DATA SHEET

GEN series GN840B, GN1640B
Universal/Sensor ISO 500 kS/s Input Card

SPECIAL FEATURES

- Ranges ± 0.2 mV/V up to ± 500 mV/V
- Quarter/Half/Full bridge
- 6 wire configuration
- Quick sensor test (shunt)
- Voltage excited sensors
- IEPE sensors
- IEEE 1451.4 TEDS class 1, 2 and 3
- Piezoelectric/Charge sensors
- 4 to 20 mA sensors
- Pt10, Pt100, Pt500, Pt1000 and Pt2000 (3 and 4 wire RTD)
- Thermocouples K, J, T, B, E, N, R, S, C
- Resistor value
- 33 V RMS Isolation
- Analog/digital anti-alias filters
- 500 kS/s sample rate/channel
- 24 bit ADC resolution

GN840B/GN1640B FUNCTIONS and BENEFITS

The Universal Sensor Card supports quarter, half and full bridges with built-in 350 Ω and 120 Ω quarter bridge completion resistors. The shunt resistor offers a quick test of the sensor.
In IEPE mode the card supports open and shorted wire detection and TEDS sensor setup.
Thermocouples, piezoelectric, RTD and 4 to 20 mA sensors are all directly supported. All sensor types connect to the input without external adapters.
Measurement ranges starting at ± 0.2 mV/V up to ± 500 mV/V and sensor impedance from 17 Ω up to 10 kΩ support virtually any sensor.
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 500 kS/s.
The second stage feeds the 500 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 500 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.
The optional real-time formula database calculators solve almost any mathematical challenge. Real-time digital cycle detection enables periodic results like PeakToPeak. Real-time channel to channel sample math can reverse calculate crosstalk interdependencies within a three axes force sensor. Calculated results can be used to trigger the recording or signal alarms to the external world.

Capabilities Overview	
Model	**GN840B, GN1640B**
Maximum sample rate per channel	500 kS/s
Memory per card	2 GB
Analog channels	8 for GN840B and 16 for GN1640B
Anti-alias filters	Fixed bandwidth analog AA-filter combined with sample rate tracking digital AA-filter
ADC resolution	24 bit
Isolation	33 V RMS, ± 70 V DC, channel to channel and channel to chassis
Input type	Analog isolated balanced differential
Passive voltage/current probes	Active single-ended and differential probes
Sensors	Quarter, half and full strain gauges/ bridges. Force, pressure, MEMS-type accelerometers and potentiometric displacement transducers. IEPE, piezoelectric, Pt10, Pt100, Pt500, Pt1000, Pt2000, 4...20 mA sensors Thermocouples types K, J, T, B, E, N, R, S and C
TEDS	Class 1, 2 and Class 3 (pending IEEE acceptance)
Real-time formula database calculators (option)	Extensive set of user programmable math routines
Digital Event/Timer/Counter	Supported; 16 digital events and 2 Timer/Counter channels
Standard data streaming (CPCI up to 200 MB/s)	Not supported
Fast data streaming (PCIe up to 1 GB/s)	Supported
Slot width	1 for GN840B 2 for GN1640B

Mainframe Support

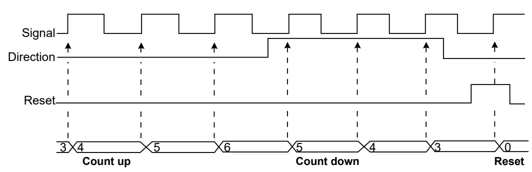
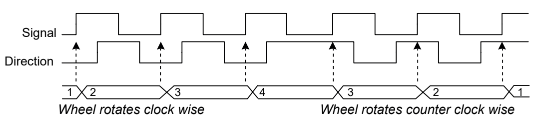
	GEN2tB	GEN4tB	GEN7tA / GEN7tB	GEN17tA / GEN17tB	GEN3iA	GEN7iA / GEN7iB
GN840B/GN1640B	Yes					
GEN DAQ API	Yes				Yes(1)	
EtherCAT®	No	Yes			No	
CAN/CAN FD	Yes				No	

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

Supported Analog Sensors and Probes

Amplifier mode	Supported analog sensors and probes	Features, Cabling and Accessories
Basic voltage	• Electrical voltages single-ended and differential • Active single-ended probes • Active differential probes	• ± 1 mV up to ± 10.0 V • Isolated voltage input • 14 pin ODU connector • DIN rail mounted dual BNC breakout 1-G090 • ODU to BNC cable 1-KAB433-2
Basic sensor	• (Damped) Piezoresistive accelerometers • Potentiometric displacement transducers • Voltage output sensors using DC voltage excitation like Force, Pressure, MEMS-type and Kulite sensors	• ± 0.2 mV/V up to ± 500 mV/V • Basic sensor mode is a simplified bridge GUI • Sensor impedance from 17 Ω to 10 kΩ • ± 0.5 V to ± 5.0 V DC sensor supply voltage • DIN rail mounted push-pull breakout 1-G088 • Breakout cable with open ends 1-KAB183-x
Bridge	• Quarter, half and full strain gauges/ bridges • Strain gauge based sensors: load cells, force transducers, torque transducers and pressure transducers	• ± 0.2 mV/V up to ± 500 mV/V • No external support tools required • Bipolar ± 0.5 V to ± 5.0 V DC excitation voltage • 2 * 10 kΩ built in half bridge completion resistors • 120 Ω and 350 Ω built in quarter bridge completion • 3 wire quarter bridge support • Built in 100 kΩ shunt resistor • DIN rail mounted push-pull breakout: 1-G088 • Breakout cable with open ends 1-KAB183-x
Charge	• Piezo-electric sensors	• ± 1 nC up to ± 10 µC • AC input coupled • ODU to BNC cable 1-KAB433-2
IEPE	• IEPE based sensors like accelerometers, microphones and pressure transducers • ICP® Accelerometers	• ± 1 mV up to, ± 10.0 V • IEPE current: 2, 4, 6 or 8 mA @ ≥ 23 V • TEDS class I • Sensor connected, open or shorted diagnostics • DIN rail mounted dual BNC breakout : 1-G090 • ODU to BNC cable 1-KAB433-2
Current loop	• Electrical current 4 to 20 mA • Sensors with to 20 mA output	• Built in burden resistor • DIN rail mounted dual BNC breakout : 1-G090 • ODU to BNC cable 1-KAB433-2
Thermocouple	• Thermocouples types K, J, T, B, E, N, R, S and C	• Digital cold junction compensation • DIN rail mounted cold junction plug: 1-G089 • Thermocouple bandwidth up to 10 kHz
Resistance thermometers	• Resistive Temperature Detectors (RTD) • Pt10, Pt100, Pt500, Pt1000 and Pt2000	• 3 and 4 wire support • DIN rail mounted push-pull breakout : 1-G088 • Breakout cable with open ends 1-KAB183-x

Supported Digital Sensors (TTL Level Input)

Timer counter Input type	Supported digital sensors	Features
 **Figure 1:** Uni and Bi-directional clock	• AngleTorque sensors • Frequency / RPM • Count/position	• Count frequency up to 5 MHz • Input signal minimum width setting • Several reset options • RT-FDB can add a calculated Frequency/ RPM channel based on the angle measurement
 **Figure 2:** ABZ Incremental Encoder (Quadrature)	• AngleTorque sensors • 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 • RT-FDB can add a calculated Frequency/ RPM channel based on the angle measurement

Block Diagram

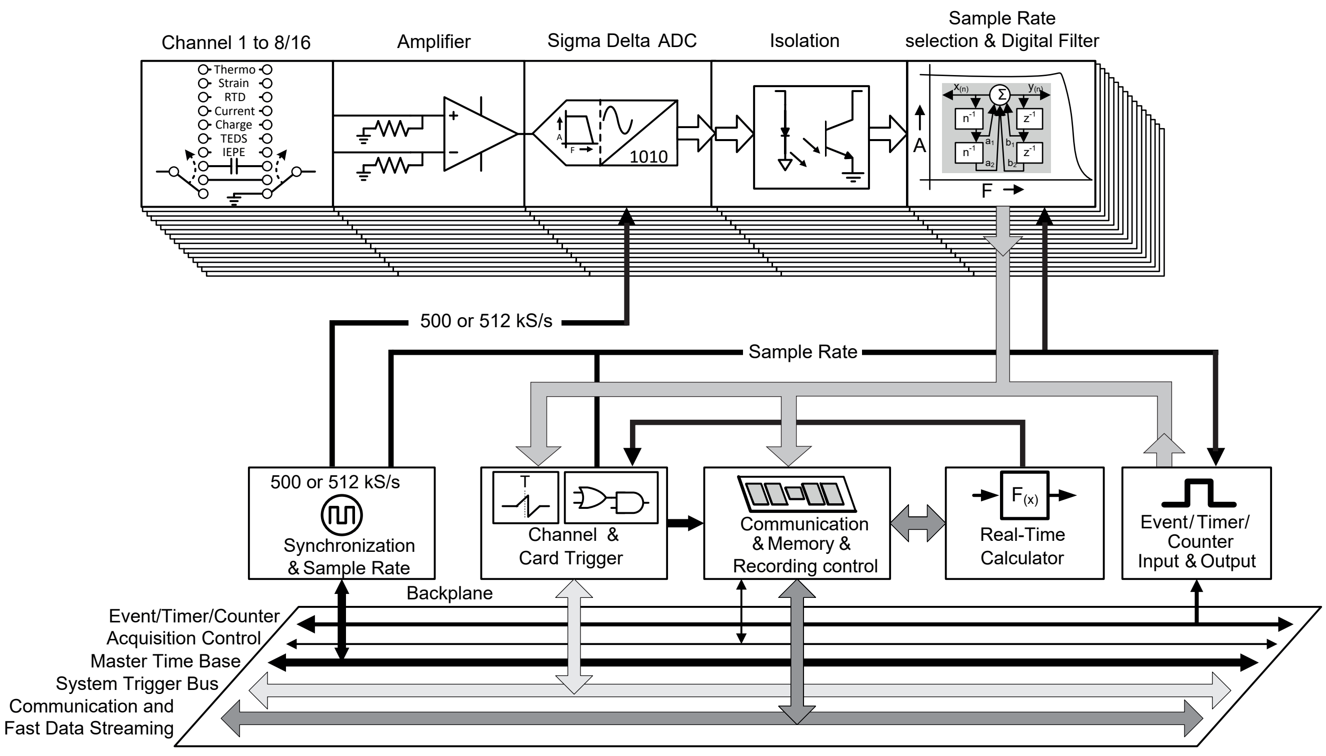


Figure 3: Block diagram

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		
Input type	Analog isolated balanced differential	
Impedance	2 * 10 MΩ ± 1% // 45 pF ± 10% (Differential)	
Input coupling	Single-ended positive, single-ended negative and differential	
Signal input coupling		
Coupling modes	AC, DC, GND	
AC coupling frequency	1.6 Hz ± 10%; - 3 dB	

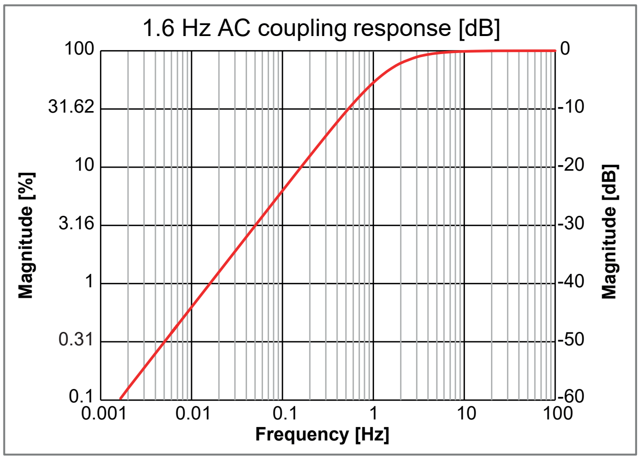


Figure 4: Representative AC coupling response

Ranges	± 1 mV, ± 10 mV, ± 0.1 V, ± 1.0 V, ± 10.0 V	
Offset	± 50% in 1000 steps (0.1%). For all ranges except ± 10 V range (20 V span)	
Common mode (referred to system ground/earth)		
Ranges	Less than or equal to ± 100m V	Larger than or equal to ± 1 V
Rejection (CMR)	> 100 dB @ 80 Hz (105 dB typical)	> 80 dB @ 80 Hz (95 dB typical)
Maximum common mode voltage	7 V RMS	7 V RMS

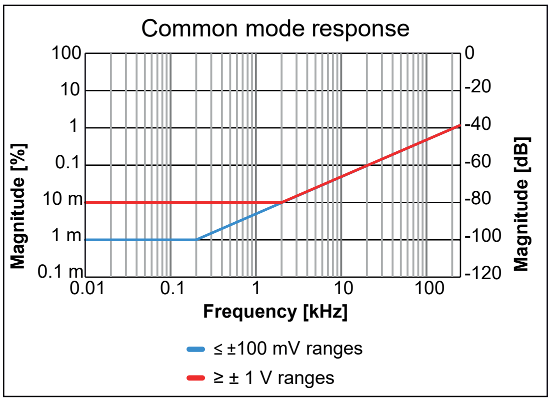


Figure 5: Representative common mode response

Input overload protection	
Overvoltage impedance change	The activation of the overvoltage protection system results in a reduced input impedance. The overvoltage protection is not active for as long as the input voltage is between -12 V and +15 V in respect to channel ground.
Maximum nondestructive voltage	± 25 V DC

Basic Voltage Specifications (Wideband)	
Wideband	**Pass/Fail limits**
DC Reading error	0.02% of reading ± 3 µV
DC Range error	0.001% of range ± 10 µV
DC Reading error drift	30 ppm / °C (17 ppm / °F)
DC Range error drift	± (15 ppm + 2 µV) / °C (± (9 ppm + 2 µV) / °F)
RMS Noise (50 Ω terminated)	0.002% of range ± 20 µV

