Data sheet

# GEN series
# GN411

## Bridge ISO 1 MS/s Input Card

### Special features

- **Quarter/Half/Full bridge support**
- **Voltage excited sensors**
- **Positive and negative shunt calibration**
- **Voltage or current excitation**
- **Up to 10 wire bridge connections**
- **Zero-balance by adding voltage to sensor**
- **User bridge completion cards**
- **Balanced differential inputs**
- **± 2 mV to ± 10 V input range**
- **50 V DC Isolation**
- **Analog/digital anti-alias filters**
- **4 analog channels**
- **1 MS/s sample rate**
- **16 bit resolution**

**Bridge ISO 1 MS/s Input Card**

The Bridge ISO 1 MS/s Input Card supports quarter, half and full bridges with constant voltage or constant current excitation. In basic sensor mode, string pots, PT100 and other voltage or current excited sensors can be used. Built-in shunts offer the possibility of positive or negative shunting of the Wheatstone bridge. For quarter bridge support the card has a 350 Ω built-in resistor. For other strain gauges like 120 Ω, the user bridge completion card offers an user adaptable solution. To lower partial discharges within the cable used, a common mode driven guard is available. The card provides four channels of isolated balanced differential inputs from ± 2 mV to ± 10 V Full Scale with auto-zero capability.

Optimum anti-alias protection is achieved by the 7-pole analog anti-alias filter combined with a fixed 1 MS/s sampling Analog-to-Digital converter. For all sample rates the digital anti alias filter allows for a large range of high order filter characteristics with precise phase match and noise-free digital output.
Each channel features two set-points for trigger or alarm purposes. Extensive acquisition and trigger modes allow many different ways to capture valuable data even at the highest sample rates. All channels are synchronously sampled at full speed without multiplexing and almost immeasurable crosstalk.

| Capabilities Overview | |
|---|---|
| Model | GN411 |
| Maximum sample rate per channel | 1 MS/s |
| Memory per card | 512 MB |
| Analog channels | 4 |
| Anti-Alias filters | Fixed bandwidth analog AA-filter combined with sample rate tracking digital AA-filter |
| ADC resolution | 16 bit |
| Isolation | Channel to channel and channel to chassis |
| Input type | Analog, isolated balanced differential |
| Passive voltage/current probes | Not supported |
| Sensors | Quarter, half and full bridges using either voltage or current excitation.<br>Force, Pressure, MEMS-type Accelerometers and Potentiometric Displacement and other strain gauge bridge sensors using either voltage or current excitation |
| TEDS | Not supported |
| Real-time cycle based calculators | Not supported |
| Real-time formula database calculators (option) | Not supported |
| EtherCat® output | Not supported |
| Digital Event/Timer/Counter | Not supported |
| Standard data streaming (up to 200 MB/s) | Supported |
| Fast data streaming (up to 1 GB/s) | Not supported |
| Slot width | 1 |

