DATA SHEET

GEN series GN3210
Basic/IEPE/Charge 250 kS/s Input Card

SPECIAL FEATURES

- Charge transducer support
- IEPE transducer support
- TEDS Class 1 support for IEPE
- 32 analog channels
- Balanced differential inputs
- ± 10 mV to ± 20 V input range
- Analog/digital anti-alias filters
- Digital Elliptic bandpass filters
- 250 kS/s sample rate
- 24 bit resolution
- Real-time cycle based calculators with triggering on calculated result
- Digital Event/Timer/Counter support
- Up to ± 10 kV input range using passive probe (option)
- Up to ± 1.2 kA input range using current clamp (option)

GN3210 Functions and Benefits

In differential mode, the card can be used in electrically noisy environments. The CMRR of the true differential amplifiers ensures high signal fidelity.
When using the passive voltage probe and/or the current clamp options, the card can be used as an entry-level electrical-input amplifier to measure high voltages and currents.
In single-ended mode, the card can serve as a cost effective input for preconditioned signals to be recorded with the GEN DAQ series of products.
In IEPE mode the card supports open and shorted wire detection and TEDS sensor setup, with excellent price/performance ratio for an array of IEPE based sensors (accelerometers, microphones, etc.).
The high dynamic range of the amplifier and the 24 bit A/D converter as well as the excellent band-pass flatness up to a 100 kHz bandwidth ensure phase alignment and accurate amplitude measurements.

In charge mode, the card can be used directly with charge type sensors, such as piezoelectric accelerometers or pressure transducers.
Superior, best in class anti-alias protection is achieved by a unique, multi stage approach.
The first stage the Sigma Delta converter with built-in anti-aliasing filter creates an alias free digital data stream at constant rate of 250 kS/s.
The second stage feeds the 250 kS/s data stream into a user selectable digital filter, to reduce the signal to the desired maximum bandwidth. The digital filter supports both 11 or 12 orders as well as Bessel/Butterworth or Elliptic filter characteristics.
The third stage decimates the 250 kS/s filtered signal to the desired sample rate.
The digital filter before decimation guarantees a superior phase match, ultra-low noise and alias free result.

Capabilities Overview

Model	GN3210
Maximum sample rate per channel	250 kS/s
Memory per card	2 GB
Analog channels	32
Anti-alias filters	Fixed bandwidth analog AA-filter combined with sample rate tracking digital AA-filter
ADC resolution	16/24 bit
Isolation	Not supported
Input type	Analog balanced differential
Passive voltage/current probes	Passive, single-ended voltage probes Passive, differential matched voltage probes
Sensors	IEPE and charge
TEDS	Class 1, IEPE sensors
Real-time formula database calculators (option)	Not supported
Digital Event/Timer/Counter	16 digital events and 2 Timer/Counter channels
Standard data streaming (CPCI up to 200 MB/s)	Yes, supported by all GEN series mainframes
Fast data streaming (PCIe up to 1 GB/s)	Not supported
Slot width	1

Mainframe Support

	GEN2tB	GEN4tB	GEN7tA / GEN7tB (2)	GEN17tA	GEN17tB	GEN3iA	GEN7iA / GEN7iB (2)
GN3210/GN3211	No	No	Yes	Yes	No	Yes	Yes
GEN DAQ API	Yes					Yes(1)	
EtherCAT®	No						
CAN/CAN FD	No						

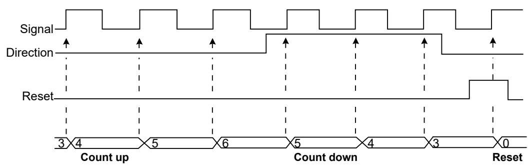
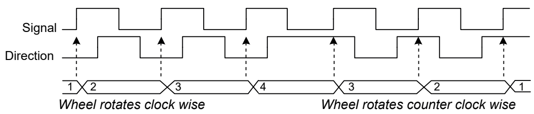
(1) Close Perception to enable GEN DAQ API access.

(2) GEN7tB/GEN7iB with limited support (first three slots only)

Supported Analog Sensors and Probes

Perception input type	Sensor/probe types	Remarks
Basic voltage	• Electrical voltages single-ended and differential • Active single-ended probes • Active differential probes	• ± 10 mV up to ± 20 V • D-sub connector • D-sub to BNC cables KAB171 and KAB172
Charge	• Piezo-electric sensors	• ± 10 pC up to ± 2 nC • AC input coupled • D-sub to BNC cables KAB171 and KAB172
IEPE	• IEPE based sensors like accelerometers, microphones and pressure transducers • ICP® Accelerometers	• ± 10 mV up to, ± 20 V • IEPE current: 2, 4, 6 or 8 mA @ ≥ 22 V • TEDS class I • Sensor connected, open or shorted diagnostics • D-sub to BNC cables KAB171 and KAB172

Supported Digital Sensors (TTL Level Input)

Timer counter Input type	Supported digital sensors	Features
 **Figure 1:** Uni and Bi-directional clock	• Frequency / RPM • Count/position	• Count frequency up to 5 MHz • Input signal minimum width setting • Several reset options
 **Figure 2:** ABZ Incremental Encoder (Quadrature)	• Angle • Frequency / RPM • Count/position	• Count frequency up to 2 MHz • Single, dual and quad precision count • Input signal minimum width setting • Transition tracking to avoid count drift • Several reset options

Block Diagram

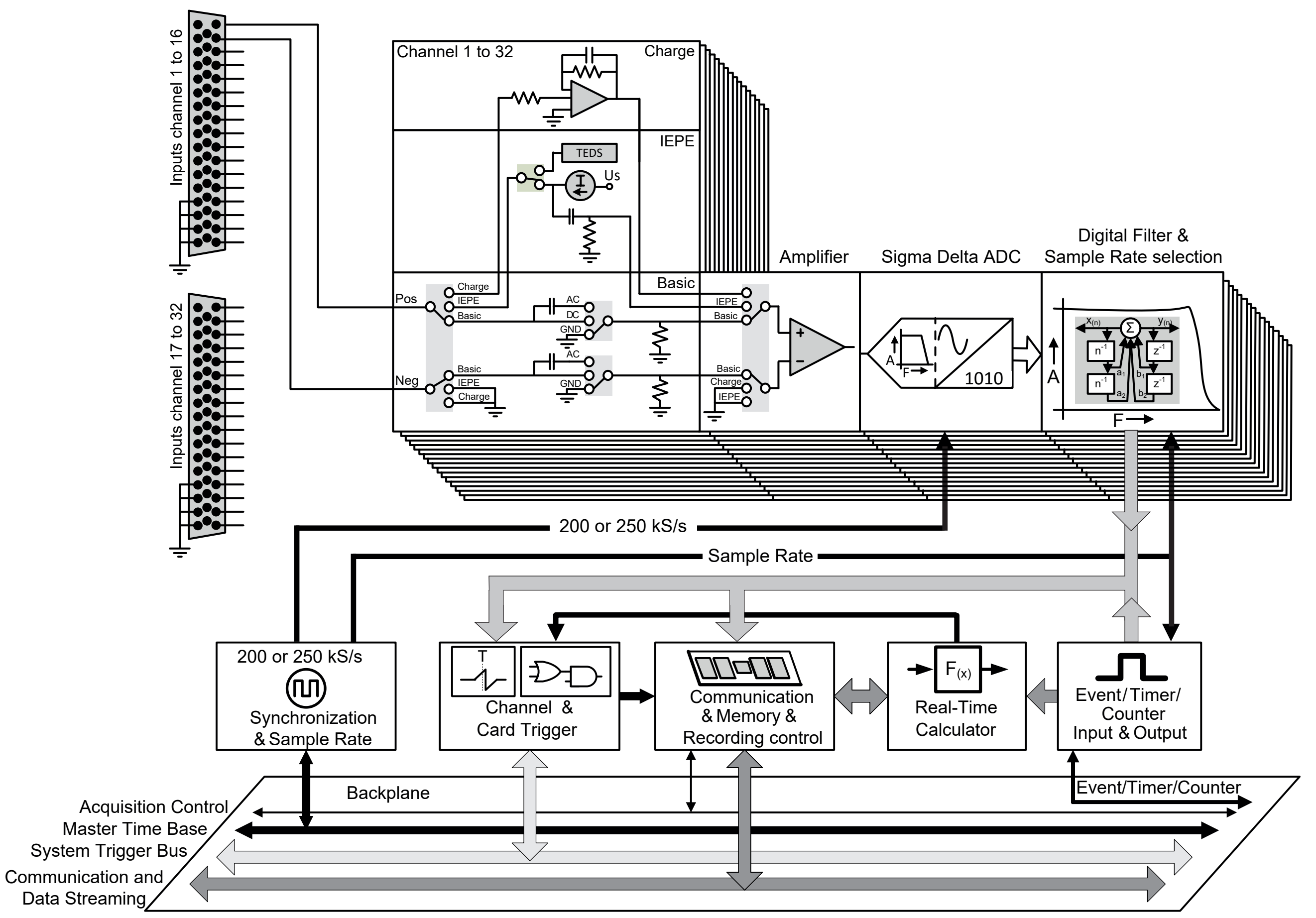


Figure 3: Block diagram

Specifications and measurement uncertainty

Specifications are established using 23 °C environmental temperature.
For measurement uncertainty improvements, the system could be readjusted at a specific environmental temperature to minimize the impact of temperature drift.

Any analog amplifier error source follows the = **a**x + **b** curve.

a % of reading error, represents the linear increasing error due to the increase of the input voltage: often referred to as gain error.
b % of range error, represents the error when measuring 0 V; often referred to as offset error.
For measurement uncertainty these errors can be considered independent error sources.

Noise is not a separate error source outside of the standard specification.
Noise specifications are added separately in case you need dynamic accuracy on sample by sample level.
Only for sample by sample measurement uncertainty add the RMS noise error.
For e.g. power accuracy, the RMS noise error is already included in the power specifications.

Pass/Fail limits are rectangular distributed specifications, therefore measurement uncertainty is 0.58 * specified value.

Adding/removing or swapping cards

The specifications listed are valid for cards that have been calibrated and are used in the same mainframe, mainframe configuration and slots as they were at the time of calibration.
If cards are added, removed or relocated the thermal conditions of the card will change, resulting in additional thermal drift errors. The maximum expected error can be up to two times the specified Reading and Range error as well as 10 dB reduced common mode rejection.
Recalibration after configuration changes is therefore highly recommended.

Analog Input Section	
Channels	32
Connectors	D-Sub (DD-50) connector
Input type	Analog isolated balanced differential
Input coupling	Differential, single-ended (positive or negative)
Signal input coupling	
Coupling modes	AC, DC, GND
AC coupling frequency	1.6 Hz ± 10%; - 3 dB

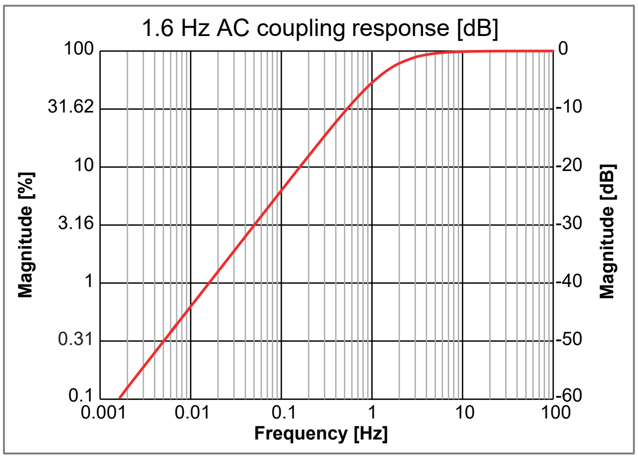


Figure 4: Representative AC coupling response

Impedance	2 x 1 MΩ ± 0.5% // 75 pF ± 15%
Ranges	± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V
Offset	± 50% in 1000 steps (0.1%); ± 20 V range has fixed 0% offset
DC Range error *(Pass/Fail limits)*	
Wideband	0.01% of range ± 25 µV
All IIR filters	0.01% of range ± 25 µV
DC range error drift	±(10 ppm + 2 µV)/°C (±(6 ppm + 1.5 µV)/°F)
DC Reading error *(Pass/Fail limits)*	
Wideband	0.015% of reading ± 25 µV
All IIR filters	0.015% of reading ± 25 µV
DC reading error drift	± 10 ppm/°C (± 6 ppm/°F)
RMS Noise (50 Ω terminated) *(Pass/Fail limits)*	
Wideband	0.01% of range ± 25 µV
All IIR filters	0.01% of range ± 25 µV

Analog Input Section		
Common mode (referred to system ground)		
Ranges	Less than ± 2 V	Larger than or equal to ± 2 V
Rejection (CMR)	> 80 dB @ 80 Hz (100 dB typical)	> 60 dB @ 80 Hz (80 dB typical)
Maximum common mode voltage	2 V RMS	33 V RMS

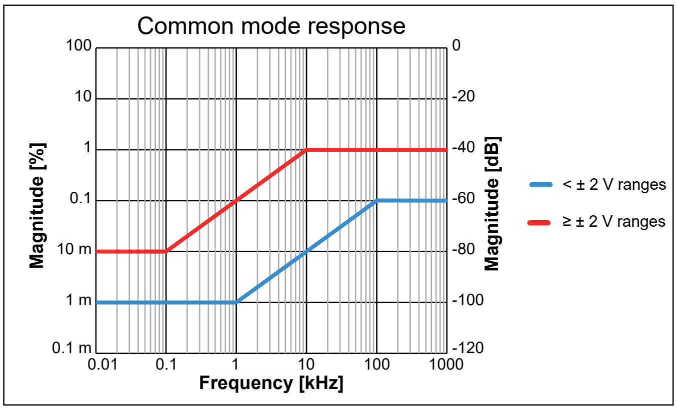


Figure 5: Representative common mode response

Input overload protection	
Overvoltage impedance change	The activation of the over voltage protection system will result in a reduced input impedance. The over voltage protection will not be active as long as the input voltage is less than 200% of the selected input range or 50 V DC whichever is the smallest value.
Maximum nondestructive voltage	± 50 V DC
Overload recovery time	Restored to 0.1% accuracy in less than 5 µs after 200% overload