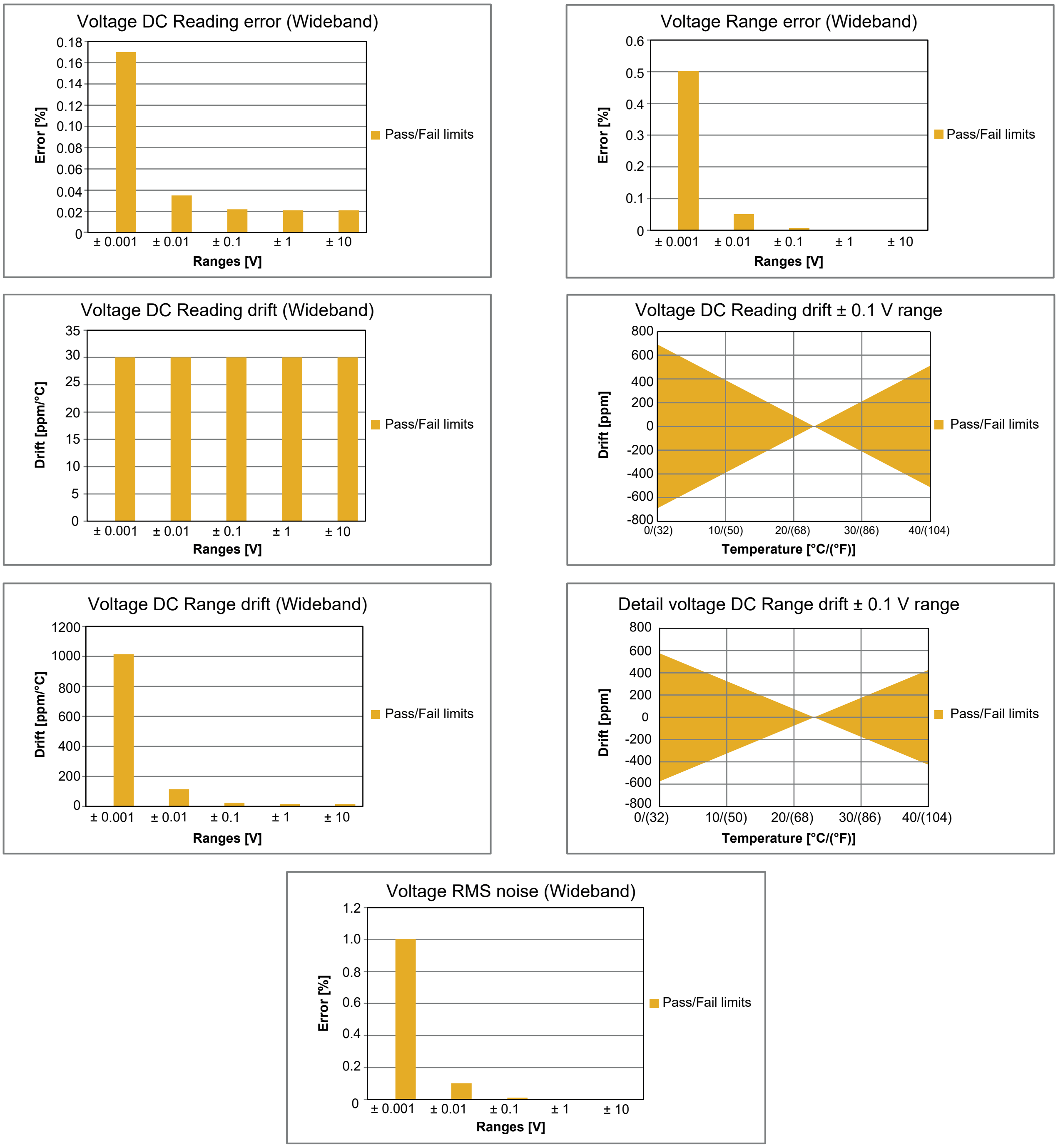


Figure 6: Wideband voltage specification

Basic Voltage Mode

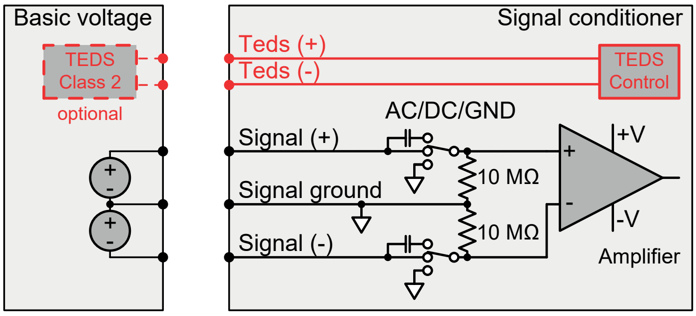


Figure 7: Basic mode block diagram

Input type	Analog isolated balanced differential
Input coupling	Single-ended positive, single-ended negative and differential
Supported probes	Passive single-ended probes Passive differential probes Active differential probes
Signal input coupling	
Coupling modes	AC/DC/GND
AC coupling frequency	1.6 Hz, ± 10%; -3 dB

Basic Voltage Wiring Diagram

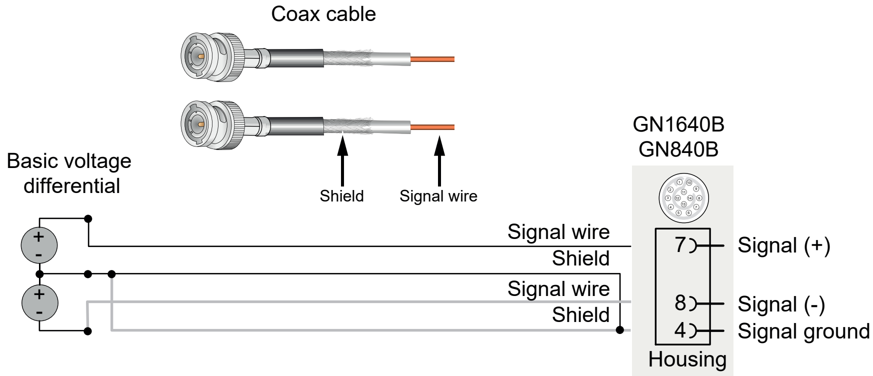


Figure 8: Recommended basic voltage differential connection

Bridge Mode

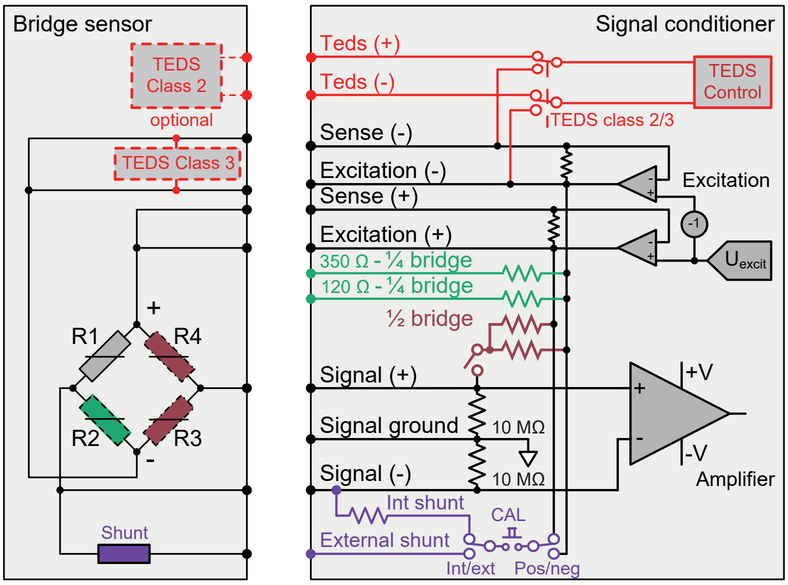


Figure 9: Bridge mode block diagram

Supported sensors	Quarter, half and full strain gauges/ bridges. Strain gauge based sensors: load cells, force transducers, torque transducers and pressure transducers.			
Quarter bridge connection	Three wire support; the third wire keeps the measurement wire current free eliminating wire resistance errors through the measurement wire			
Built in quarter bridge completion resistor	120 Ω and 350 Ω, 0.1% 2 ppm/°C, wired to separate connector pin			
Built in half bridge completion resistors	2 times 10 kΩ, 0.05% 2 ppm/°C tracking			
Bridge excitation modes	Constant voltage			
TEDS support	Class 2 and 3 (no software support at release date)			
Constant voltage excitation				
Excitation voltage inaccuracy	± 0.25%			
Bipolar excitation voltage	**± 0.5 V @ 30 mA**	**± 1 V @ 30 mA**	**± 2 V @ 30 mA**	**± 5 V @ 30 mA**
Transducer impedance	16.7 Ω to 10 kΩ	33.3 Ω to 10 kΩ	66.7 Ω to 10 kΩ	166.7 Ω to 10 kΩ
Measuring ranges (mV/Volt excitation)(1)	± 2 mV/V	± 1 mV/V	± 0.5 mV/V	± 0.2 mV/V
	± 20 mV/V	± 10 mV/V	± 5 mV/V	± 2 mV/V
	± 200 mV/V	± 100 mV/V	± 50 mV/V	± 20 mV/V
			± 500 mV/V	± 200 mV/V
Excitation voltage sense	2 separate connector pins available, wiring required (no internal bypass)			
Maximum cable length	100 m (328 ft), cable impedance ≤ 0.2 Ω/m (0.06 Ω/ ft)			
Bridge balance				
Operation principal	Bridge in-balance measured and software compensated by means of auto zero			
Auto zero	Parallel execution of auto zero on all channels on multiple cards reducing zero time significantly			
Bridge shunt (Sensor quick test)				
Bridge shunt resistor selection	Software selectable 2 sources 1 built-in shunt resistors, or external shunt			
Bridge shunt method	Software selectable to positive or negative excitation voltage			
External shunt	1 separate connector pin to wire shunt out to sensor connection points			
Built-in shunt resistor				
Type	Metal foil			
Shunt resistor	100 kΩ, 0.1% 5 ppm/°C			

(1) Used amplifier range = mV/V range * Excitation voltage level

Bridge Wiring Diagrams

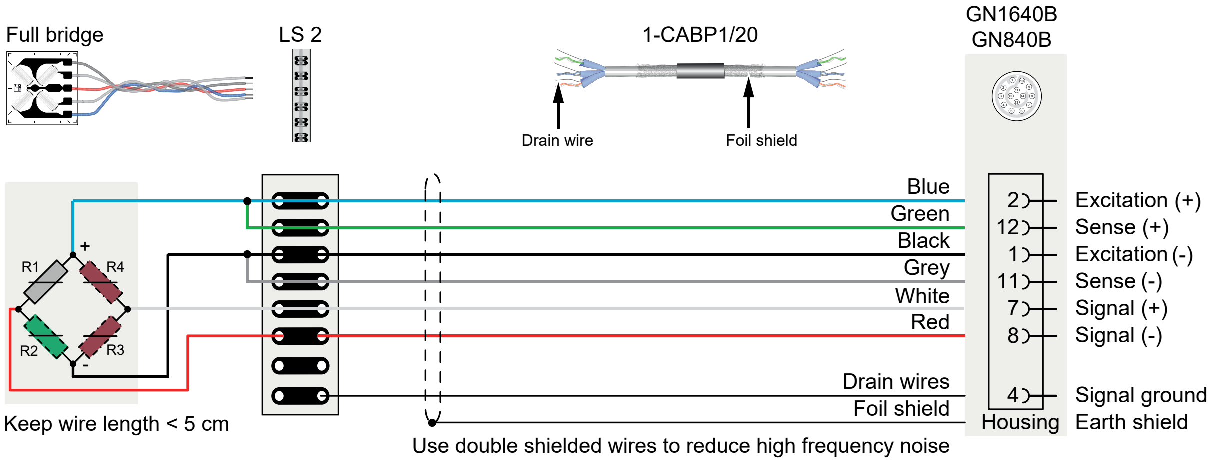


Figure 10: Recommended 6 wire full bridge connection (more options are available)

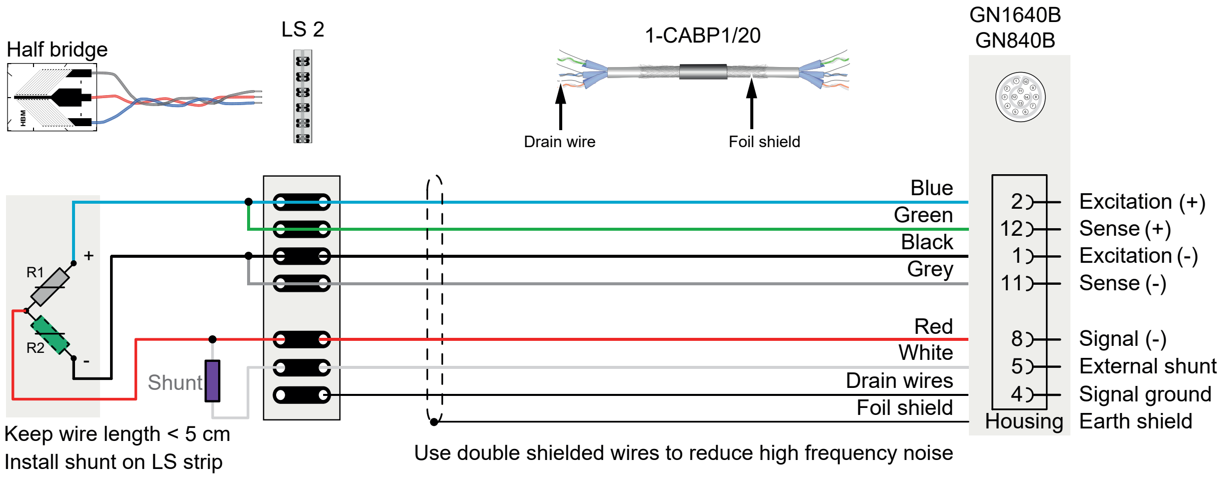


Figure 11: Recommended 6 wire half bridge with shunt resistor connection (more options are available)

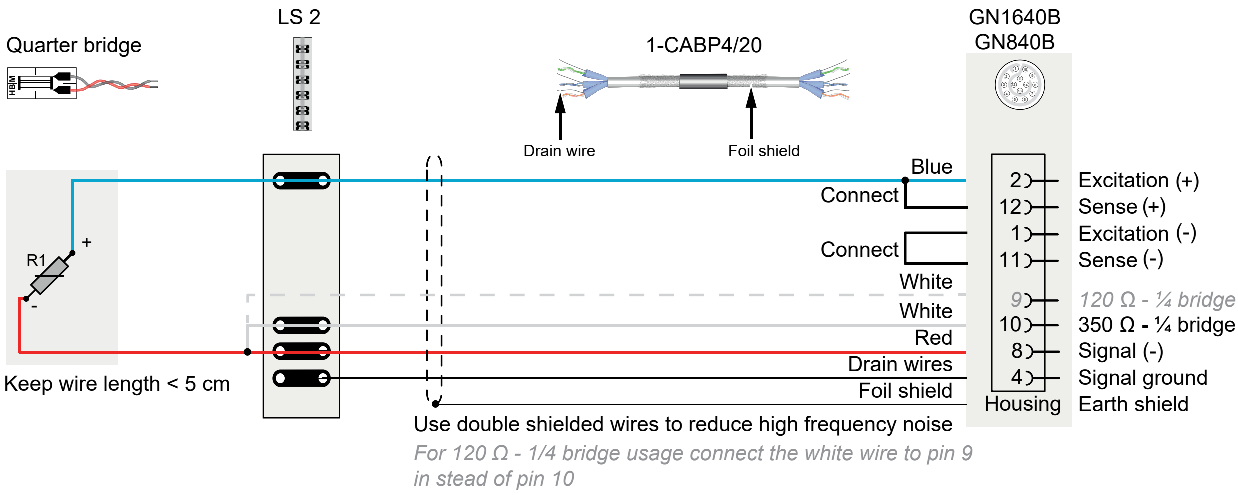


Figure 12: Recommended 3 wire 350 Ω quarter bridge connection (more options are available)

