# GEN series GN611

## Isolated 1 kV 200 kS/s Input Card



### Special features

- 6 analog channels
- Isolated, balanced differential inputs
- ± 20 mV to ± 1000 V input range
- 600 V RMS CAT II reinforced isolation, tested up to 6.4 kV
- Analog/digital anti-alias filters
- 200 kS/s sample rate
- 18 bit resolution
- 200 MB memory
- Two 4 mm banana plugs for each channel
- Real-time cyclic calculators
- Triggering on real-time results
- Digital Event/Timer/Counter support

### Isolated 1 kV 200 kS Input Card

The isolated balanced differential inputs offers voltage ranges from ± 20 mV to ± 1000 V. Tested up to 6.4 kV, the reinforced isolation allows for safe measurements up to 600 V RMS CAT II (IEC61010-1:2010 safety standard).

Optimum anti-alias protection is achieved by the 7-pole analog anti-alias filter combined with a fixed 2 MS/s sampling Analog-to-Digital converter. At lower sample rates the digital anti alias filters allow for a large range of high order filter characteristics with precise phase match and ultra low noise output.

Besides the instantaneous values, the real-time cycle detection allows for cycle based real-time calculations like TrueRMS on all analog channels as well as torque, angle and speed on all timer counter channels simultaneously.

Every real-time calculated result can be used to trigger the recording.

If supported by the selected mainframe, the GEN DAQ series input card offers 16 digital input events, two digital output events and two Timer/Counter channels.

The two Timer/Counters together with the GEN series mainframe Digital Event/Timer Counter connector and the G070A torque/RPM adapter allow for direct interfacing to HBM torque transducers or other torque and speed sensors.

## Capabilities Overview

| Model | GN611 |
|---|---|
| Maximum sample rate per channel | 200 kS/s |
| Memory per card | 200 MB |
| Analog channels | 6 |
| Anti-Alias filters | Fixed bandwidth analog AA-filter combined with sample rate tracking digital AA-filter |
| ADC resolution | 18 bit |
| Isolation | Channel to channel and channel to chassis |
| Input type | Analog, isolated balanced differential |
| Passive voltage/current probes | Special designed matching probes only (e.g. Elas HDP) |
| Sensors | Not supported |
| TEDS | Not supported |
| Real-time cycle based calculators | 32; Cycle and Timer based calculations with triggering on calculated results |
| Real-time formula database calculators (option) | Not supported |
| EtherCat® output | Not supported |
| Digital Event/Timer/Counter | 16 digital events and 2 Timer/Counter channels |
| Standard data streaming (up to 200 MB/s) | Supported |
| Fast data streaming (up to 1 GB/s) | Not supported |
| Slot width | 1 |

## Block Diagram



**Figure 1.1:** Block Diagram
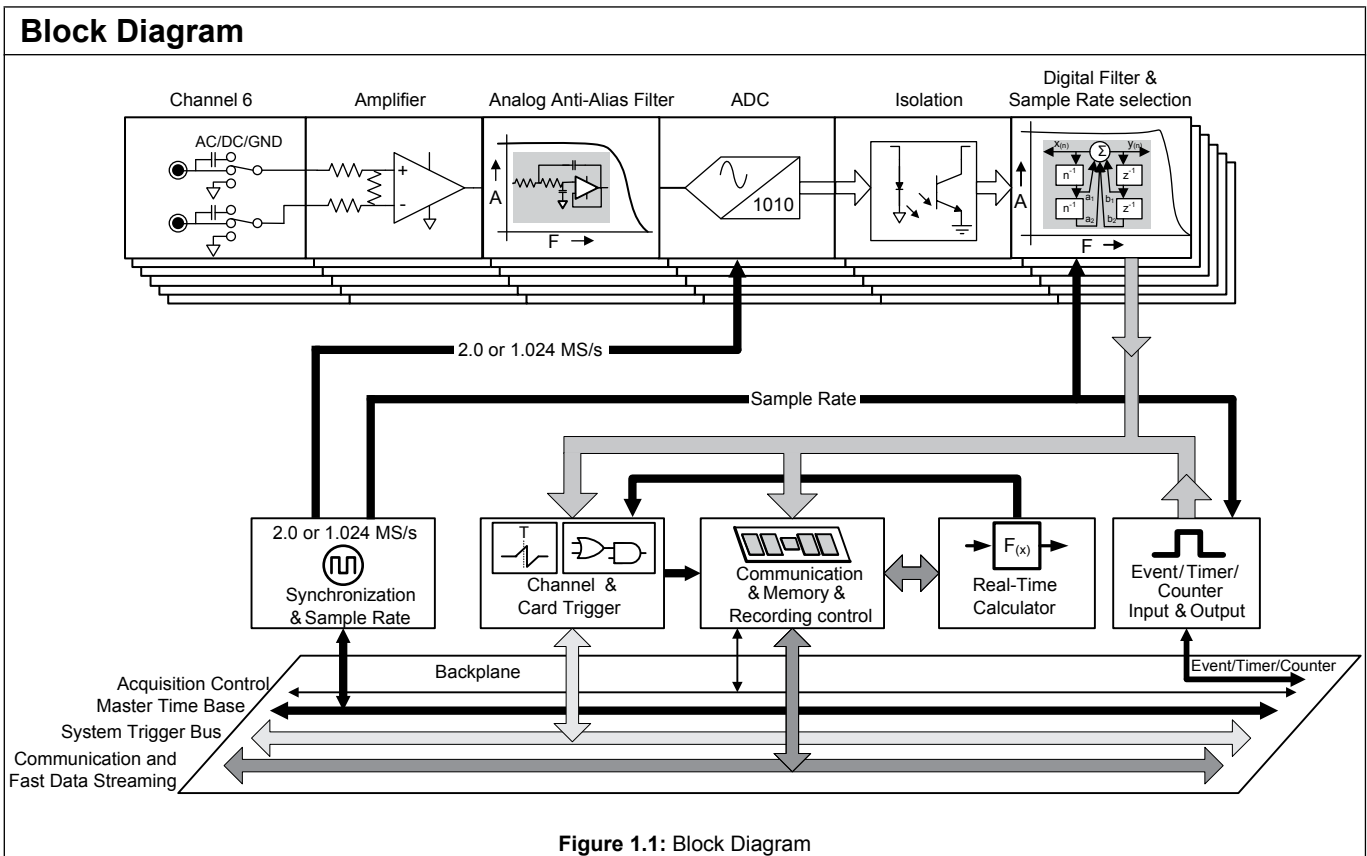
**Note** *The specifications listed are valid for cards that have been calibrated and are used in the same mainframe and slots as they were at the time of calibration. When the card is removed from its original location and placed in another slot and/or mainframe, the Offset error, Gain error and MSE specifications are expected to increase (up to double the original specification) due to thermal differences within the configurations. All specification are defined at 23 °C ± 2 °C.*

## Analog Input Section

| | |
|---|---|
| Channels | 6 |
| Connectors | Fully isolated 4 mm banana plugs (plastic), 2 per channel (red and black) |
| Input type | Analog, isolated balanced differential |
| Input impedance | 2 * 1 MΩ ± 1% // 33 pF ± 10% ranges larger than ± 5 V. All other ranges 57 pF ± 10% |
| Input coupling | |
| Coupling modes | AC, DC, GND |
| AC coupling frequency | 48 Hz ± 5 Hz (-3 dB) |
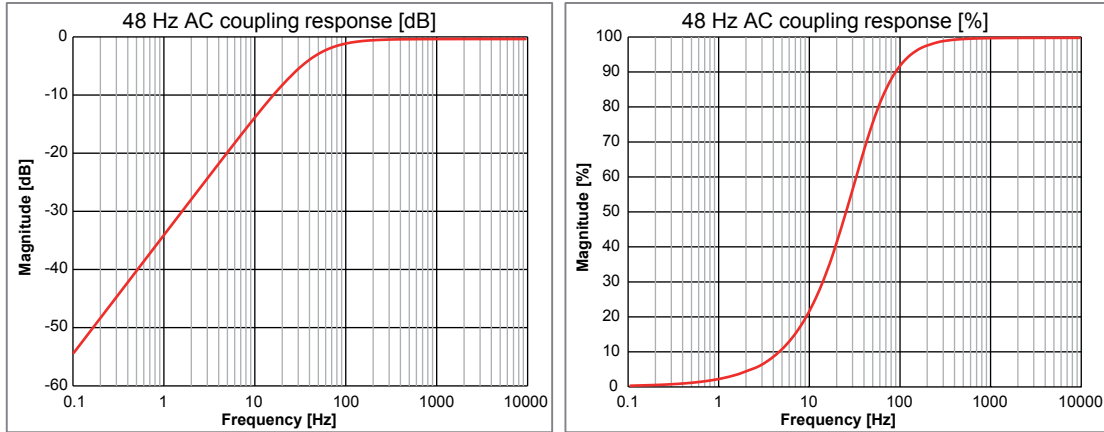


**Figure 1.2:** Representative AC coupling response

| | |
|---|---|
| Ranges | ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V, ± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1000 V |
| Offset | ± 50% in 1000 steps (0.1%); <br> ± 1000 V range has fixed 0% offset |
| DC Offset error | |
| All IIR filters | 0.02% of Full Scale ± 10 µV |
| Offset error drift | ±(20 ppm + 10 µV)/°C (±(12 ppm + 6 µV)/°F) |
| DC Gain error | |
| All IIR filters | 0.1% of Full Scale ± 10 µV |
| Gain error drift | ±30 ppm/°C (±17 ppm/°F) |
| Maximum static error (MSE) | |
| All IIR filters | 0.075% of Full Scale ± 10 µV |
| RMS Noise (50 Ω terminated) | |
| All IIR filters | 0.035% of Full Scale ± 50 µV |

# Analog Input Section

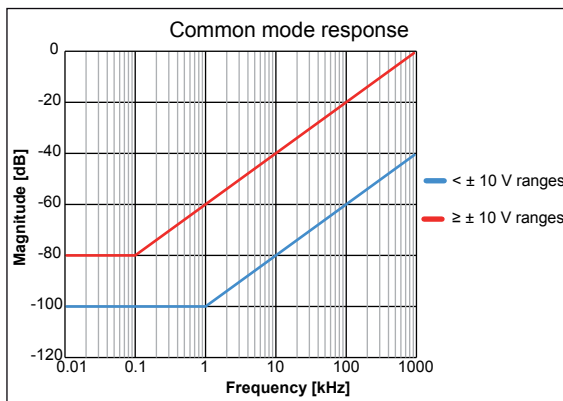| Common mode (referred to system ground) | | |
|---|---|---|
| Ranges | Less than ± 10 V | Larger than or equal to ± 10 V |
| Rejection (CMR) | > 80 dB @ 80 Hz (100 dB typical) | > 60 dB @ 80 Hz (80 dB typical) |
| Maximum common mode voltage | 7 V RMS | 1000 V RMS |



**Figure 1.3:** Representative common mode response

| 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 1250 V, whichever value is the smallest. |
| Maximum nondestructive voltage | ± 2000 V DC |
| Maximum overload without auto range | 200% of selected range |
| Automatic auto range | When overload causes the amplifier to overheat, the amplifier increases its range in steps of a factor of 10 until the overload ceases. When the overload exceeds 1000 V, the input signal is disconnected and the amplifier input is grounded. When the temperature returns to normal, the range that was originally selected is restored. The automatic auto range cannot be turned off. |
| Overload recovery time | Restored to 0.1% accuracy in less than 5 µs after 200% overload |

# Analog to Digital Conversion

| | |
|---|---|
| Sample rate per channel | 0.1 S/s to 200 kS/s |
| ADC resolution; one ADC per channel | 18 bit |
| ADC type | Successive Approximation Register (SAR); Analog Devices AD7641BCPZ |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm [1]; aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; produces rounded BIN values when calculating FFTs |
| Maximum binary sample rate | 204.8 kS/s |
| External time base frequency | 0 S/s to 200 kS/s |
| External time base frequency divider | Divide external clock by 1 to $2^{20}$ |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