Input Ranges When Using Passive Voltage Probes

Detailed probe specifications can be found at the end of this datasheet

Single-ended	**Added voltage ranges**
G901 (10:1 divide factor)	± 50 V, ± 100 V, ± 200 V
G902 (10:1 divide factor)	± 50 V, ± 100 V, ± 200 V
G903 (100:1 divide factor)	± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1 kV
G904 (100:1 divide factor)	± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1 kV, ± 2 kV
G906 (1000:1 divide factor)	± 50 V, ± 100 V, ± 200 V, ± 500 V, ± 1 kV, ± 2 kV, ± 5 kV, ± 10 kV (± 20 kV @ DC to 60 Hz)
Differential matched	**Added voltage ranges**
G907 (10:1 divide factor)	± 50 V, ± 100 V, ± 200 V

Input Ranges When Using Active Differential Voltage Probes

G909 (20:1 divide factor)	± 140 V RMS input and ± 1000 V RMS common mode
G909 (200:1 divide factor)	± 1000 V RMS input and ± 1000 V RMS common mode

Input Ranges When Using Current Clamps

Detailed probe specifications can be found at the end of this datasheet

Clamp type	**Added current ranges**
G912 (AC/DC)	± 30 mA to ± 30 A DC ± 30 mA to ± 20 A RMS
G913 (AC)	± 100 mA to ± 1000 A RMS
G914 (AC)	± 50 mA to ± 20 A RMS

IEPE Sensor	
In IEPE mode the negative input of each channel is internally grounded. Best measurement results can be obtained if the negative input pin of each channel is used for the coaxial ground/shield. The return current then flows straight to the channel ground and not to the common card ground.	
Input ranges	± 10 mV, ± 20 mV, ± 50 mV, ± 0.1 V, ± 0.2 V, ± 0.5 V, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V
Overvoltage protection	- 1 V to 22 V DC
IEPE reading error *(Pass/Fail limits)*	0.1% of reading ± 300 µV
IEPE reading error drift *(Pass/Fail limits)*	± 10 ppm/°C (± 6 ppm/°F)
IEPE compliance voltage	≥ 22 V
Excitation current	2, 4, 6, 8 mA, software selectable
Excitation current accuracy	± 5%
Coupling time constant	1.5 s
-3 dB high pass bandwidth	0.11 Hz
Maximum cable length	100 m (RG-58)
Wire diagnostics	Open and shorted IEPE wiring detected (Requires Perception V7.00 or higher)
TEDS support	Class 1, including software selectable auto detect the presence of an attached sensor

Charge Amplifier	
In charge mode the negative input of each channel is internally grounded. Best measurement results can be obtained if the negative input pin of each channel is used for the coaxial ground/shield. The return current then flows straight to the channel ground and not to the common card ground.	
Input ranges	± 10 pC, ± 20 pC, ± 50 pC, ± 100 pC, ± 200 pC, ± 0.5 nC, ± 1 nC, ± 2 nC
Over voltage protection	± 20 V DC
Charge reading error (*Pass/Fail limits*)	± 2% of reading
Charge reading error drift (*Pass/Fail limits*)	± 30 ppm/°C (± 17 ppm/°F)
-3 dB high pass bandwidth limit	1 Hz
-3 dB low pass bandwidth limit	33 kHz ± 10% when a 650 pF source capacity is used 106 kHz ± 10% when a 250 pF source capacity is used
TEDS support	No

Channel Earthing

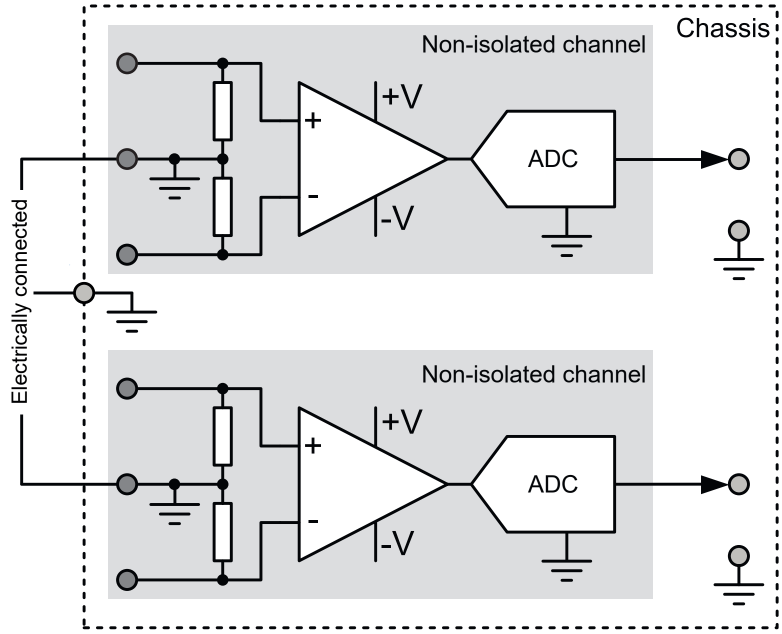


Figure 6: Earthing schematic

Analog to Digital Conversion

Sample rate; per channel	1 S/s to 250 kS/s
ADC resolution; one ADC per channel	24 bit
ADC type	Sigma Delta (Σ-Δ) ADC; Analog Devices AD7764BRUZ
Time base accuracy	Defined by mainframe: ± 3.5 ppm; aging after 10 years ± 10 ppm

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

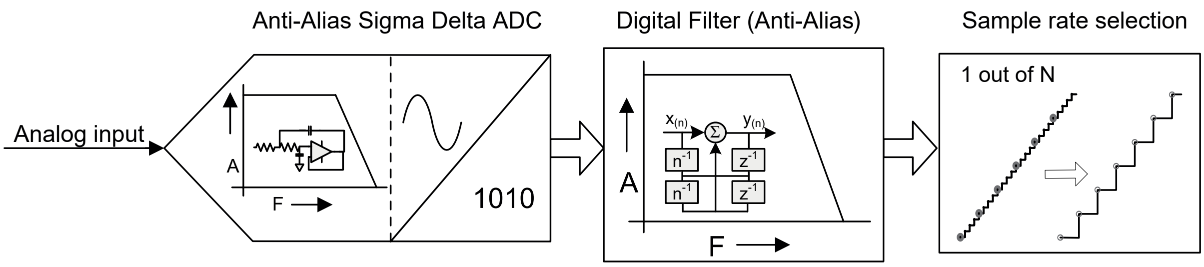


Figure 7: Combined analog and digital anti-alias filter block diagram

Anti-aliasing is prevented by a steep, fixed frequency analog anti-alias filter integrated inside the Sigma Delta Analog to Digital Converter (ADC) always sampling at a fixed sample rate. This setup avoids the need for other analog anti-alias filters.
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.

Sigma Delta Wideband	When Sigma Delta wideband is selected the built-in anti-alias filter of the Sigma Delta ADC (no digital filter) is always in the signal path. Therefore, the anti-alias protection is always active when Sigma Delta wideband is selected.
Bessel IIR	When Bessel IIR filter is selected, this is always a combination of the built-in anti-alias filter of the Sigma Delta ADC and a digital Bessel IIR filter. 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 the built-in anti-alias filter of the Sigma Delta ADC and a digital Butterworth IIR filter. 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 the built-in anti-alias filter of the Sigma Delta ADC and a digital Elliptic IIR filter. 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 Bandpass IIR	When Elliptic Bandpass IIR filter is selected, this is always a combination of the built-in anti-alias filter of the Sigma Delta ADC and a digital Elliptic Bandpass IIR filter. Elliptic Bandpass filters are 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.

Bandwidth and Filter Characteristic Selection versus Sample Rate

The digital filter before decimation guarantees a superior phase match, ultra-low noise and alias free result.

	AA-filter[1]	Digital lowpass filters (alias free)					Digital bandpass[2]	
	Sigma Delta	Butterworth IIR Elliptic IIR	Bessel IIR Butterworth IIR Elliptic IIR	Bessel IIR Butterworth IIR Elliptic IIR	Bessel IIR Butterworth IIR Elliptic IIR	Bessel IIR	Elliptic IIR	
User selectable sample rates		**1/4 Fs**	**1/10 Fs**	**1/20 Fs**	**1/40 Fs**	**1/100 Fs**	**Highpass**	**Lowpass**
250 kS/s	ΣΔ Wideband	62.5 kHz	25 kHz	12.5 kHz	6.25 kHz	2.5 kHz	40 Hz, 100 Hz	2 kHz, 20 kHz, 40 kHz, 50 kHz
200 kS/s	ΣΔ Wideband	50 kHz	20 kHz	10 kHz	5 kHz	2 kHz		
125 kS/s	ΣΔ Wideband	25 kHz	12.5 kHz	6.25 kHz	2.5 kHz	1.25 kHz		
100 kS/s	ΣΔ Wideband	20 kHz	10 kHz	5 kHz	2 kHz	1 kHz		
50 kS/s	ΣΔ Wideband	12.5 kHz	5 kHz	2.5 kHz	1.25 kHz	500 Hz		
40 kS/s	ΣΔ Wideband	10 kHz	4 kHz	2 kHz	1 kHz	400 Hz		
25 kS/s	ΣΔ Wideband	6.25 kHz	2.5 kHz	1.25 kHz	625 Hz	250 Hz		
20 kS/s	ΣΔ Wideband	5 kHz	2 kHz	1 kHz	500 Hz	200 Hz		
12.5 kS/s	ΣΔ Wideband	2.5 kHz	1.25 kHz	625 Hz	312.5 Hz	125 Hz		
10 kS/s	ΣΔ Wideband	2 kHz	1 kHz	500 Hz	250 Hz	100 Hz		
5 kS/s	ΣΔ Wideband	1.25 kHz	500 Hz	250 Hz	125 Hz	50 Hz		
4 kS/s	ΣΔ Wideband	1 kHz	400 Hz	200 Hz	100 Hz	40 Hz		
2.5 kS/s	ΣΔ Wideband	625 Hz	250 Hz	125 Hz	62.5 Hz	25 Hz		
2 kS/s	ΣΔ Wideband	500 Hz	200 Hz	100 Hz	50 Hz	20 Hz		
1.25 kS/s	ΣΔ Wideband	312.5 Hz	125 Hz	62.5 Hz	31.25 Hz	12.5 Hz		
1 kS/s	ΣΔ Wideband	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz		
500 S/s	ΣΔ Wideband	125 Hz	50 Hz	25 Hz	12.5 Hz	5 Hz		
400 S/s	ΣΔ Wideband	100 Hz	40 Hz	20 Hz	10 Hz	4 Hz		
250 S/s	ΣΔ Wideband	62.5 Hz	25 Hz	12.5 Hz	6.25 Hz	2.5 Hz		
200 S/s	ΣΔ Wideband	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz		
125 S/s	ΣΔ Wideband	31.25 Hz	12.5 Hz	6.25 Hz	3.125 Hz	1.25 Hz		
100 S/s	ΣΔ Wideband	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz		
50 S/s	ΣΔ Wideband	12.5 Hz	5 Hz	2.5 Hz	1.25 Hz	0.5 Hz		
40 S/s	ΣΔ Wideband	10 Hz	4 Hz	2 Hz	0.5 Hz	0.4 Hz		
25 S/s	ΣΔ Wideband	6.25 Hz	2.5 Hz	1.25 Hz	0.625 Hz	0.25 Hz		
20 S/s	ΣΔ Wideband	5 Hz	2 Hz	0.5 Hz	0.5 Hz	0.2 Hz		
12.5 S/s	ΣΔ Wideband	3.125 Hz	1.25 Hz	0.625 Hz	0.3125 Hz	0.125 Hz		
10 S/s	ΣΔ Wideband	2.5 Hz	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz		

(1) Sigma Delta ΣΔ Wideband prevents aliasing before the digitization of the signal.

(2) Digital bandpass filters are selectable in all sample rates.

Sigma Delta Wideband (Analog Anti-Alias)

When Sigma Delta wideband is selected there is always the built-in anti-alias filter of the Sigma Delta ADC (no digital filter) in the signal path. Therefore there is always anti-alias protection when wideband is selected. Care must be taken as this filter introduces slight overshoots on square wave or pulse response signals. Signals of sine wave type will not be effected.