Basic Sensor Mode

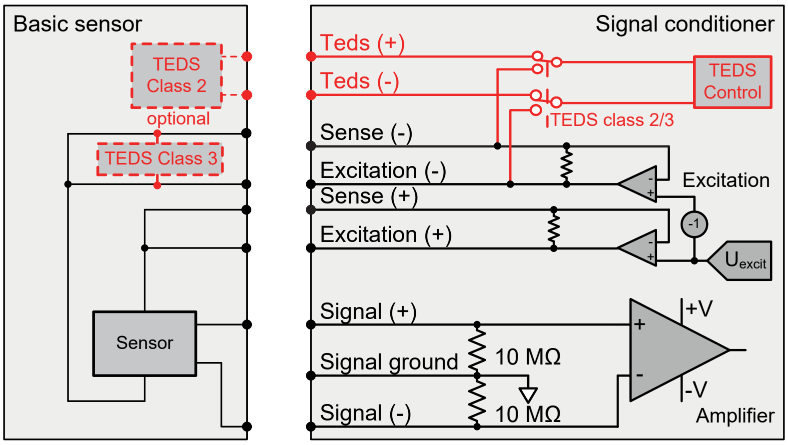


Figure 13: Basic sensor mode block diagram

Supported sensors	(Damped) Piezoresistive accelerometers Potentiometric Displacement transducers Voltage output sensors using DC voltage excitation like Force, Pressure, MEMS-type and Kulite sensors			
Sensor excitation modes	Constant voltage			
TEDS support	Class 2 and 3 (no software support at release date)			
Constant voltage excitation				
Excitation voltage inaccuracy	± 0.25%			
Bipolar excitation voltage	**± 0.5 V @ 30 mA**	**± 1 V @ 30 mA**	**± 2 V @ 30 mA**	**± 5 V @ 30 mA**
Transducer impedance	16.7 Ω to 10 kΩ	33.3 Ω to 10 kΩ	66.7 Ω to 10 kΩ	166.7 Ω to 10 kΩ
Measuring ranges (mV/Volt excitation)(1)	± 2 mV/V	± 1 mV/V	± 0.5 mV/V	± 0.2 mV/V
	± 20 mV/V	± 10 mV/V	± 5 mV/V	± 2 mV/V
	± 200 mV/V	± 100 mV/V	± 50 mV/V	± 20 mV/V
			± 500 mV/V	± 200 mV/V
Excitation voltage sense	2 separate connector pins available, wiring required (no internal bypass)			
Maximum cable length	100 m (328 ft), cable impedance ≤ 0.2 Ω/m (0.06 Ω/ ft)			

(1) Used amplifier range = mV/V range * Excitation voltage level

Basic Sensor Mode Wire Diagram

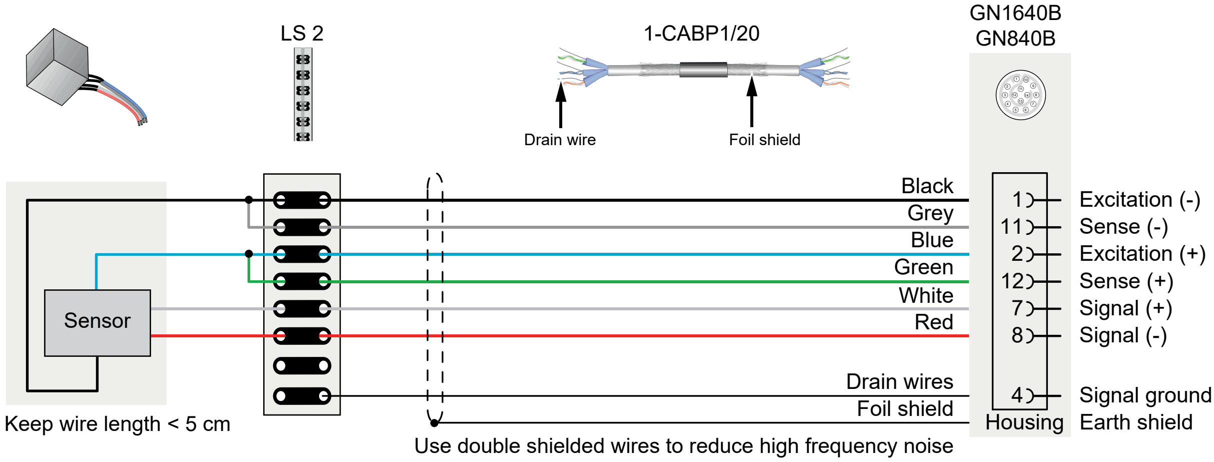


Figure 14: Recommended 6 wire basic sensor connection (more options are available)

Integrated Electronic PiezoElectric (IEPE)

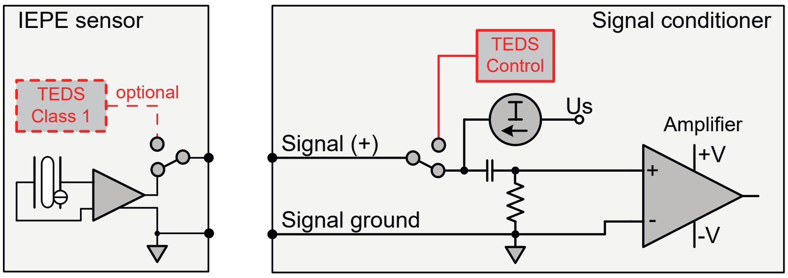


Figure 15: IEPE mode block diagram

Input ranges	± 1 mV, ± 10 mV, ± 100 mV, ± 1 V, ± 10 V
Over voltage protection	- 15 V to + 26 V
IEPE compliance voltage (Us)	≥ 24 V
IEPE gain error drift	Typical: ± 15 ppm/°C (9 ppm/°F), maximum: ± 35 ppm/°C (20 ppm/°F)
Excitation current (I)	2, 4, 6, 8 mA, software selectable
Excitation current accuracy	± 5%
Coupling time constant	1.5 s
-3 dB high pass bandwidth limit	0.1 Hz ± 20%
Maximum cable length	100 m (RG-58)
Wire diagnostics	Open and shorted IEPE wiring detected
TEDS support	Class 1, including software selectable auto detect the presence of an attached sensor

IEPE Mode Wire Diagram

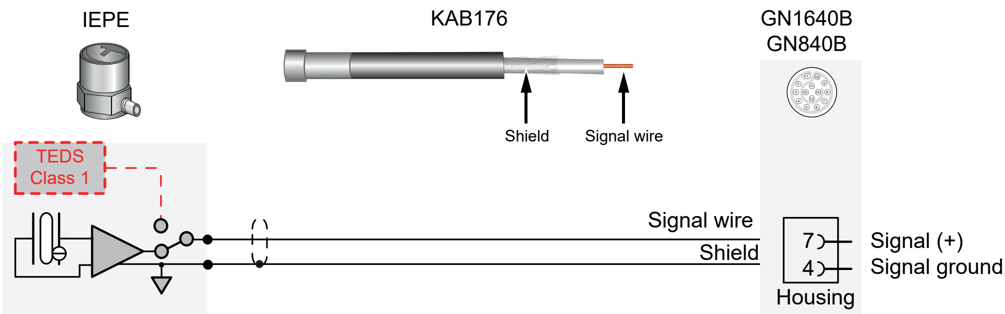


Figure 16: Recommended IEPE connection

Voltage IEPE Gain

Wideband	**Pass/Fail limits**
Voltage IEPE gain error	0.05% of reading ± 20 µV

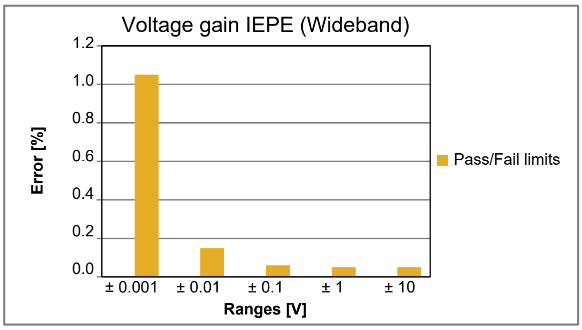


Figure 17: Wideband IEPE specification

Piezoelectric (Charge) Mode

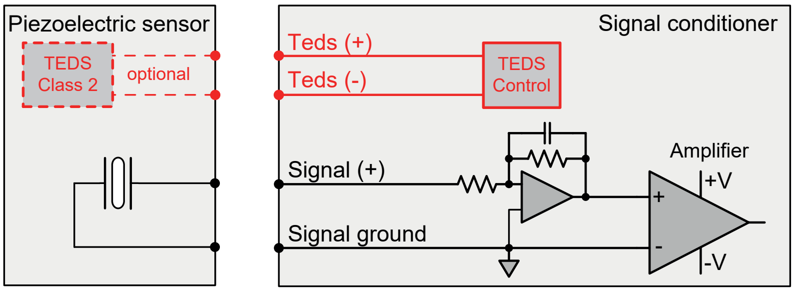


Figure 18: Piezoelectric mode block diagram

Input ranges	± 1 nC, ± 10 nC, ± 100 nC, ± 1 µC, ± 10 µC
Input coupling	AC coupled only
Over voltage protection	± 25 V
Piezoelectric gain error	Typical: ± 1% of reading Guaranteed: ± 2% of reading
Piezoelectric gain error drift	Typical: ± 20 ppm/°C (± 12 ppm/°F) Guaranteed: ± 65 ppm/°C (± 36 ppm/°F)
-3 dB high pass bandwidth limit	1 Hz ± 20%
-3 dB low pass bandwidth limit	33 kHz ± 10% when a 650 pF source capacity is used 106 kHz ± 10% when a 100 pF source capacity is used
TEDS support	Class 2 (no software support at release date)

Piezoelectric Mode Wire Diagram

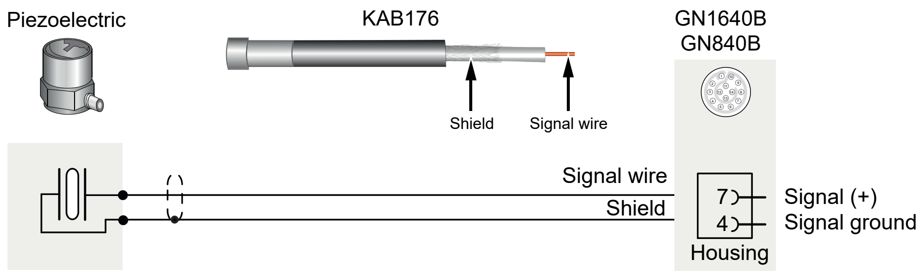


Figure 19: Recommended piezoelectric connection

Resistive Temperature Detectors (RTD)

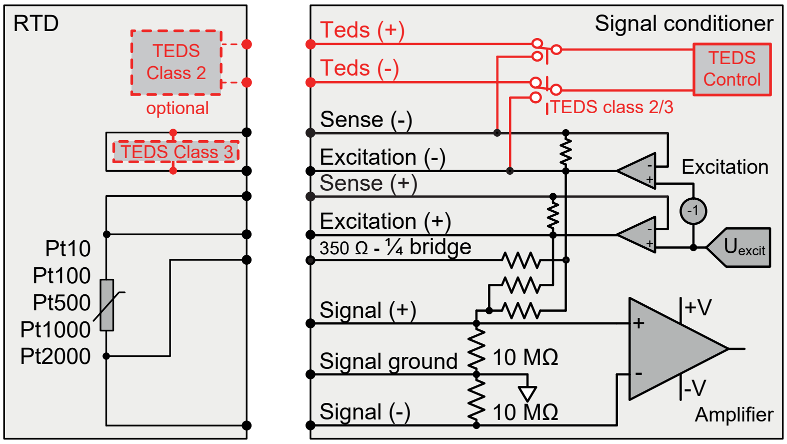


Figure 20: RTD mode block diagram

Supported sensors	Pt10, Pt100, Pt500, Pt1000 and Pt2000		
Type	3 wire and 4 wire possible		
Inaccuracy	Temperature range	Typical inaccuracy(1)(2)	Guaranteed inaccuracy(1)(2)
Pt10	-200 °C to 0 °C (-328 °F to +32 °F)	± 2.2 °C°C	± 11 °C
	0 °C to +850 °C (+32 °F to +1562 °F)	± (2.2 °C + 0.07% of reading [°C])	± (11 °C + 0.35% of reading [°C])
Pt100	-200 °C to 0 °C (-328 °F to +32 °F)	± 0.25 °C	± 1.1 °C
	0 °C to +850 °C (+32 °F to +1562 °F)	± (0.25 °C + 0.04% of reading [°C])	± (1.1 °C + 0.055% of reading [°C])
Pt500	-200 °C to 0 °C (-328 °F to +32 °F)	± 0.1 °C	± 0.35 °C
	0 °C to +850 °C (+32 °F to +1562 °F)	± (0.1 °C + 0.2% of reading [°C])	± (0.35 °C + 1% of reading [°C])
Pt1000	-200 °C to 0 °C (-328 °F to +32 °F)	± 0.2 °C	± 0.9 °C
	0 °C to +850 °C (+32 °F to +1562 °F)	± (0.2 °C + 0.4% of reading [°C])	± (0.9 °C + 2% of reading [°C])
Pt2000	-200 °C to 0 °C (-328 °F to +32 °F)	± 0.35 °C	± 1.7 °C
	0 °C to +850 °C (+32 °F to +1562 °F)	± (0.35 °C + 0.8% of reading [°C])	± (1.7 °C + 3.9% of reading [°C])
Maximum cable length	100 m		
Measurement range	-200 °C to 850 °C (-328 °F to 1562 °F)		
TEDS support	Class 2 and 3 (no software support at release date)		

(1) Used amplifier range = mV/V range * Excitation voltage level

(2) Measured with Meatest M632 precision resistance decade.

Resistance Mode

Resistance measurement works as a bridge measurement.