(1)      Mainframes using Interface/Controller Modules shipped before 2012: ±30 ppm.
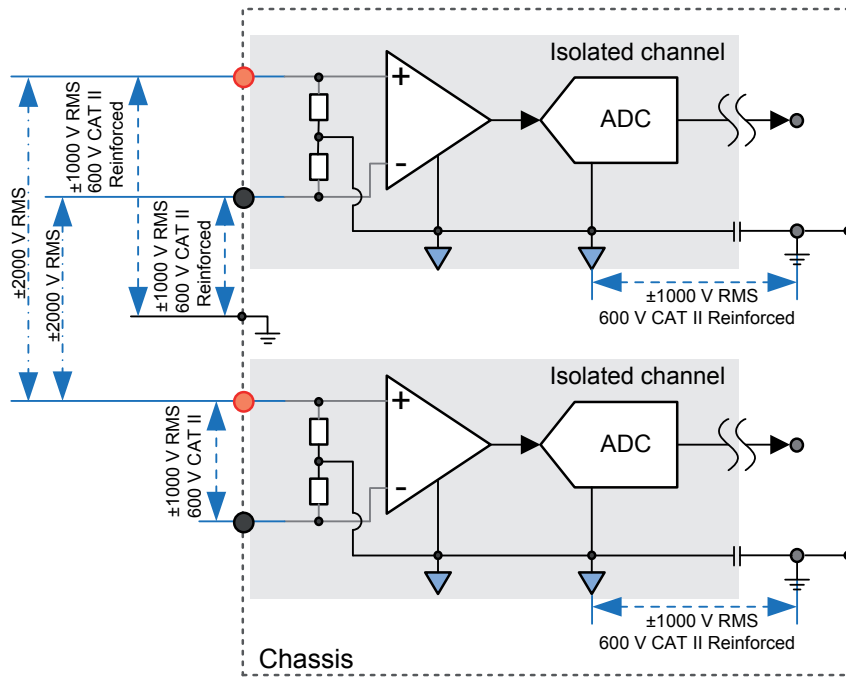
# Isolation



**Figure 1.4:** Isolation 1kV card overview

|  |  | CAT II | CAT III |
|---|---|---|---|
| Channel to chassis (earth) | 1000 V RMS | 600 V RMS [1] | 300 V RMS[1] |
| Channel to channel | 2000 V RMS | [2] | [2] |

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

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


# Isolation and Input Type Testing

| IEC61010-1:2010 and EC61010-2-30:2010 isolation tests | |
|---|---|
| Channel to channel | 3510 V RMS and 4935 V DC for 5 s<br>3260 V  RMS and 4596 V DC for 1 minute |
| Channel to chassis | 3510 V RMS and 4935 V DC for 5 s<br>3260 V  RMS and 4596 V DC for 1 minute |
| Channel to channel impulse | 6400 V peak using a 2 Ω series resistor<br>Rise time 1.2 µs, 50% amplitude reduction in 50 µs |
| Channel to chassis impulse | 6400 V peak using a 2 Ω series resistor<br>Rise time 1.2 µs, 50% amplitude reduction in 50 µs |
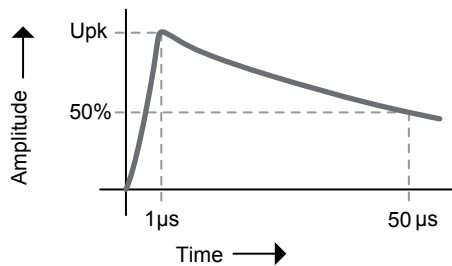


**Figure 1.5:** Example of 1.2/50 µs impulse

| Input impulse test | |
|---|---|
| Channel positive to negative input | 4000 V peak using a 12 Ω series resistor, rise time 1.2 µs, 50% amplitude reduction in 50 µs |

# Anti-Alias Filters

Using different filter selections (Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths can result in phase mismatches between channels.
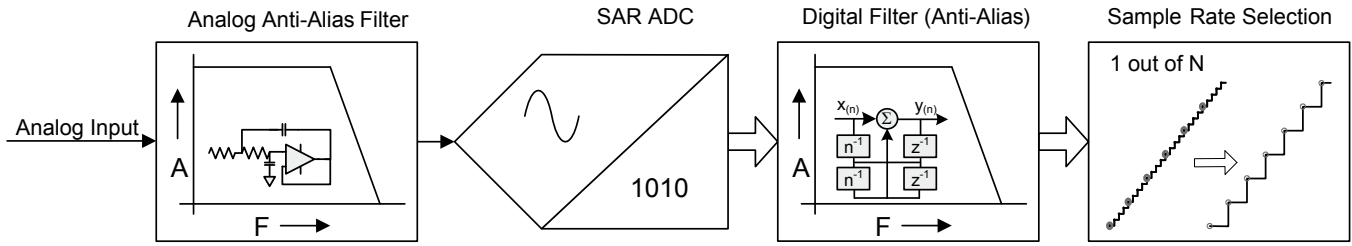


**Figure 1.6:** Combined analog and digital anti-alias filter block diagram

Anti-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.

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

# Bessel IIR Filter (Digital Anti-Alias)
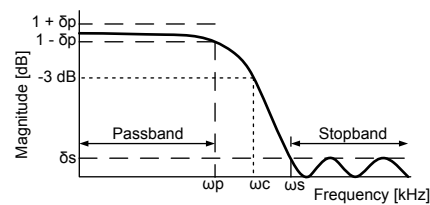


δp: Passband ripple

δs: Stopband attenuation

ωp: Passband frequency

ωc: Corner frequency

ωs: Stopband frequency

**Figure 1.7:** Digital Bessel IIR Filter

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

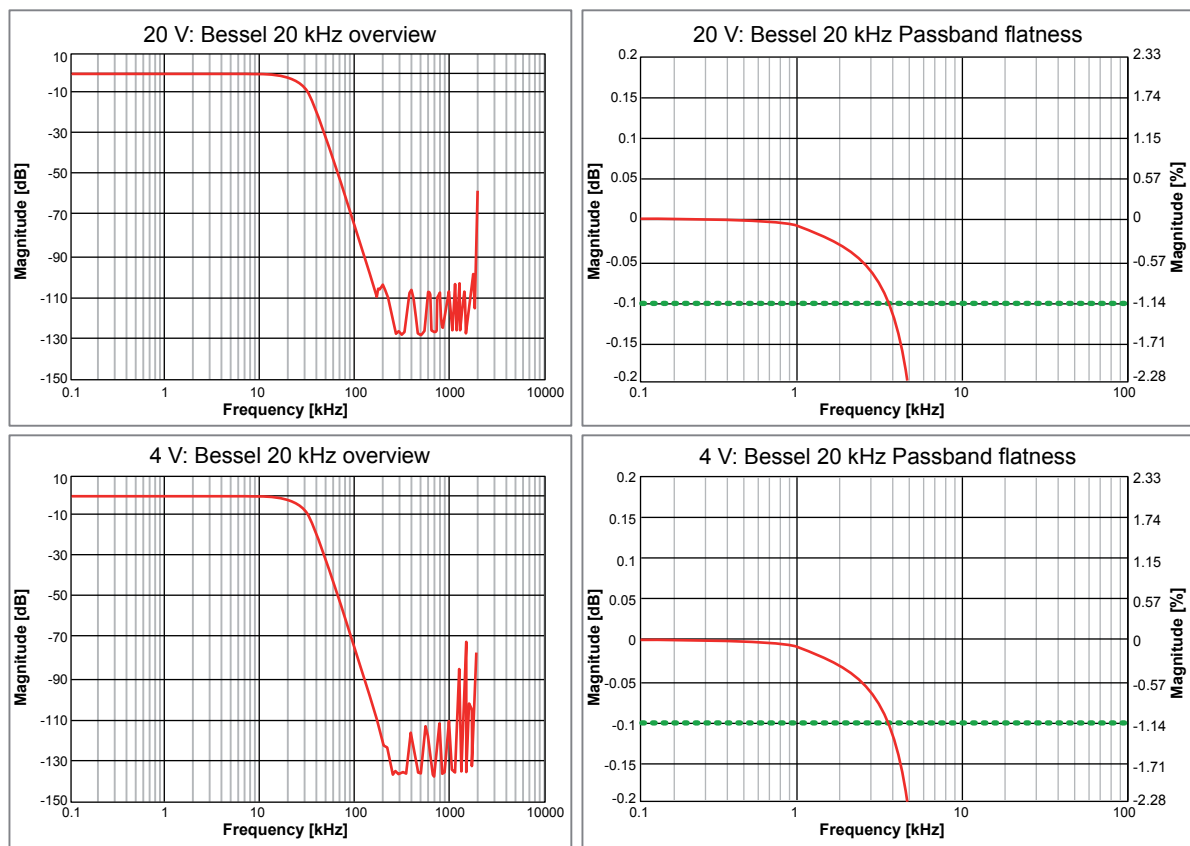| | |
|---|---|
| Analog anti-alias filter bandwidth | 400 kHz ± 25 kHz (-3 dB) |
| Analog anti-alias filter characteristic | 7-pole Bessel, optimal step response |
| Bessel IIR filter characteristic | 8-pole Bessel style IIR |
| Bessel IIR filter user selection | Auto tracking for sample rate divided 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. |
| Bessel IIR filter bandwidth (ωc) | User selectable from 0.4 Hz to 20 kHz |
| Bessel IIR 0.1 dB passband (ωp)[1] | DC to 0.14 * ωc |
| Bessel IIR filter stopband attenuation (δs) | 60 dB |
| Bessel IIR filter roll-off | 48 dB/octave |



**Figure 1.8:** Representative Bessel IIR examples

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

# Butterworth IIR Filter (Digital Anti-Alias)

δp: Passband ripple

δs: Stopband attenuation

ωp: Passband frequency
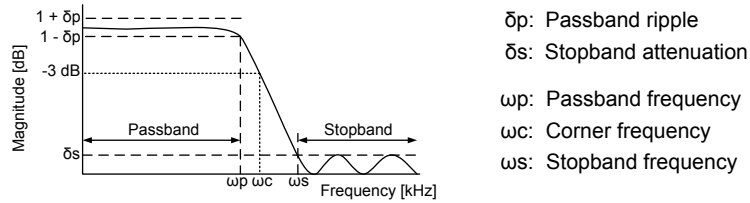
ωc: Corner frequency

ωs: Stopband frequency

**Figure 1.9:** Digital Butterworth IIR Filter

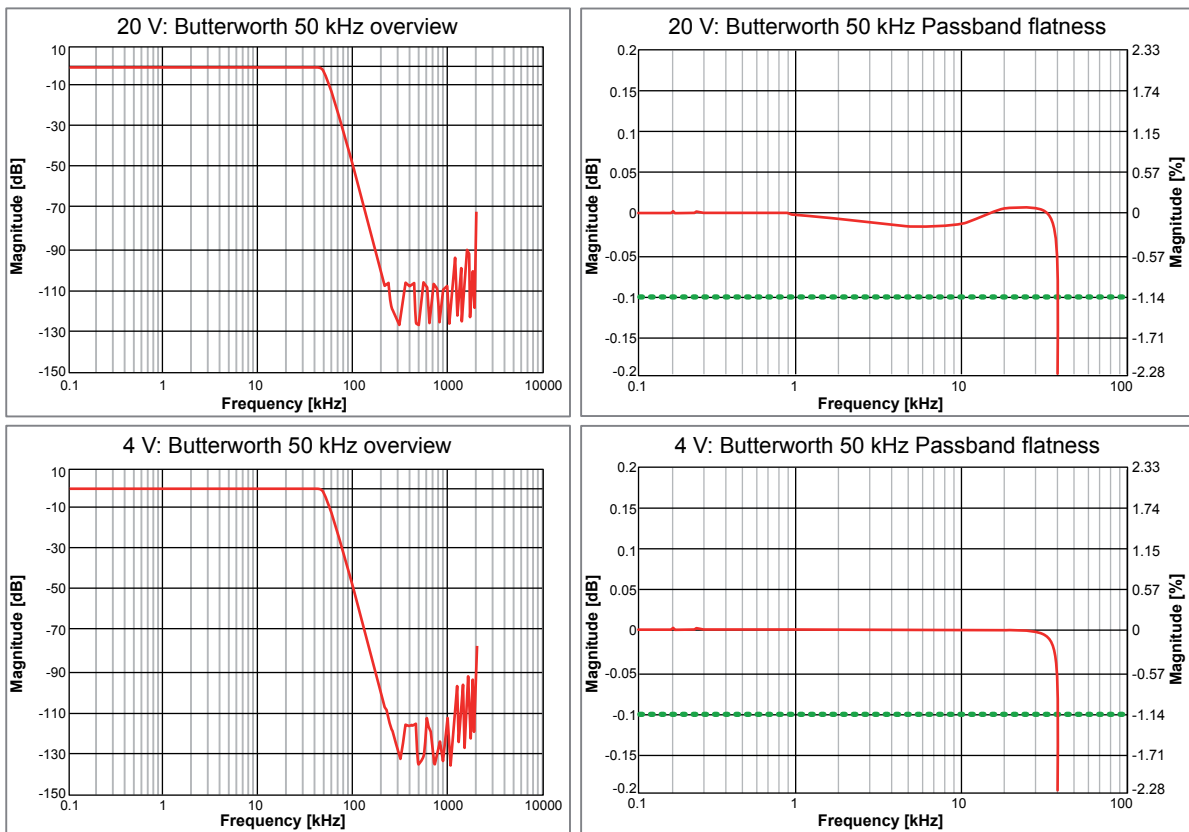| When Butterworth IIR filter is selected, this is always a combination of an analog Butterworth anti-alias filter and a digital Butterworth IIR filter. | |
|---|---|
| Analog anti-alias filter bandwidth | 450 kHz ± 25 kHz (-3 dB) |
| Analog anti-alias filter characteristic | 7-pole Butterworth, extended passband response |
| Butterworth IIR filter characteristic | 8-pole Butterworth style IIR |
| Butterworth IIR filter user selection | Auto tracking for sample rate divided by: 4, 10, 20, 40. The user selects a division factor from the current sample rate; software then adjusts the filter when the sample rate is changed. |
| Butterworth IIR filter bandwidth (ωc) | User selectable from 1 Hz to 50 kHz |
| Butterworth IIR 0.1 dB passband (ωp)[1] | DC to 0.7 * ωc |
| Butterworth IIR filter stopband attenuation (δs) | 75 dB |
| Butterworth IIR filter roll-off | 48 dB/octave |