## Block Diagram

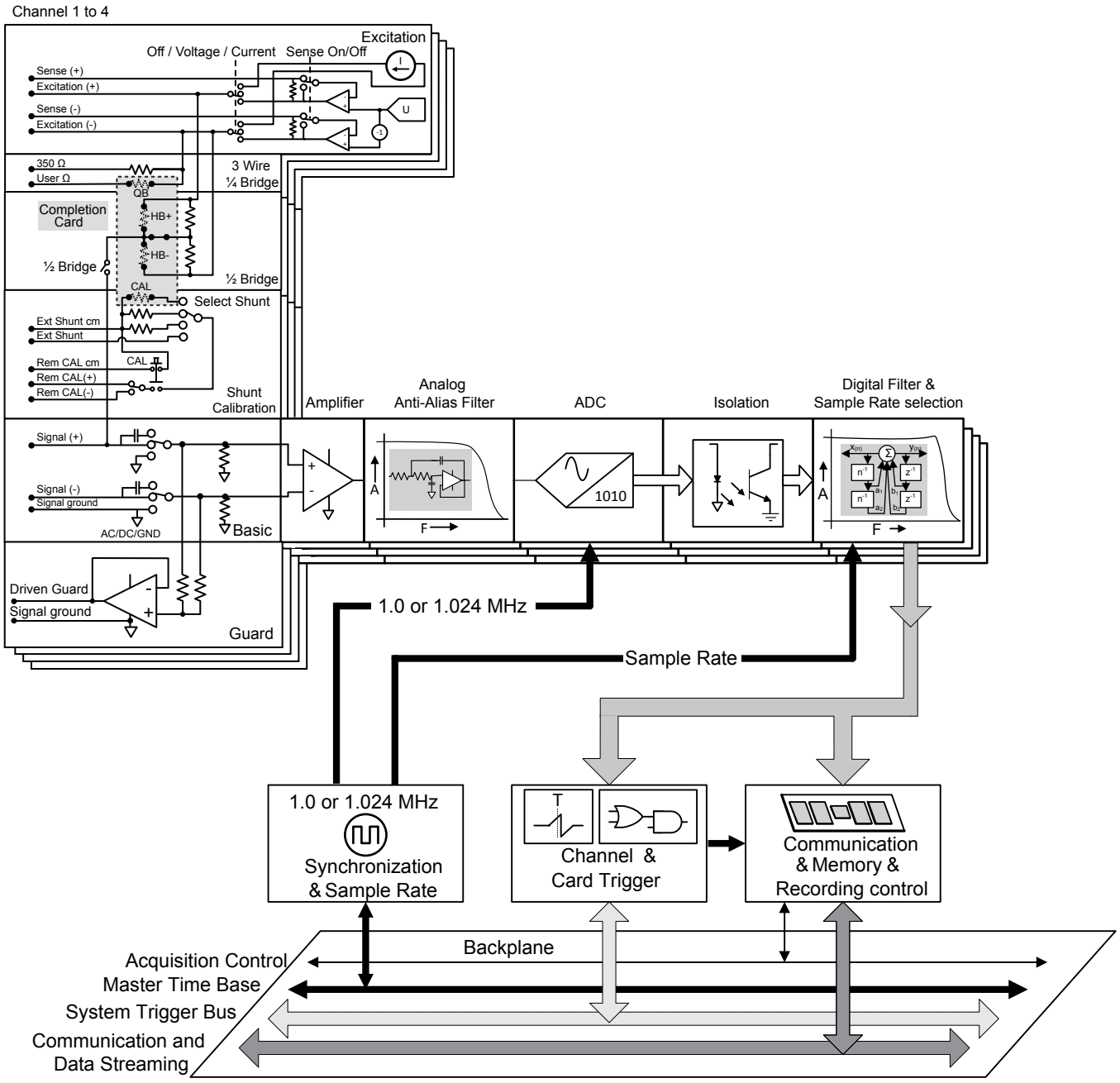



**Figure 1.1:** Block Diagram

**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 | 4 |
| Connectors | 16 pin Lemo with connector chassis grounded, 1 per channel<br>Lemo EGG.2B.316.CYM |
| Mating connector | Lemo FGG.2B.316.CLAD52 |
| Input type | Analog, isolated balanced differential |
| Input impedance | 2 * 10 MΩ ± 1% // 130 pF ± 10% |
| Input coupling | |
| Coupling modes | AC, DC, GND |
| AC coupling frequency | 0.16 Hz, ± 10%; -3 dB |

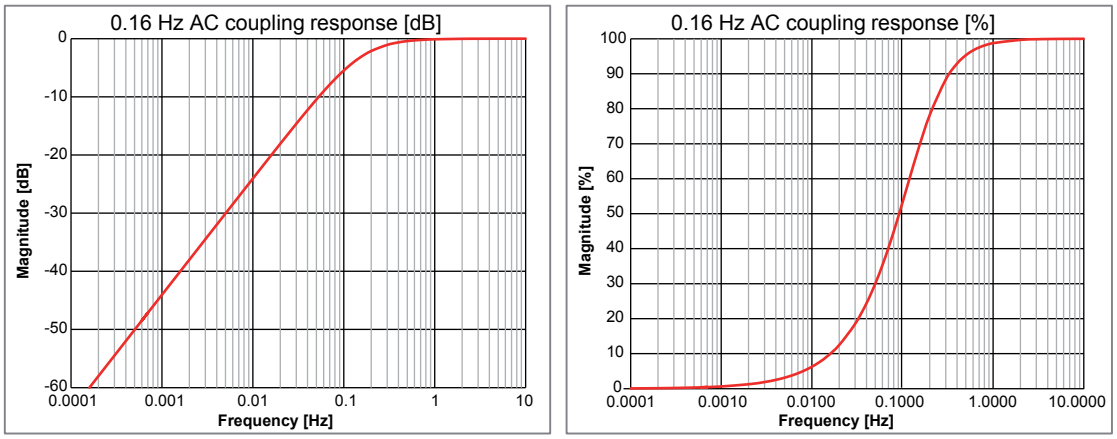



**Figure 1.2:** Representative AC coupling response

| | |
|---|---|
| Ranges | ± 2 mV, ± 5 mV, ± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V,± 0.2 V, ± 0.5 V, ± 1.0 V,± 2.0 V, 5.0 V± , ± 10.0 V<br>Each range supports a variable gain in 1000 steps (0.1%). This creates 1000 extra ranges between 2 specified ranges |
| Offset | ± 50% in 1000 steps (0.1%)<br>± 10 V range has fixed 50% offset |
| DC Offset error | |
| Wideband | 0.2% of Full Scale ± 120 µV |
| Bessel IIR and FIR | 0.1% of Full Scale ± 40 µV |
| Offset error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| DC Gain error | |
| Wideband | 0.1% of Full Scale ± 40 µV |
| Bessel IIR and FIR | 0.1% of Full Scale ± 40 µV |
| Gain error drift | ± 100 ppm/°C (± 180 ppm/°F) |
| Maximum static error (MSE) | |
| Wideband | 0.2% of Full Scale ± 120 µV |
| Bessel IIR and FIR | 0.1% of Full Scale ± 40 µV |
| RMS Noise | |
| Wideband | 0.02% of Full Scale ± 30 µV |
| Bessel IIR and FIR | 0.02% of Full Scale ± 30 µV |
| Common mode | |
| Rejection (CMR) | > 72 dB @ 80 Hz |
| Maximum common mode voltage | ± 10 V RMS to amplifier ground<br>± 50 V RMS to isolated ground |
| Input overload protection | |
| Maximum voltage | ± 35 V DC |
| Overload recovery time | Restored to 10% accuracy in 1 µs after 200% overload<br>Restored to 0.1% accuracy in 10 µs after 200% overload |