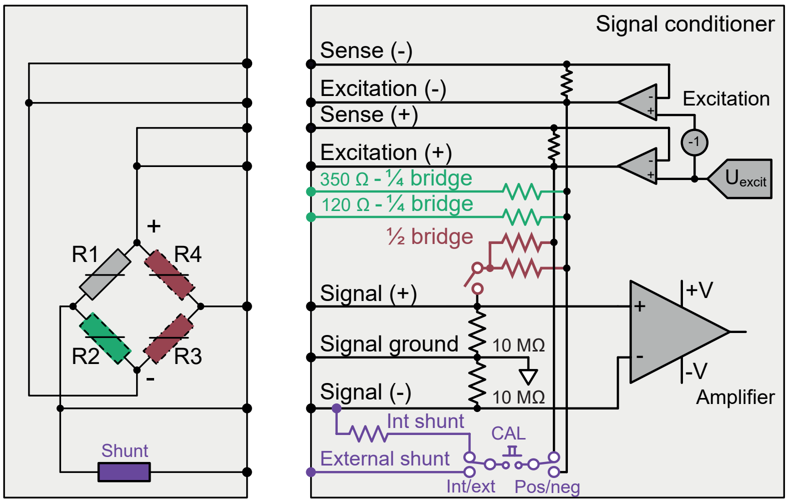


Figure 21: Resistance measurement using bridge setup

Supported sensors	Resistor
Quarter bridge connection	Four wire support; the third wire keeps the measurement wire current free eliminating wire resistance errors through the measurement wire, the fourth wire is used to sense the excitation voltage
Built in quarter bridge completion resistor	120 Ω and 350 Ω, 0.1% 2 ppm/°C, wired to separate connector pin
Built in half bridge completion resistors	2 times 10 kΩ, 0.05% 2 ppm/°C tracking
Bridge excitation modes	Constant voltage
Constant voltage excitation	
Selectable excitation voltage	Bipolar ± 0.5 V DC to ± 5.0 V DC, maximum 30 mA
Excitation voltage in-accuracy	± 0.25%
Excitation voltage sense	2 separate connector pins available, wiring required (no internal bypass)

Resistance Mode Wiring Diagrams

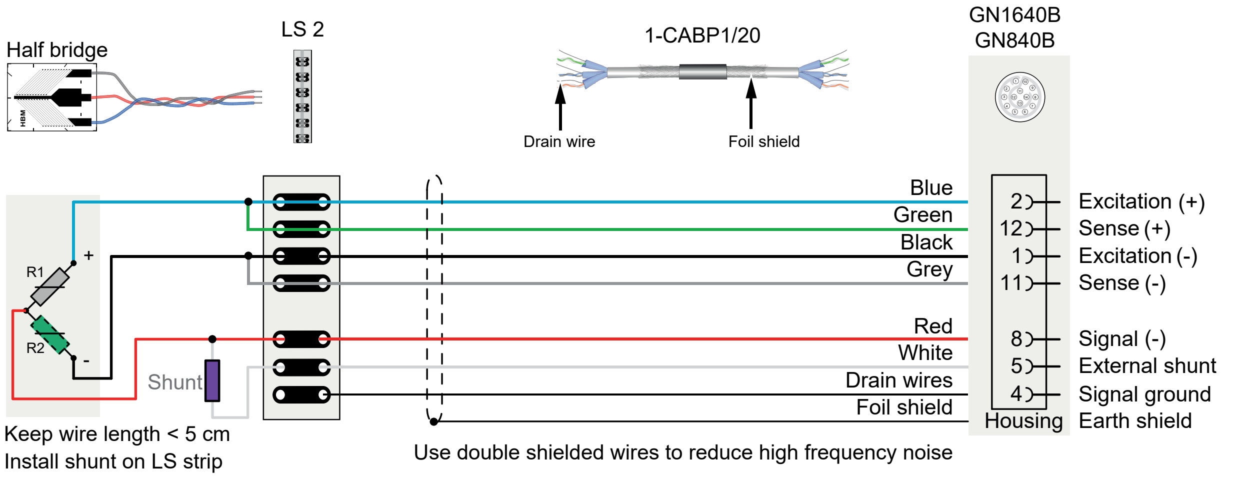


Figure 22: Recommended 6 wire resistance with shunt resistor connection (more options are available)

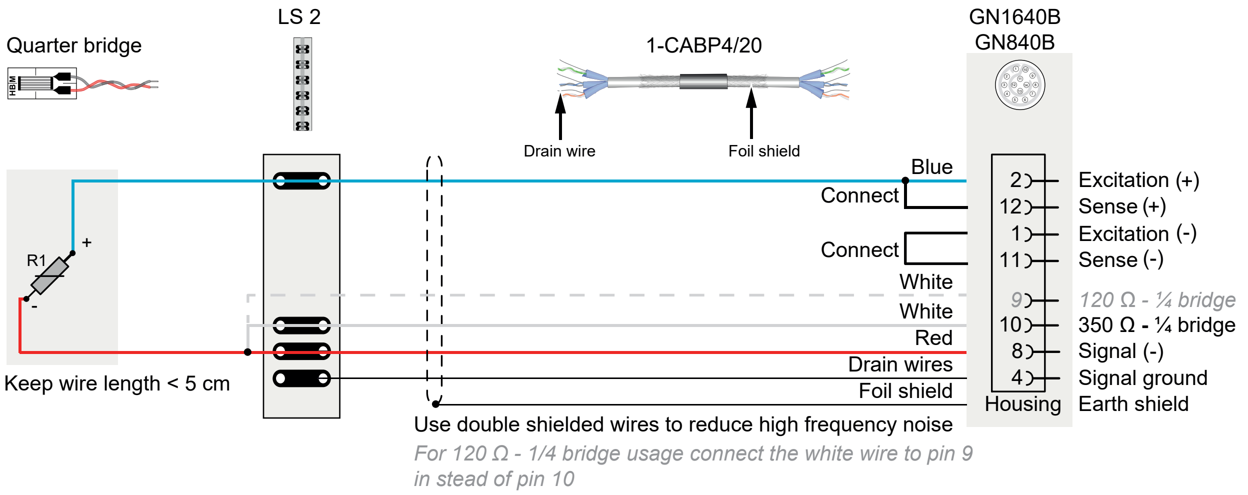


Figure 23: Recommended 3 wire resistance connection (more options are available)

Accuracy

Mode	Completion resistor	Range R1	Typical(1)(2)(3)
Half bridge	1000 Ω	250 Ω to 550 Ω 550 Ω to 3050 Ω 3050 Ω to 3350 Ω	0.25% 0.10% 0.25%
Quarter bridge	350 Ω	90 Ω to 160 Ω 160 Ω to 1060 Ω 1060 Ω to 1170 Ω	0.25% 0.10% 0.25%
	120 Ω	45 Ω to 70 Ω 70 Ω to 250 Ω 250 Ω to 420 Ω	0.25% 0.10% 0.25%

(1) Completion resistor 1000 Ω and 350 Ω measured with excitation voltages ± 500 mV, ± 1 V, ± 2.5 V and ± 5V.

(2) Completion resistor 120 Ω measured with excitation voltages ± 500 mV, ± 1 V, and ± 2.5V.

(3) Filter setting Bessel Low pass 5 Hz

Measured with Meatest M632 precision resistance decade.

RTD Wire Diagram

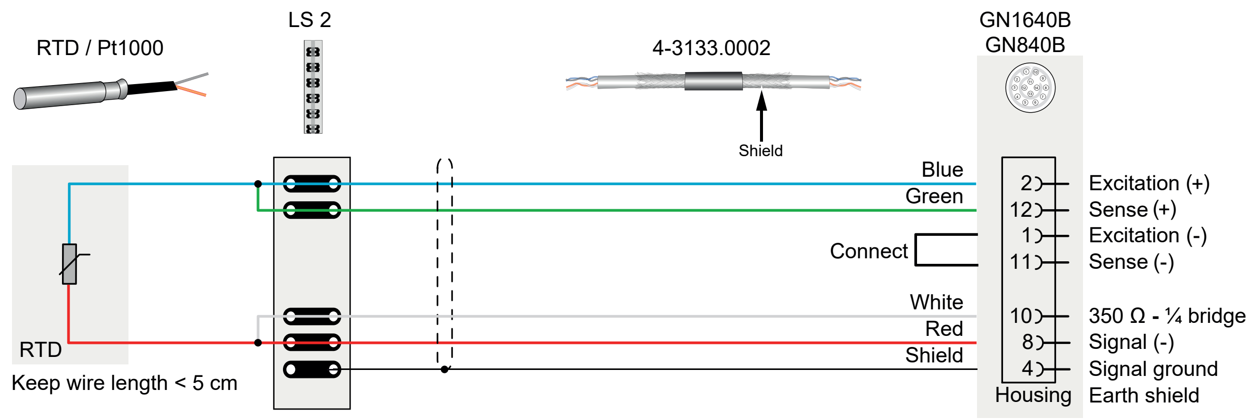


Figure 24: Recommended 4 wire RTD connection (more options are available)

Current Loop Mode

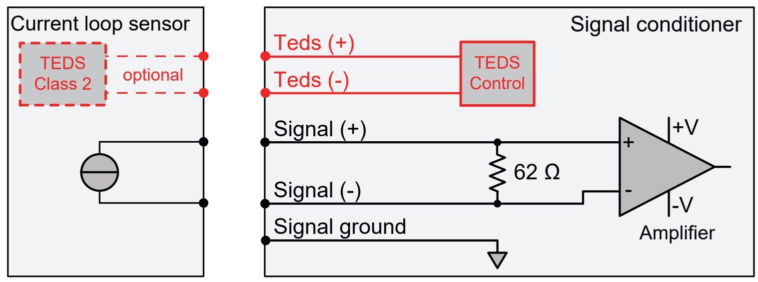


Figure 25: Current loop mode block diagram

Resistance value (typical)	62 Ω
Input fuse	0.1 A (self-resettable)
Cable length	100 m Max.
Range	± 20 µA, ± 0.2 mA, ± 2 mA, ± 20 mA (0 to 40 mA with offset used)
TEDS support	Class 2 (no software support at release date)

Current Loop Wire Diagram

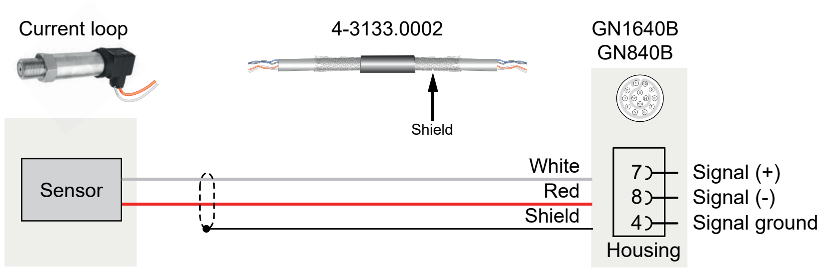


Figure 26: Recommended current loop connection

Current Loop Specifications

Wideband	Pass/Fail limits
Current loop DC gain error	0.03% of reading ± 100 nA
Current loop offset error	0.001% of Full Scale ± 300 nA
Current loop DC gain error drift	80 ppm / °C (45 ppm of Full Scale / °F)
Current loop offset error drift	± (15 ppm + 40 nA) / °C (± (9 ppm + 23 nA) / °F)

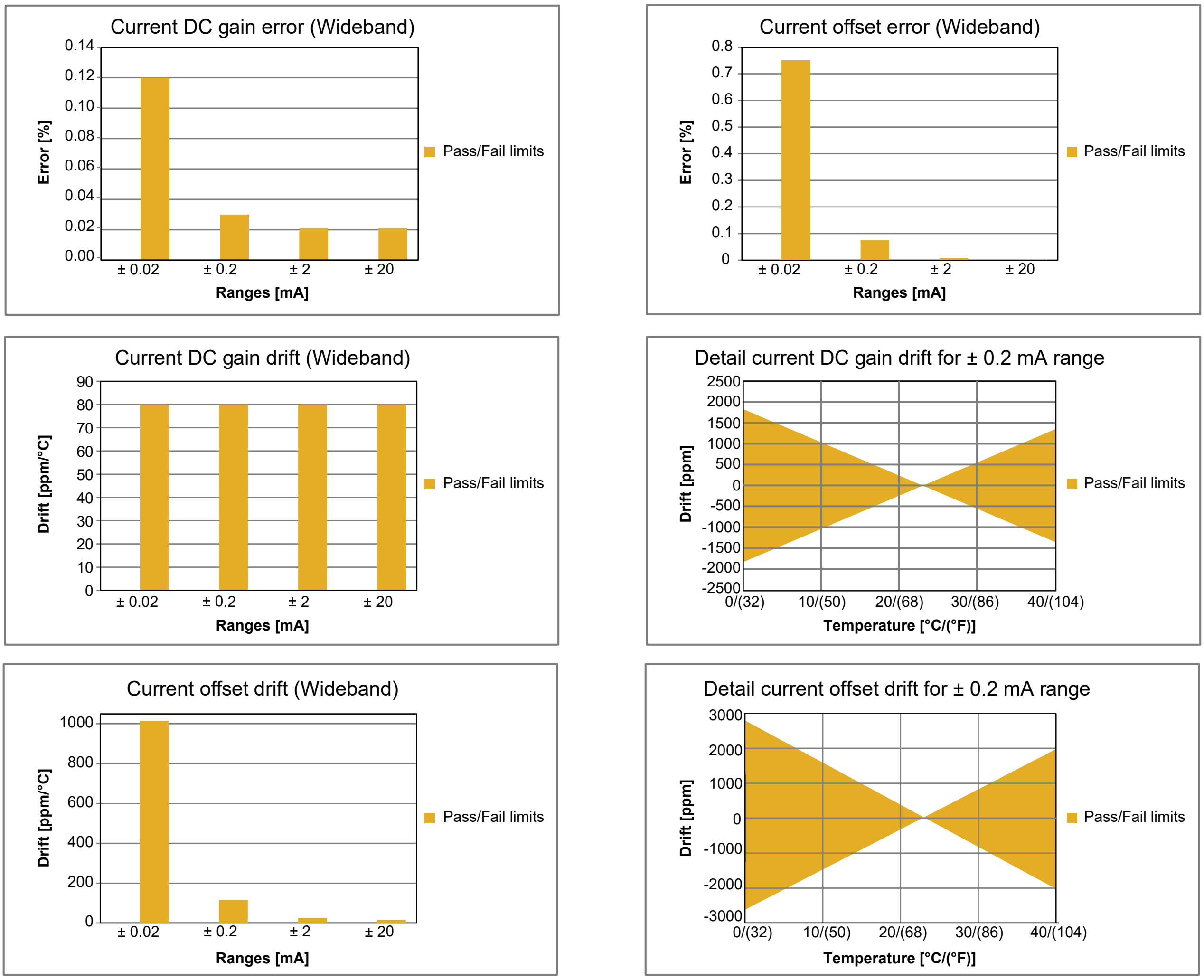


Figure 27: Wideband current loop specification

Thermocouple Mode

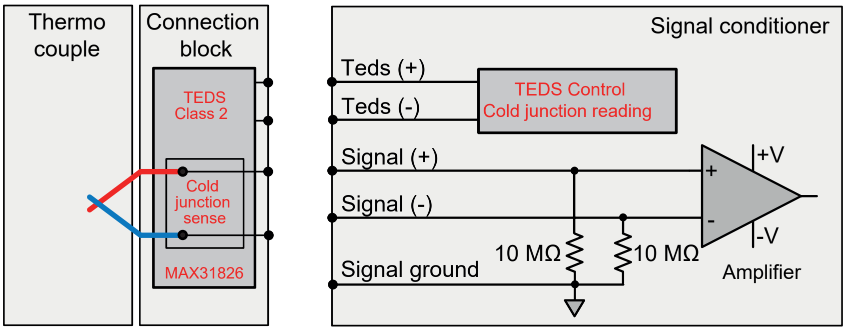


Figure 28: Thermocouple mode block diagram

Linearization for thermocouples	K, J, T, B, E, N, R, S, C
Cold junction compensation	Digital 1-wire readout of MAX31826 or DS18S20 digital thermometer
Filter types	Bessel, Butterworth and Elliptic
Filter frequencies	10 kHz, 5 kHz, 2.5 kHz, 2 kHz, 1 kHz, 500 Hz, 250 Hz, 200 Hz, 100 Hz, 50 Hz, 25 Hz, 20 Hz, 10 Hz, 5 Hz, 2.5 Hz, 2 Hz, 1 Hz, 0.5 Hz, 0.25 Hz Bessel filter additionally supports 0.2 Hz and 0.1 Hz
Thermocouple sample rate	Sample rate depends on filter frequency used. See table: “Thermocouple Update Rates”
Connector cable	Connection box
TEDS support	Class 2 (no software support at release date)