**Figure 1.10:** Representative Butterworth IIR examples

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

# Elliptic IIR Filter (Digital Anti-Alias)



δp: Passband ripple

δs: Stopband attenuation

ωp: Passband frequency
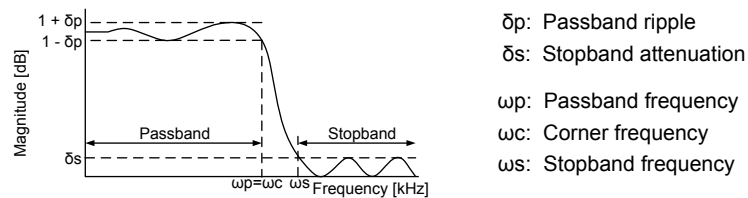
ωc: Corner frequency

ωs: Stopband frequency

**Figure 1.11:** Digital Elliptic IIR Filter

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

| | |
|---|---|
| Analog anti-alias filter bandwidth | 450 kHz ± 25 kHz (-3 dB) |
| Analog anti-alias filter characteristic | 7-pole Butterworth, extended passband response |
| Elliptic IIR filter characteristic | 7-pole Elliptic style IIR |
| Elliptic IIR filter user selection | Auto tracking 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. |
| Elliptic IIR filter bandwidth (ωc) | User selectable from 1 Hz to 50 kHz |
| Elliptic IIR 0.1 dB passband (ωp)[1] | DC to ωc |
| Elliptic IIR filter stopband attenuation (δs) | 75 dB |
| Elliptic IIR filter roll-off | 72 dB/octave |
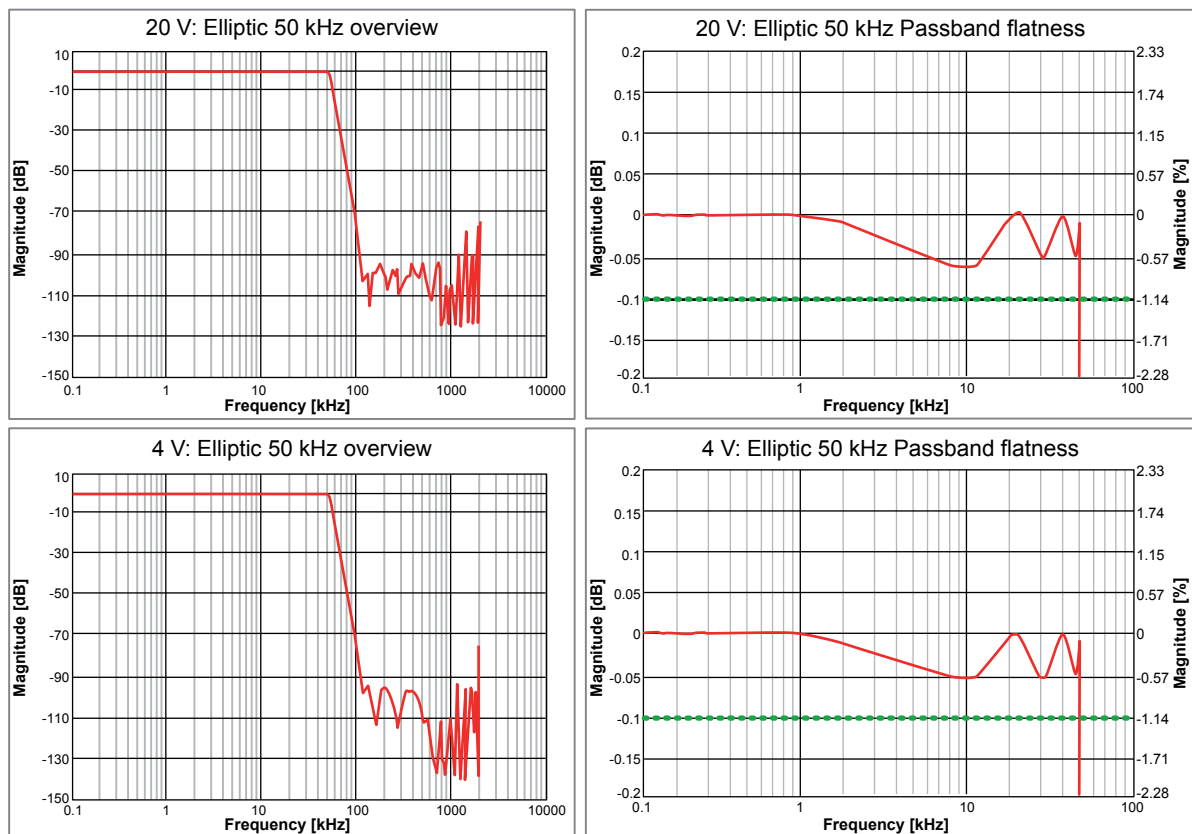


**Figure 1.12:** Representative Elliptic IIR examples

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

## Channel to Channel Phase Match

Using different filter selections (Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths results in phase mismatches between channels. All specifications are typical static values and measured using a 10 kHz sine wave and 200 kS/s sample rate.

| Bessel IIR, Filter frequency 20 kHz | |
| --- | --- |
| Channels on card | 0.6 deg (0.17 µs) |
| GN611 Channels within mainframe | 0.6 deg (0.17 µs) |
| Butterworth IIR, Filter frequency 50 kHz | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN611 Channels within mainframe | 0.5 deg (0.14 µs) |
| Elliptic IIR, Filter frequency 50 kHz | |
| Channels on card | 0.5 deg (0.14 µs) |
| GN611 Channels within mainframe | 0.5 deg (0.14 µs) |
| GN611 channels across mainframes | Defined by synchronization method used (None, IRIG, GPS, Master/Slave, PTP) |


## Channel to Channel Crosstalk

Channel to channel crosstalk is measured with a 50 Ω termination resistor on the input and uses sine wave signals on the channel above and below the channel being tested. To test Channel 2, Channel 2 is terminated with 50 Ω and Channels 1 and 3 are connected to the sine wave generator.
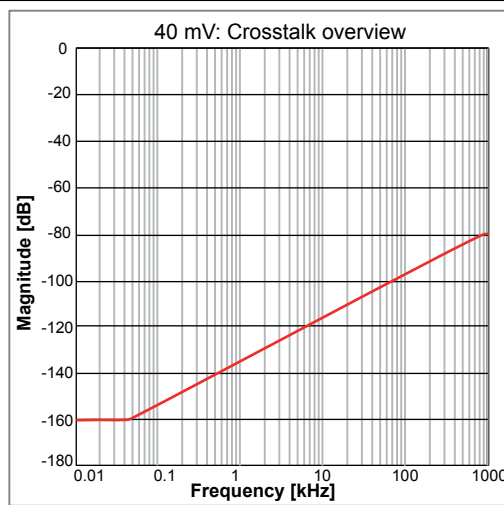


**Figure 1.13:** Representative Channel to Channel crosstalk


## On-board Memory

| | |
| --- | --- |
| Per card | 200 MB (100 MS16 bits, 50 MS @ 18 bits storage) |
| Organization | Automatically distributed amongst channels enabled for storage or real-time calculations |
| Memory diagnostics | Automatic memory test when system is powered on but not recording |
| Storage sample size | User selectable storage sample size 16 or 18 bits<br>16 bits, 2 bytes/sample<br>18 bits, 4 bytes/sample (required for Timer/Counter usage) |

## Digital Event/Timer/Counter[1]

| The Digital Event/Timer/Counter input connector is located on the mainframe. For exact layout and pinning see mainframe data sheet. | |
|---|---|
| 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 |
| Overvoltage protection | ± 30 V DC continuously |
| Minimum pulse width | 100 ns |
| Maximum frequency | 5 MHz |
| Digital output events | 2 per card |
| Levels | TTL output levels, short circuit protected |
| Output event 1 | User selectable: Trigger, Alarm, set High or Low |
| Output event 2 | User selectable: Recording active, set High or Low |
| Digital output event user selections | |
| Trigger | 1 high pulse per trigger (on every channel trigger of this card only)<br>12.8 µs minimum pulse width<br>200 µs ± 1 µs ± 1 sample period pulse delay |
| Alarm | High when alarm condition is activated, low when not activated (alarm conditions of this card only)<br>200 µs ± 1 µs ± 1 sample period alarm event delay |
| Recording active | High when recording, low when in idle or pause mode<br>Recording active output delay 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; only available in 32 bit storage mode |
| Levels | TTL input levels |
| Inputs | All pins are shared with digital event inputs |
| Timer-Counter modes | Uni- and bi-directional count<br>Bi-directional quadrature count<br>Angle<br>Uni- and bi-directional frequency/RPM measurement |
| External start | Rising/Falling edge selected by user starts a new recording |
| External stop | Rising/Falling edge selected by the user stops the recording |

(1)     Only if supported by mainframe

# Timer/Counter 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.
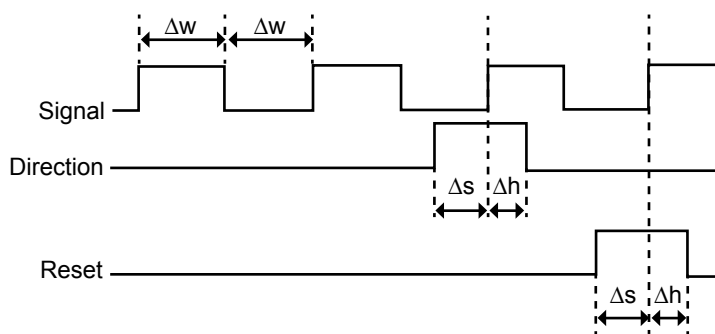


**Figure 1.14:** Uni- and Bi-directional count timing

| Inputs | 3 pins: signal, reset and direction (only used in bi-directional count) |
|---|---|
| Maximum input frequency | 5 MHz |
| Minimum pulse width ($\Delta w$) | 100 ns |
| Counter range | 0 to $2^{31}$; uni-directional count<br>$-2^{31}$ to $+2^{31} - 1$; bi-directional count |
| Gate measuring time | Sample period (1 / sample rate) to 50 s<br>Can be selected by user to control update rate independent of sample rate |
| Reset input | |
| Level sensitivity | User selectable invert level |
| Minimum setup time prior to signal edge ($\Delta s$) | 100 ns |
| Minimum hold time after signal edge ($\Delta h$) | 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 count<br>Low: increment counter<br>High: decrement counter |
| Minimum setup time prior to signal edge ($\Delta s$) | 100 ns |
| Minimum hold time after signal edge ($\Delta h$) | 100 ns |