Wideband	
Characteristic	Sigma delta, optimal frequency response
-3 dB Bandwidth	100 kHz ± 5 kHz for sample rates 250 kS/s and 125 kS/s 80 kHz ± 5 kHz for all other sample rates
0.1 dB passband flatness [(1)]	DC to 20 kHz

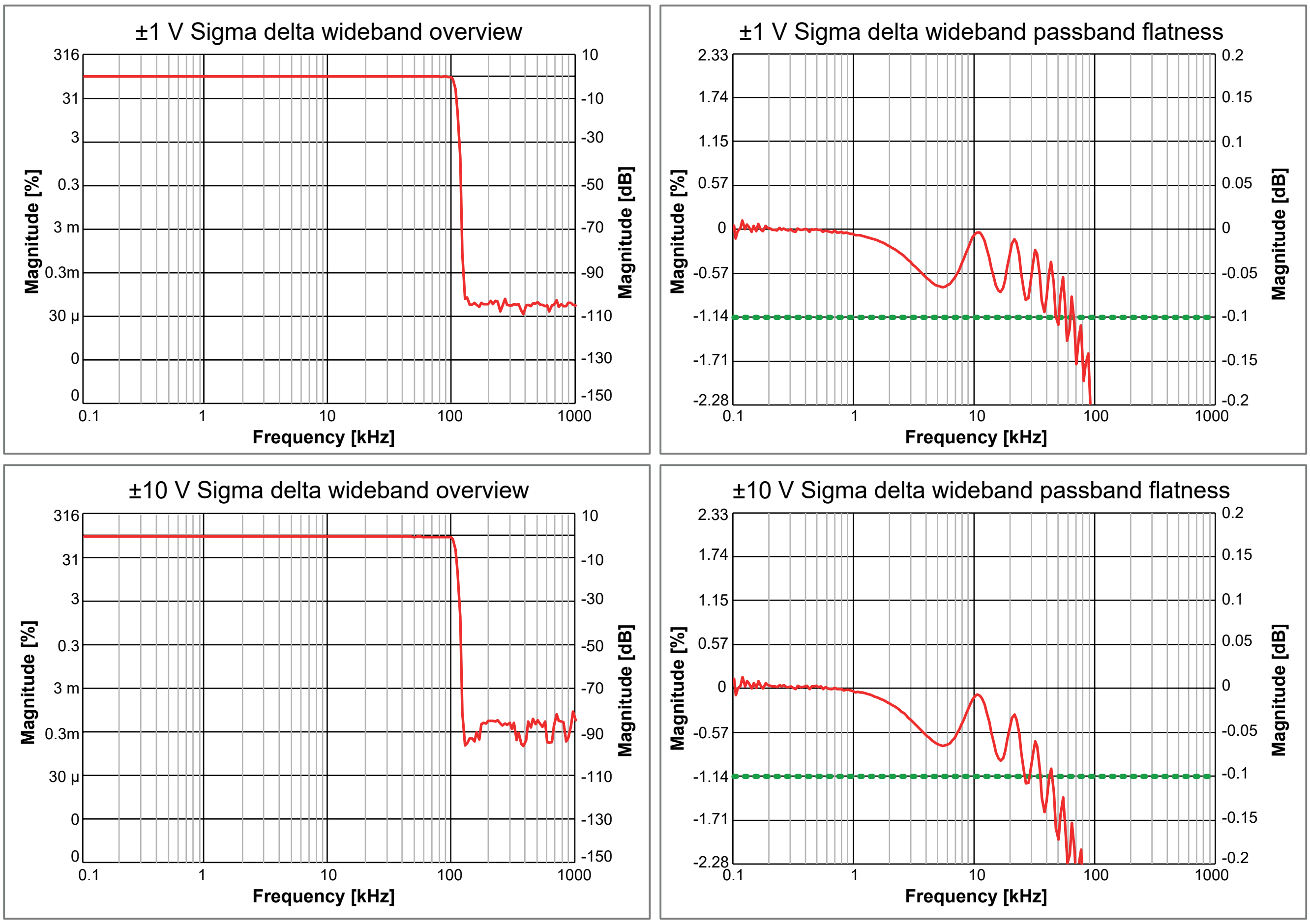
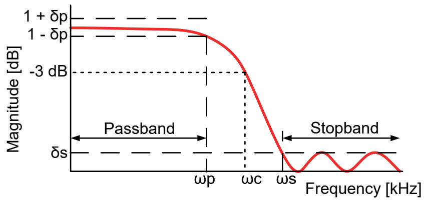


Figure 8: Representative Sigma Delta Wideband examples

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

Bessel IIR Filter (Digital Anti-Alias)



δp: Passband ripple
δs: Stopband attenuation

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

Figure 9: Digital Bessel IIR Filter

When Bessel IIR filter is selected, this is always a combination of the built-in anti-alias filter of the Sigma Delta ADC and a digital Bessel IIR filter.	
Analog anti-alias filter	
Characteristic	Sigma delta, optimal frequency response
-3 dB low pass bandwidth	100 kHz ± 5 kHz for sample rates 250 kS/s and 125 kS/s 80 kHz ± 5 kHz for all other sample rates
Bessel IIR Filter	
Characteristic	12-pole Bessel style IIR 8-pole Bessel style IIR filter frequencies ωc = 25 kHz and ωc = 12.5 kHz
User selection	Auto tracking to sample rate divided by: 10, 20, 40, 100 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bandwidth (ωc)	User selectable from 40 Hz to 25 kHz
0.1 dB passband flatness (ωp)(1)	DC to ωc/10
Stopband attenuation (δs)	80 dB
Roll-off	72 dB/octave for 12-pole filters; 48 dB/octave for 8-pole filters

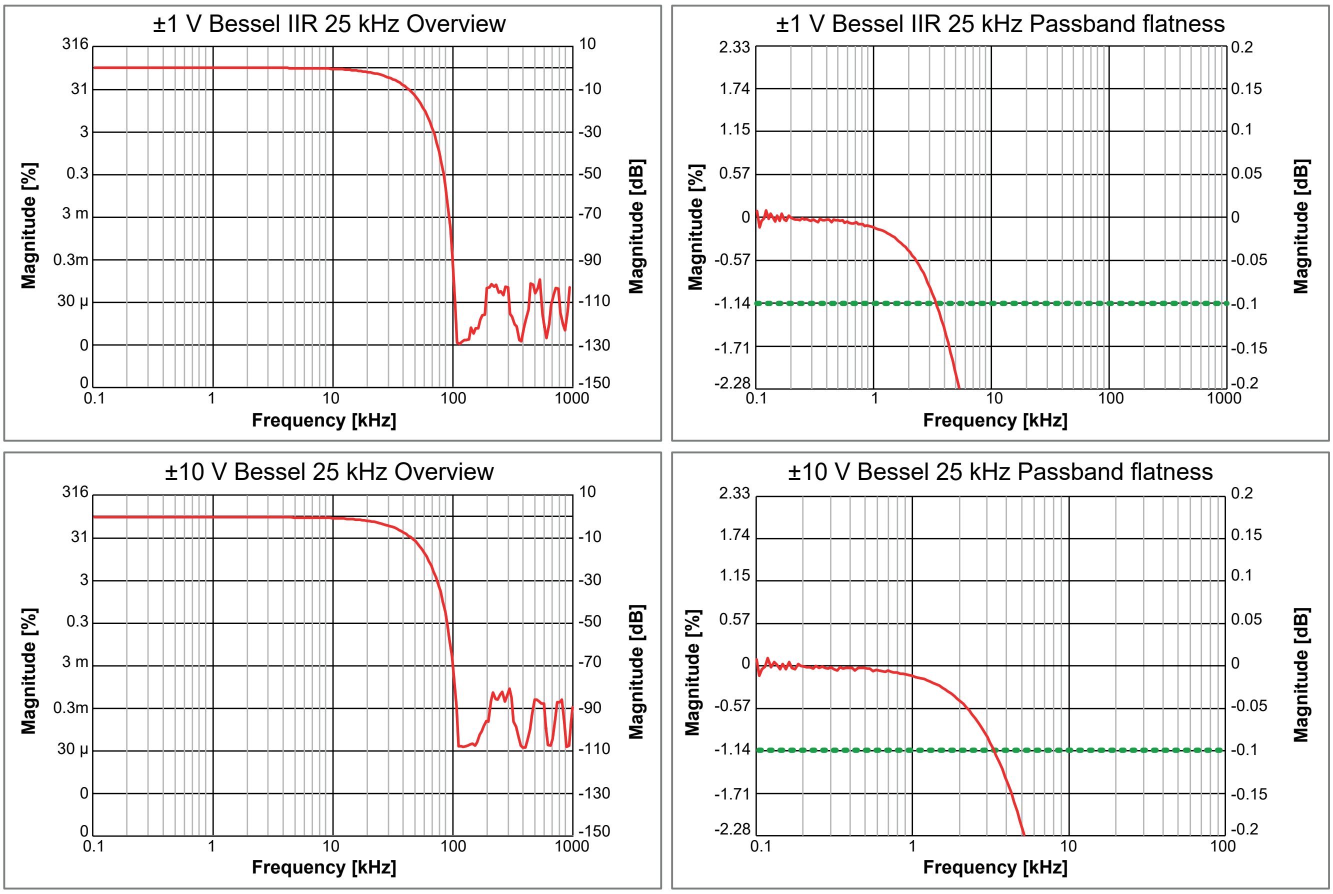
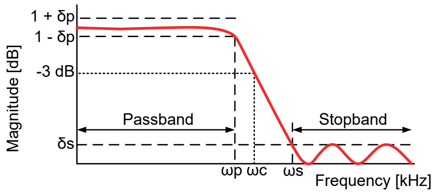


Figure 10: Representative Bessel IIR examples

(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 11: Digital Butterworth IIR Filter

When Butterworth IIR filter is selected, this is always a combination of the built-in anti-alias filter of the Sigma Delta ADC and a digital Butterworth IIR filter.

Analog anti-alias filter	
Characteristic	Sigma delta, optimal frequency response
-3 dB low pass bandwidth	100 kHz ± 5 kHz for sample rates 250 kS/s and 125 kS/s 80 kHz ± 5 kHz for all other sample rates
Butterworth IIR Filter	
Characteristic	12-pole Butterworth style IIR
User selection	Auto tracking to sample rate divided by: 4, 10, 20, 40 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bandwidth (ωc)	User selectable from 100 Hz to 62.5 kHz
0.1 dB passband flatness (ωp)(1)	DC to ωc/2 or maximum 10 kHz
Stopband attenuation (δs)	80 dB
Roll-off	72 dB/octave

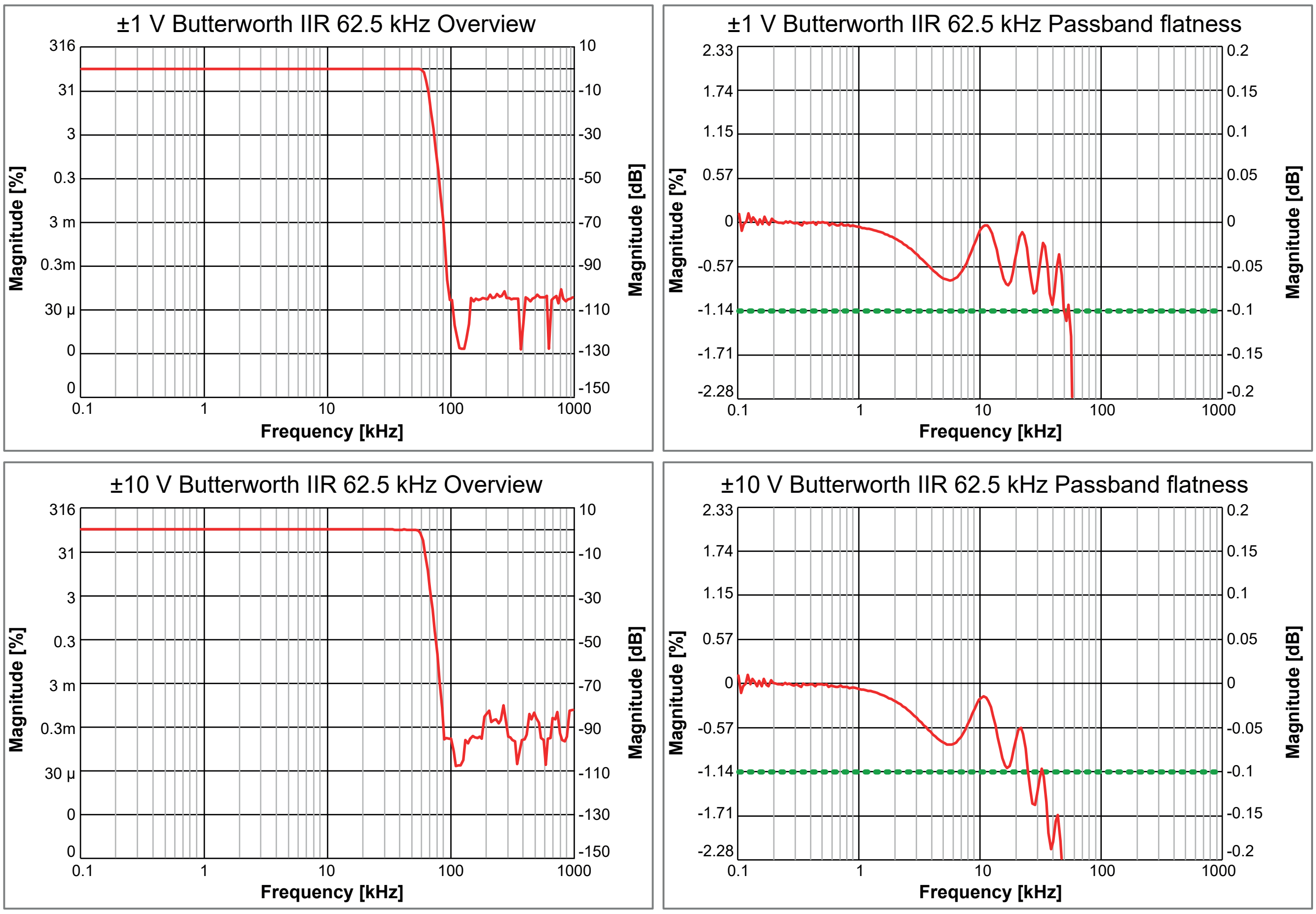
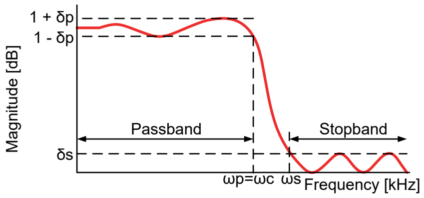


Figure 12: Representative Butterworth IIR examples

(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 13: Digital Elliptic IIR Filter

When Elliptic IIR filter is selected, this is always a combination of the built-in anti-alias filter of the Sigma Delta ADC and a digital Elliptic IIR filter.