Types	**Temperature range**	**Typical**(1)	**Guaranteed**(1)
Type B	From 100° C to 200° C (212° F to 392° F)	± 1.4° C (± 2.52° F)	± 7° C (± 12.6° F)
	From 200° C to 500° C (392° F to 932° F)	± 0.75° C (± 1.35° F)	± 3.5° C (± 6.3° F)
	From 500 °C to 1820° C (932° F to 3308° F)	± 0.5° C (± 0.9° F)	± 2°C (± 3.6° F)
Type C	From 0° C to 1000° C (32° F to 1832° F)	± 0.6° C (± 1.08° F)	± 1.5° C (± 2.7° F)
	From 1000° C to 2315° C (1832° F to 4199° F)	± 1.5° C (± 2.7° F)	± 3°C (± 5.4° F)
Type E	From -200 °C to 900° C (-328° F to 1652° F)	± 0.4°C (± 0.72° F)	± 0.8°C (± 1.44° F)
Type J	From -210° C to 1200° C (-346° F to 2192° F)	± 0.5° C (± 0.9° F)	± 1°C (± 1.8° F)
Type K	From -200° C to 1372° C (-328° F to 2501.6° F)	± 0.6° C (± 1.08° F)	± 1°C (± 1.8° F)
Type N	From -250°C to -100°C (-418° F to -148° F)	± 1.25°C (± 2.25° F)	± 2.5°C (± 4.5° F)
	From -100°C to 1300°C (-148° F to 2372° F)	± 0.5° C (± 0.9° F)	± 1°C (± 1.8° F)
Type R	From -50° C to 0° C (-58° F to 32° F)	± 1°C (± 1.8° F)	± 2°C (± 3.6° F)
	From 0° C to 1100° C (32° F to 2012° F)	± 0.5° C (± 0.9° F)	± 1°C (± 1.8° F)
	From 1100° C to 1768° C (2012° F to 3214.4° F)	± 0.7°C (± 1.26° F)	± 1.4°C (± 2.52° F)
Type S	From -50° C to 0° C (-58° F to 32° F)	± 1°C (± 1.8° F)	± 2°C (± 3.6° F)
	From 0° C to 1100° C (32° F to 2012° F)	± 0.5° C (± 0.9° F)	± 1°C (± 1.8° F)
	From 1100° C to 1768° C (2012° F to 3214.4° F)	± 0.7°C (± 1.26° F)	± 1.4°C (± 2.52° F)
Type T	From -260°C to -100°C (-436° F to -148° F)	± 2°C (± 3.6° F)	± 4°C (± 7.2° F)
	From -100° C to 400° C (-148° F to 752° F)	± 0.3°C (± 0.54° F)	± 0.6°C (± 1.08° F)

(1) Measured using Bessel filter at 5 Hz bandwidth.

Thermocouple Wire Diagram

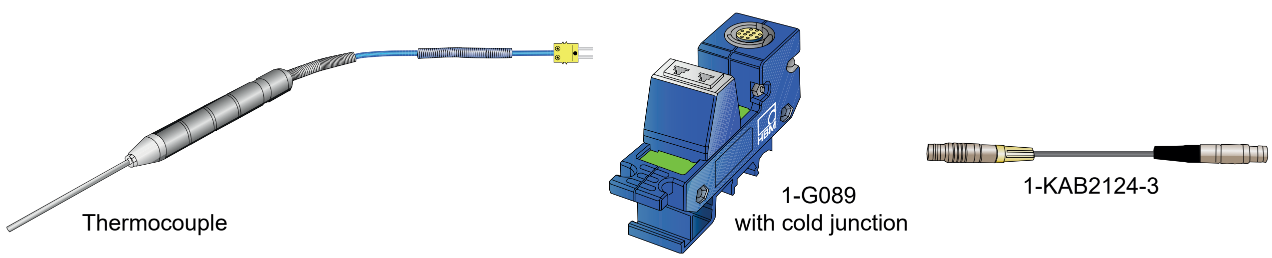


Figure 29: Recommended thermocouple tools

Thermocouple Update Rates

Limited update rate	**GN840B/GN1640B Sample rate**		
Filter cut off	1 S/s to 500 S/s	1 kS/s to 5 kS/s	5 kS/s to 500 kS/s
0.25 Hz	500 Hz	500 Hz	500 Hz
0.5 Hz	500 Hz	500 Hz	500 Hz
1 Hz	500 Hz	5 kHz	5 kHz
2 Hz	500 Hz	5 kHz	5 kHz
2.5 Hz	500 Hz	5 kHz	5 kHz
5 Hz	500 Hz	5 kHz	5 kHz
10 Hz	500 Hz	5 kHz	50 kHz
20 Hz	500 Hz	5 kHz	50 kHz
25 Hz	500 Hz	5 kHz	50 kHz
50 Hz	500 Hz	5 kHz	50 kHz
100 Hz	500 Hz	5 kHz	500 kHz
200 Hz	-	5 kHz	500 kHz
250 Hz	-	5 kHz	500 kHz
500Hz	-	5 kHz	500 kHz
1000 Hz	-	5 kHz	500 kHz
2000 Hz	-	-	500 kHz
2500 Hz	-	-	500 kHz
5000 Hz	-	-	500 kHz
10000 Hz	-	-	500 kHz

Isolation

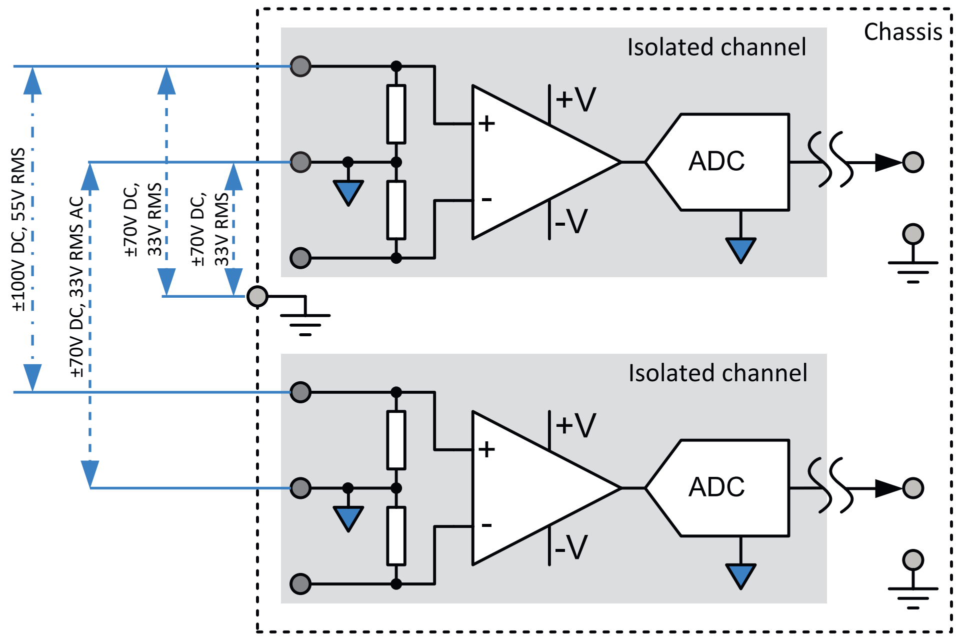


Figure 30: Isolation schematic

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

GN1640B/GN840B Connector and Pinning

Mating connector	HBM 1-CON-P1007; ODU SX2B0C-P14MFG0-0001 (male)
Connectors	ODU GX2B0C-P14QF00-0002 (female)

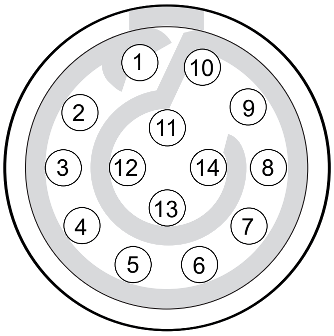


Figure 31: Cable connector soldering view

GN1640B/GN840B	KAB183 colors	Pin number
Excitation (-) / TEDS class 3 (-)	Black	1
Excitation (+)	Blue	2
Reserved	White/Black	3
Signal ground	Red/Black	4
External shunt	Pink/Black	5
Reserved	Yellow/Black	6
Signal (+)	White	7
Signal (-)	Red	8
120 Ω -¼ bridge	Brown	9
350 Ω -¼ bridge	Yellow	10
Sense (-) / TEDS class 3 +	Grey	11
Sense (+)	Green	12
TEDS class 2 (-)	Grey/Black	13
TEDS class 2 (+)	Green/Black	14

Analog to Digital Conversion	
Sample rate; per channel	0.1 S/s to 500 kS/s
ADC resolution; one ADC per channel	24 bit
ADC type	Sigma Delta (Σ-Δ) ADC; Texas Instruments® ADS127L01
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.

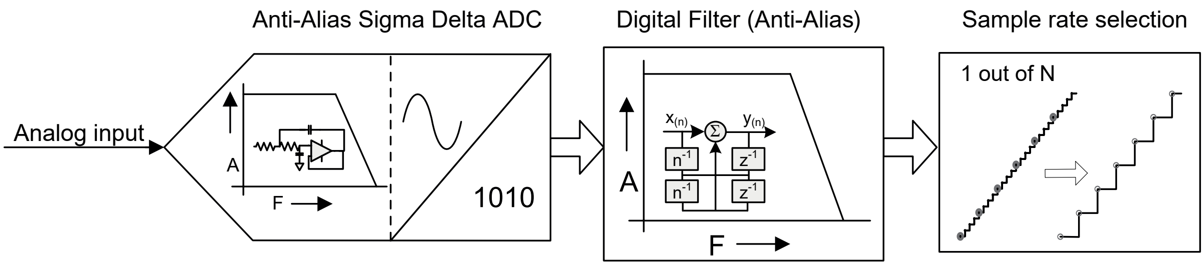


Figure 32: Combined analog and digital anti-alias filter block diagram

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 anti-alias filter built-in the Sigma Delta ADC and a digital Bessel IIR filter to prevent aliasing at lower sample rates. Bessel filters are typically used when looking at signals in the time domain. They are best used for measuring transient signals or sharp edge signals like square waves or step responses.
Butterworth IIR	When Butterworth IIR filter is selected, this is always a combination of the anti-alias filter built-in the Sigma Delta ADC and a digital Butterworth IIR filter to prevent aliasing at lower sample rates. This filter is best used when working in the frequency domain. When working in the time domain, this filter is best used for signals that are (close to) sine waves.
Elliptic IIR	When Elliptic IIR filter is selected, this is always a combination of the anti-alias filter built-in the Sigma Delta ADC and a digital Elliptic IIR filter to prevent aliasing at lower sample rates. This filter is best used when working in the frequency domain. When working in the time domain, this filter is best used for signals that are (close to) sine waves.
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**
500 kS/s	ΣΔ Wideband	125 kHz	50 kHz	25 kHz	12.5 kHz	5 kHz	50 Hz, 100 Hz, 200 Hz, 500 Hz	1 kHz, 2 kHz, 5 kHz, 10 kHz, 12.5 kHz, 25 kHz, 50 kHz, 100 kHz
400 kS/s	ΣΔ Wideband	100 kHz	40 kHz	20 kHz	10 kHz	4 kHz		
250 kS/s	ΣΔ Wideband	62.5 kHz	25 kHz	12.5 kHz	6.25 kHz	2.5 kHz		
200 kS/s	ΣΔ Wideband	50 kHz	20 kHz	10 kHz	5 kHz	2 kHz		
125 kS/s	ΣΔ Wideband	31.25 kHz	12.5 kHz	6.25 kHz	2.5 kHz	1.25 kHz		
100 kS/s	ΣΔ Wideband	25 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	3.125 kHz	1.25 kHz	625 Hz	312.5 Hz	125 Hz		
10 kS/s	ΣΔ Wideband	2.5 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 anti-alias filter built-in the Sigma Delta ADC (no digital filter) in the signal path. Therefore there is always anti-alias protection when Sigma Delta wideband is selected.