# Timer/Counter Mode Bi-directional Quadrature Count

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.
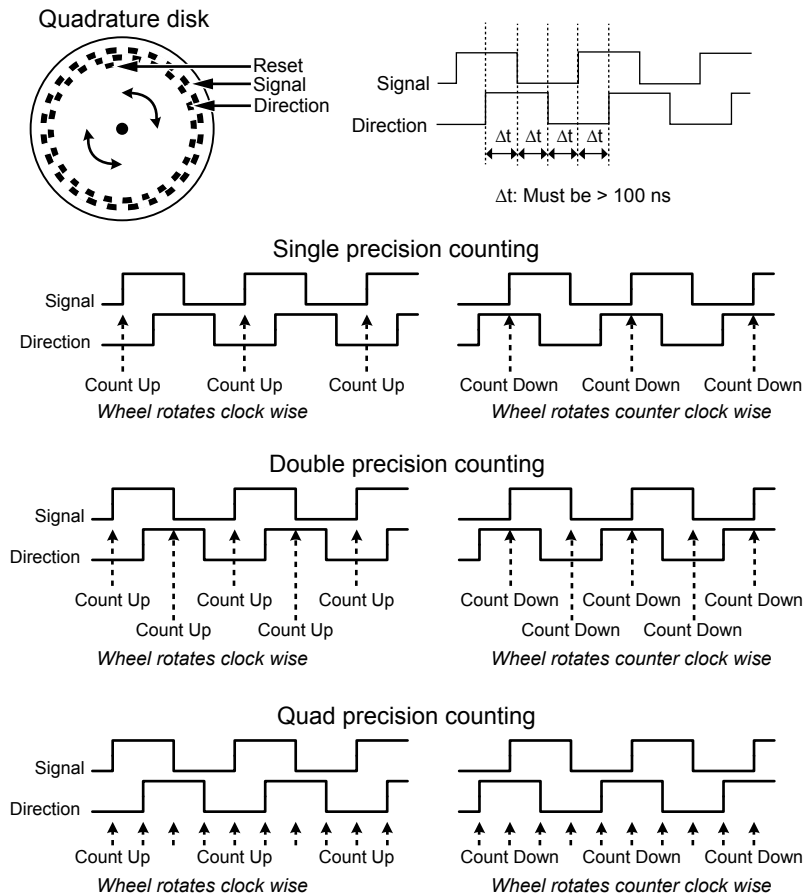


**Figure 1.15:** Bi-directional quadrature count modes

| | |
|---|---|
| Inputs | 3 pins: signal, direction and reset |
| Maximum input frequency | 2 MHz |
| Minimum pulse width | 200 ns (2 * $\Delta t$) |
| Minimum setup time | 100 ns ($\Delta t$) |
| Minimum hold time | 100 ns ($\Delta t$) |
| Accuracy | Single, dual or quad precision |
| Counter range | $-2^{31}$ to $+2^{31}$ - 1 |
| Reset input | |
| Level sensitivity | User selectable invert level |
| Minimum setup time prior to signal edge ($\Delta t$) | 100 ns |
| Minimum hold time after signal edge ($\Delta t$) | 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. |

# Timer/Counter 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.
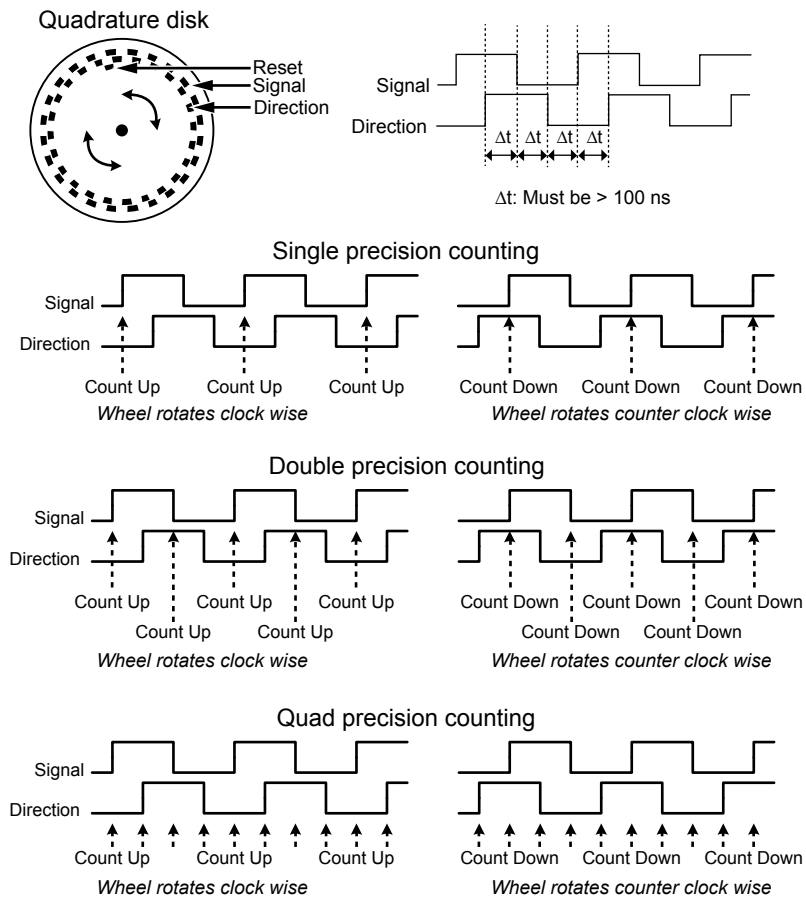
Quadrature disk



Single precision counting

Double precision counting

Quad precision counting

**Figure 1.16:** Bi-directional quadrature count modes

| Inputs | 3 pins: signal, direction and reset |
|---|---|
| Maximum input frequency | 2 MHz |
| Minimum pulse width | 200 ns (2 * Δt) |
| Minimum setup time | 100 ns (Δt) |
| Minimum hold time | 100 ns (Δt) |
| Accuracy | Single, dual and quad precision |
| 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 |
| 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 resolution |
| Maximum pulses per rotation | 32767 |
| Maximum RPM | 30 * sample rate (Example: Sample rate 10 kS/s means maximum 300 k RPM) |

# Timer/Counter Mode: Uni- and Bi-directional Frequency/RPM Measurement

Used to measure any kind of frequency like engine RPM, or active sensors with proportional frequency output signal.
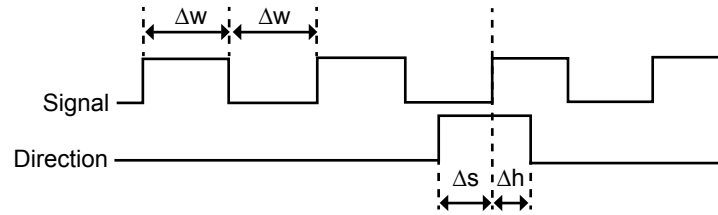


**Figure 1.17:** Uni- and Bi-directional count timing

| | |
|---|---|
| Inputs | 2 pins: signal, direction |
| Maximum input frequency | 5 MHz |
| Minimum pulse width ($\Delta w$) | 100 ns |
| Accuracy | 0.1%, when using a gate measuring time of 40 µs or more. 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 Can be selected by user to control update rate independent of sample rate |
| Direction input | |
| Level sensitivity | Only used when in bi-directional frequency/RPM mode Low: Positive frequency/RPM, e.g. left rotations High: Negative frequency/RPM, e.g. right rotations |
| Minimum setup time prior to signal edge ($\Delta s$) | 100 ns |
| Minimum hold time after signal edge ($\Delta h$) | 100 ns |

# Triggering

| | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent per channel, software selectable either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Maximum trigger rate | 400 triggers per second |
| Maximum delayed trigger | 1000 seconds after a trigger occurred |
| Manual trigger (Software) | Supported |
| **External Trigger In** | |
| Selection per card | User selectable On/Off |
| Trigger In edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Trigger In delay | ± 1 µs + maximum 1 sample period (identical for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| **External Trigger Out** | |
| Selection per card | User selectable On/Off |
| Trigger Out level | High/Low/Hold High; mainframe selectable, identical for all cards |
| Trigger Out pulse width | High/Low: 12.8 µs<br>Hold High: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe; For details, please refer to the mainframe datasheet |
| Trigger Out delay | Selectable (10 µs to 516 µs) ± 1 µs + maximum 1 sample period using decimal time base<br>Selectable (9.76 µs to 504 µs) ± 1 µs + maximum 1 sample period using binary time base<br>Default 516 (504) µs for decimal (binary) time base, 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 | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| **Alarm levels** | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015%) for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

# Real-time Statstream®

Patent Number : 7,868,886
Real-time extraction of basic signal parameters.
Supports real-time live scrolling and scoping waveform displays as well as real-time meters while recording.
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 (Perception V6.72 and higher)
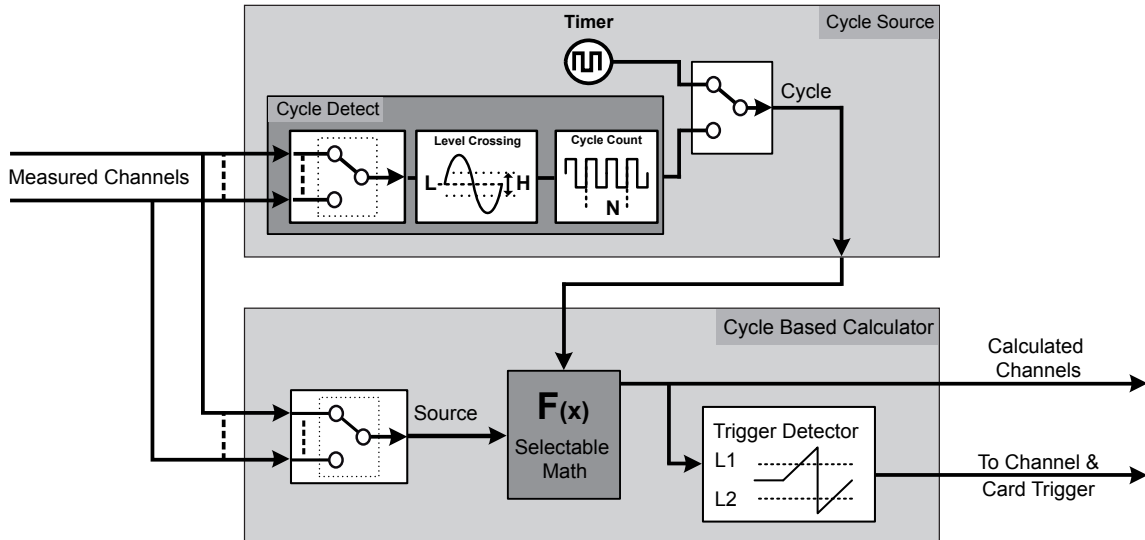


**Figure 1.18:** Real-time cycle based calculators

| 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 |
| 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, Energy and MeanOfMultiplication |
| 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) |

## Real-Time Cycle Based Calculators (Perception V6.72 and higher)

| 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. |
| Slow-Fast Sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. Slow-Fast Sweep is not supported by the RT-FDB calculators. |
| 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. 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. |

## Acquisition Mode Details

### 16 Bit Resolution

| Recording Mode | Single Sweep Multiple Sweeps Slow-Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled channels | | | Enabled channels | | | Enabled channels | | |
| | 1 Ch | 6 Ch | 6 Ch & events | 1 Ch | 6 Ch | 6 Ch & events | 1 Ch | 6 Ch | 6 Ch & events |
| Max. sweep memory | 100 MS | 16 MS | 14 MS | not used | | | 80 MS | 13 MS | 11 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 100 MS | 16 MS | 14 MS | 18 MS | 3 MS | 2.5 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep sample rate / 2 | | |
| Max. aggregate continuous streaming rate | not used | | | 0.2 MS/s 0.4 MB/s | 1.2 MS/s 2.4 MB/s | 1.4 MS/s 2.8 MB/s | 0.2 MS/s 0.4 MB/s | 1.2 MS/s 2.4 MB/s | 1.4 MS/s 2.8 MB/s |