Analog anti-alias filter	
Characteristic	Sigma delta, optimal frequency response
-3 dB low pass bandwidth	100 kHz ± 5 kHz for sample rates 250 kS/s and 125 kS/s 80 kHz ± 5 kHz for all other sample rates
Elliptic IIR Filter	
Characteristic	11^{th} order Elliptic style IIR
User selection	Auto tracking to sample rate divided by: 4, 10, 20, 40 User selects divide factor from current sample rate, software then adjusts filter when sample rate is changed
Bandwidth (ωc)	100 Hz to 62.5 kHz
Stopband frequency (ωs)	Approximately 1.25 * ωc
0.1 dB passband flatness (ωp)(1)	DC to ωc/1.5 or maximum 10 kHz
Stopband attenuation (δs)	80 dB

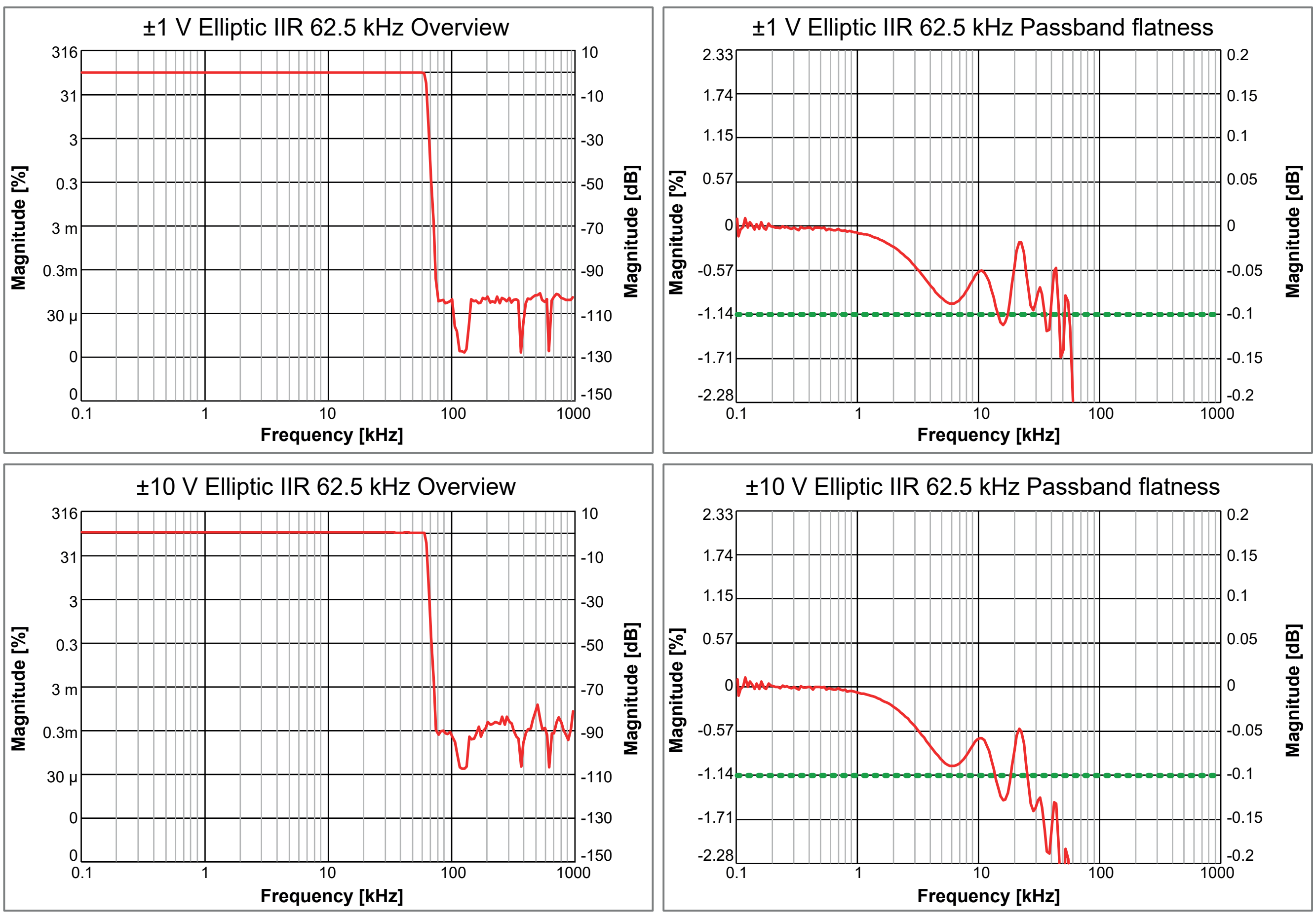
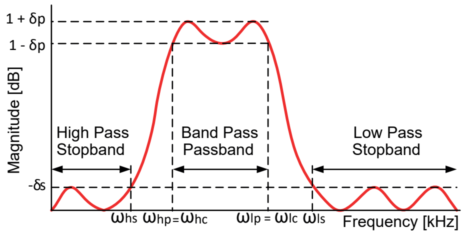


Figure 14: Representative Elliptic IIR examples

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

Elliptic IIR Bandpass Filter (Digital Anti-Alias)



δp: Passband ripple
δs: Stopband attenuation

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

Figure 15: Digital Elliptic IIR Bandpass Filter

When Elliptic IIR filter is selected, this is always a combination of the built-in anti-alias filter of the Sigma Delta ADC and a digital Elliptic IIR filter.	
Analog anti-alias filter	
Characteristic	Sigma delta, optimal frequency response
-3 dB low pass bandwidth	100 kHz ± 5 kHz for sample rates 250 kS/s and 125 kS/s 80 kHz ± 5 kHz for all other sample rates
Elliptic IIR bandpass filter	
Characteristic	14^{th} order Elliptic style IIR
User selection	Two fixed high pass frequencies to be combined with four fixed low pass frequencies
High pass bandwidth (ωhc)	40 Hz and 100 Hz
High pass stopband frequency (ωhs)	Approximately ωhc / 2.5
Low pass bandwidth (ωlc)	2 kHz, 20 kHz, 40 kHz and 50 kHz
Low pass stopband frequency (ωs)	Approximately 1.5 to 2.5 * ωc
0.1 dB passband flatness (ωp)(1)	ωhc to ωlc or maximum 10 kHz
Stopband attenuation (δs)	80 dB

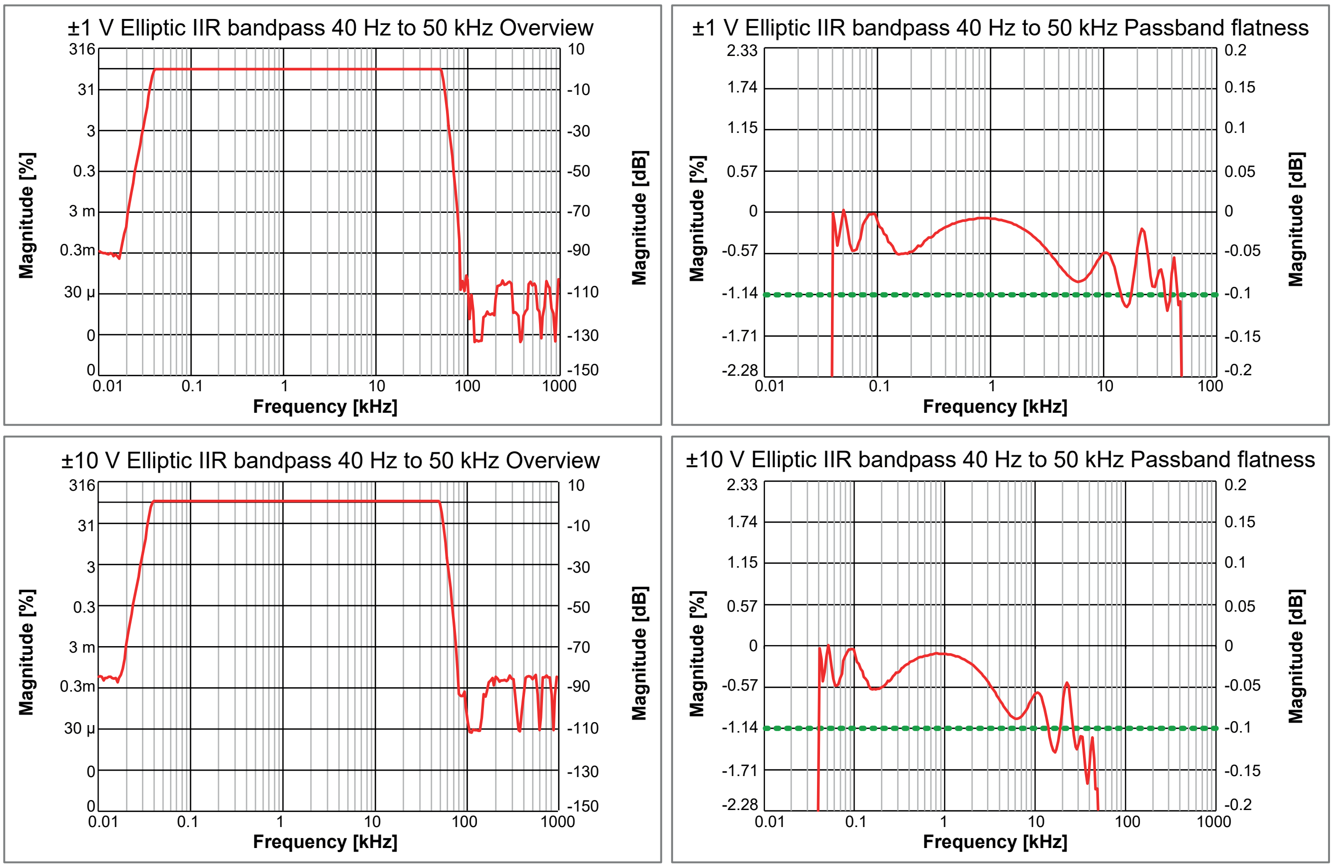


Figure 16: Representative Elliptic IIR band pass examples

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

Channel to Channel Phase Match	
Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths will lead to phase mismatches between channels.	
Wideband	10 kHz Sine wave
Channels on card	0.1 deg (30 ns)
GN3210 Channels within mainframe	0.1 deg (30 ns)
Bessel IIR, Filter frequency 25 kHz @ 250 kS/s	
Channels on card	0.1 deg (30 ns)
GN3210 Channels within mainframe	0.1 deg (30 ns)
Butterworth IIR, Filter frequency 62.5 kHz @ 250 kS/s	
Channels on card	0.1 deg (30 ns)
GN3210 Channels within mainframe	0.1 deg (30 ns)
Elliptic IIR, Filter frequency 62.5 kHz @ 250 kS/s	
Channels on card	0.1 deg (30 ns)
GN3210 Channels within mainframe	0.1 deg (30 ns)
GN3210 channels across mainframes	Defined by synchronization method used (None, IRIG, GPS, Master/Sync, PTP)

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.

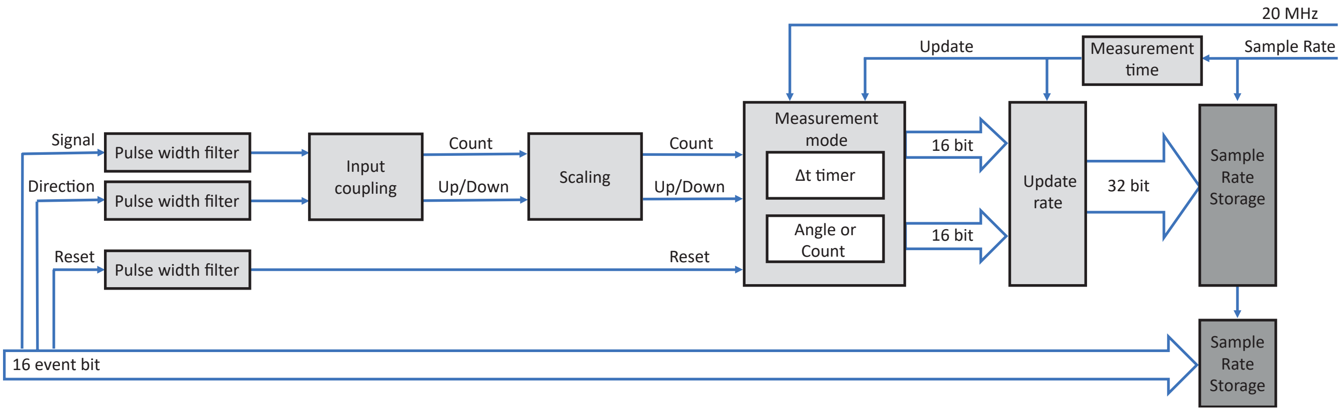


Figure 17: Timer/Counter block diagram

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) 12.8 µs minimum pulse width 200 µs ± 1 µs ± 1 sample period pulse delay			
Alarm	High when alarm condition of card is activated, low when not activated 200 µs ± 1 µs ± 1 sample period alarm event delay			
Recording active	High when recording, low when in idle or pause mode Recording active output delay 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 Bi-directional quadrature count Uni- and bi-directional frequency/RPM measurement			
Gate time	1 to n samples (User selectable maximum Δt)			
Gate time and reading update rate	Gate time sets the maximum update rate of the measurement values			
Gate time and minimum frequency	Minimum measured frequency or RPM = 1 / gate time			
Gate time and frequency accuracy	Accuracy = 50 ns / gate time			
Gate time impact	**Gate time**	**1 us**	**10 us**	**100 us**
	Δt Error	5%	0.5%	0.05%
	Update rate	1 MS/s	100 kS/s	10 kS/s

(1) Only if supported by mainframe.