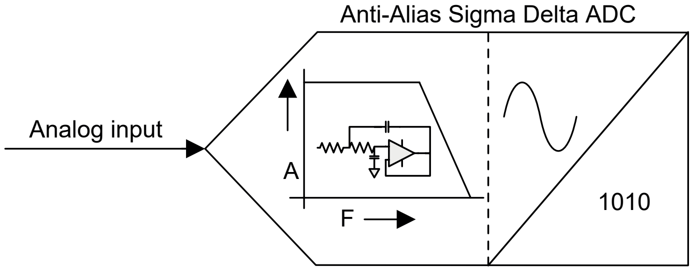


Figure 33: Anti-alias filter built-in (Sigma Delta ADC)

Wideband -3 dB bandwidth(1)	DC to 211 kHz DC to 56 kHz for ± 1 mV range due to high amplifier gain
0.1 dB passband flatness(1)	DC to 150 kHz DC to 7 kHz for ± 1 mV range due to high amplifier gain

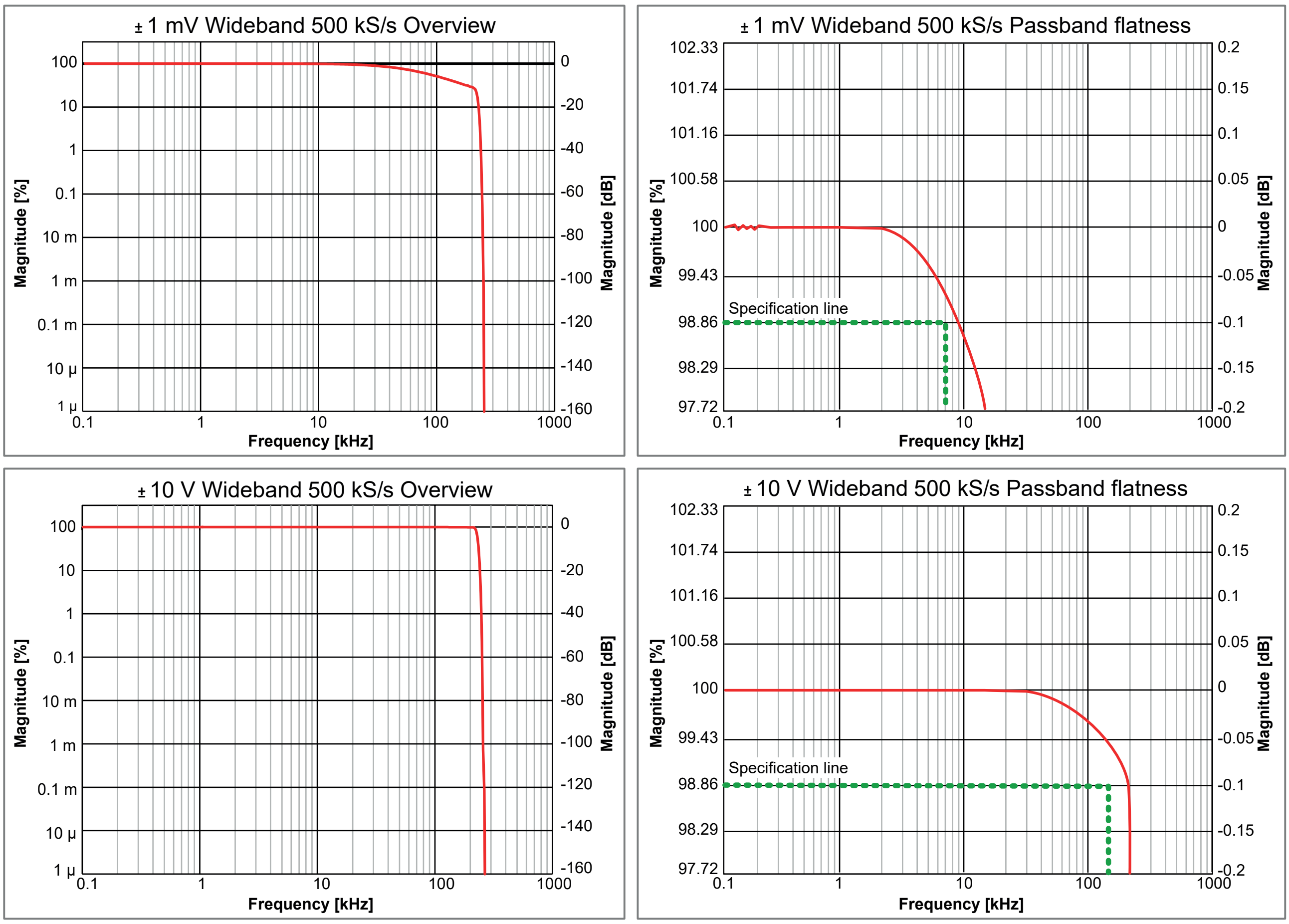


Figure 34: Representative Wideband examples

(1) Measured using Fluke 5730A calibrator, DC normalized

Bessel IIR Filter (Digital Anti-Alias)

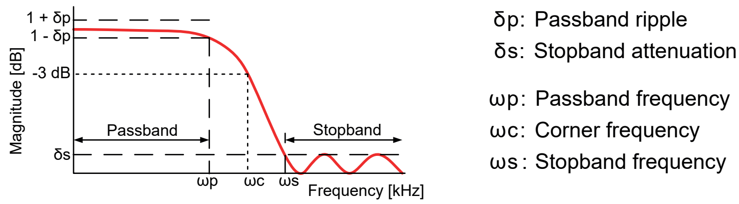


Figure 35: Representative Bessel IIR examples

When Bessel IIR filter is selected, this is always a combination of the anti-alias filter built-in the Sigma Delta ADC and a digital Bessel IIR filter.	
Analog anti-alias filter	The Sigma Delta ADC anti-alias filter
Bessel IIR filter	
Characteristic	12-pole Bessel style IIR
User selection	Auto tracking for sample rate divided by: 10, 20, 40, 100 User selects a division factor from the current sample rate; software then adjusts the filter when the sample rate is changed.
Bandwidth (ωc)	User selectable from 1 Hz to 50 kHz
0.1 dB passband flatness (ωp)[1]	DC to 0.18 * ωc. Limited to 6 kHz for ± 1 mV range
Stopband	-180 dB (-160 dB for ± 1 mV range)
Roll-off	-72 dB/octave

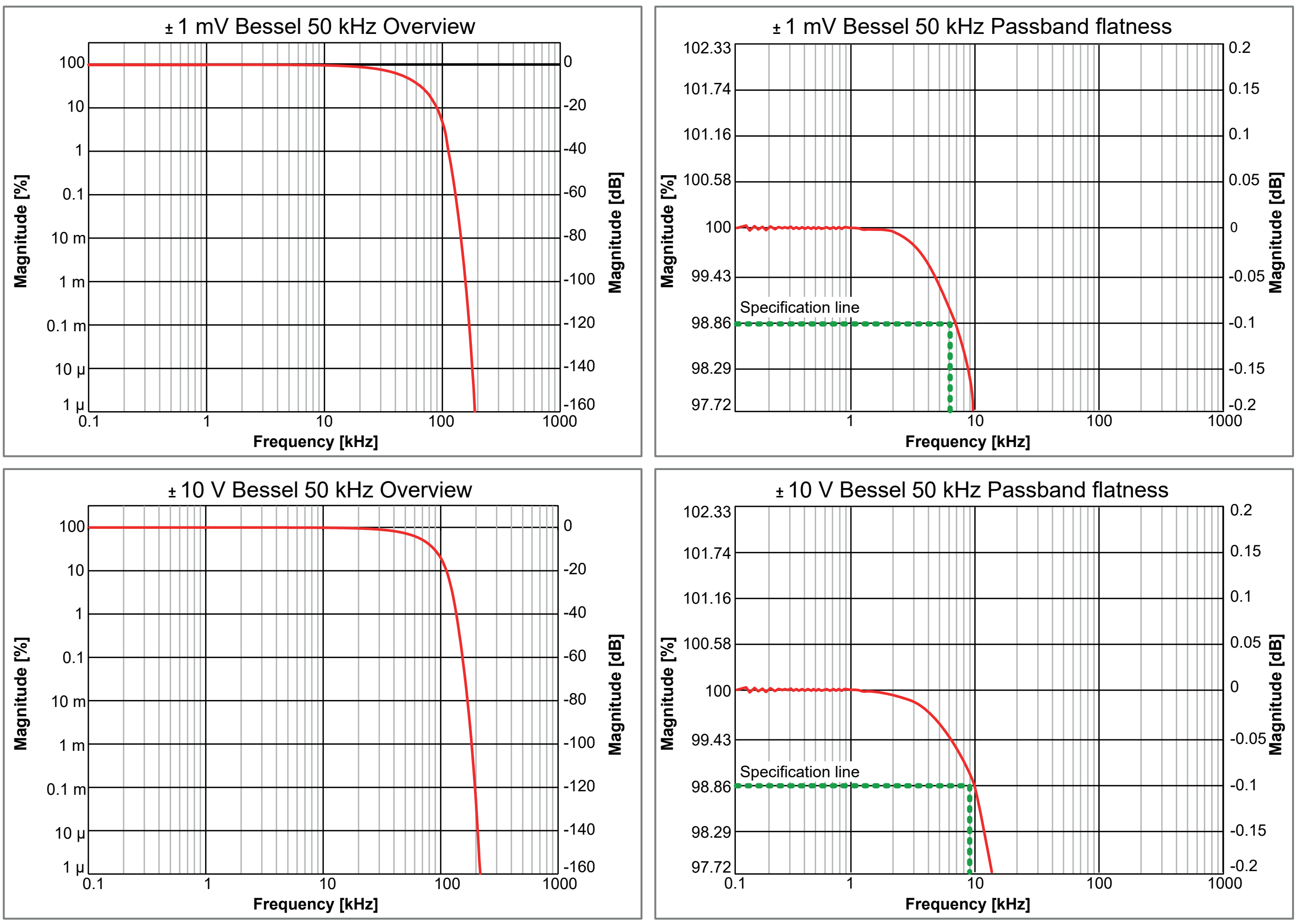
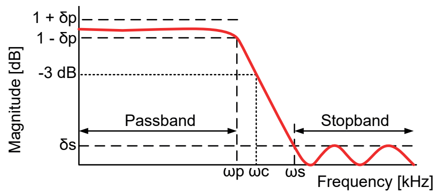


Figure 36: Representative Bessel IIR examples

(1) Measured using Fluke 5730A 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 37: Representative Digital Butterworth IIR Filter

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

Analog anti-alias filter	The Sigma Delta ADC anti-alias filter
Butterworth IIR filter	
Characteristic	12-pole Butterworth style IIR
User selection	Auto tracking for sample rate divided by: 4, 10, 20, 40 User selects a division factor from the current sample rate; software then adjusts the filter when the sample rate is changed
Bandwidth (ωc)	User selectable from 2.5 Hz to 125 kHz
0.1 dB passband (ωp) (1)	DC to 0.8 * ωc. Limited to 7 kHz for ± 1 mV range
Stopband attenuation (δs)	-180 dB (-160 dB for ± 1 mV range)
Roll-off	-72 dB/octave

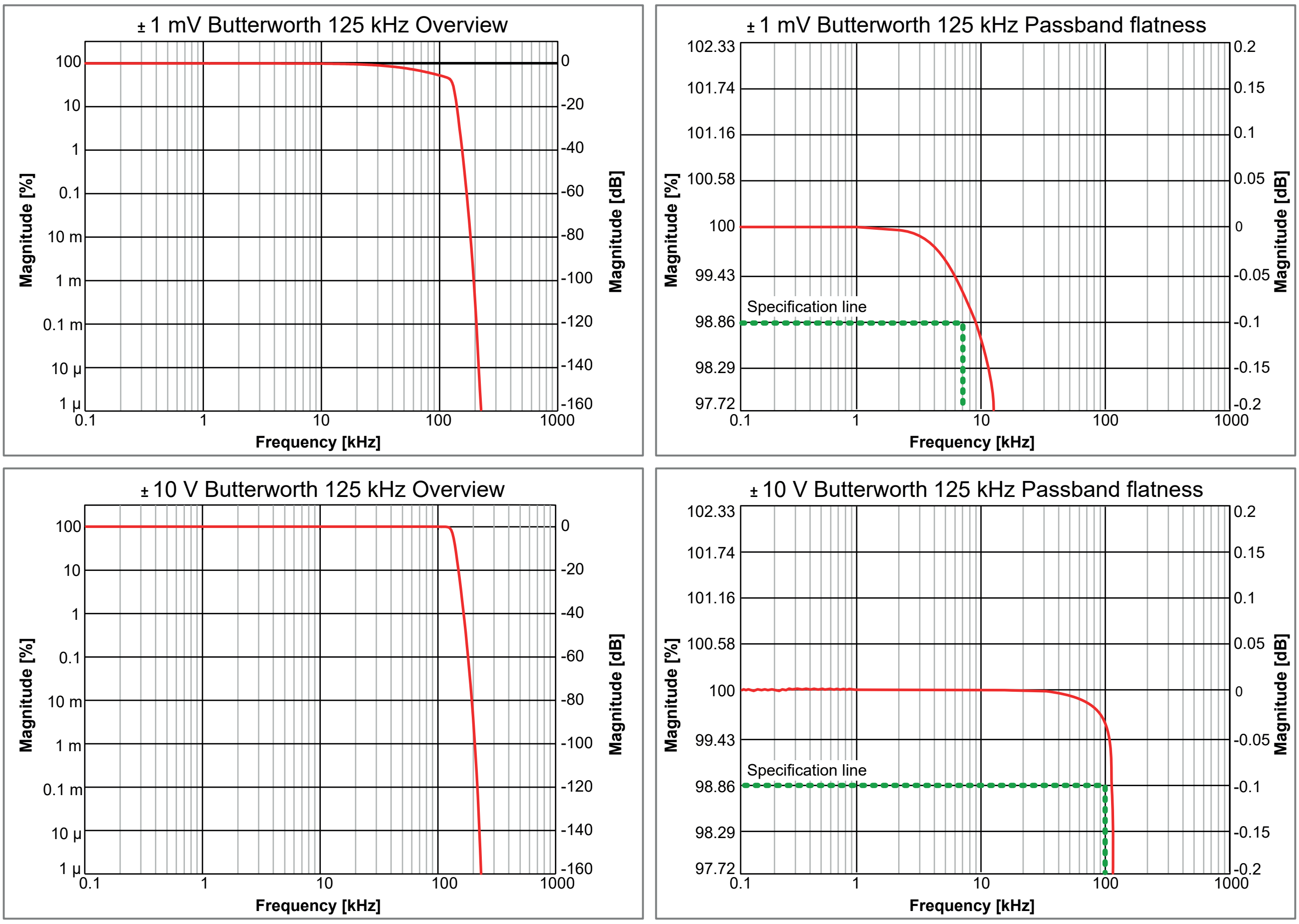


Figure 38: Representative Butterworth IIR examples

(1) Measured using Fluke 5730A calibrator, DC normalized

Elliptic IIR Filter (Digital Anti-Alias)

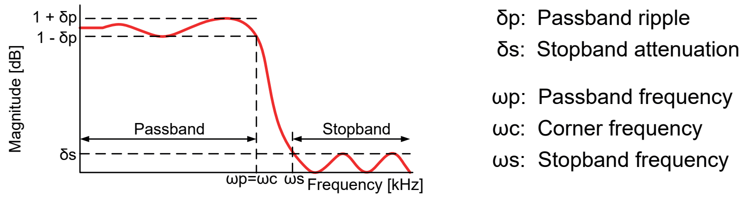


Figure 39: Digital Elliptic IIR Filter

When Elliptic IIR filter is selected, this is always a combination of the anti-alias filter built-in the Sigma Delta ADC and a digital Elliptic IIR filter.	
Analog anti-alias filter	The Sigma Delta ADC anti-alias filter
Elliptic IIR filter	
Characteristic	11-pole Elliptic style IIR
User selection	Auto tracking for sample rate divided by: 4, 10, 20, 40 The user selects a division factor from the current sample rate; software then adjusts the filter when the sample rate is changed
Bandwidth (ωc)	User selectable from 2.5 Hz to 125 kHz
0.1 dB passband ripple (ωp)(1)	DC to ωc. For ωc = 125 kHz, DC to 100 kHz due to amplifier bandwidth When using the range ± 1 mV for ωc > 10 kHz, DC to 7 kHz due to amplifier bandwidth
Stopband attenuation (δs)	-180 dB (-160 dB for ± 1 mV range)
Roll-off	-100 dB/octave