### 18 Bit Resolution

| Recording Mode | Single Sweep Multiple Sweeps Slow-Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled channels | | | Enabled channels | | | Enabled channels | | |
| | 1 Ch | 6 Ch | 6 Ch & events & Timer/ Counter | 1 Ch | 6 Ch | 6 Ch & events & Timer/ Counter | 1 Ch | 6 Ch | 6 Ch & events & Timer/ Counter |
| Max. sweep memory | 50 MS | 8 MS | 5 MS | not used | | | 40 MS | 6.5 MS | 4 MS |
| Max. sweep sample rate | 200 kS/s | | | not used | | | 200 kS/s | | |
| Max. continuous FIFO | not used | | | 50 MS | 8 MS | 5 MS | 9 MS | 1.5 MS | 1 MS |
| Max. continuous sample rate | not used | | | 200 kS/s | | | Sweep sample rate / 2 | | |
| Max. aggregate continuous streaming rate | not used | | | 0.2 MS/s 0.8 MB/s | 1.2 MS/s 4.8 MB/s | 1.8 MS/s 7.2 MB/s | 0.2 MS/s 0.8 MB/s | 1.2 MS/s 4.8 MB/s | 1.8 MS/s 7.2 MB/s |

## Single Sweep

| | |
|---|---|
| Pre-trigger segment | 0% to 100% of selected sweep length<br>If trigger occurs before the pre-trigger segment is recorded, the pre-trigger segment is truncated to recorded data only. |
| Delayed trigger | Maximum 1000 seconds 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. |

## 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 1000 seconds 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. |

## Multiple Sweeps

| | |
|---|---|
| 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. |

## Slow-Fast Sweep

| | |
|---|---|
| Maximum number of Sweeps | 1 per recording |
| Maximum slow sample rate | Fast sample rate divided by two |
| Maximum fast sample rate switches | 20, sample rate switching always stops when sweep ends |
| Minimum time between sample rate switches | 2.5 ms |

## 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. |

## 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 1000 seconds 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 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. |

## Environmental Specifications

| Temperature Range | |
| --- | --- |
| Operational | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (Storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
| Thermal protection | Automatic thermal shutdown at 85 °C (+185 °F) internal temperature<br>User warning notifications at 75 °C (+167 °F) |
| Relative humidity | 0% to 80%; non-condensing; operational |
| Protection class | IP20 |
| Altitude | Maximum 2000 m (6562 ft) 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<br>IEC 60068-2-14 Test Na | -25 °C to +70 °C (-13 °F to +158 °F)<br>5 cycles, rate 2 to 3 minutes, dwell time 3 hours |
| Damp heat cyclic test<br>IEC 60068-2-30 Test Db variant 1 | +25 °C/+40 °C (+77 °F/+104 °F), humidity > 95/90% RH<br>6 cycles, cycle duration 24 hours |

## Harmonized Standards for CE Compliance, According to the Following Directives

Low Voltage Directive (LVD): 2006/95/EC
ElectroMagnetic Compatibility Directive (EMC): 2004/108/EC

| **Electrical Safety** | |
| --- | --- |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| EN 61326-1 (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 Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B |
| 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, 3 V RMS @ channel, both using clamp: performance criteria A |
| EN 61000-4-11 | Voltage dips, short interruptions and voltage variations immunity tests<br>Dips: performance criteria A; Interruptions: performance criteria C |

## KAB290: Shielded 2 Wire 600 V RMS CAT II Cable (Option, to be ordered separately)

This cable is specially designed to be used with the GN610, GN611 and GN610B, GN611B cards. Significantly reduces signal disturbance pickup by using two identical signal wires with earthed shield. This cable must not be used for 3 wire measurements. The shield is not a standard signal wire.

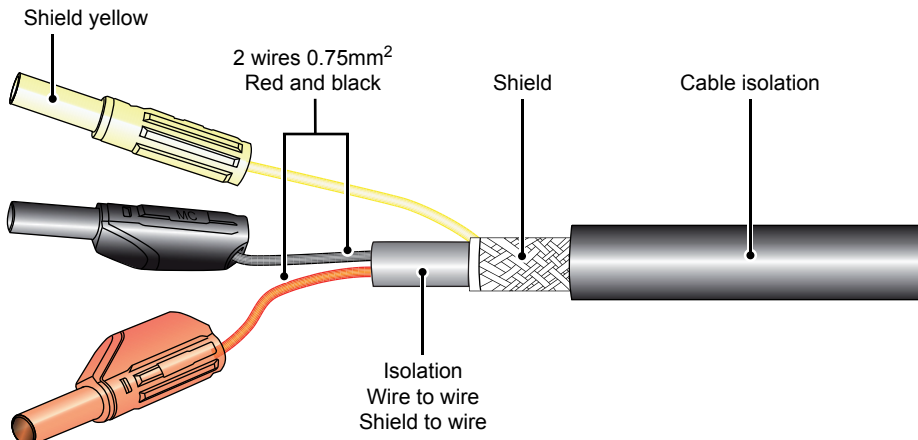| Cable setup | 2 wires with shield and isolation<br>3 shrouded banana plugs on each side: red, black and yellow |
|---|---|



**Figure 1.19:** Shielded cable setup

| | |
|---|---|
| Wire thickness | 2 * 0.75 mm$^2$ (0.00116 in$^2$) |
| Maximum wire resistance | 0.250 Ω / m (0.0763 Ω / ft) |
| Weight | Approximately 143 g/m (1.54 oz/foot) |
| Outside cable diameter | Approximately 9 mm (0.354 inch) |
| Minimum bend radius | 10 times that of the cable diameter |
| Isolation | |
| Resistance | 20 MΩ / km (32.19 MΩ/ mile) |
| Voltage | 600 V RMS CAT II; wire to wire; wire to shield; shield to outside |
| Capacitance | |
| Wire to wire | Approximately 110 pF/m (33.54 pF/ft) |
| Wire to shield | Approximately 150 pF/m (45.73 pF/ft) |
| Temperature range | |
| Operational | -15 °C (+5 °F) to +80 °C (+176 °F) |
| Non-operational (storage) | -40 °C (-40 °F) to +80 °C (+176 °F) |
| Available lengths | 1.5 m (4.92 ft), 3.0 m (9.84 ft), 6.0 m (19.7 ft) |
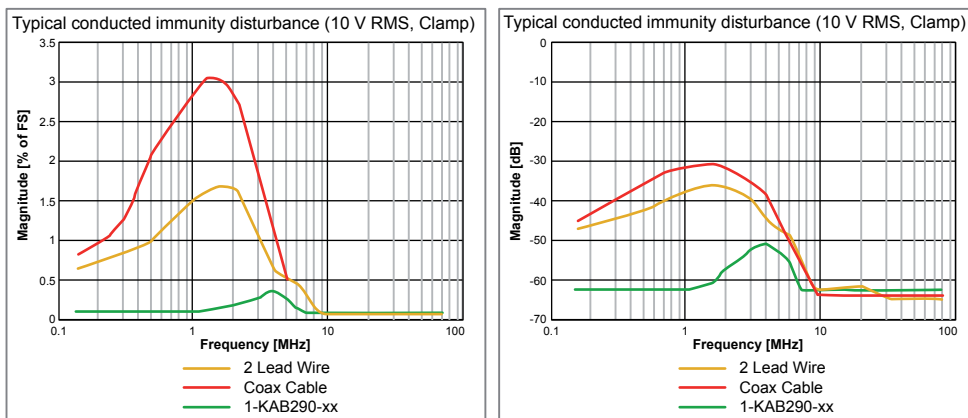


**Figure 1.20:** Typical conducted immunity, tested using ± 10 V range

## G068: Artificial Star Adapter (Option, to be ordered separately)

| | |
|---|---|
| The artificial star adapter creates an artificial star point to measure 3 phase signals | |
| Maximum input voltage | 1000 V DC (707 V RMS) between each of the phases |
| Inputs | 3; 4 mm safety banana plugs |
| Outputs | 6; 4 mm safety banana pins; plugs straight into GN610/GN611/GN610B/GN611B cards |
| Artificial star N | Reference plug only. Not to be used as input |
| Safety | Compliant with IEC61010-1 600 V RMS CAT II |
| Application use | The 3 phase signals L1, L2 and L3 can be connected with inputs L1, L2, L3 of the artificial star adapter. The connection N* is the voltage present on the artificial "star point". |
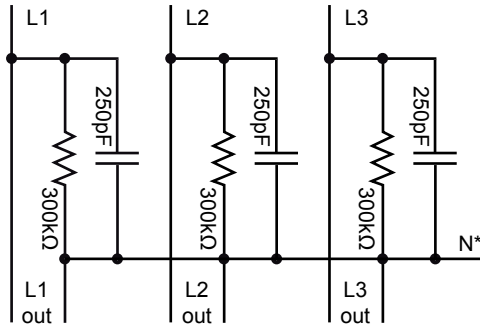


**Figure 1.21:** Electrical schematic

| | |
|---|---|
| Weight | 170 g (6 oz) |
| Material housing | Polyurethane, vacuum resin casting |
| Setup | Two boxes can be plugged into a single GN610/GN611/GN610B/GN611B card<br>Two or more GN610/GN611/GN610B/GN611B cards with Artificial star adapters fit next to each other |
| Temperature range | |
| Operational temperature | 0 °C to +40 °C (+32 °F to +104 °F) |
| Non-operational (storage) | -25 °C to +70 °C (-13 °F to +158 °F) |
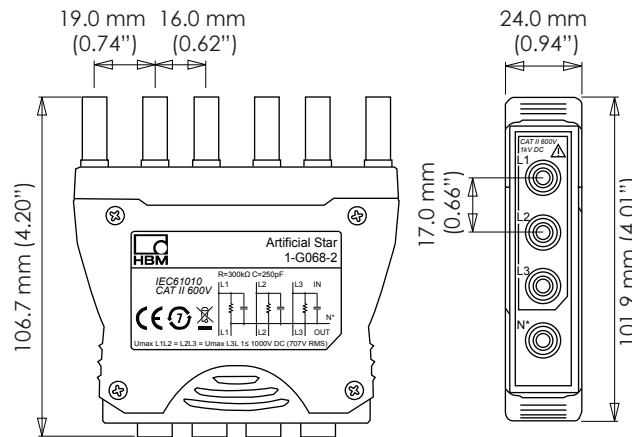


**Figure 1.22:** Artificial star adapter

## Artifical Star Adapter Wiring Diagram



L1
L2
L3
L1 Out
L2 Out
L3 Out
N*

Phase to
Artificial Star
Voltages

DC-AC
Power
Converter

L1
L2
L3

Electric
Motor

**Warning : N*** (Artificial Star Point)
is not ground or earth.
This pin should be left unconnected.
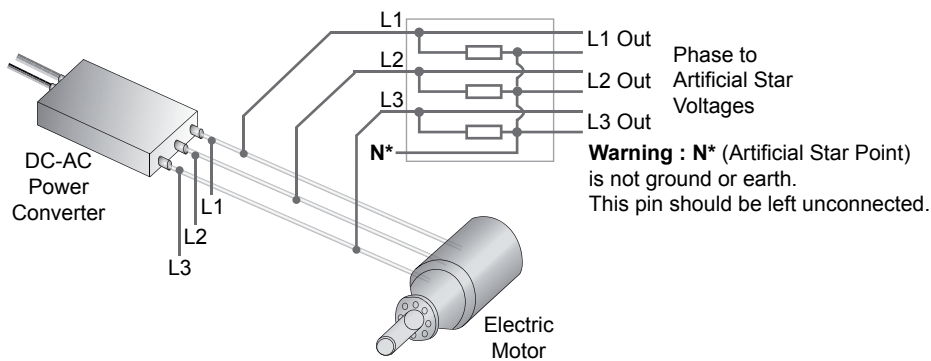
**Figure 1.23:** Three phase representative use of artificial star adapter



