our support and service teams.

# F Using Fiber Optic Cables

## F.1 Patch panels

Patch panels are switchboard look-alikes that house cable connections. In a typical setup, the connection consists of a shorter cable plugged into the front side of the patch panel and a longer cable plugged into the back.

In addition to having different lengths of cable connecting to the front and back, patch panels can have different types of electrical connectors as well. One example of this is a breakout box, which has individual connectors on the front leading to a compound connector on the back, into which all of the individual cables plug. In all cases, patch panels transmit signals from one cable to another without any loss of data.

Another function is the ability to change and interchange the individual cables on the front. Patch panels have compound connectors on the back side that don’t differentiate which signal is coming from which individual port.

A patch panel provides a convenient place to terminate all of the cable runs coming from different locations into the laboratory. You can label the patch panel. Putting the labels on the cables is tougher to read than labels on a patch panel and also there is risk of having the cable labels fall off.

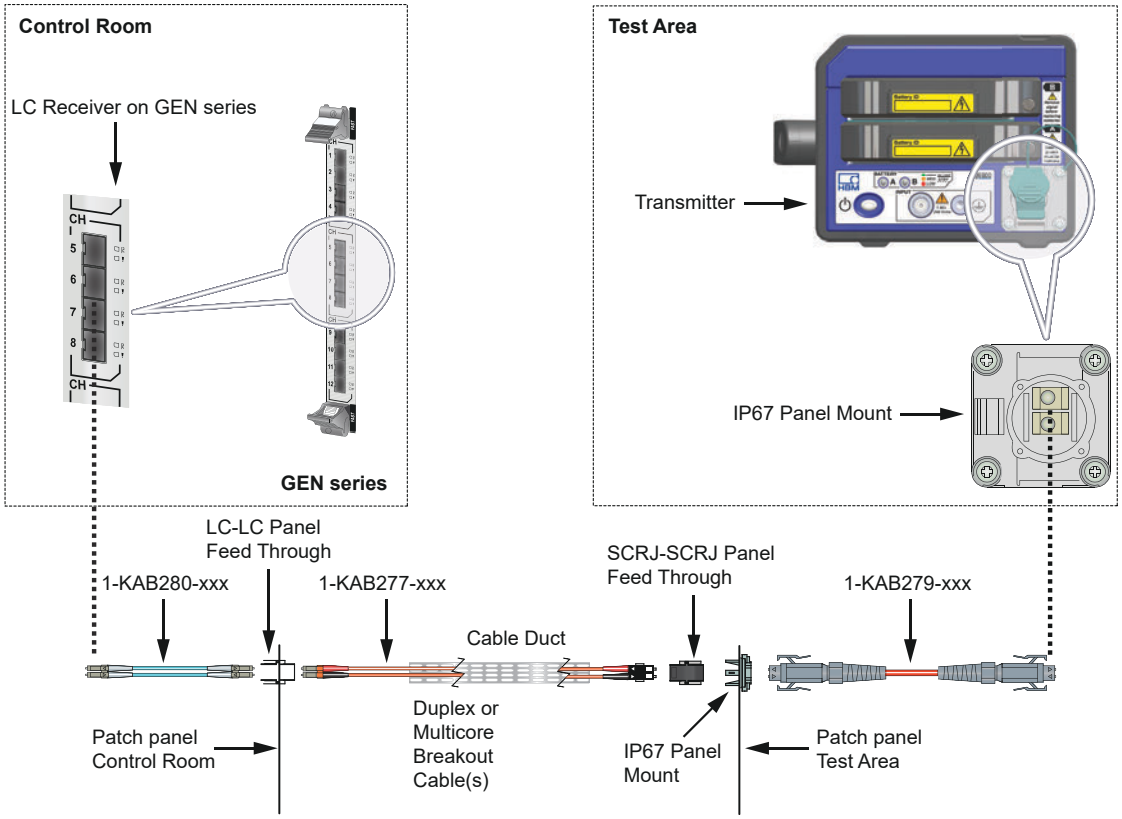



**Figure F.1:** Example of a patch panel configuration

Depending on the cables used the actual configuration may differ from the situation depicted in the above diagram.

**Note** *The maximum cable length will decrease by 200 m for each patch panel installed.*

Contact your local dealer or HBM directly for details on availability of connectors and cables.

## F.2 Calculating maximum fiber cable length

Maximum optical fiber length is determined by two major factors: optical loss and bandwidth limit. These types of optical fiber performance and quality are defined in the ISO standard ISO/IEC 11801.

| OMx/OCx = ISO/ IEC 11801 standard (optical fiber type) | For wave-length | Optical power budget | Cable loss | Coupler loss. ANSI/TIA/ EIA-568-A | BW Length limit |
|---|---|---|---|---|---|
| OM1 = Multi Mode 62.5/125 µm | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 200 MHz*km |
| OM2 = Multi Mode 50/125 µm | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 500 MHz*km |
| OM3 = Multi Mode 50/125 µm laser optimized fiber | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 2000 MHz*km |
| OM4 = Multi Mode 50/125 µm laser optimized fiber | 850 nm | 8 dB | -3.5 dB/km | -0.75 dB | 4700 MHz*km |
| OS1 = Single Mode 9/125 µm | 1310 nm | 10 dB | -1 dB/km | -0.75 dB | N/A |
| OS2 = Single Mode 9/125 µm | 1310 nm | 10 dB | -0.4 dB/km | -0.75 dB | N/A |

**Note** *Table shows worst-case specifications.*

Standard GHS systems use VCSEL 850 nm optical transmitters/receivers; they have an optical power budget of 8 dB. Calculating the maximum length of optical cable can be done in the following manner:

| | | |
|---|---|---|
| Optical budget GHS system 850 nm | : | 8 dB |
| Maximum fiber cable length | : | $L_{optical}$ (km) |
| Fiber cable loss | : | -3.5 dB/km |
| Number of couplers | : | c |
| Coupler loss | : | -0.75 dB |
| Safety margin for aging and repair | : | -3 dB |

$$L_{optical} = -\frac{8dB + (c * -0.75dB) + (-3\,dB)}{-3.5dB}\ (km)$$

This formula also applies to Single Mode systems

For example, if two couplers are used in the cable, c = 2, the maximum length would be $L_{optical}$ = 1 km

The second limiting factor for cable length is fiber cable bandwidth.
Bandwidth limit is caused by light pulse dispersion in the optical fiber; this only affects Multi Mode fiber systems.
This limit is the product of the GHS system's maximum signaling speed and the defined fiber cable bandwidth.

| | | |
|---|---|---|
| GHS signaling speed over optical fiber | : | 1000 MHz |
| OM class defined bandwidth | : | BW |
| Maximum fiber cable length | : | $L_{BW}$ (km) |

$$L_{BW} = \frac{BW}{1000MHz} \ (km)$$

For example, if an OM2-type cable is used, the maximum length will be $L_{BW}$ = 0.5 km

**The 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 followed, the optical fiber length must be limited to $L_{BW}$ = 0.5 km

# Index

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