| Bridge Mode | |
|---|---|
| Supported sensors | Quarter/half/full bridge; strain gauge based sensors: load cells, force transducers, torque transducers and pressure transducers |
| Quarter-bridge completion | 3 wire support; the 3rd wire keeps the measurement wire current free, eliminating wire resistance errors in the measurement wire |
| Built-in quarter-bridge completion resistor | 350 Ω, 0.11%, 0.6 ppm/°C (1.1 ppm/°F), wired to separate connector pin |
| Built-in half-bridge completion resistors | 2 times 100 kΩ, 0.1%, 2 ppm/°C (3.6 ppm/°F) tracking |
| Bridge completion card | |
| Access/Replacement | Access in front panel of bridge card, removable without opening mainframe |
| Shunt resistor | 1 user mountable shunt resistor |
| Half-bridge completion resistor | 2 user mountable half-bridge completion resistors<br>When used, the built-in half-bridge completion resistors are bypassed |
| Quarter-bridge completion resistor | 1 user mountable quarter-bridge completion resistor<br>Wired to separate connector pin |
| Bridge excitation modes | User selectable Off, constant voltage or constant current |
| Constant voltage excitation | |
| Selectable excitation voltage | Bipolar ± 1.0 V to ± 7.5 V DC, selectable in 0.02 V steps, maximum 85 mA |
| Excitation voltage accuracy | 0.5% of Full Scale |
| Excitation voltage sense | User selectable On/Off<br>2 separate connector pins available; wiring requires no internal bypass |
| Constant current excitation | |
| Excitation current | 2.0 mA to 40.0 mA, selectable in 0.05 mA steps, using ± 7.5 V DC |
| Excitation current accuracy | 0.5% of Full Scale |
| Bridge balance | |
| Operation principal | Voltage is added to bridge to electrically balance the bridge. The remaining offset is corrected by software auto zero |
| Maximum bridge balance voltage | ± 250 mV |
| Bridge balance gain error | 0.5% of Full Scale |
| Bridge balance restore | Reloadable bridge balance after power down |
| Auto zero and balance | Simultaneous execution of auto zero and balance on all channels on multiple cards, reducing zero and balance time significantly |
| Bridge shunt | |
| Bridge shunt resistor selection | 4 software selectable sources<br>2 built-in shunt resistors, bridge completion card, external shunt |
| Bridge shunt method | Software selectable to positive or negative excitation voltage<br>Separate pins available to wire both selections |
| External shunt | 2 separate connector pins to wire shunt out to sensor connection points |
| Built-in shunt resistors | |
| Type | Metal foil |
| First shunt resistor | 20 kΩ, 0.11%, 0.6 ppm/°C (1.1 ppm/°F) |
| Second shunt resistor | 100 kΩ, 0.11%, 0.6 ppm/°C (1.1 ppm/°F) |
| Driven guard | The measured common mode voltage on positive and negative input is active driven by a low ohmic output to the driven guard pin. Connecting the driven guard to the cable shield minimizes the potential difference between the shield and signal wires. A lower potential difference lowers the effect between the shield and signal wires called partial discharge. Partial discharges result in noise on the measured signal. |

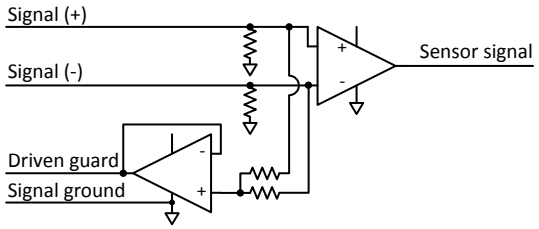



**Figure 1.3:** Driven guard

## Basic Sensor Mode

| | |
|---|---|
| Supported sensors | Strain gauge bridge sensors using voltage or current excitation Force, Pressure, MEMS-type Accelerometers and Potentiometric Displacement transducers, PT100 and PT1000 |
| Sensor excitation modes | User selectable Off, constant voltage or constant current |
| Constant voltage excitation | |
| Selectable excitation voltage | Bipolar ± 1.0 V to ± 7.5 V DC, selectable in 0.02 V steps, maximum 85 mA |
| Excitation voltage accuracy | 0.5% of Full Scale |
| Constant current excitation | |
| Excitation current | 2.0 mA to 40.0 mA, selectable in 0.05 mA steps, using ± 7.5 V DC |
| Excitation current accuracy | 0.5% of Full Scale |

## Input Connector

Pin 1 : Excitation (+)
Pin 2 : Excitation (-)
Pin 3 : Sense (+)
Pin 4 : Sense (-)
Pin 5 : Signal (+)
Pin 6 : Signal (-)
Pin 7 : Driven guard
Pin 8 : Signal ground
Pin 9 : User - 1/4 bridge
Pin 10 : 350Ω - 1/4 bridge
Pin 11 : Remote CAL (+)
Pin 12 : Remote CAL (-)
Pin 13 : External shunt common
Pin 14 : External shunt
Pin 15 : Remote CAL common
Pin 16 : Signal ground

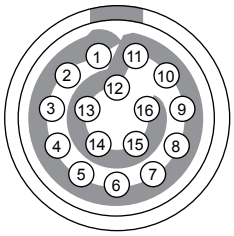



**Figure 1.4:** Input connector, solder cup view of male connector

## Bridge Completion Card

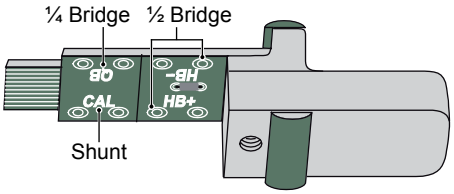



**Figure 1.5:** Shunt calibration completion plug-in module

| | |
|---|---|
| Suggested resistors | Vishay S102C: 1 Ω to 150 kΩ ± 0.005%, ± 2 ppm/ºC, 0.6 W @ 75ºC (167ºF)<br>Vishay S102K: 1 Ω to 100 kΩ ± 0.005%, ± 1 ppm/ºC, 0.4 W @ 75ºC (167 ºF) |
| Suggested mounting | Two resistors on top of each other |