Input Coupling Uni- and Bi-directional Signal

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

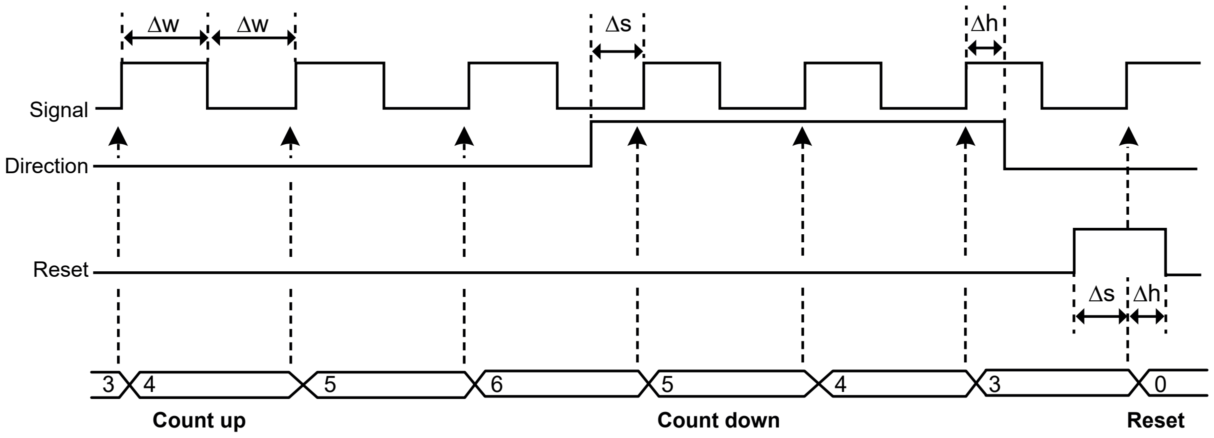


Figure 18: Uni- and Bi-directional timing

Inputs	3 pins: signal, reset and direction (only used in bi-directional count)
Minimum pulse width (Δw)	100 ns
Maximum input signal frequency	5 MHz
Counter range	0 to 231; uni-directional count -231 to +231 - 1; bi-directional count
Gate measuring time	Sample period (1 / sample rate) to 50 s 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 (Δs)	100 ns
Minimum hold time after signal edge (Δh)	100 ns
Reset options	
Manual	Upon user request by software command
Start recording	Count value set to 0 at Start of recording
First reset pulse	After the recording is started, the first reset pulse sets the counter value to 0. The next reset pulses are ignored.
Each reset pulse	On each external reset pulse, the counter value is reset to 0.
Direction input	
Input Level sensitivity	Only used when in bi-directional mode Low: increment counter/positive frequency High: decrement counter/negative frequency
Minimum setup time prior to signal edge (Δs)	100 ns
Minimum hold time after signal edge (Δh)	100 ns

Input Coupling ABZ Incremental Encoder (Quadrature)

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

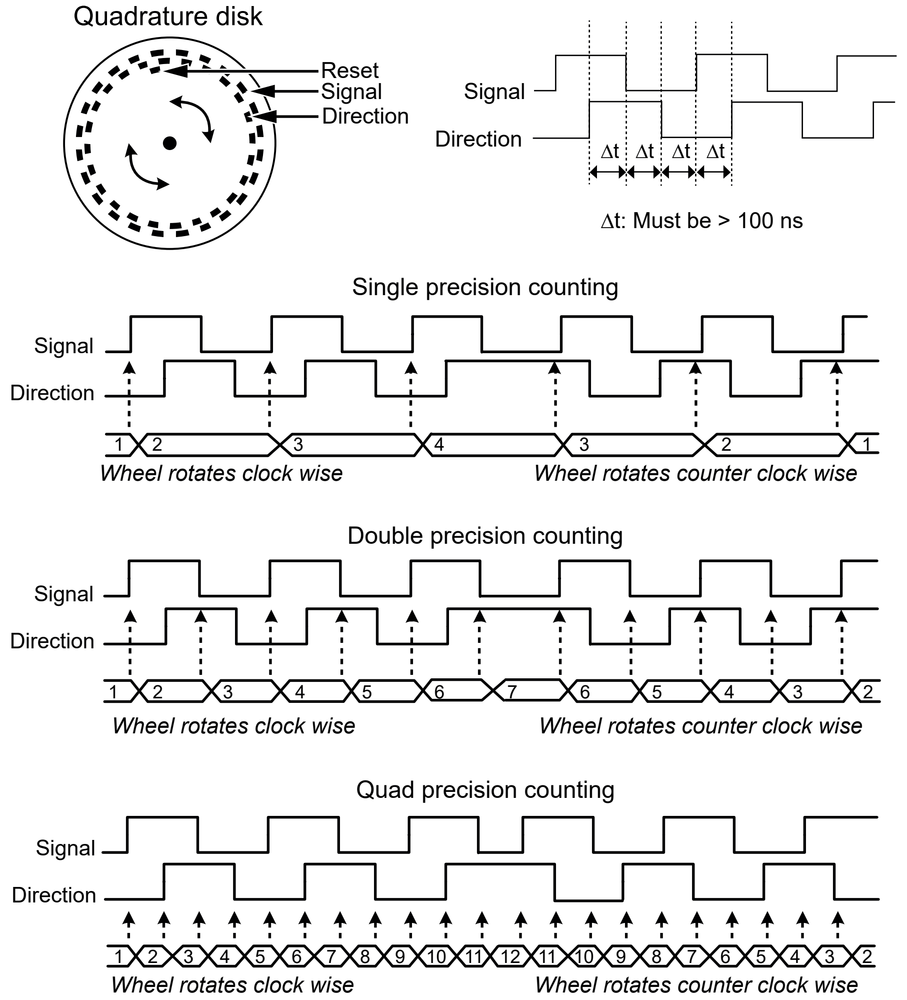
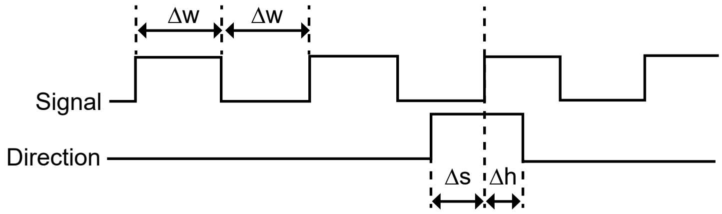


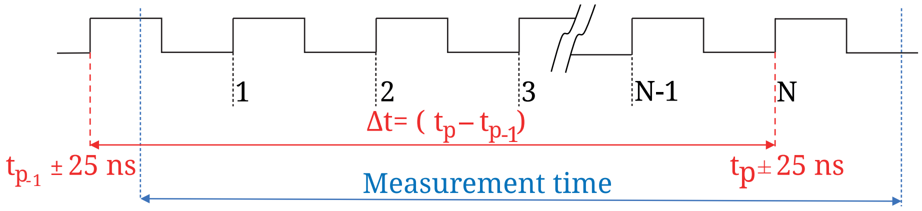
Figure 19: Bi-directional quadrature count modes

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 (X1), dual (X2) or quad (X4) precision
Counter range	-2^{31} to $+2^{31} - 1$
Input coupling	ABZ incremental encoder (Quadrature)
Reset input	
Level sensitivity	User selectable invert level
Minimum setup time prior to signal edge (Δt)	100 ns
Minimum hold time after signal edge (Δt)	100 ns
Reset options	
Manual	Upon user request by software command
Start recording	Count value set to 0 at Start of recording
First reset pulse	After the recording is started, the first reset pulse sets the counter value to 0. The next reset pulses are ignored.
Each reset pulse	On each external reset pulse, the counter value is reset to 0.

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 20:** Uni- and Bi-directional count timing	
Inputs	2 pins: signal, direction
Minimum pulse width (Δw)	100 ns
Maximum input signal frequency	5 MHz
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	
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 (Δs)	100 ns
Minimum hold time after signal edge (Δh)	100 ns

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

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



$$Frequency = \frac{N}{(t_p - t_{p-1}) \pm 50\ \text{ns}}$$

Figure 21: Frequency measurement

Accuracy	0.1%, when using a measurement time of 40 µs or more. With lower measurement times, the real-time calculators or Perception formula database can be used to enlarge the measurement time and improve the accuracy more dynamically e.g. based on measured cycles.
Measurement time	Sample period (1 / sample rate) to 50 s. Minimum measurement time is 50 ns. Can be selected by user to control update rate independent of sample rate

Measurement Mode Count/Position	
Count/position mode is typically used for tracking movement of device under test. To reduce the sensitivity for count/position errors due to clock glitches use the minimum pulse width filter or enable the ABZ in stead of uni-/bipolar input coupling.	
Counter range	0 to 2^{31}; uni-directional count -2^{31} to $+2^{31}$ - 1; bi-directional count

Maximum Timer Inaccuracy

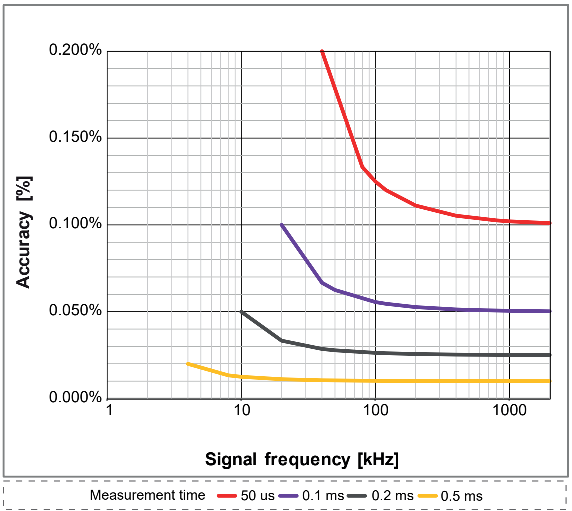
Timer accuracy is a tradeoff between update rate and minimum required accuracy. This table shows the relationships between measured signal frequency, selected measurement time (update rate) and timer accuracy. The inaccuracy distribution is to be considered rectangular.

Calculate the inaccuracy by using:

$$\text{Inaccuracy} = \pm\left(\frac{(signal\ \ frequency\ \ * 50\ ns)}{INTEGER\ (\ (signal\ \ frequency\ \ \text{-}1) * \text{measurement time})}\right) * 100\%$$

Measurement	Higher signal frequencies: Signal frequency (2 MHz down to 10 kHz)									
	2 MHz	1 MHz	500 kHz	400 kHz	200 kHz	100 kHz	50 kHz	40 kHz	20 kHz	10 kHz
1 µs	±10.000%									
2 µs	±3.333%	±5.000%								
5 µs	±1.111%	±1.250%	±1.333%	±2.000%						
10 µs	±0.526%	±0.556%	±0.625%	±0.667%	±1.000%					
20 µs	±0.256%	±0.263%	±0.278%	±0.286%	±0.333%	±0.500%				
50 µs	±0.101%	±0.102%	±0.103%	±0.105%	±0.111%	±0.125%	±0.133%	±2.000%		
0.1 ms	±0.050%	±0.051%	±0.051%	±0.051%	±0.053%	±0.056%	±0.063%	±0.067%	±0.100%	
0.2 ms	±0.025%				±0.026%	±0.026%	±0.028%	±0.029%	±0.033%	±0.050%
0.5 ms	±0.010%					±0.010%	±0.010%	±0.0011%	±0.0011%	±0.0013%
1 ms	±0.0050%					±0.0051%	±0.0051%	±0.0051%	±0.0053%	±0.0056%
2 ms	±0.0025%								±0.0026%	±0.0026%
5 ms	±0.0010%									
10 ms	±0.0005%									
20 ms	±0.00025%									
50 ms	±0.00010%									
100 ms	±0.00005%									

Measurement	Lower signal frequencies: Signal frequency (40 Hz to 5 kHz)									
	5 kHz	4 kHz	2 kHz	1 kHz	500 Hz	400 Hz	200 Hz	100 Hz	50 Hz	40 Hz
0.5 ms	±0.0133%	±0.0200%								
1 ms	±0.0063%	±0.0067%	±0.0100%							
2 ms	±0.0028%	±0.0029%	±0.0033%	±0.0050%						
5 ms	±0.0010%	±0.0011%	±0.0011%	±0.0013%	±0.0013%	±0.0020%				
10 ms	±0.00051%	±0.00051%	±0.00053%	±0.00056%	±0.00063%	±0.00067%	±0.00100%			
20 ms	±0.00025%	±0.00025%	±0.00026%	±0.00026%	±0.00028%	±0.00029%	±0.00033%	±0.00050%		
50 ms	±0.00010%	±0.00010%	±0.00010%	±0.00010%	±0.00010%	±0.00011%	±0.00011%	±0.00130%	±0.00013%	±0.00020%
100 ms	±0.000050%	±0.000050%	±0.000050%	±0.000051%	±0.000051%	±0.000051%	±0.000053%	±0.000056%	±0.000063%	±0.000067%



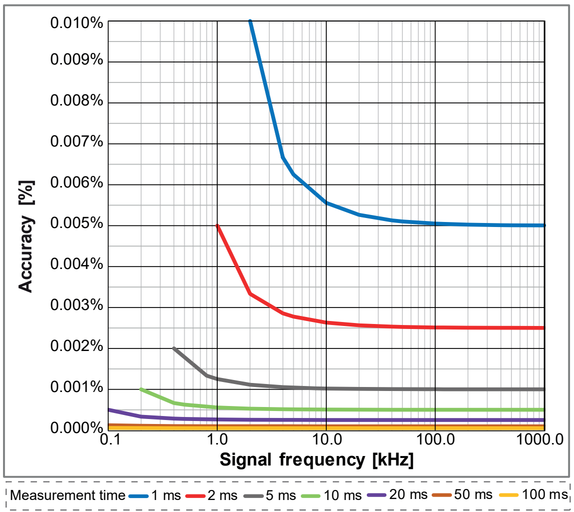


Figure 22: Maximum Timer Inaccuracy

Torque Measurement Uncertainty using Frequency Measurements

When using the Timer/Counter channels to measure torque, the measurement uncertainty introduced by the timer inaccuracies can be calculated using the following examples based on HBK T40 torque transducers.
The T40 torque transducer comes with 3 variants for frequency output: 10 kHz, 60 kHz or 240 kHz center frequency.
From the data sheets you can extract the minimum and maximum frequency output like table below.