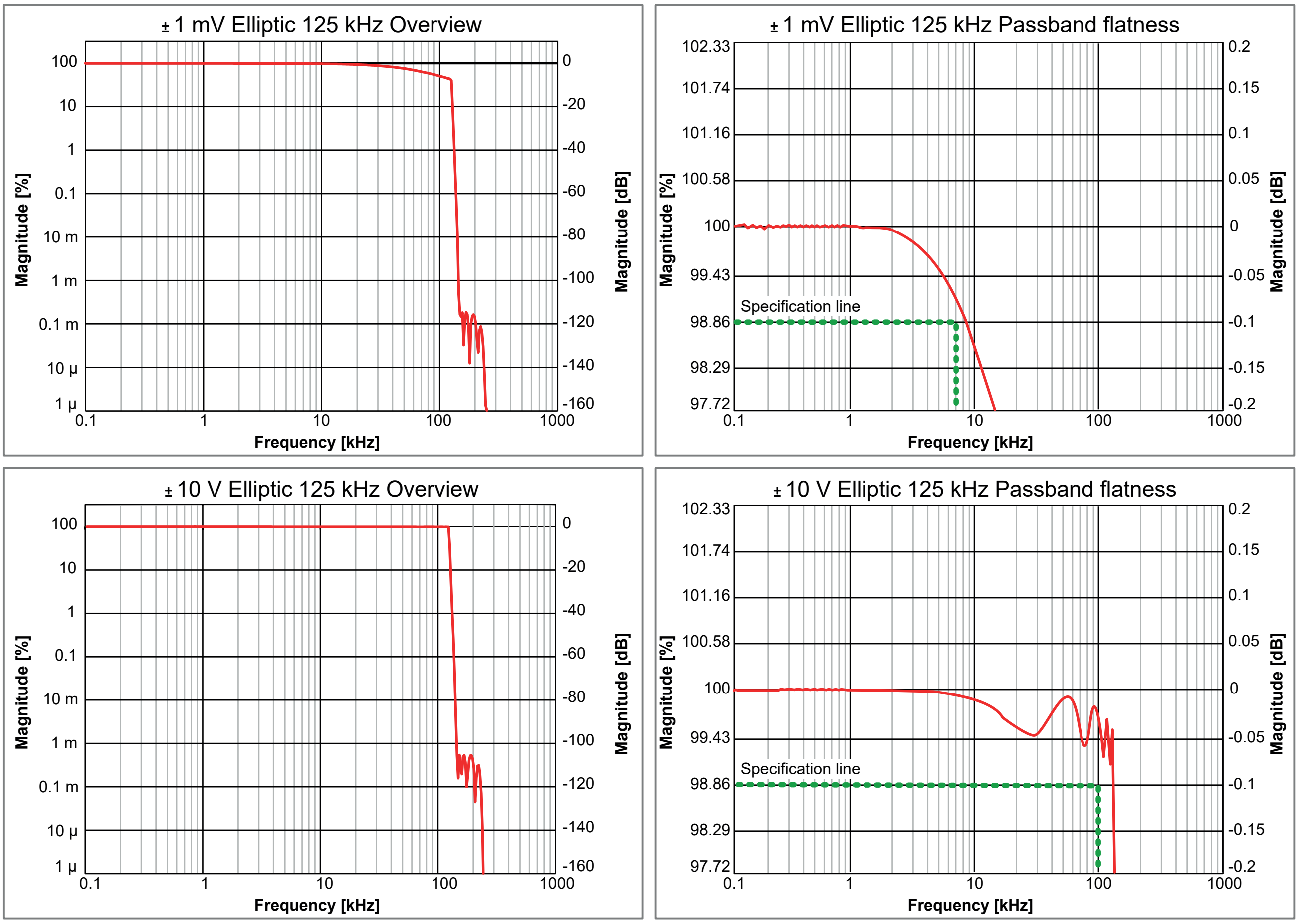
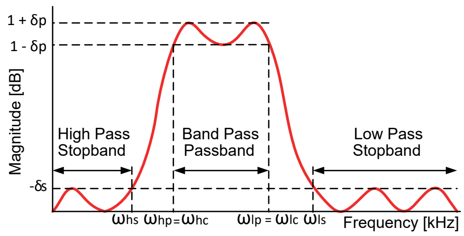


Figure 40: Representative Elliptic IIR examples

(1) Measured using Fluke 5730A 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 41: Representative 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	The Sigma Delta ADC anti-alias filter
Elliptic IIR Bandpass filter	
Characteristic	12^{th} order Elliptic style IIR
User selection	Fixed high pass frequencies to be combined with fixed low pass frequencies
High pass bandwidth (ωhc)	500 Hz, 200 Hz, 100 Hz, 50 Hz
High pass stopband frequency (ωhs)	Approximately ωhc / 2.5
Low pass bandwidth (ωlc)	125 kHz, 100 kHz, 50 kHz, 25 kHz, 12.5 kHz, 10 kHz, 5 kHz, 2 kHz, 1 kHz
Low pass stopband frequency (ωls)	Approximately 1.5 to 2.5 * ωc
0.1 dB passband flatness (ωp)(1)	ωhc to ωlc, limited to 7 kHz for ± 1 mV range
High pass stopband attenuation (δhs)	- 90 dB
Low pass stopband attenuation (δls)	-180 dB (-160 dB for ± 1 mV range)

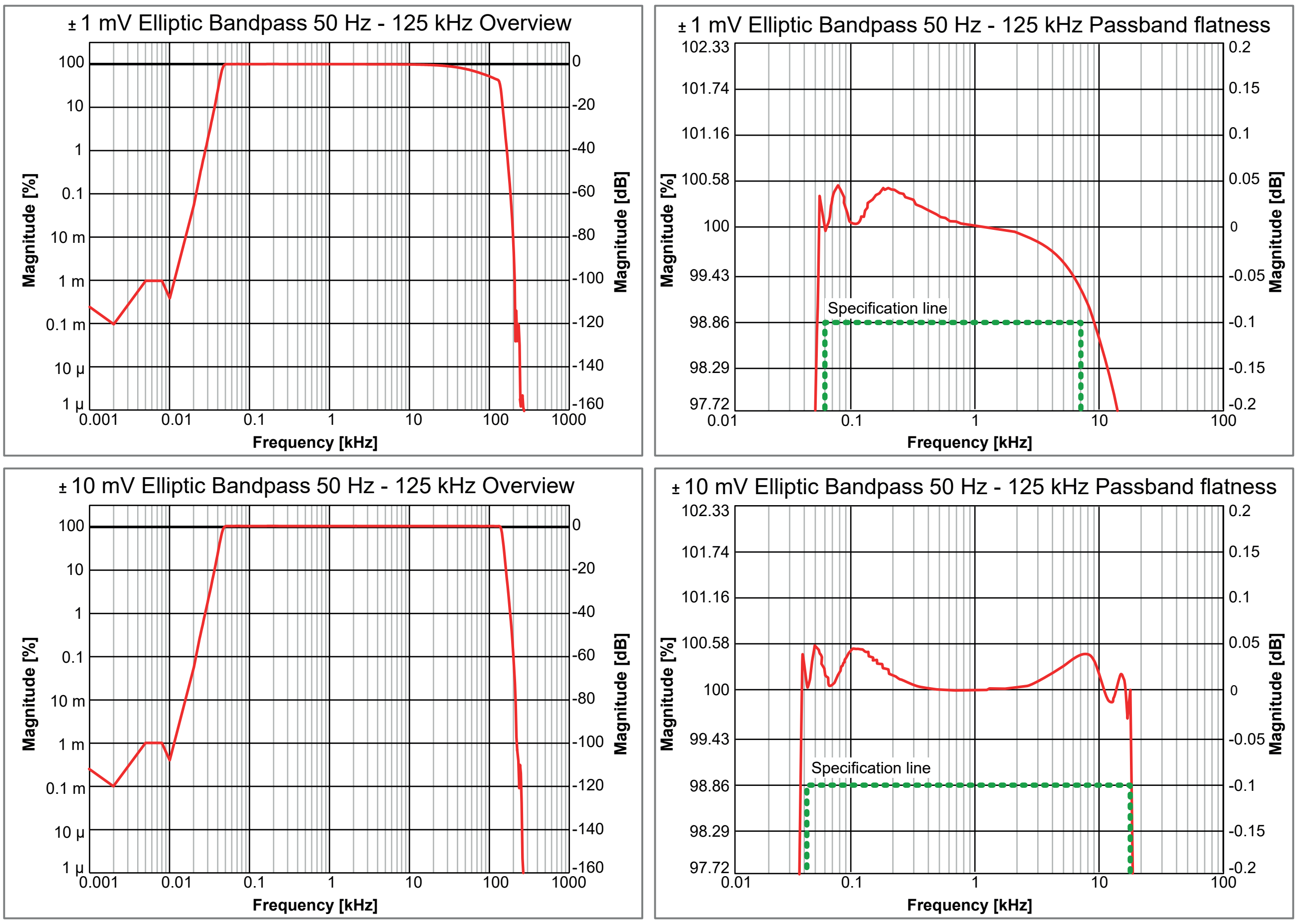


Figure 42: Representative Elliptic IIR Bandpass examples

(1) Measured using Fluke 5730A calibrator, DC normalized

Channel to Channel Phase Match

Using different filter selections (Wideband/Bessel IIR/Butterworth IIR/etc.) or different filter bandwidths results in phase mismatches between channels. Specifications valid for channel to channel and card to card, all specifications are typical statistical values and measured using a 500 kS/s sample rate with sine wave ranging from 100 Hz to 100 kHz or filter frequency, whichever is reached first.

	Range ±1 mV	Ranges ≥ ±10 mV	Ranges combined
Wideband	200 ns	30 ns	200 ns
Bessel IIR	100 ns	30 ns	100 ns
Butterworth IIR	100 ns	30 ns	100 ns
Elliptic IIR	110 ns	30 ns	110 ns
Elliptic IIR Bandpass	80 ns	30 ns	80 ns
GN840B/GN1640B channels across mainframes	Defined by synchronization method used (None, IRIG, GPS, Master/Sync, PTP)		

Channel to Channel Crosstalk

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

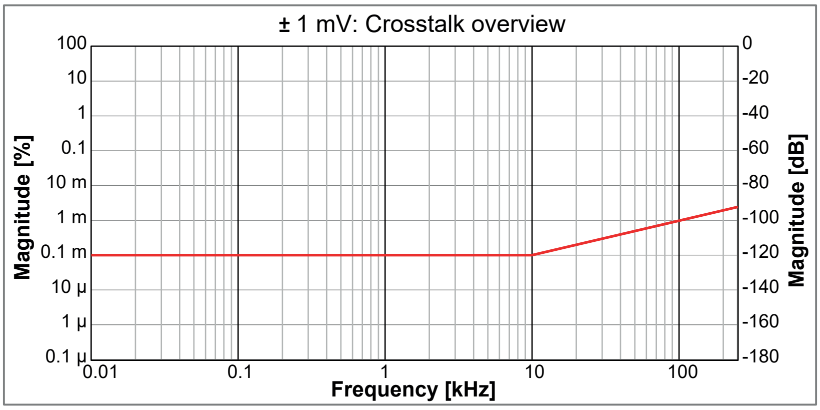


Figure 43: Representative Channel to Channel crosstalk

Digital Event/Timer/Counter

The Digital Event/Timer/Counter input connector is located on the mainframe. For exact layout and pinning see mainframe data sheet.

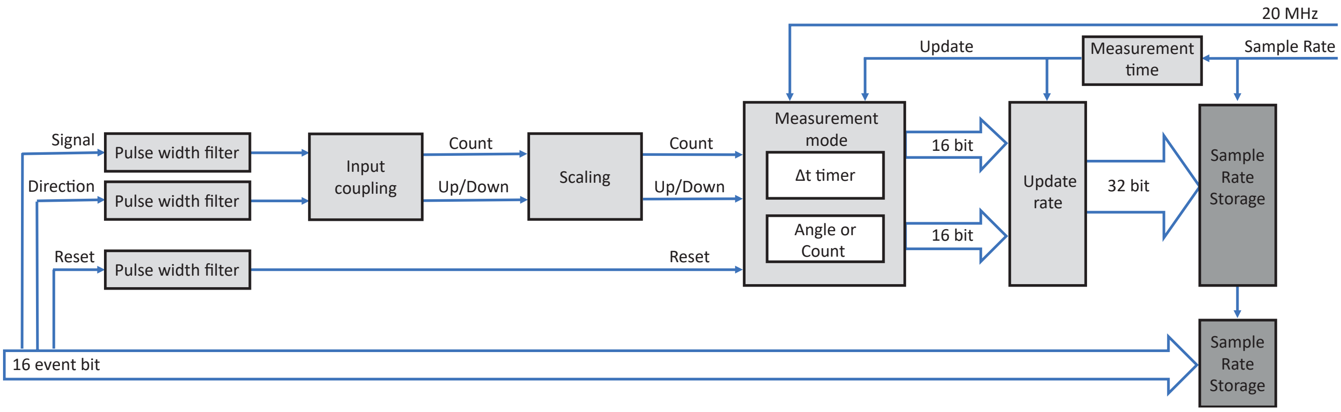


Figure 44: Timer/Counter block diagram

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	4 per card
Levels	TTL input levels
Inputs	3 pins: signal, reset and direction All pins are shared with digital event inputs
Input coupling	Uni-directional, Bi-directional and ABZ incremental encoder (Quadrature)
Measurement modes	Count (C) Angle (0 to 360 degrees) Frequency (Δcount / Δt) RPM (Δcount / Δt / 60 s)
Timer accuracy	± 25 ns (20 MHz)
Measurement time	1 to n samples (User selectable maximum Δt)
Measurement time and reading update rate	Measurement time sets the maximum update rate of the Measurement values
Measurement time and minimum frequency	Minimum measured frequency or RPM = 1 / Measurement time

Input Coupling Uni- and Bi-directional Signal

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

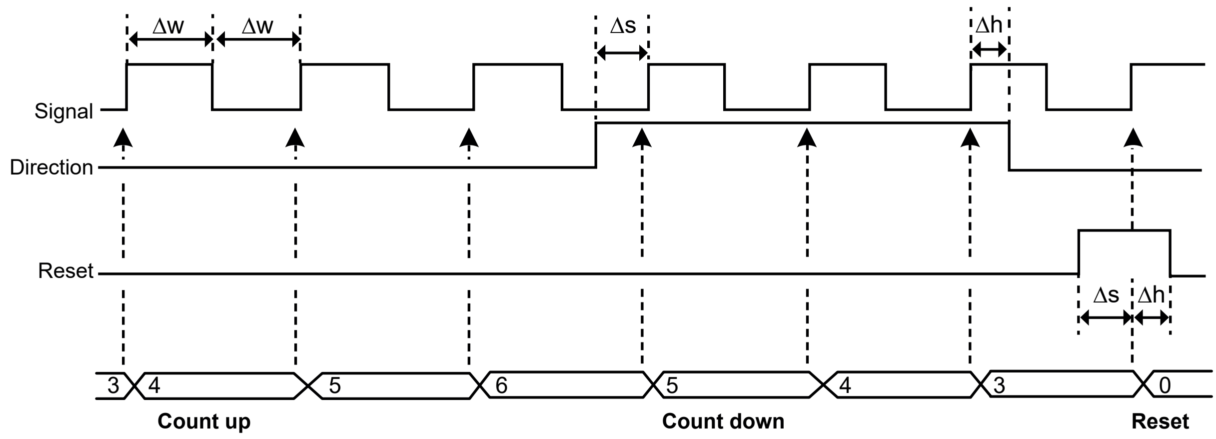


Figure 45: Uni- and Bi-directional timing

Inputs	3 pins: signal, reset and direction (only used in bi-directional count)
Minimum pulse width filter	100 ns, 200 ns, 500 ns, 1 µs, 2 µs, 5 µs
Maximum input signal frequency	4 MHz
Minimum pulse width (Δw)	100 ns
Reset input	
Level sensitivity	User selectable invert level
Minimum setup time prior to signal edge (Δs)	100 ns
Minimum hold time after signal edge (Δh)	100 ns
Reset options	
Manual	Upon user request by software command
Start recording	Count value set to 0 at Start of recording
First reset pulse	After the recording is started, the first reset pulse sets the counter value to 0. The next reset pulses are ignored.
Each reset pulse	On each external reset pulse, the counter value is reset to 0.
Direction input	
Input Level sensitivity	Only used when in bi-directional mode 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.