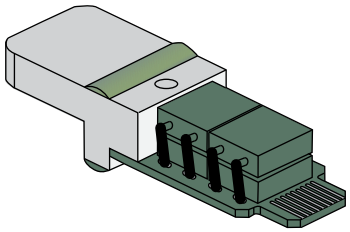


**Figure 1.6:** Mounted completion resistors

## Isolation

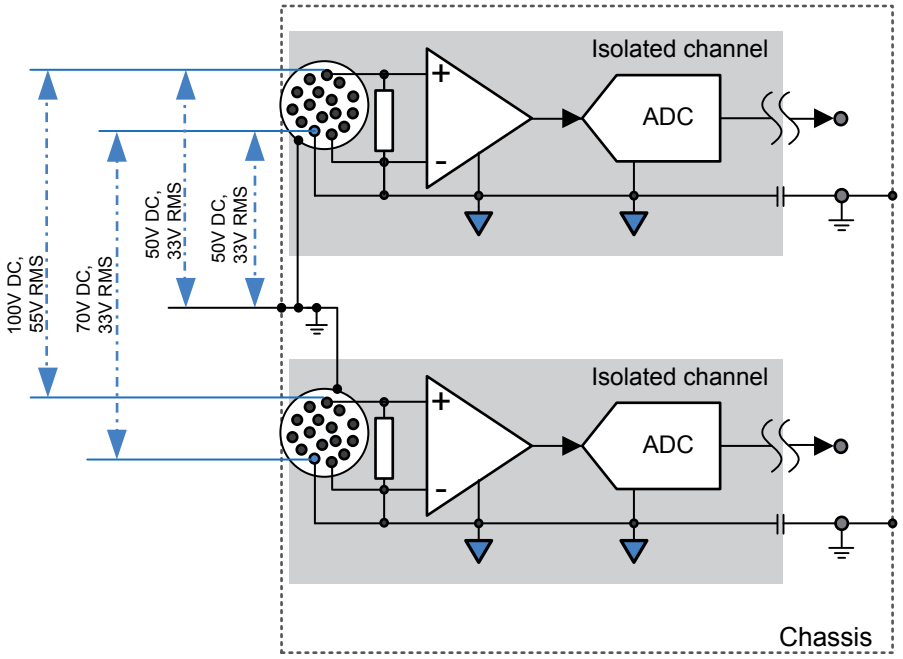



**Figure 1.7:** Isolation schematic

| | |
|---|---|
| Channel to chassis (earth) | 33 V RMS, ± 50 V DC |
| Channel to channel<br>(Isolated GND to isolated GND) | 33 V RMS, ± 70 V DC |
| Input signal to input signal | 55 V RMS, ± 100 V DC |

## Analog to Digital Conversion

| | |
|---|---|
| Sample rate per channel | 0.1 S/s to 1 MS/s |
| ADC resolution; one ADC per channel | 16 bit |
| ADC Type | Successive Approximation Register (SAR); TI ADS8401IB |
| Time base accuracy | Defined by mainframe: ± 3.5 ppm (1); aging after 10 years ± 10 ppm |
| Binary sample rate | Supported; when calculating FFTs results in rounded/integer BIN sizes |
| Maximum binary sample rate | 1.024 MS/s |
| External time base sample rate | 0 S/s to 500 kS/s |
| External time base level | TTL |
| External time base minimum pulse width | 200 ns |

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

## Anti-Alias Filters

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

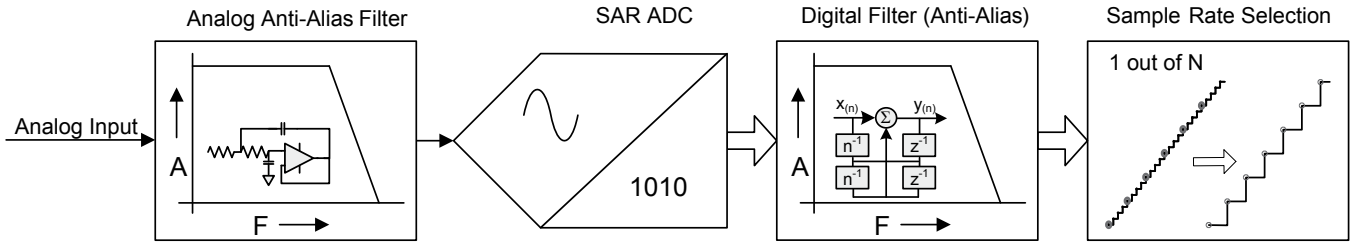



**Figure 1.8:** Combined analog and digital anti-alias filter block diagram

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.

| | |
|---|---|
| Wideband | When wideband is selected, there is neither an analog anti-alias filter nor any digital filter in the signal path. Therefore, there is no anti-alias protection when wideband is selected. Should not be used if working in a frequency domain with recorded data. |
| Digital 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.<br>Bessel filters are typically used when looking at signals in the time domain. Best used for measuring transient signals or sharp edge signals like square waves or step responses. |
| Digital FIR (Fc @ -0.1 dB) | Standard FIR filter with corner frequency (Fc) defined at -0.1 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti-alias filter and a digital FIR filter to prevent aliasing at lower sample rates.<br>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. |
| Digital FIR (Fc @ -3 dB)<br>Supported by Perception V6.40 and higher | Adapted FIR filter with corner frequency (Fc) calculated as close as possible to -3 dB.<br>When FIR filter is selected, this is always a combination of an analog Butterworth anti-alias filter and a digital FIR filter to prevent aliasing at lower sample rates.<br>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. |

## Wideband Filter (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.

| | |
|---|---|
| Bandwidth | Between 120 kHz and 160 kHz (-3 dB) all ranges < 100mV<br>Between 450 kHz and 520 kHz (-3 dB) all ranges ≥ 100 mV |
| 0.1 dB passband flatness (1) | DC to 10 kHz all ranges < 100 mV<br>DC to 80 kHz all ranges ≥ 100 mV |