T40 Variant	-Full Scale frequency output	+Full Scale frequency output
T40 - 10 kHz	5 kHz	15 kHz
T40 - 60 kHz	30 kHz	90 kHz
T40 - 240 kHz	120 kHz	360 kHz

Overlay these operating ranges on top of the timer inaccuracy plots of Figure 22 will result in Figure 23 (see below).

- Remains the step to balance the update rate (torque bandwidth) versus the torque accuracy required.
- Calculate the inaccuracy using the -Full Scale frequency output and desired measurement time.
- Using a minimum of 60 RPM the following inaccuracies are calculated.

Selected measurement time	Maximum inaccuracy: T40 - 240 kHZ	Maximum inaccuracy: T40 - 60 kHZ	Maximum inaccuracy: T40 - 10 kHZ
50 µs (left red curve)	0.1200%	0.1500%	Not possible
100 µs (left purple curve)	0.0546%	0.0750%	Not possible
500 µs (left orange curve)	0.0101%	0.0107%	0.0125%
1 ms (right blue curve)	0.0050%	0.0052%	0.0063%
2 ms (right red curve)	0.0025%	0.0025%	0.0028%
5 ms (right grey curve)	0.0010%	0.0010%	0.0010%

For K=1 (70% probability) use the specified rectangular distribution and the maximum inaccuracy numbers and calculate:

```
Measurement uncertainty = Maximum inaccuracy * 0.58 (Conversion for rectangular distribution)
```

Measurement uncertainty K=1 (About 70% probability)	Maximum inaccuracy: T40 - 240 kHZ	Maximum inaccuracy: T40 - 60 kHZ	Maximum inaccuracy: T40 - 10 kHZ
50 µs (left red curve)	0.0696%	0.0870%	Not possible
100 µs (left purple curve)	0.0316%	0.0435%	Not possible
500 µs (left orange curve)	0.0059%	0.0062%	0.00725%
1 ms (right blue curve)	0.0029%	0.0029%	0.00365%
2 ms (right red curve)	0.00145%	0.0015%	0.00162%
5 ms (right grey curve)	0.00058%	0.0006%	0.00058%

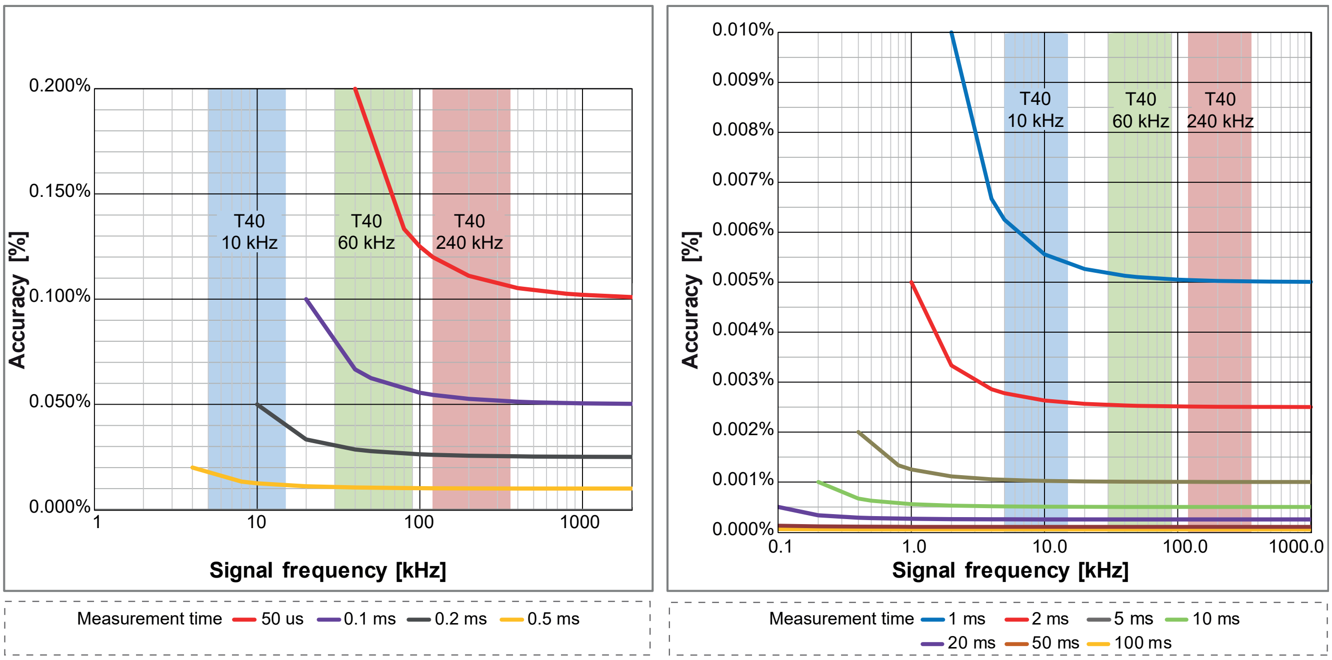


Figure 23: Torque operating range versus inaccuracy and measurement time

Speed (RPM) Measurement Uncertainty using Frequency Measurements

When using the Timer/Counter channels to measure speed (RPM), the measurement uncertainty introduced by the timer inaccuracies can be calculated using the following example.
In the data sheet of the speed sensor locate the specified number of pulse per rotation to calculate the frequency range of the sensor output:

```
Minimum frequency = minimum RPM used during testing * number of pulse per rotation / 60 sec
Maximum frequency = maximum RPM used during testing * number of pulse per rotation / 60 sec
```

Speed Sensor pulse per rotation	Frequency at 60 RPM	Frequency at 10 000 RPM	Frequency at 20 000 RPM
180	180 Hz	30 kHz	60 kHz
360	360 Hz	60 kHz	120 kHz
1024	1024 Hz	170.7 kHz	341.3 kHz

Overlay these operating ranges on top of the timer inaccuracy plots of Figure 22 will result in Figure 24 (see below).

- Remains the step to balance the update rate (torque bandwidth) versus the torque accuracy required.
- Using the graphs find the crossings of the overlayed operating frequencies with the measurement time curves.
- As examples the following crossings can be found in the graphs (at 60 RPM)..

Selected measurement time	180 pulse sensor	360 pulse sensor	1024 pulse sensor
2 ms (red curve)	Can't record at 60 RPM	Can't record at 60 RPM	0.00256%
5 ms (grey curve)	Can't record at 60 RPM	0.0018%	0.0010%
10 ms (Green curve)	0.0009%	0.0006%	0.00051%

For K=1 (70% probability) use the specified rectangular distribution and the maximum inaccuracy numbers and calculate:

```
Measurement uncertainty = Maximum inaccuracy * 0.58 (Conversion for rectangular distribution)
```

Measurement uncertainty K=1 (About 70% probability)	180 pulse sensor	360 pulse sensor	1024 pulse sensor
2 ms (red curve)	Can't record at 60 RPM	Can't record at 60 RPM	0.00148%
5 ms (grey curve)	Can't record at 60 RPM	0.00104%	0.00059%
10 ms (Green curve)	0.00052%	0.00035%	0.00030%

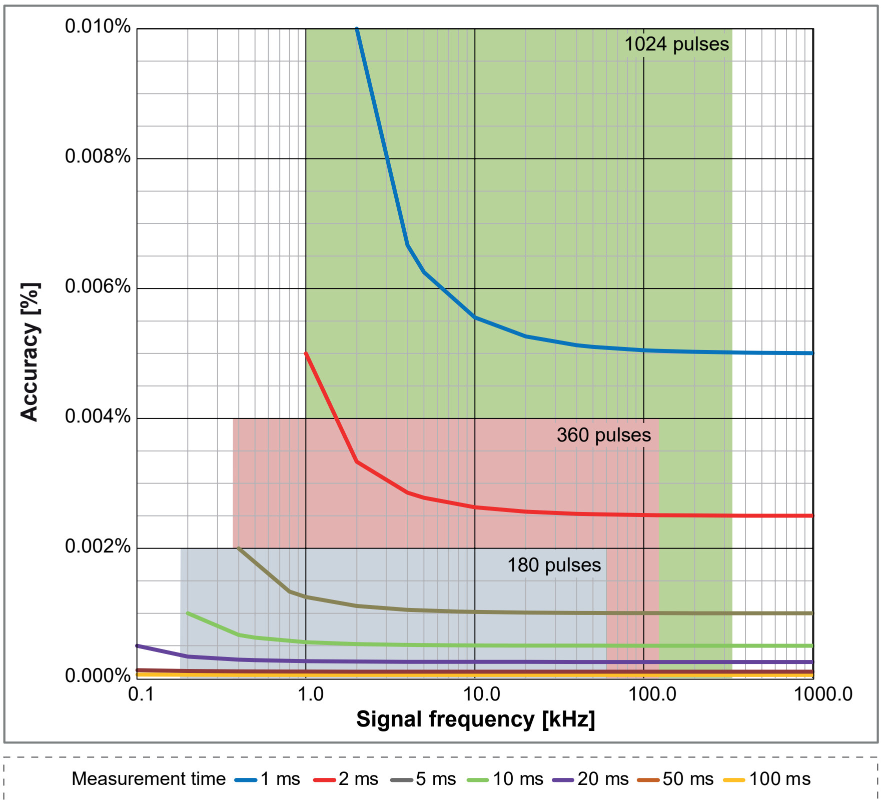


Figure 24: RPM sensor operating range versus inaccuracy and measurement time

Simultaneous Dynamic Torque Ripple and Accurate Torque Efficiency Measurement

If a high update rate is required to measure e.g. dynamic torque ripple yet for efficiency a high accuracy is required use both a measurement time of 50 µs as well as a RT-FDB function to calculate the mean value for each electric cycle.
The measured torque signal coming from the timer counter will be 0.15 to 0.17% accurate, while the torque calculate for the electric cycle (typically being 1 ms or less) results in 0.0075% accuracy.
As both signals are simultaneously available, the dynamic signal allows you to analyse the torque ripple behaviour, the electric cycle signal will be extremely accurate for efficiency calculations.

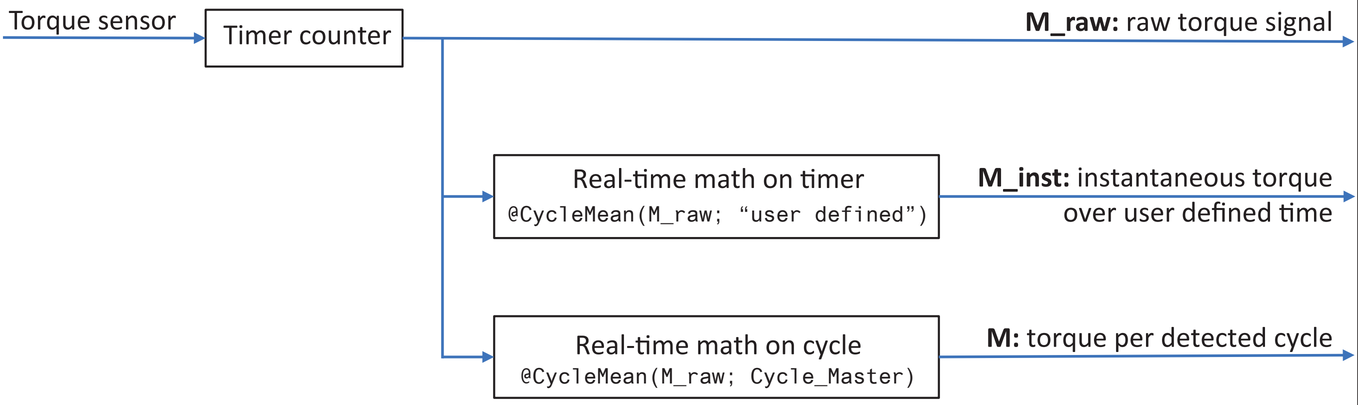


Figure 25: Simultaneous dynamic and accurate torque calculations

ePower signals	Application use	Dynamic response	Accuracy
M_raw	Torque ripple	Highest	Lowest
M_inst	Torque mean	Average	Average
M	Efficiency calculation	Lowest	Highest

Alarm Output

Event channel alarm modes	High or low level check
Cross channel alarms	Logical OR of alarms from all measured channels
Alarm output	Active during valid alarm condition, output supported through mainframe
Alarm output level	High or low user selectable
Alarm output delay	515 µs ± 1 µs + maximum 1 sample period. Default 516 µs, compatible with standard behavior. Minimum selectable delay is the smallest delay available for all acquisition cards used within the mainframe. Delay equal to Trigger Out delay.
Selection per card	User selectable On/Off
Analog channel alarm modes	
Basic	Above or below level check
Dual	Outside or within bounds check
Analog channel alarm levels	
Levels	Maximum 2 level detectors
Resolution	16 bit (0.0015%) for each level

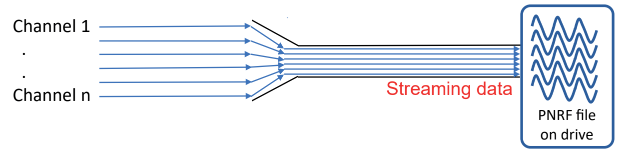
Triggering	
Channel trigger/qualifier	1 per channel; fully independent per channel, software selectable either trigger or qualifier
Pre- and post-trigger length	0 to full memory
Maximum trigger rate	400 triggers per second
Maximum delayed trigger	1000 seconds after a trigger occurred
Manual trigger (Software)	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
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 Hold High: Active from first mainframe trigger to end of recording Pulse width created by mainframe; For details, please refer to the mainframe data sheet
Trigger Out delay	Selectable (10 µs to 516 µs) ± 1 µs + maximum 1 sample period Default 516 µs, compatible with standard behavior. 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 Logical AND of qualifiers from all measured signals
Calculated channels	Logical OR of triggers from all calculated signals (RT-FDB) Logical AND of qualifiers from all calculated signals (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 selectable. Maximum pulse width 65 535 samples
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	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, falling edge or both edges
Qualifiers	Active High or Active Low for every event channel

On-board Memory	
Per card	2 GB (1 GSample @ 16 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	16 bits, 2 bytes/sample 24 bits, 4 bytes/sample (required for Timer/Counter usage)

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	Maximum, Minimum, Mean, Peak to Peak, Standard Deviation and RMS values
Event/Timer/Counter channels	Maximum, Minimum and Peak to Peak values

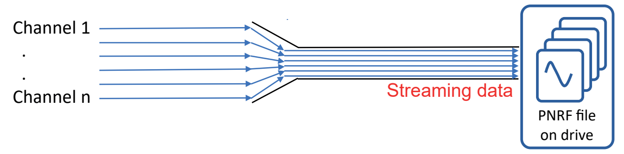
Data Recording Modes

On start of acquisition



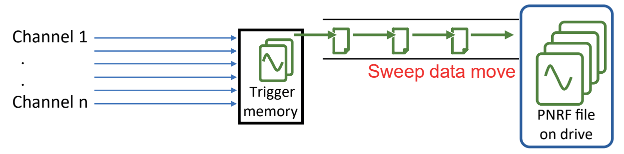
Data recording to PC or mainframe drive.
Data recording to a drive is limited by an **aggregate sample rate**, the recording time is limited by the **size of drive**.
Note: As the aggregate sample rate limit depends on Ethernet speed and storage drive used, as well as the PC and drive not being used for other purposes as data recording, it is strongly recommended for higher aggregate sample rates to test the chosen setup prior to performing your test.