L1
L2
N*
L1 Out
L2 Out

Phase to
Artificial Star
Voltages

Connect two **N*** Star Points together

L3
L4
L5
N*
L3 Out
L4 Out
L5 Out

Phase to
Artificial Star
Voltages

DC-AC
Power
Converter

L1
L2
L3
L4
L5

Electric
Motor

**Warning : N*** (Artificial Star Point)
is not ground or earth.
Only connect the both **N*** pins together
to create one artificial star point.
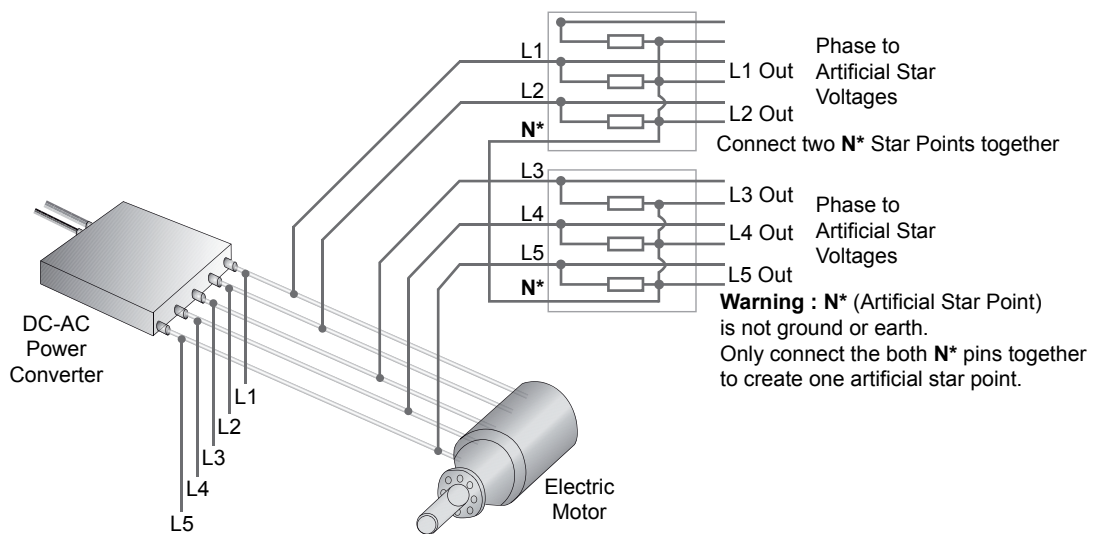
**Figure 1.24:** Five or more phase representative use of dual star adapter

## Gxxx: 1 kV DC High Precision Differential Probe (Option, to be ordered separately)

High precision 10 MΩ differential probe (HDP) to be used in combination with GN610, GN611, GN610B and GN611B acquisition cards. Reduces the resistive/current load on the device under test by increasing the input impedance to 10 MΩ with 0.2% in-accuracy. The use of the 10:1 divider reduces the lowest user range to ± 0.1 V ( ± 0.2 V when using GN610/GN611). The highest input range is ± 1000 V due to the maximum voltage rating of the probe.

The HDP10H probe is optimized to match the 33 pF input capacitance when using the ranges ± 10 V up to ± 1000 V.

The HDP10L probe is optimized to match the 57 pF input capacitance when using the ranges ± 10 mV up to ± 5 V.
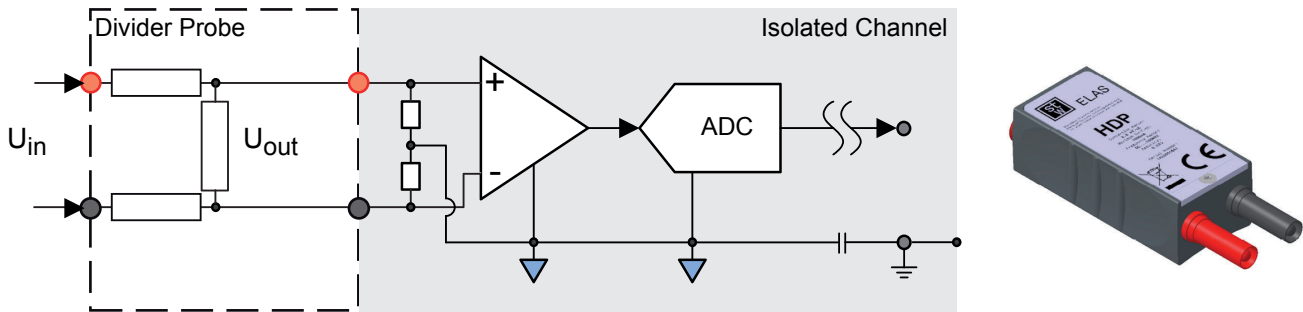


**Figure 1.25:** Block diagram and image

| | |
|---|---|
| Maximum input voltage | ± 1000 V DC |
| Divider ratio | 10:1 |
| In-accuracy | ± 0.2% |
| Input impedance | 10 MΩ ± 0.2% |
| Temperature coefficient | ± 25 ppm / ºC (± 45 ppm / ºF) |
| -0.5 dB Bandwidth | 100 kHz |
| Output capacitive match | HDP10H 33 pF<br>HDP10L 57 pF |
| Input pins | 4 mm safety banana, 13 mm (0.51") spacing |
| Output pins | 4 mm safety banana, 19 mm (0.75") spacing |
| Isolation (terminals – earth) | 1000 V RMS |
| Resistor technology | Metal foil |
| Original manufacturers part number | HDP |
| Weight | 53 g (1.87 oz) |
| Operating temperature range | 0 ºC to +40 ºC (32 °F to 104 °F) |
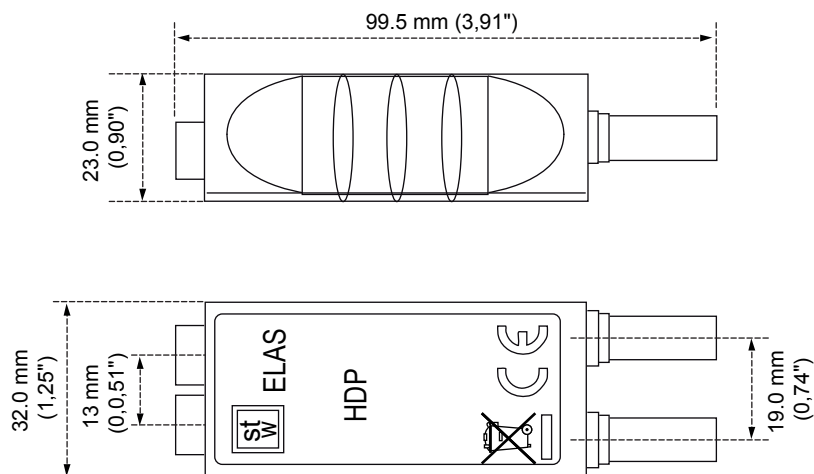


**Figure 1.26:** Dimensions

## Gxxx: 5 kV RMS High Precision Differential Probe (Option, to be ordered separately)

5 kV RMS, 20 MΩ, 50:1, 0.2% high precision, differential probe to be used in combination with GN610, GN611, GN610B and GN611B acquisition cards. The built-in earthing monitor system increases safety of the user and protects the GEN series inputs for isolation overloads.
The probe is optimized to match the 33 pF input capacitance when using the ranges ± 10 V, ± 20 V, ± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1000 V. In the lower ranges passband attenuation exceeds the HDP specified amplitude response.
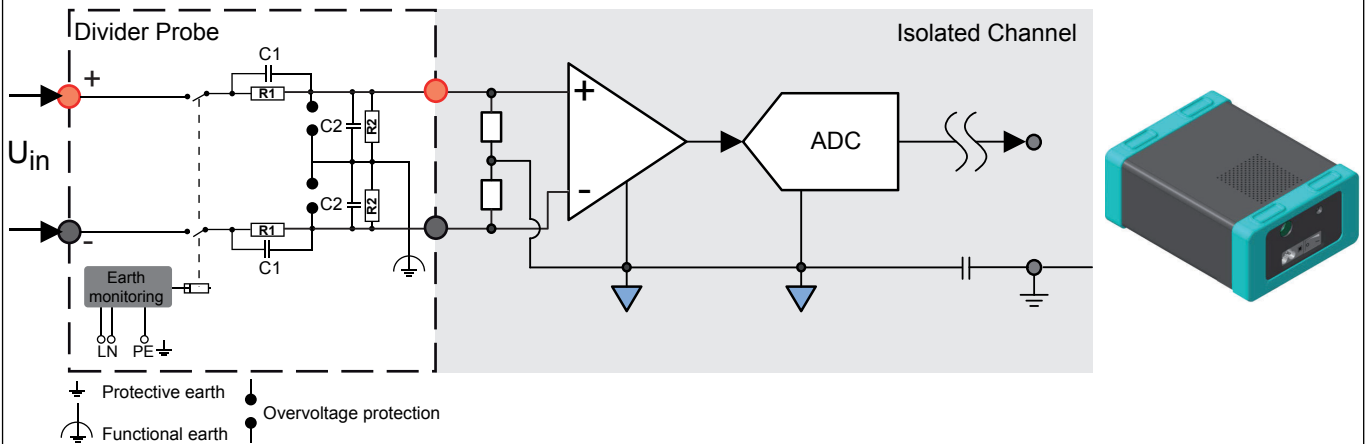


**Figure 1.27:** Block diagram and image

| | |
|---|---|
| Maximum input voltage | ± 5000 V RMS |
| Divider ratio | 50:1 |
| In-accuracy | ± 0.2% |
| Input impedance | 20 MΩ ± 0.2% |
| Temperature coefficient | ± 25 ppm / °C (± 45 ppm / °F) |
| Bandwidth | -0.5 dB @ 100 kHz, phase match 0.1° |
| Input pins | 4 mm safety banana |
| Output pins | Cable with 4 mm banana plugs |
| Isolation test voltages (terminals – earth, terminal – terminal) | 12.5 kV for 5 seconds |
| Earth monitoring | If functional earth is not attached divider is floating and inputs are disconnected from the output |
| Original manufacturers part number | HVD50 |
| Operating temperature range | 5 °C to +40 °C (41 °F to 104 °F) |
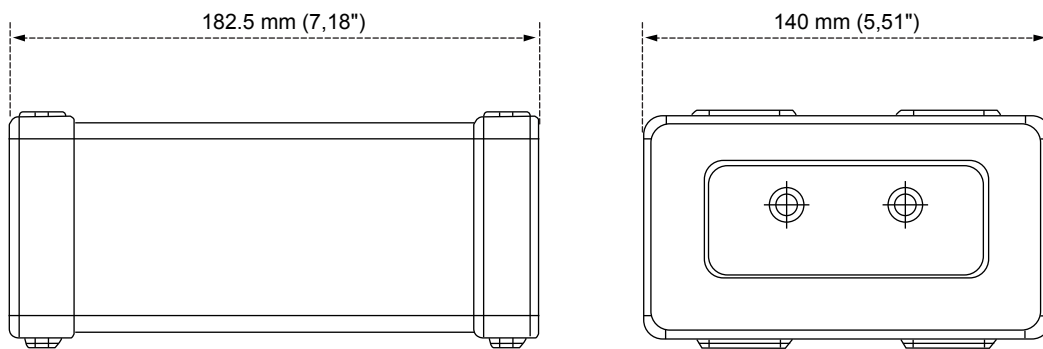


**Figure 1.28:** Dimensions

## Gxxx: High Precision Burden Resistor (Option, to be ordered separately)

Low ohmic, 1 W, 0.02% high precision, low thermal drift burden resistor. Uses 4 wire connection to reduce inaccuracy caused by the currents running to the burden resistor. Using banana input connectors and banana output pins. Directly compatible with GN610, GN611, GN610B and GN611B acquisition cards.
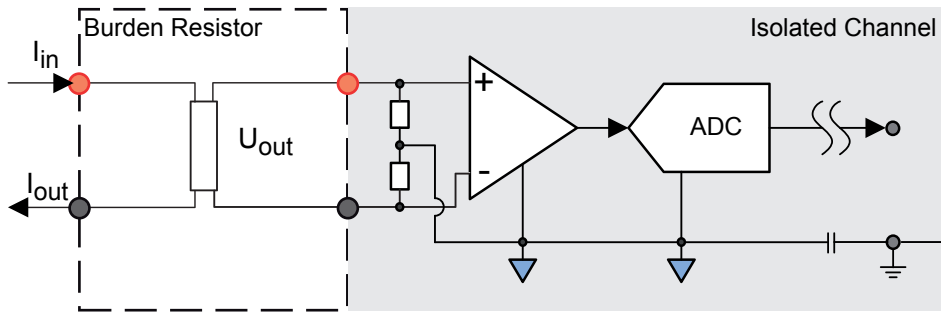