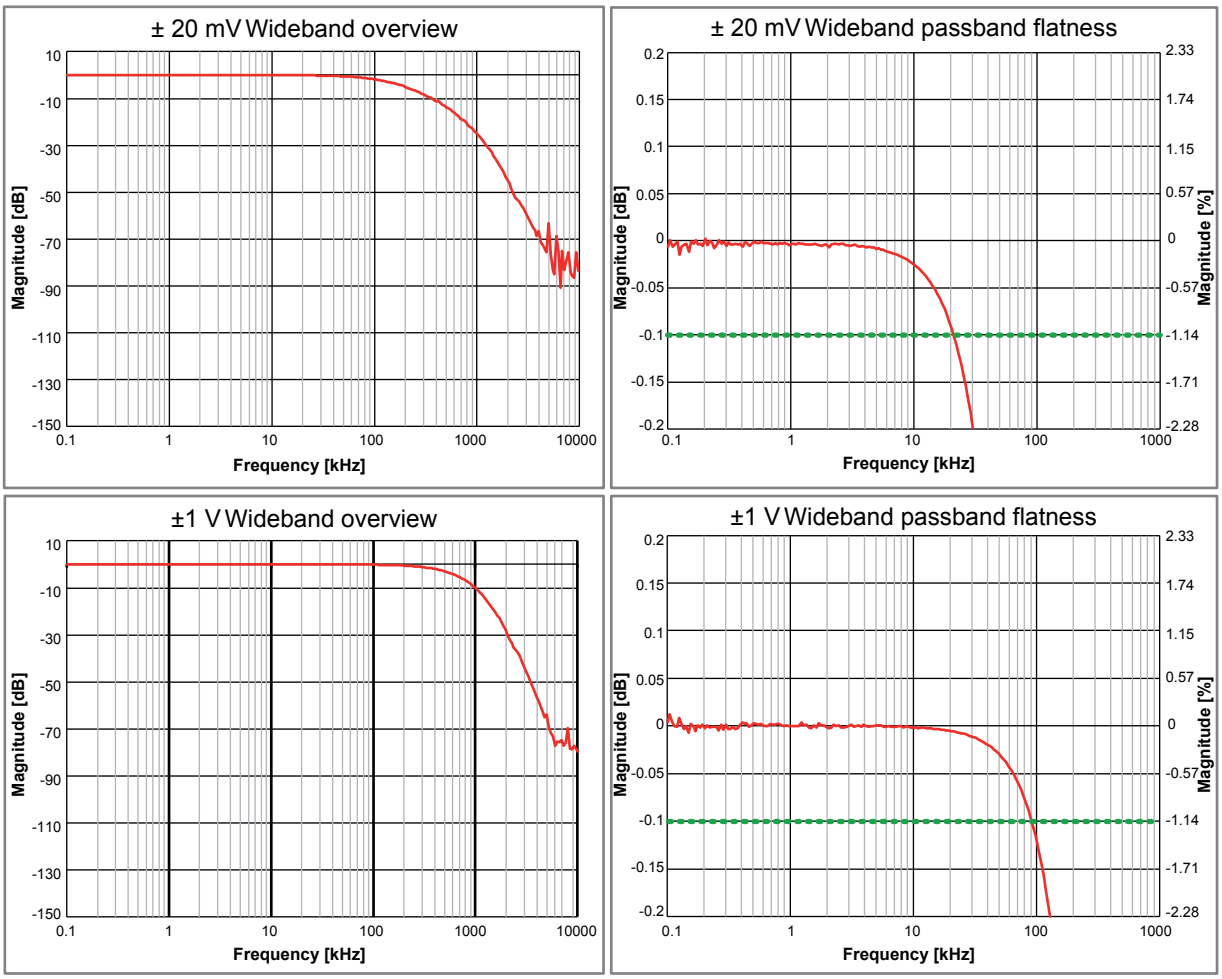
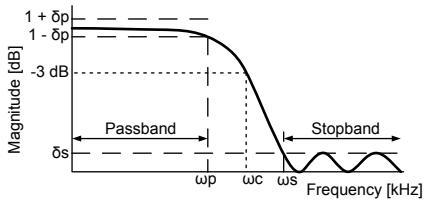



**Figure 1.9:** Representative Wideband examples

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

## Digital Bessel IIR Filter (Digital Anti-Alias)




δp: Passband ripple
δs: Stopband attenuation

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

**Figure 1.10:** 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 | |
| Characteristic | 7-pole Bessel, optimal step response |
| Bandwidth | 120 kHz ± 20 kHz (-3dB) All Ranges < 100 mV<br>220 kHz ± 20 kHz (-3 dB) All Ranges ≥ 100 mV |
| Digital Bessel IIR filter | |
| Characteristic | 6-pole Bessel style IIR |
| User selection | Auto tracking for sample rate divided by: 10, 20, 40, 100<br>User selects divide factor, software then adjusts filter when sample rate is changed |
| Bandwidth (ωc) | User selectable from 0.0125 Hz to 100 kHz |
| 0.1 dB passband flatness (ωp)(1) | DC to 10 kHz |
| Stopband attenuation (δs) | 60 dB |
| Roll-off | 36 db/Octave |

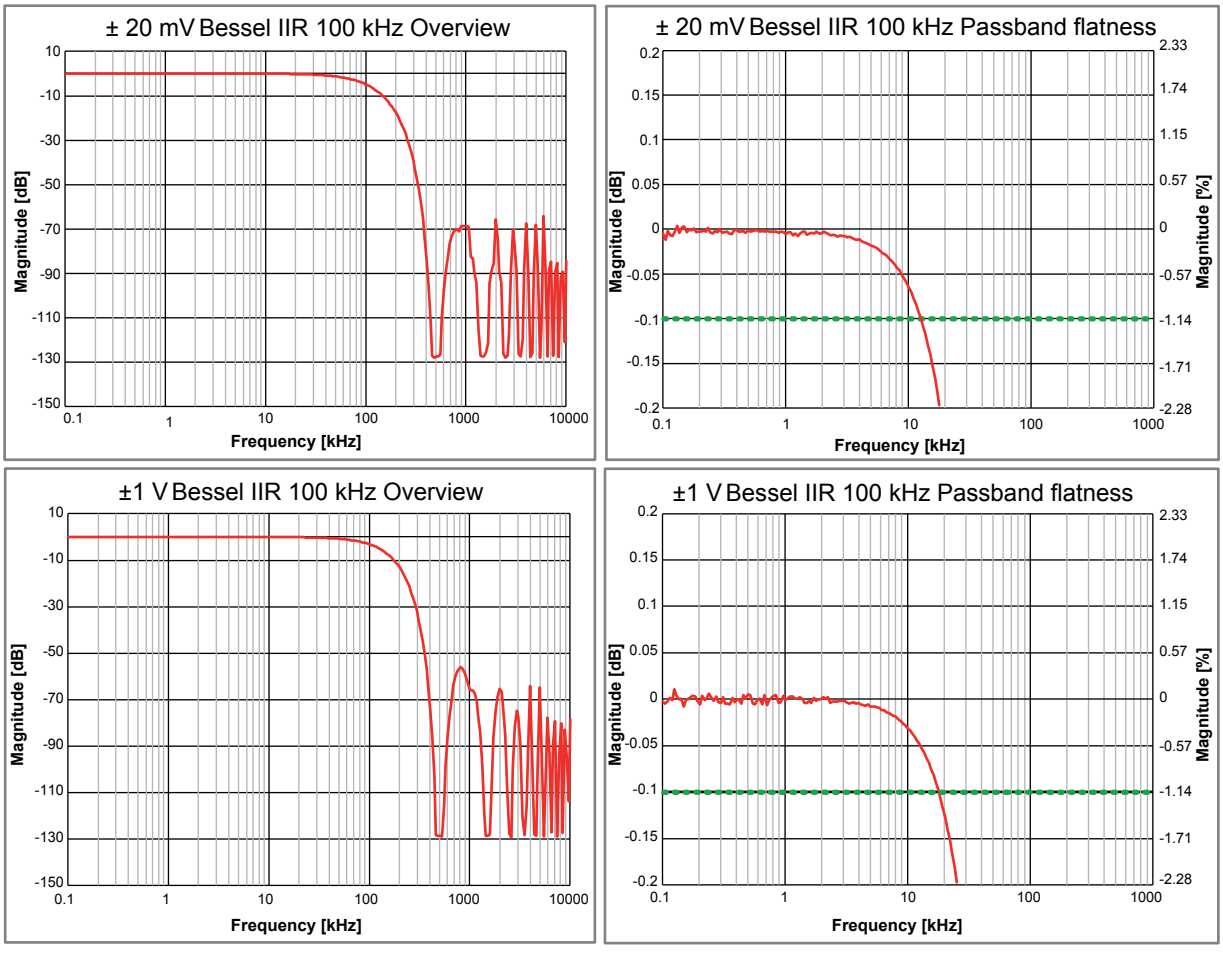
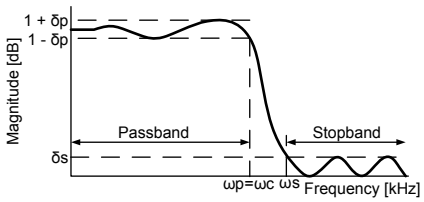