Wait for trigger



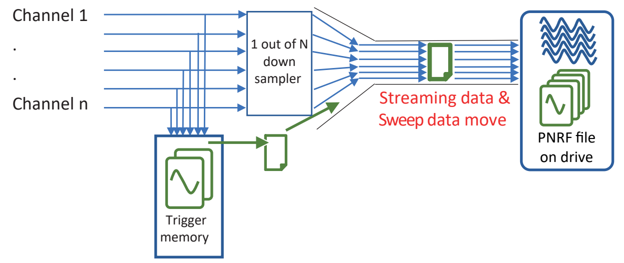
Triggered data recording to PC or mainframe drive.
Trigger data recording to a drive is limited by an **aggregate sample rate**, the recording time is limited by the size of drive.
Note: As the aggregate sample rate limit depends on Ethernet speed and storage drive used, as well as the PC and drive not being used for other purposes as data recording, it is strongly recommended for higher aggregate sample rates to test the chosen setup prior to performing your test.
Not recommended for transient/one time only/destructive tests.

Wait for trigger to trigger memory first



Triggered data recording to trigger memory on the acquisition card.
Triggered data recording to trigger memory has **no sample rate limits**, the recording time is limited by the **size of trigger memory**. Triggered data recorded in trigger memory is moved to a drive as quickly as possible.
Note: This data recording mode guarantees the data will always be recorded according to the user defined settings.
Recommended for transient/one time only/destructive tests.

On start of acquisition reduced rate and wait for trigger to trigger memory first

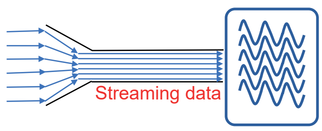


Data recording to PC or mainframe drive and simultaneous triggered data recording to trigger memory on the acquisition card.
The reduced rate data recording to a drive is limited by an **aggregate sample rate** and the recording time is limited by the **size of drive**.
The triggered data recording to trigger memory has **no sample rate limits,** the triggered data recording time is limited by the **size of trigger memory.** The triggered data recorded in trigger memory is moved to a drive as quickly as possible. As this data move happens simultaneously with the reduce rate data recording, it uses bandwidth of the aggregate sample rate.
Note: As the aggregate sample rate limit depends on Ethernet speed and storage drive used, as well as the PC and drive not being used for other purposes as data recording, it is strongly recommended for higher aggregate sample rates as well as higher number of triggers per second to test the chosen setup prior to performing your test.

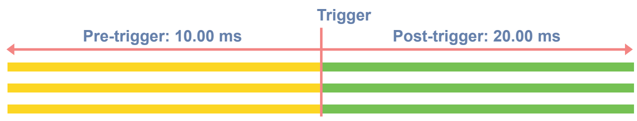
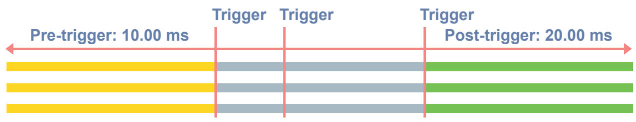
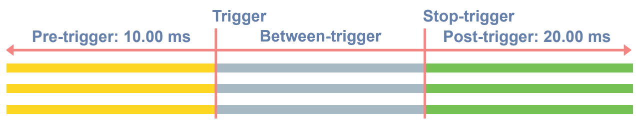
Data Recording Compared

	Aggregate sample rate limit	Maximum recorded data	Direct recording to drive	Trigger memory first	Trigger required to start recording
On start of acquisition	Yes	Free drive space	Yes	No	No
Wait for trigger	Yes	Free drive space	Yes	No	Yes
Wait for trigger to trigger memory first	No	Trigger memory	No	Yes	Yes
On start of acquisition reduced rate and wait for trigger to trigger memory first	Reduced rate: Yes	Free drive space	Yes	No	No
	Sample rate: No	Trigger memory	No	Yes	Yes

Aggregate sample rate limits when using streaming data



The maximum aggregate streaming rate per mainframe is defined by mainframe type and solid state drive, Ethernet speed, PC drive and other PC parameters.
When an aggregate sample rate is higher than the aggregate streaming rate of the system is selected, the memory on each acquisition card acts as a FIFO. As soon as this FIFO fills up, the recording is suspended (no data is recorded temporarily). During this period, the FIFO memory is transferred to a drive. When all FIFO's are empty, the recording is automatically resumed.
User notifications are added to the recording file for post recording identification of suspended recording.

Triggered Recording Definitions	
The details in this table apply to: • Wait for trigger • Wait for trigger to trigger memory first • On start of acquisition reduced rate and wait for trigger to trigger memory first	
Sweep 	 Defined by a trigger signal, pre- and post-trigger data and optionally between-trigger data and/or stop-trigger signal.
Triggered data segments	
Pre-trigger data	Data recorded prior to a trigger signal. **Note:** If a trigger signal is received before the full length of pre-trigger data is recorded, the trigger is accepted and the pre-trigger data recorded is automatically reduced to the available pre-trigger data at the time of the trigger.
Post-trigger data	Data recorded after a trigger or stop-trigger signal. **Note:** The recording of the post-trigger data can be re-started or delayed depending on the "*post-trigger begins on*" selection.
Between-trigger data	Data recorded due to re-trigger(s) or while waiting for the Stop-trigger. The length of between-trigger data is not specified and added based on the timing of the trigger or stop-trigger signals.
Trigger signals	
Trigger signal	This signal ends the pre-trigger and starts the post-trigger data recording. See table section "Post-trigger begins on" for more details. A trigger signal can be set up on external input trigger, analog and digital channels as well as using simple to complex RT-FDB formulas.
Stop-trigger signal	This signal starts the post-trigger data recording when in "post-trigger begins on stop-trigger" mode. See table section "Post-trigger begins on" for more details. A stop-trigger signals can be set up on external input trigger and simple to complex RT-FDB formulas.
Post-trigger begins on	
First trigger	 The first trigger signal ends the pre-trigger data recording and starts the recording of the post-trigger data. Any **trigger** received during the post-trigger data recording is ignored. Between-trigger data does not exist in this mode. The resulting sweep contains pre- and the post-trigger data.
Every trigger	 The first trigger ends the pre-trigger data recording and starts the recording of the post-trigger data. Any **trigger** received during the post-trigger data recording restarts the recording of post-trigger data. All recorded post-trigger data recorded at the time of the trigger is added to the between-trigger data. The resulting sweep contains pre-, between- and the post-trigger data.
Stop-trigger	 The trigger signal ends the pre-trigger data recording and starts the between-trigger data recording. The stop-trigger then ends the between-trigger data recording and starts the post-trigger data recording. Any **trigger** received during the between-trigger and post-trigger data recording is ignored. Any **stop-trigger** received during the pre-trigger and post-trigger data recording is ignored. The resulting sweep contains pre-, between- and the post-trigger data.

Trigger Memory Filled While Recording	
The trigger memory is limited in size and can easily get filled when using high sample rates combined with high trigger rates. This section explains how triggers are handled when the trigger memory is completely filled.	
Post-trigger begins on	Sweep recording selection
First trigger	A new sweep is only recorded if both pre- and post-trigger data fits in the free trigger memory at the time a trigger signal is received. When not enough free trigger memory is available, only the trigger time and trigger source get recorded (No pre- or post data is recorded).
Every trigger	A new sweep is started using the same rules as for the first trigger mode. If during the post-trigger recording a new trigger is received, the sweep is only extended with new post-trigger data if the additional post-trigger data fits the available free trigger memory. When not enough trigger memory is available, the already recorded pre-, between and post-trigger data for the previously received trigger(s) will be recorded.
Stop-trigger signal	A new sweep is only recorded if both pre-, 2.5 ms between and post-trigger data fits in the free trigger memory at the time a trigger signal is received. If no stop-trigger signal is received before the trigger memory fills up, the sweep recording is automatically stopped at the time the trigger memory is completely filled.

Triggered Recording Limits				
The details in this table apply to: ● Wait for trigger ● Wait for trigger to trigger memory first ● On start of acquisition reduced rate and wait for trigger to trigger memory first				
	Wait for trigger to trigger memory first **On start of acquisition reduced rate and wait for trigger to trigger memory first**		**Wait for trigger**	
Triggered data recording	Limited recording time		Use available size of drive	
Sample rate	Unlimited sample rates		Low to medium sample rates (Depending on system used)	
Channel count	Unlimited channel count		Low to medium channel counts (Depending on system used)	
Maximum number of sweeps				
In trigger memory	2000		Not applicable	
In PNRF recording file	200 000		1	
Sweep parameters	Minimum	Maximum	Minimum	Maximum
Pre-trigger length	0	Trigger memory of acquisition card	0	Available free drive space
Post-trigger length	0	Trigger memory of acquisition card	0	0
Sweep length	10 samples	Trigger memory of acquisition card	1 minute	Available free drive space
Maximum sweeps rate	400/s		Not applicable	
Minimum time between-triggers	2.5 ms		Not applicable	
Dead time between sweeps	0 ms		Not applicable	

Data Recording Details [1]

16 Bit Resolution

Data Recording Mode	**On start of acquisition & Wait for trigger**			**Wait for trigger to trigger memory first**			**On start of acquisition reduced rate and wait for trigger to trigger memory first**		
	Enabled channels			Enabled channels			Enabled channels		
	1 Ch	16 Ch	32 Ch	1 Ch	16 Ch	32 Ch	1 Ch	16 Ch	32 Ch
Max. trigger memory	not used			1000 MS	62 MS	31 MS	800 MS	50 MS	25 MS
Max. trigger sample rate	not used			250 kS/s			250 kS/s		
Max. reduced FIFO	1000 MS	62 MS	31 MS	not used			200 MS	12.5 MS	6 MS
Max. (reduced) sample rate	250 kS/s			not used			Trigger sample rate / 2		
Max. aggregate reduced streaming rate	0.25 MS/s 0.5 MB/s	4.0 MS/s 8.0 MB/s	8.0 MS/s 16.0 MB/s	not used			0.25 MS/s 0.5 MB/s	4.0 MS/s 8.0 MB/s	8.0 MS/s 16.0 MB/s

24 Bit Resolution

Data Recording Mode	**On start of acquisition & Wait for trigger**			**Wait for trigger to trigger memory first**			**On start of acquisition reduced rate and wait for trigger to trigger memory first**		
	Enabled channels			Enabled channels			Enabled channels		
	1 Ch	16 Ch	32 Ch	1 Ch	16 Ch	32 Ch	1 Ch	16 Ch	32 Ch
Max. trigger memory	not used			500 MS	31 MS	15.5 MS	400 MS	25 MS	12.5 MS
Max. trigger sample rate	not used			250 kS/s			250 kS/s		
Max. reduced FIFO	500 MS	31 MS	15.5 MS	not used			100 MS	6 MS	3 MS
Max. (reduced) sample rate	250 kS/s			not used			Trigger sample rate / 2		
Max. aggregate reduced streaming rate	0.25 MS/s 1.0 MB/s	4.0 MS/s 16.0 MB/s	8.0 MS/s 32.0 MB/s	not used			0.25 MS/s 1.0 MB/s	4.0 MS/s 16.0 MB/s	8.0 MS/s 32.0 MB/s

(1) Terminology used in alignment with Perception software.