**Figure 1.29:** Block diagram and image

| In-accuracy | ± 0.02% | | |
|---|---|---|---|
| Temperature coefficient | ± 5 ppm / ºC (± 9 ppm / ºF) | | |
| Bandwidth | -0.5 dB @ 300 kHz | | |
| Input pins | 4 mm safety banana, 13 mm (0.51") spacing | | |
| Output pins | 4 mm safety banana, 19 mm (0.75") spacing | | |
| Isolation (terminals – earth) | 50 V RMS | | |
| Resistor technology | Metal foil | | |
| Maximum power dissipation | 1 W | | |
| Original manufacturers part number | HBR1.0 | HBR2.5 | HBR10 |
| Impedance | 1 Ω | 2.5 Ω | 10 Ω |
| Maximum input current | 1 A | 0.63 A | 0.31 A |
| Weight | 60 g (2.12 oz) | | |
| Operating temperature range | 0 ºC to +40 ºC (32 °F to 104 °F) | | |
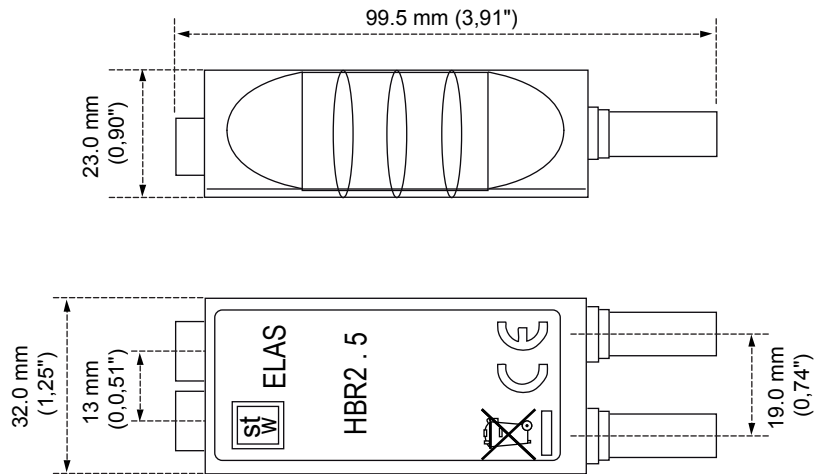


**Figure 1.30:** Dimensions

# Gxxx: Current Transducers (Option, to be ordered separately)

Current loop (compensated) current transducers (CT) using an extremely accurate zero flux detector with excellent linearity and low temperature drift. Electrostatic shield between primary and secondary circuit, with low insertion loss and high immunity to electrostatic and magnetic fields. To be used with CT power supply and burden resistor to measure high frequency currents.
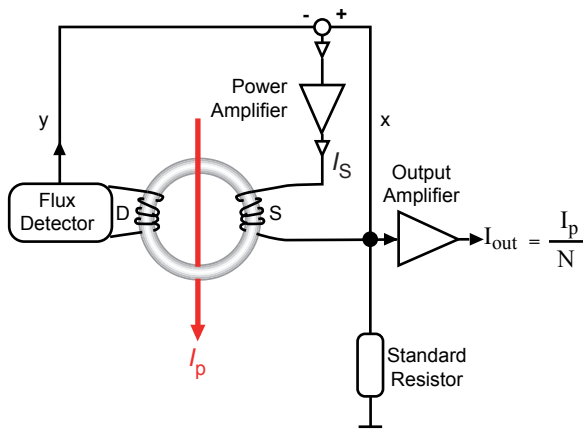


**Figure 1.31:** Simplified block diagram and image

$$I_{out} = \frac{I_p}{N}$$

| Isolation | 150 V RMS reinforced isolation<br>300 V RMS single isolation | | | | |
|---|---|---|---|---|---|
| Linearity | ≤ 3 ppm | | | | |
| Temperature coefficient of $I_{oe}$ | ≤ 0.5 ppm/ºC (± 0.9 ppm / ºF) | | | | |
| Supply voltages | + 15 V (± 5%) and - 15 V (± 5%), ≤ 80 mA + $I_s$ | | | | |
| Original manufacturers part number | LEM ULTRASTAB series | | | | |
| Operating temperature range | 10 ºC to +50 ºC (50 °F to 122 °F) | | | | |
| Device | IT 1000-S/SP1 | IT 700-S | IT400-S | IT 200-S | IT 60-S |
| Primary nominal current DC | 1000 A DC | 700 A DC | 400 A DC | 200 A DC | 60 A DC |
| Primary nominal current AC | 707 A RMS | 495 A RMS | 282 A RMS | 141 A RMS | 42 A RMS |
| Secondary nominal current DC | 1000 mA DC | 400 mA RMS | 200 mA RMS | 200 mA RMS | 100 mA DC |
| Conversion ratio (N) | 1000:1 | 1750:1 | 2000:1 | 1000:1 | 600:1 |
| Burden recommendation | HBR1.0 | HBR2.5 | HBR2.5 | HBR2.5 | HBR10.0 |
| dI/dt risetime | ≥100 A/µs | ≥100 A/µs | ≥100 A/µs | ≥100 A/µs | ≥25 A/µs |
| Small signal bandwidth (-3 dB) | 500 kHz | 500 kHz | 500 kHz | 500 kHz | 800 kHz |
| Weight (typical) | 1.0 kg (35.3 oz) | 0.8 kg (28.2 oz) | 0.3 kg (10.6 oz) | 0.3 kg (10.6 oz) | 0.3 kg (10.6 oz) |
| Dimensions | | | | | |
| Cable diameter | 30 mm (1.18") | 30 mm (1.18") | 26 mm (1.02") | 26 mm (1.02") | 26 mm (1.02") |
| Width | 128 mm (5,03") | 128 mm (5,03") | 93 mm (3,66") | 93 mm (3,66") | 93 mm (3,66") |
| Height | 106 mm (4,17") | 106 mm (4,17") | 77.7 mm (3,05") | 77.7 mm (3,05") | 77.7 mm (3,05") |
| Depth | 85 mm (3,34") | 67 mm (2,63") | 57 mm (2,24") | 57 mm (2,24") | 57 mm (2,24") |
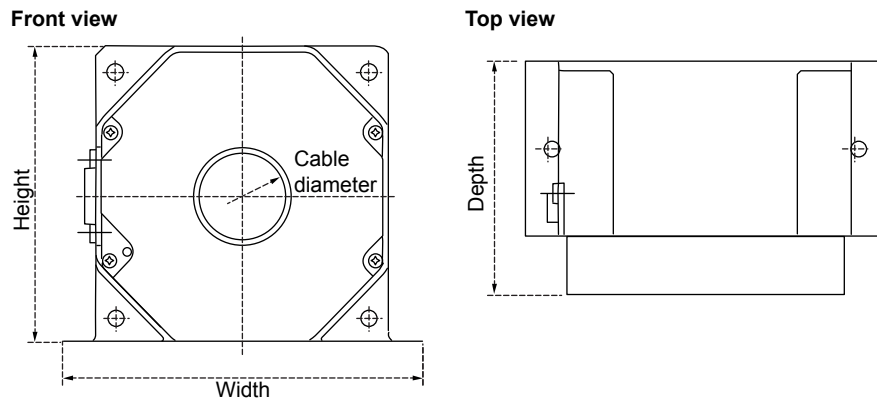


**Figure 1.32:** Dimensions

## Gxxx: Power Supply for Current Transducer (Option, to be ordered separately)

Empty modular 19" rack with 1 to maximum 6 channel CT support. Housing for the modular power supply and control for LEM current transducers.



**Figure 1.33:** Front side (left) and rear side (right)

| | |
|---|---|
| Maximum number of CTs | 6 |
| Input connectors | 9 pin SUBD |
| Output connectors | 4 mm banana plugs |
| Signal LEDS | CT Power, CT Status |
| Power supply | 100 to 240 V AC, 47 to 63 Hz @ 650 mA |
| Weight | Typical 6.5 kg (14.33 lbs) configured with 6 channels |
| Original manufacturers part number | MCTS |
| Operating temperature range | 0 °C to +50 °C (32 °F to 122 °F) |
| Dimensions | |
| Height | 132 mm (5.20") |
| Width / Width including mounting ears | 447 mm (17.56") / 490 mm (19.25") |
| Depth / Depth including handles | 256 mm (10.08") / 276 mm (10.87") |
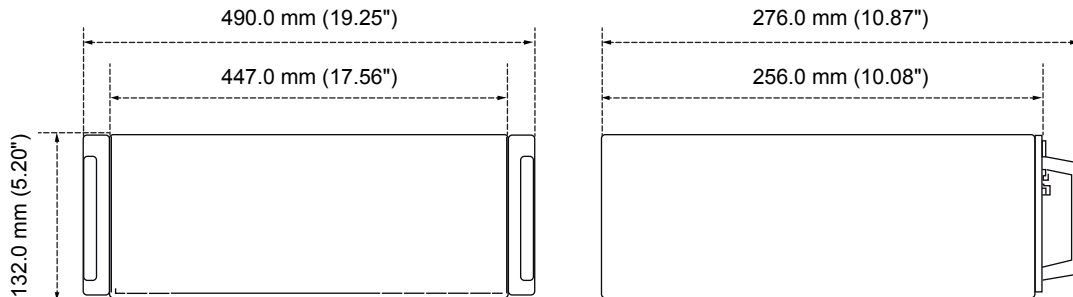


**Figure 1.34:** Dimensions

## Current Transducer (CT) Wire Diagram
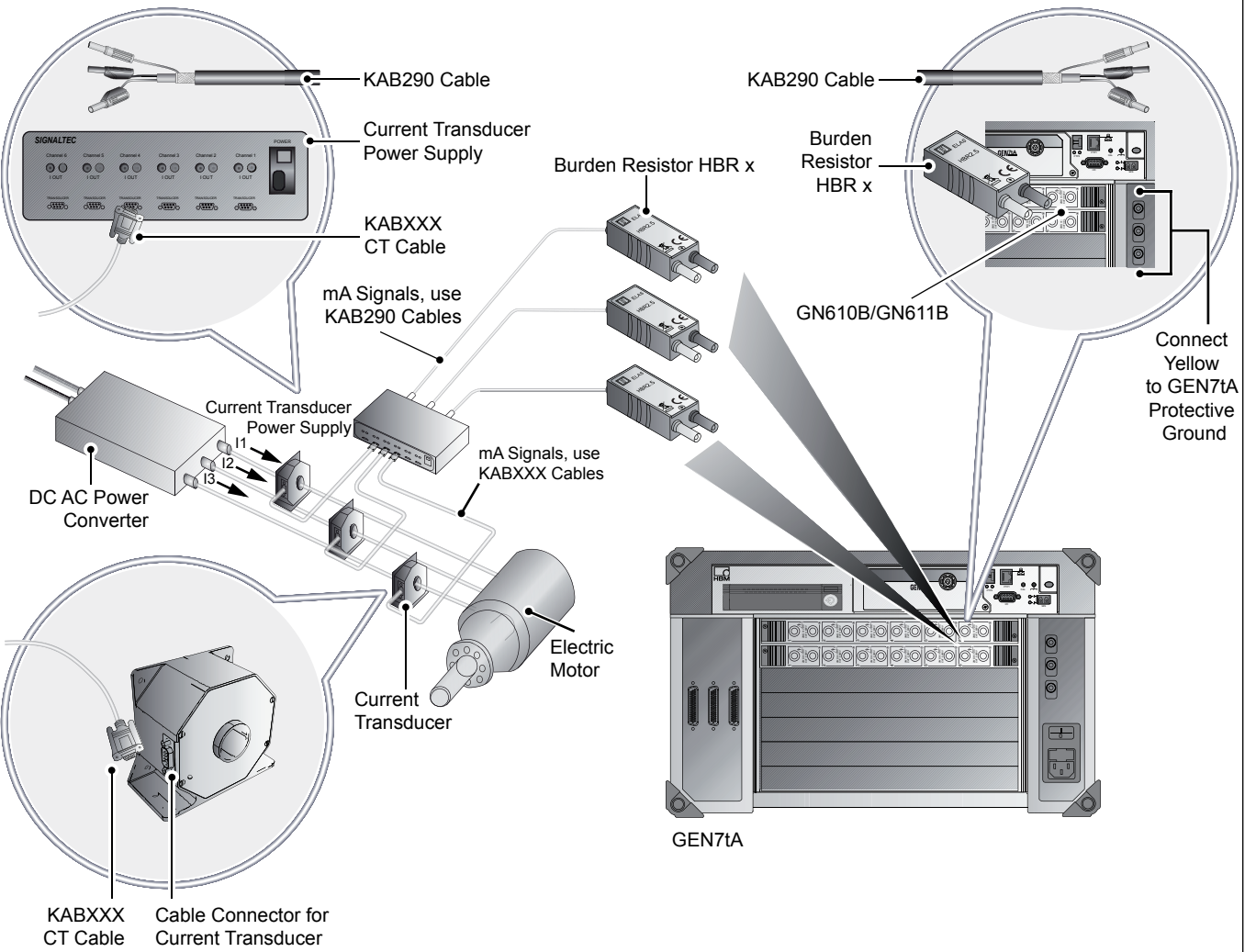


**Figure 1.35:** Current transducer connection diagram
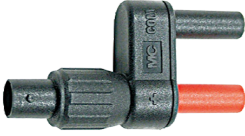
## Ordering Information [1]

| Article | | Description | Order No. |
|---------|---|-------------|-----------|
| Basic 1 kV ISO 200 kS/s |  | 6 channels, 18 bit, 200 kS/s, ± 20 mV to ± 1000 V input range, 200 MB RAM, 1 kV isolated balanced differential input (600 V RMS CAT II isolation), 4 mm fully isolated banana plugs. Real-time cycle based calculators with triggering on calculated results.<br><br>Supported by Perception V6.30 and higher | 1-GN611-2 |