**Figure 1.11:** Representative Bessel IIR examples

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

## Digital FIR (Fc @ -0.1 dB) Filter (Digital Anti-Alias)




δp: Passband ripple
δs: Stopband attenuation

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

**Figure 1.12:** Digital FIR (Fc @ -0.1 dB) filter

| | |
|---|---|
| When FIR (Fc @ -0.1 dB) filter is selected, this is always a combination of an analog Butterworth anti-alias filter and a digital FIR filter | |
| Analog anti-alias filter | |
| Characteristic | 7-pole Butterworth, extended passband response |
| Bandwidth | 140 kHz ± 20 kHz (-3 dB) All Ranges < 100 mV<br>350 kHz ± 20 kHz (-3 dB) All Ranges ≥ 100 mV |
| Digital FIR (Fc @ -0.1 dB) filter | |
| Characteristic | 12-pole FIR; FIR is a purely digital characteristic. Its closest analog resemblance is to an Elliptic filters. However, FIR has both ringing on the signal before the step input is started and ringing after the step input is complete. |
| User selection | Auto tracking for sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor, software then adjusts filter when sample rate is changed |
| Bandwidth (ωc) | User selectable from 0.031 Hz to 250 kHz |
| 0.1 dB Passband flatness (ωp) (1) | DC to ≈ωc<br>DC to 60 kHz; bandwidth selection ωc = > 50 kHz, limited by the analog anti-alias filter amplitude response.<br>For all Ranges < 100 mV, ωp is limited to 10 kHz due to an anti-alias filter. |
| Stopband attenuation (δs) | 60 dB; with filter bandwidth selection of ωc = 250 kHz, a peak of -35 dB occurs between 500 kHz and 1 MHz due to limited analog anti-alias filter amplitude reduction. At lower bandwidth selections, the digital filter reduces this peak to -60 dB. |
| Roll-off | 72 dB/Octave |

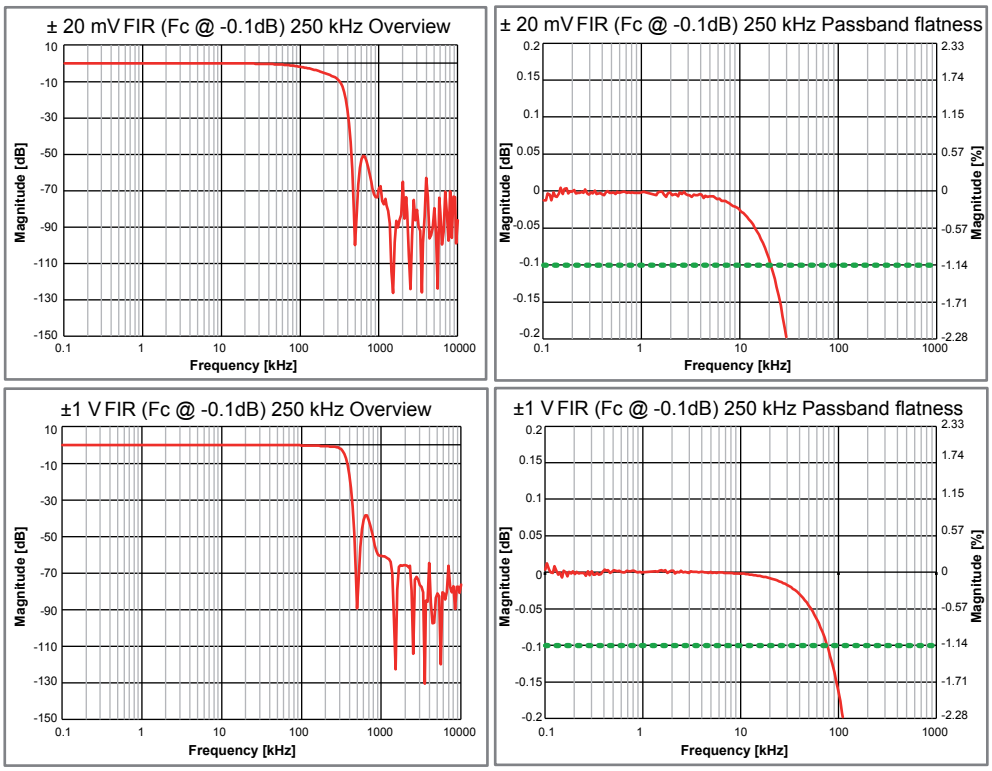
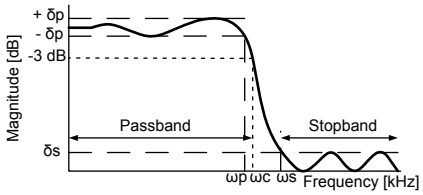