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 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 IEC60068-2-1 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 IEC60068-2-14 Test Na	-25 °C to +70 °C (-13 °F to +158 °F) 5 cycles, rate 2 to 3 minutes, dwell time 3 hours
Damp heat cyclic test IEC60068-2-30 Test Db variant 1	+25 °C/+40 °C (+77 °F/+104 °F), humidity > 95/90% RH 6 cycles, cycle duration 24 hours

Harmonized Standards for CE and UKCA Compliance, According to the Following Directives[(1)]	
Low Voltage Directive (LVD): 2014/35/EU **Electromagnetic Compatibility Directive (EMC): 2014/30/EU**	
Electrical Safety	
EN 61010-1 (2017)	Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements
EN 61010-2-030 (2017)	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 Conducted disturbance: class B; Radiated disturbance: class A
EN 61000-3-2	Limits for harmonic current emissions: class D
EN 61000-3-3	Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems
Immunity	
EN 61000-4-2	Electrostatic discharge immunity test (ESD); contact discharge ± 4 kV/air discharge ± 8 kV: performance criteria B
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test; 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 Mains ± 2 kV using coupling network. Channel ± 2 kV using capacitive clamp: performance criteria B
EN 61000-4-5	Surge immunity test Mains ± 0.5 kV/± 1 kV Line-Line and ± 0.5 kV/± 1 kV/± 2 kV Line-earth Channel ± 0.5 kV/± 1 kV using coupling network: performance criteria B
EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 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 Dips: performance criteria A; Interruptions: performance criteria C

(1) UKCA The manufacturer declares on its sole responsibility that the product is in conformity with the essential requirements of the applicable UK legislation and that the relevant conformity assessment procedures have been fulfilled.

Manufacturer:

Hottinger Brüel & Kjaer GmbH
Im Tiefen See 45
64293 Darmstadt
Germany

Importer:

Hottinger Bruel & Kjaer UK Ltd.
Technology Centre Advanced Manufacturing Park
Brunel Way Catcliffe
Rotherham
South Yorkshire
S60 5WG
United Kingdom

Connector Pin Assignment	
Connector type	POSITRONIC HDC50F5R8N0X/AA
Mating connector type	Harting part number 9670505615 (Metal shell 61030010019, cable clamp 61030000145, blanking piece 61030000041)
Output voltage	5 V ± 20%
Output current	0.3 A maximum (all output pins internally connected)

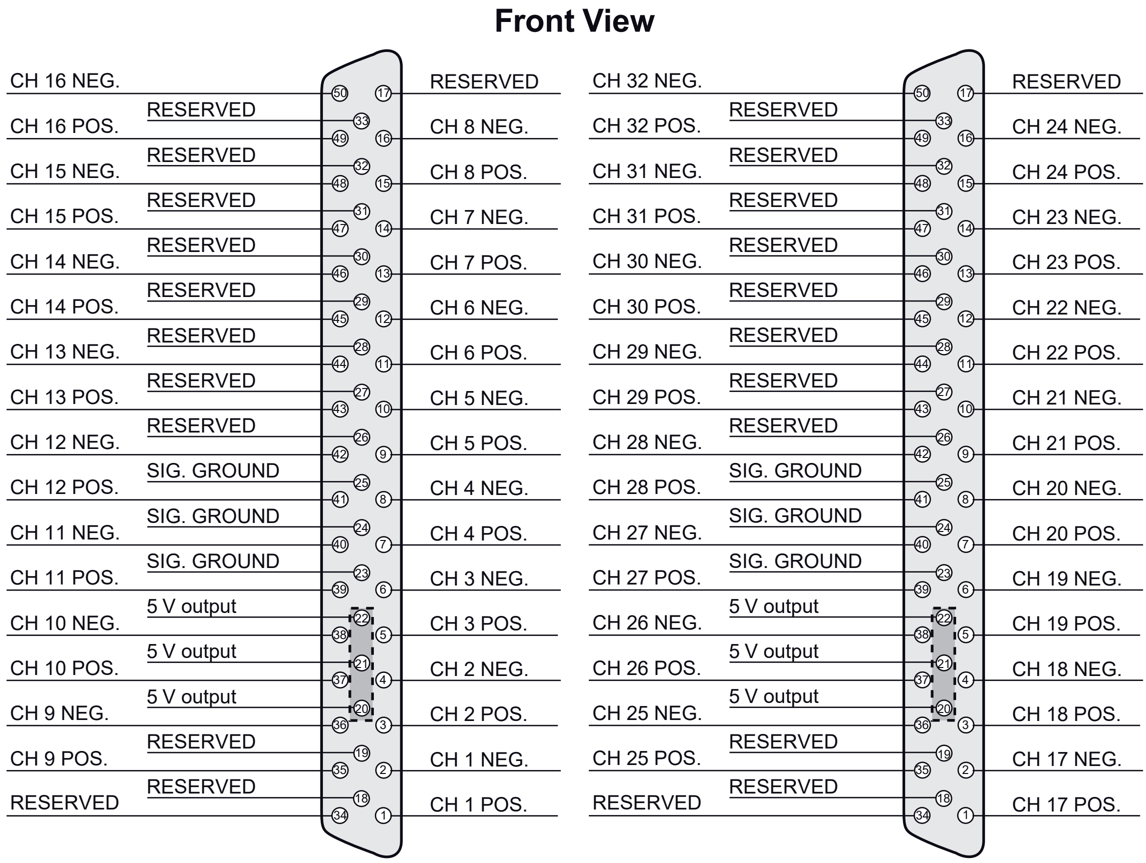
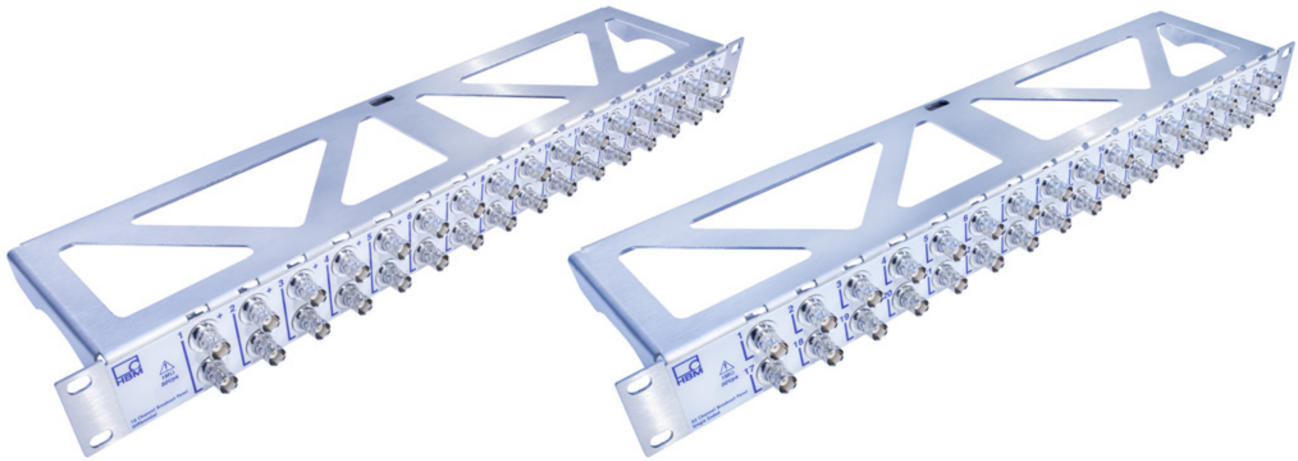


Figure 26: Input connector pin diagram (Front view)

KAB171, KAB172: Breakout Cables (Option, to be ordered separately)	
 Figure 27: KAB171/KAB172 breakout cable	
Cable length	1.5 m
Cable type	Multiple coax cables bundled in a sleeve to minimize crosstalk between cables
Coax cable	Axon RG178 B/U (RoHS compliant)
Cable impedance	50 Ω, 105 pF/m
Cable shield	All shields are connected to one another and connected to D-sub ground pins
BNC label	Each BNC is labeled using color and text. Label indicates the channel number and the input type (positive or negative).
Cable variants	
KAB171	D-sub connector to 16 male BNCs, 1 BNC/channel (single-ended) 16 coax cables (1 coax cable/channel), 5 V output not connected in cable
KAB172	D-sub connector to 32 male BNCs, 2 BNCs/channel (differential) 32 coax cables (2 coax cables/channel), 5 V output not connected in cable

G056, G058: Breakout Panels (Option, to be ordered separately)



G056 16 channel panel differential

G058 32 channel panel single ended

Figure 28: G056/G058 Breakout panel

Rackmount	19-inch, 1U height
Panel connector	Metal BNC, female in to female out, not isolated from panel
Panel variants	
G056	16 channel, differential (2 BNCs / channel) To be used with: GN3210/GN3211 using KAB171 GN840B/GN1640B using KAB433
G058	32 channel, single-ended (1 BNC / channel) To be used with: GN3210/GN3211 using KAB172

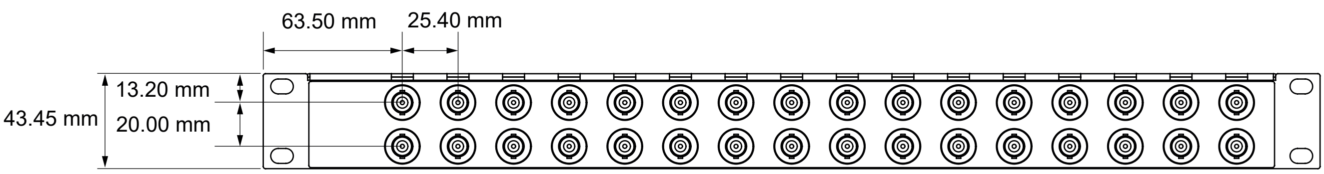


Figure 29: Breakout panel dimensions

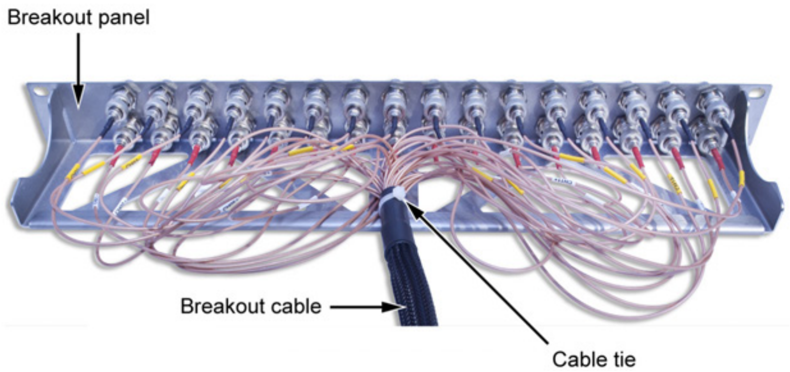
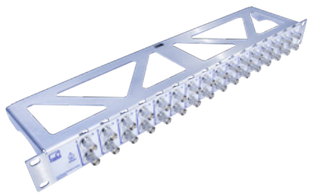
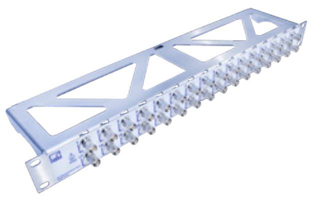


Figure 30: Breakout cable connected to breakout panel

Ordering Information

Article		Description	Order No.
Basic/IEPE/Charge 250 kS/s input card		32 Channel 250 kS/s per channel Differential digitizer, 2 GB RAM per card, 16/24 bit, IEPE, TEDS and charge support. Support for mainframe Digital Event/Timer/Counter.	1-GN3210

Accessories, to be ordered separately

Article		Description	Order No.
16 channel single-ended break out cable		16 ch single-ended break out cable, HD-sub to 16x BNC, 2 m; for use with GEN DAQ GN1610, GN1611, GN3210 and GN3211 input cards	1-KAB171-2
16 channel differential break out cable		16 ch differential break out cable, HD-sub to 32x BNC, 2 m; for use with GN1610, GN1611, GN3210 and GN3211 input cards	1-KAB172-2
16 channel differential ended break out panel		16 ch differential 19 inch mountable 1 U (44.45 mm) height breakout panel; 16 x 2 BNC feed-through; to be used with 16 ch differential break out cable	1-G056
32 channel single-ended break out panel		32 ch single-ended 19-inch mountable 1 U (44.45 mm) height breakout panel; 32 BNC feed-through To be used with: GN3210/GN3211 using KAB171 GN840B/GN1640B using KAB433	1-G058

Voltage Probes (Options, to be ordered separately)			
Article		**Description**	**Order No.**
Passive, SE probe 10:1, 400 MHz, 10 MΩ, 1.2 m		Passive, single-ended voltage probe. Has a capacitive compensation range from 10 to 25 pF. Divide factor is 10:1, bandwidth is -3dB @ 400 MHz, maximum input voltage is 300 V RMS CAT II, maximum DC inaccuracy is 2%, and the probe connected to a channel has an input impedance of 10 MΩ. Probe cable length is 1.2 m (3.9 ft).	1-G901
Passive, SE isolated probe, 100:1, 400 MHz, 100 MΩ		Passive, single-ended isolated voltage probe. Has a capacitive compensation range from 10 to 50 pF. The divide factor is 100:1, bandwidth is -3 dB @ 400 MHz, maximum input voltage is 1000 V RMS CAT II, maximum DC inaccuracy is 2%, and the probe connected to a channel has an input impedance of 50 MΩ. Probe cable length is 2 m (6.5 ft).	1-G903
Passive, DIFF matched isolated probe, 10:1, 100 MHz, 10 MΩ		Passive, differential matched isolated voltage probe. Has a capacitive compensation range from 35 to 70 pF. The divide factor is 10:1, the bandwidth is -3 dB @ 100 MHz, maximum input voltage is 300 V RMS CAT II, maximum DC In-accuracy is 2%, and the probe attached to a channel has an input impedance of 10 MΩ. Probe cable length is 3 m (9.8 ft).	1-G907
Active, DIFF probe, 200:1, 25 MHz, 4 MΩ		Active, differential voltage probe. Supported by every input channel due to the active output. Divide factors of 20:1 and 200:1 can be manually selected. Supported bandwidth -3 dB @ 25 MHz. Maximum input voltage and common mode voltage both are 1000 V RMS. Maximum DC inaccuracy is 2%, and the probe has an input impedance of 4 MΩ on each input. Probe coax cable length is 0.95 m (3.12 ft).	1-G909

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