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

## Special Voltage Probes, to be ordered separately

| Article | | Description | Order No. |
|---------|---|-------------|-----------|
| 1 kV DC, 10 MΩ, 10:1 differential probe |  | 1 kV DC, 10 MΩ, 10:1, 0.2% high precision differential probe to be used in combination with GN610, GN611, GN610B and GN611B acquisition cards. Reduces the resistive/current load on the device under test by increasing the input impedance to 10 MΩ. The use of the 10:1 divider reduces the lowest range of the acquisition card to ± 0.1 V ( ± 0.2 V GN610/GN611). The highest input range remains at ± 1000 V due to the maximum voltage rating of the probe. | Ordered from custom systems[1] |
| 5 kV RMS, 20 MΩ, 50:1 differential probe |  | 5 kV RMS, 20 MΩ, 50:1, 0.2% high precision, differential probe to be used in combination with GN610, GN611, GN610B and GN611B acquisition cards. The built-in earthing monitor system increases safety of the user and protects the GEN series inputs for isolation overloads. | Ordered from custom systems[1] |

(1)    Contact custom systems at: customsystems@hbm.com
       *Request quote/information for special products for GEN series.*

## Accessories, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| Isolated shielded test leads | | Black/red lead set combined within shielded housing (Yellow). 600 V RMS CAT II, safety-shrouded stackable banana plugs. Significantly reduces signal disturbance pickup on GN610/ GN611/GN610B/GN611B cards by using two identical signal wires with earthed shield. Do not use for 3 wire connections! Available lengths: 1.5 m (4.92 ft), 3.0 m (9.84 ft) and 6.0 m (19.69 ft) | 1-KAB290-1.5 1-KAB290-3 1-KAB290-6 |
| Test Leads and clips | | Black/red lead set 600 V RMS CAT II, 1.5 meter (4.9 ft) with safety-shrouded banana plugs and alligator clips  For better noise immunity, HBM recommends to use KAB290 in stead of this cables set. | 1-KAB282-1.5 |
| BNC to banana adapter | | Set of six pieces, safety isolated female BNC to dual 4 mm protected banana adapter. 1000 V RMS CAT II, 600 V RMS CAT III and 1 A current safety ratings. Can be used with GN610/GN611/GN610B/GN611B input cards. | 1-G067-2 |
| Artificial star adapter | | The artificial star adapter is a plug-on interface card to measure 3 phase signals with the GN610/GN611/GN610B/GN611B cards. This adapter is intended for measuring 3 phase signals while creating a virtual/artificial star point. | 1-G068-2 |

## Current Sensors, to be ordered separately

| Article | Description | Order No. |
|---------|-------------|-----------|
| Ultrastab 60 A RMS current transducer | LEM IT 60-S Ultrastab. 60 A DC, 42 A RMS current transducer with 800 kHz bandwidth. Recommended burden resistor HBR10.0. Resulting ratio 60 A/V (16.6667 mV/A). | Ordered from custom systems[1] |
| Ultrastab 200 A RMS current transducer | LEM IT 200-S Ultrastab. 200 A DC, 141 A RMS current transducer with 500 kHz bandwidth. Recommended burden resistor HBR2.5. Resulting ratio 400 A/V (2.5 mV/A). | Ordered from custom systems[1] |
| Ultrastab 400 A RMS current transducer | LEM IT 400-S Ultrastab. 400 A DC, 282 A RMS current transducer with 500 kHz bandwidth. Recommended burden resistor HBR2.5. Resulting ratio 800 A/V (1.25 mV/A). | Ordered from custom systems[1] |
| Ultrastab 700 A RMS current transducer | LEM IT 700-S Ultrastab. 700 A DC, 495 A RMS current transducer with 500 kHz bandwidth. Recommended burden resistor HBR2.5. Resulting ratio 700 A/V (1.4286 mV/A). | Ordered from custom systems[1] |
| Ultrastab 1000 A RMS current transducer | LEM IT 1000-S Ultrastab. 1000 A DC, 707 A RMS current transducer with 500 kHz bandwidth. Recommended burden resistor HBR1.0. Resulting ratio 1000 A/V (1.0 mV/A). | Ordered from custom systems[1] |
| Connection cable LEM CT to MCTS | Connection cable between LEM current transducer and MCTS power supply. Available in lengths of 2.5 m (8.20 ft), 5 m (16.40 ft) and 10 m (32.81 ft). | Ordered from custom systems[1] |
| MCTS 19" rack for power supply for LEM CT | Empty mainframe for power supply and control for LEM current transducers. Modular 19" rack with 1 to maximum 6 channel CT support. 100….240 V, 47…63 Hz AC input. | Ordered from custom systems[1] |
| HBR 1 Ω, 1 W precision burden resistor | 1 Ω, 1 W, 0.02% high precision, low thermal drift burden resistor. Internally uses 4 wire connection to reduce inaccuracy caused by the currents running to the burden resistor. Using banana input connectors and banana output pins. Directly compatible with GN610, GN611, GN610B and GN611B acquisition cards. | Ordered from custom systems[1] |
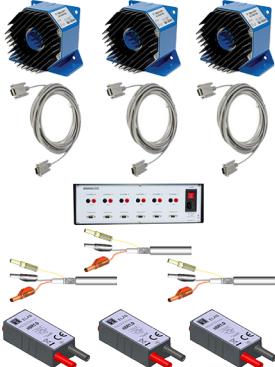
## Current Sensors, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| HBR 2.5 Ω, 1 W precision burden resistor |  | 2.5 Ω, 1 W, 0.02% high precision, low thermal drift burden resistor. Internally uses 4 wire connection to reduce inaccuracy caused by the currents running to the burden resistor. Using banana input connectors and banana output pins. Directly compatible with GN610, GN611, GN610B and GN611B acquisition cards. | Ordered from custom systems[1] |
| HBR 10 Ω, 1 W precision burden resistor |  | 10 Ω, 1 W, 0.02% high precision, low thermal drift burden resistor. Internally uses 4 wire connection to reduce inaccuracy caused by the currents running to the burden resistor. Using banana input connectors and banana output pins. Directly compatible with GN610, GN611, GN610B and GN611B acquisition cards. | Ordered from custom systems[1] |

(1)    Contact custom systems at: customsystems@hbm.com
       *Request quote/information for special products for GEN series.*

## Current Measurement Solutions, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| 3 phase 60 A RMS current solution |  | Package consisting of 3 * LEM IT 60-s current transducers, 1 * MCTS 19" rack with built-in 3 * power supply and CT control, 3 * MCTS to CT connection cable 10 m (32.81 ft), 3 * KAB290 3.0 m (9.84 ft) and 3 * HBR10.0 burden resistor | Ordered from custom systems[1] |
| 1 phase 60 A RMS current extension |  | Package consisting of 1 * LEM IT 60-s current transducers, 1 * power supply and CT control, 1 * MCTS to CT connection cable 10 m (32.81 ft), 1 * KAB290 3.0 m (9.84 ft) and 1 * HBR 10.0 burden resistor. One extension channel for the 3 phase 60 A RMS current solution. Factory installed and must be ordered together with the 3 phase 60 A RMS current solution. | Ordered from custom systems[1] |
| 3 phase 200 A RMS current solution |  | Package consisting of 3 * LEM IT 200-s current transducers, 1 * MCTS 19" rack with built-in 3 * power supply and CT control, 3 * MCTS to CT connection cable 10 m (32.81 ft), 3 * KAB290 3.0 m (9.84 ft) and 3 * HBR2.5 burden resistor | Ordered from custom systems[1] |
| 1 phase 200 A RMS current extension |  | Package consisting of 1 * LEM IT 200-s current transducers, 1 * power supply and CT control, 1 * MCTS to CT connection cable 10 m (32.81 ft), 1 * KAB290 3.0 m (9.84 ft) and 1 * HBR2.5 burden resistor. One extension channel for the 3 phase 200 A RMS current solution. Factory installed and must be ordered together with the 3 phase 200 A RMS current solution. | Ordered from custom systems[1] |

## Current Measurement Solutions, to be ordered separately

| | | | |
|---|---|---|---|
| 3 phase 400 A RMS current solution | | Package consisting of 3 * LEM IT 400-s current transducers, 1 * MCTS 19" rack with built-in 3 * power supply and CT control, 3 * MCTS to CT connection cable 10 m (32.81 ft), 3 * KAB290 3.0 m (9.84 ft) and 3 * HBR2.5 burden resistor | Ordered from custom systems[1] |
| 1 phase 400 A RMS current extension | | Package consisting of 1 * LEM IT 400-s current transducers, 1 * power supply and CT control, 1 * MCTS to CT connection cable 10 m (32.81 ft), 1 * KAB290 3.0 m (9.84 ft) and 1 * HBR2.5 burden resistor. One extension channel for the 3 phase 400 A RMS current solution. Factory installed and must be ordered together with the 3 phase 400 A RMS current solution. | Ordered from custom systems[1] |
| 3 phase 700 A RMS current solution | | Package consisting of 3 * LEM IT 700-s current transducers, 1 * MCTS 19" rack with built-in 3 * power supply and CT control, 3 * MCTS to CT connection cable 10 m (32.81 ft), 3 * KAB290 3.0 m 9.84 ft and 3 * HBR2.5 burden resistor | Ordered from custom systems[1] |
| 1 phase 700 A RMS current extension | | Package consisting of 1 * LEM IT 700-s current transducers, 1 * power supply and CT control, 1 * MCTS to CT connection cable 10 m (32.81 ft), 1 * KAB290 3.0 m (9.84 ft) and 1 * HBR2.5 burden resistor. One extension channel for the 3 phase 700 A RMS current solution. Factory installed and must be ordered together with the 3 phase 700 A RMS current solution. | Ordered from custom systems[1] |
| 3 phase 1000 A RMS current solution | | Package consisting of 3 * LEM IT 1000-s current transducers, 1 * MCTS 19" rack with built-in 3 * power supply and CT control, 3 * MCTS to CT connection cable 10 m (32.81 ft), 3 * KAB290 3.0 m (9.84 ft) and 3 * HBR1.0 burden resistor | Ordered from custom systems[1] |
| 1 phase 1000 A RMS current extension | | Package consisting of 1 * LEM IT 1000-s current transducers, 1 * power supply and CT control, 1 * MCTS to CT connection cable 10 m (32.81 ft), 1 * KAB290 3.0 m (9.84 ft) and 1 * HBR2.5 burden resistor. One extension channel for the 3 phase 1000 A RMS current solution. Factory installed and must be ordered together with the 3 phase 1000 A RMS current solution. | Ordered from custom systems[1] |

(1)    Contact custom systems at: customsystems@hbm.com
       *Request quote/information for special products for GEN series.*

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