**Figure 1.13:** Representative FIR examples

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

## Digital FIR (Fc @ -3 dB) Filter (Digital Anti-Alias)




δp: Passband ripple
δs: Stopband attenuation

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

**Figure 1.14:** Digital FIR (Fc @ -3 dB) filter

| | |
|---|---|
| When FIR (Fc @ -3 dB) filter is selected, this is always a combination of an analog Butterworth anti-alias filter and a digital FIR filter | |
| Analog anti-alias filter | |
| Characteristic | 7-pole Butterworth, extended pass band response |
| Bandwidth | 140 kHz ± 20 kHz (-3 dB) All Ranges < 100 mV<br>350 kHz ± 20 kHz (-3 dB) All Ranges ≥ 100 mV |
| Digital FIR (Fc @ -3 dB) filter | |
| Characteristic | 12-pole FIR; FIR is a purely digital characteristic. Its closest analog resemblance is to an Elliptic filter. However, FIR has both ringing on the signal before the step input is started and ringing after the step input is complete. |
| User selection | Auto tracking for sample rate divided by: 4, 10, 20, 40<br>Divided by 40 not available for 1 MS/s & 500 kS/s sample rate<br>User selects divide factor, software then adjusts filter when sample rate is changed |
| Bandwidth (ωc) | User selectable from 0.031 Hz to 250 kHz |
| 0.1 dB passband flatness (ωp)(1) | DC to ≈ωc/1.4 (Adapter FIR filter behavior)<br>DC to 50 kHz; bandwidth selection ωc = > 50 kHz, limited by the analog anti-alias filter amplitude response.<br>For all Ranges < 100 mV, ωp is limited to 10 kHz due to an anti-alias filter. |
| Stopband attenuation (δs) | 60 dB; With the bandwidth selection of ωc = 250 kHz, a peak of -45 dB occurs between 500 kHz and 1 MHz due to limited analog anti-alias filter amplitude reduction. At lower bandwidth selections, the digital filter reduces this peak to -60 dB. |
| Roll-off | 72 dB/Octave |

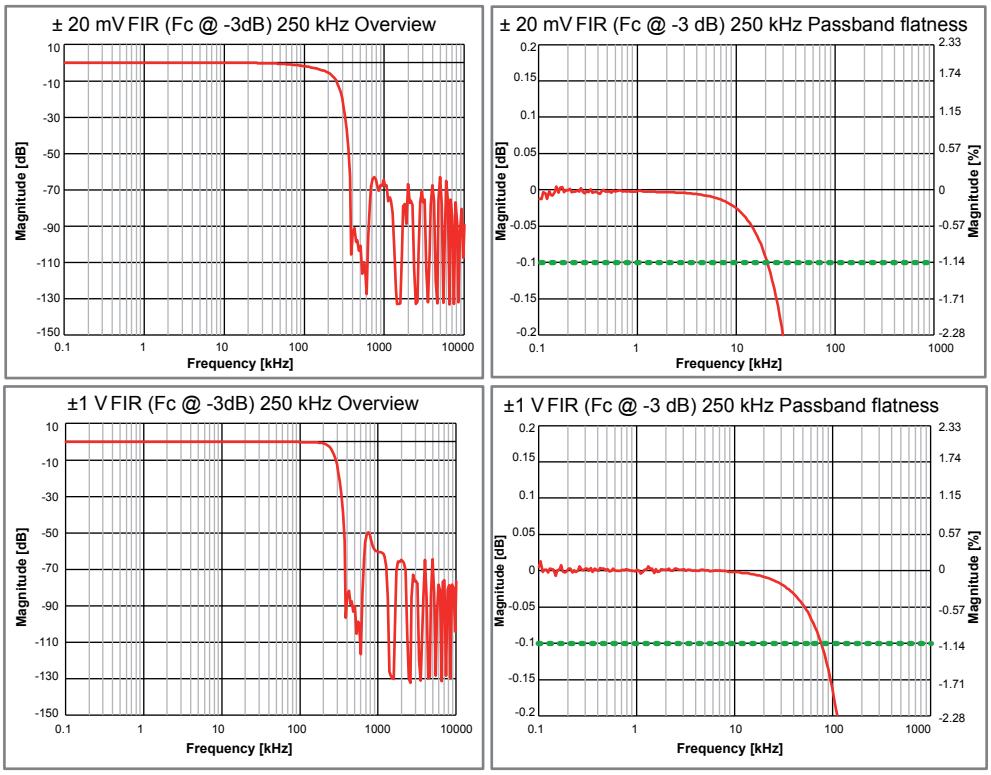



**Figure 1.15:** Representative FIR examples

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

| On-board Memory | |
|---|---|
| Per card | 512 MB (256 MS) |
| Organization | Automatic distribution amongst enabled channels |
| Memory diagnostics | Automatic memory test when system is powered on but not recording |
| Storage sample size | 16 bits, 2 bytes/sample |

| Digital Events/Timer/Counter | |
|---|---|
| Digital event inputs | Not supported |
| Digital event outputs | Not supported |
| Timer/Counter | Not supported |

| Triggering | |
|---|---|
| Channel trigger/qualifier | 1 per channel; fully independent per channel, software selectable either trigger or qualifier |
| Pre- and post-trigger length | 0 to full memory |
| Maximum trigger rate | 400 triggers per second |
| Manual trigger (Software) | Supported |
| External Trigger In | |
| Selection per card | User selectable On/Off |
| Active edge | Rising/Falling mainframe selectable, identical for all cards |
| Minimum pulse width | 500 ns |
| Delay | ± 1 µs + maximum 1 sample period (for decimal and binary time base) |
| Send to External Trigger Out | User can select to forward External Trigger In to the External Trigger Out BNC |
| External Trigger Out | |
| Selection per card | User selectable On/Off |
| Active level | High/Low/Hold High; selectable per mainframe, identical for all cards |
| Pulse width | High/Low: 12.8 µs<br>Hold high: Active from first mainframe trigger to end of recording<br>Pulse width created by mainframe |
| Delay | 516 µs ± 1 µs + maximum 1 sample period using decimal time base<br>504 µs ± 1 µs + maximum 1 sample period using binary time base |
| Cross channel triggering | |
| 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 |
| Pulse detect/reject | Disable/Detect/Reject software selectable. Maximum pulse width 65 535 samples |
| dY/dT conversion | dY: 16 bit (0.0015%) for both levels<br>dT: 1 to 1023 samples. dT setting shared for both levels |
| Analog channel trigger modes | |
| Basic | POS or NEG crossing; single level |
| Dual level | One POS and one NEG crossing; Two individual levels, OR-ed |
| Window | Arm/trigger and a disarm level; Trigger on peak level changes in a uni-polar signal |
| Dual Window | Arm/trigger/disarm per level; Trigger on peak level changes in a bi-polar signal |
| Sequential | One arm and one trigger level; eliminate false triggering due to noise or hysteresis |
| Analog channel qualifier modes | |
| Basic | Above or below level check. Enable/disable trigger with single level |
| Dual (level) | Outside or within bounds check. Enable/disable trigger with dual level |
| Trigger hold off | Disable channel trigger for 1 to 65 535 samples after trigger detected<br>Maximum hold off time depends on sample rate |

## Triggering

| | |
|---|---|
| Interval timer | |
| Modes | Less than, trigger when rate is too low<br>More than, trigger when rate is too high<br>Between, trigger when rate between lower and upper limit<br>Not between, trigger when rate is not between lower and upper limit |
| Interval timers | Start timer and width Timer |
| Timer value | 1 to 65 535 samples |
| Event counter | Counts channel trigger events before card trigger is activated<br>1 to 256 trigger events |

## Alarm Output

| | |
|---|---|
| Selection per card | User selectable On/Off |
| Alarm modes | Basic or Dual |
| Basic | Above or below level check |
| Dual (level) | Outside or within bounds check |
| Alarm levels | |
| Levels | Maximum 2 level detectors |
| Resolution | 16 bit (0.0015%) for each level |
| Alarm output | Active during valid alarm condition, output supported through mainframe |
| Alarm output delay | 515 µs ± 1 µs + maximum 1 sample period using decimal time base<br>503 µs ± 1 µs + maximum 1 sample period using binary time base |

## Real-Time Analysis

| | |
|---|---|
| StatStream®<br>Patent Number : 7,868,886 | Each channel includes real-time extraction of Maximum, Minimum, Mean, Peak-to-Peak, Standard Deviation and RMS values<br>Supports the real-time live scrolling and scoping of waveform displays and the real-time meters while recording<br>Supports fast displaying and zooming within extremely large recordings<br>Supports fast calculations of statistical channel information |

## Acquisition Modes

| | |
|---|---|
| Single sweep | Triggered acquisition to on-board memory without sample rate limitations; for single transients or intermittent phenomena. No aggregate sample rate limitations. |
| Multiple sweeps | Triggered acquisition to on-board memory without sample rate limitations; for repetitive transients or intermittent phenomena. No aggregate sample rate limitations. |
| Slow-Fast Sweep | Identical to single sweep acquisition with additional support for fast sample rate switches during the post-trigger segment of the slow rate single sweep settings. No aggregate sample rate limitations. 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.<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. |

## Recording Mode Details

| | Single Sweep<br>Multiple Sweeps<br>Slow-Fast Sweep | | | Continuous | | | Dual Rate | | |
|---|---|---|---|---|---|---|---|---|---|
| | Enabled channels | | | Enabled channels | | | Enabled channels | | |
| | 1 Ch | 2 Ch | 4 Ch | 1 Ch | 2 Ch | 4 Ch | 1 Ch | 2 Ch | 4 Ch |
| Max. sweep memory | 252 MS | 126 MS | 63 MS | not used | | | 200 MS | 100 MS | 50 MS |
| Max. sweep sample rate | 1 MS/s | | | not used | | | 1 MS/s | | |
| Max. continuous FIFO | not used | | | 252 MS | 126 MS | 63 MS | 50 MS | 25 MS | 12 MS |
| Max. continuous sample rate | not used | | | 1 MS/s | | | Sweep sample rate / 2<br>Maximum 50 kS/s | | |
| Max. aggregate continuous streaming rate | not used | | | 1 MS/s<br>2 MB/s | 2 MS/s<br>4 MB/s | 4 MS/s<br>8 MB/s | 0.05 MS/s<br>0.1 MB/s | 0.1 MS/s<br>0.2 MB/s | 0.4 MS/s<br>0.8 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. |
| 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 or 50 kS/s per channel, whichever is the smallest sample rate |
| Maximum 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) (Supported by Perception V6.30 or higher) |
| 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

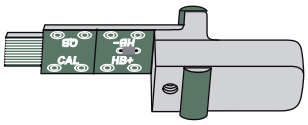
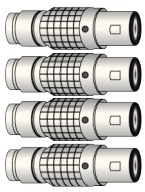
| | |
|---|---|
| **Electrical Safety** | |
| EN 61010-1 (2010) | Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements |
| EN 61010-2-030 (2010) | Particular requirements for testing and measuring circuits |
| **Electromagnetic Compatibility** | |
| 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 |
| 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 |

## Ordering Information[1]

| Article | | Description | Order No. |
|---|---|---|---|
| Bridge1M ISO |  | 4 channels, 16 bits,1 MS/s, ± 2 mV to ± 10 V input range, 512 MB RAM (256 MS), isolated, balanced differential Bridge input, with 16 pin LEMO for each channel | 1-GN411-2 |

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

## Options, to be ordered separately

| Article | | Description | Order No. |
|---|---|---|---|
| Bridge completion pack |  | GEN DAQ Bridge completion/shunt cal resistor cards, 4 additional pieces (4 pieces included in both GN410 and GN411) | 1-G021-2 |
| 16 pin LEMO connector pack |  | LEMO connector for Bridge Card GN410 and GN411; 4 additional pieces (4 pieces included in both GN410 as well as GN411) | 1-G069-2 |



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B2639-2.1 en HBM: public