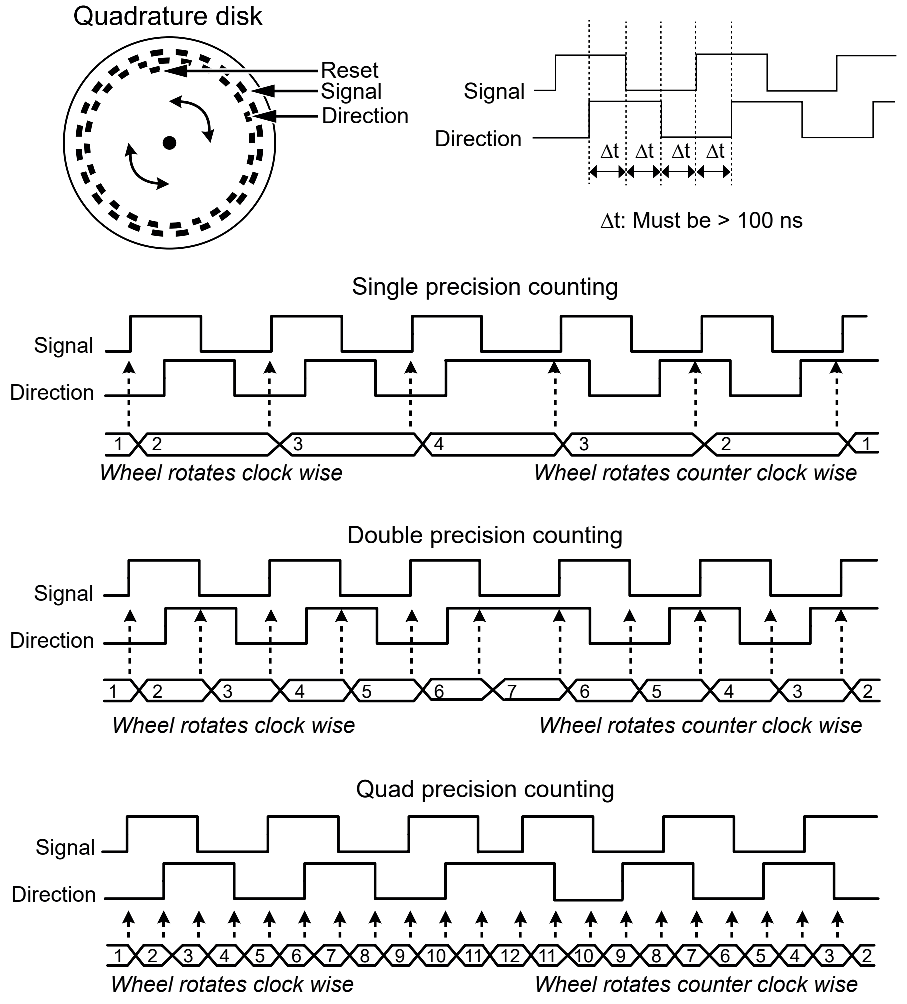


Figure 46: Bi-directional quadrature count modes

Inputs	3 pins: signal, direction and reset
Minimum pulse width filter	100 ns, 200 ns, 500 ns, 1 µs, 2 µs, 5 µs
Maximum input signal frequency	2 MHz
Minimum pulse width	200 ns (2 * Δt)
Minimum setup time	100 ns (Δt)
Minimum hold time	100 ns (Δt)
Accuracy	Single (X1), dual (X2) or quad (X4) precision
Input coupling	ABZ incremental encoder (Quadrature)
Reset input	
Level sensitivity	User selectable invert level
Minimum setup time prior to signal edge (Δt)	100 ns
Minimum hold time after signal edge (Δt)	100 ns
Reset options	
Manual	Upon user request by software command
Start recording	Count value set to 0 at Start of recording
First reset pulse	After the recording is started, the first reset pulse sets the counter value to 0. The next reset pulses are ignored.
Each reset pulse	On each external reset pulse, the counter value is reset to 0.

Measurement Mode Angle

In angle measurement mode the counter will use a user defined maximum angle and revert back to zero when this count value is reached. Using the reset input the measured angle can be synchronized to the mechanical angle. The real-time calculators can extract the RPM from the measured angle independent from the mechanical synchronization.

Angle options

Reference	User selectable. Enables the use of the reset pin to reference the mechanical angle to the measured angle
Angle at reference point	User defined to specify mechanical reference point
Reset pulse	Angle value is reset to user defined “angle at reference point” value
Pulses per rotation	User defined to specify the encoder/count resolution
Maximum pulses per rotation	32767
Maximum RPM	30 * sample rate (Example: Sample rate 10 kS/s means maximum 300 k RPM)

Measurement Mode Frequency/RPM

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

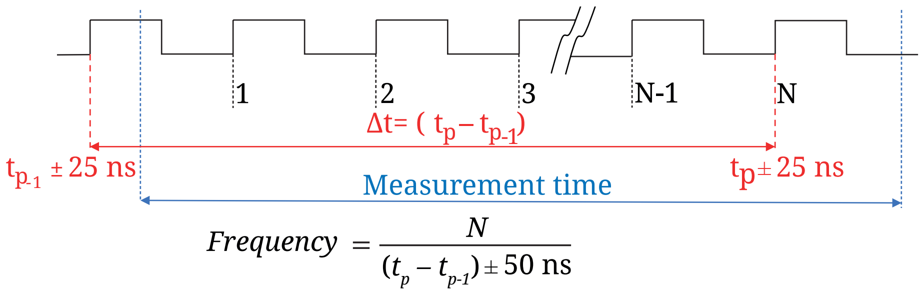


Figure 47: Frequency measurement

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%

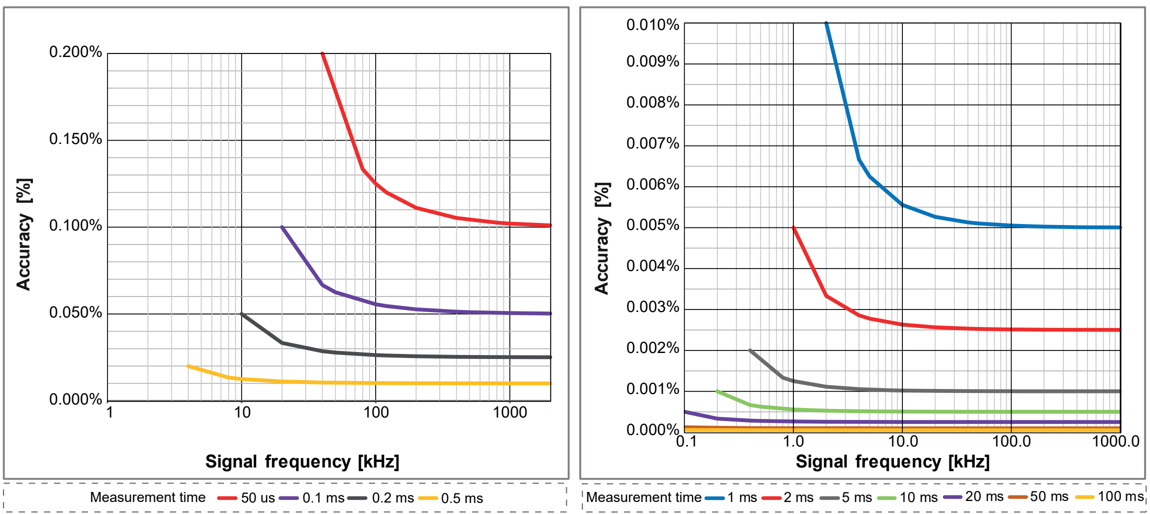


Figure 48: Maximum Timer Inaccuracy

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 48 will result in Figure 49 (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%

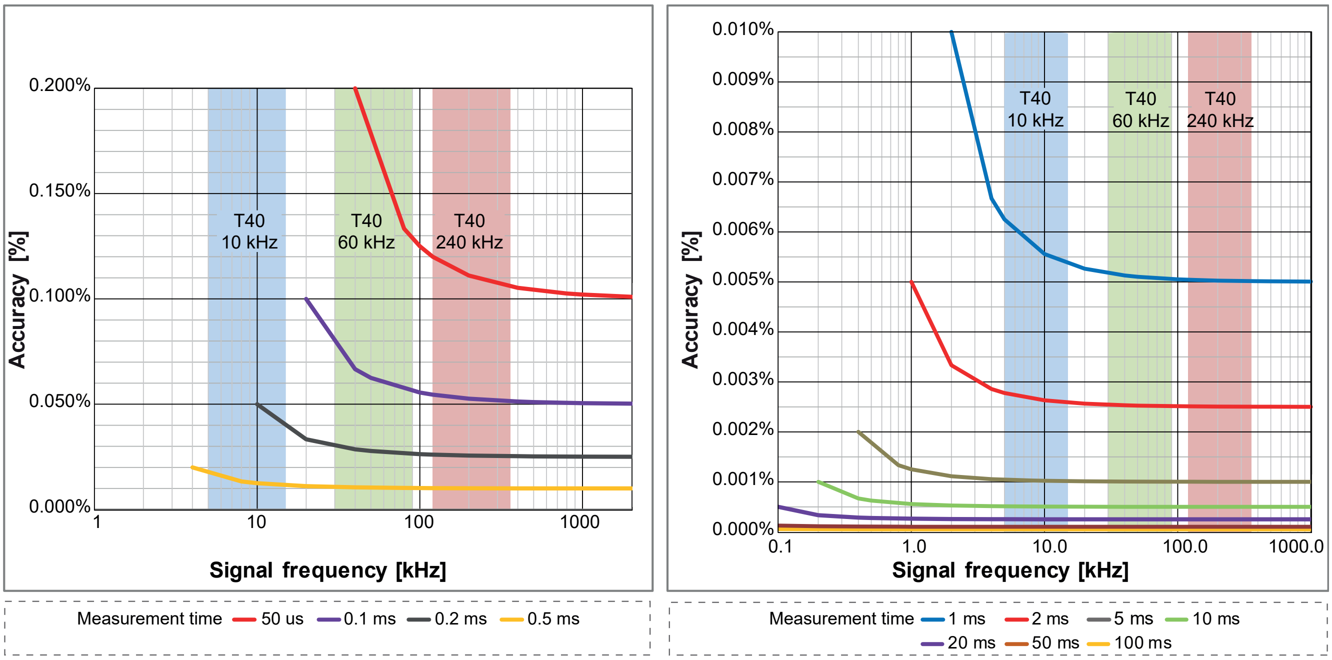


Figure 49: Torque operating range versus inaccuracy and measurement time

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 48 will result in Figure 50 (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%

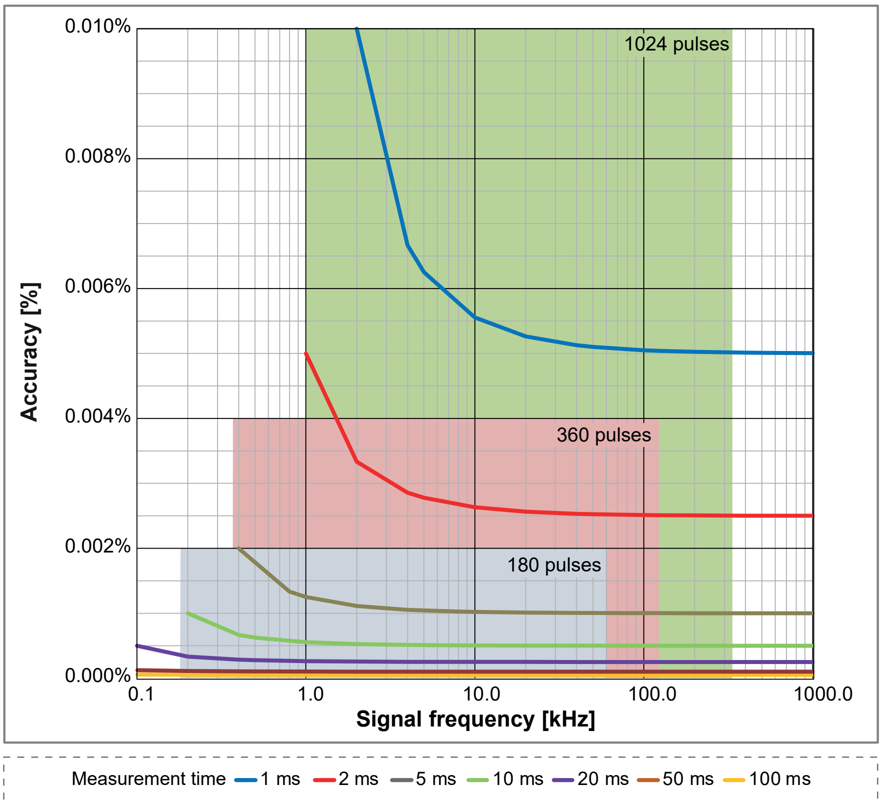


Figure 50: RPM sensor operating range versus inaccuracy and measurement time

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.

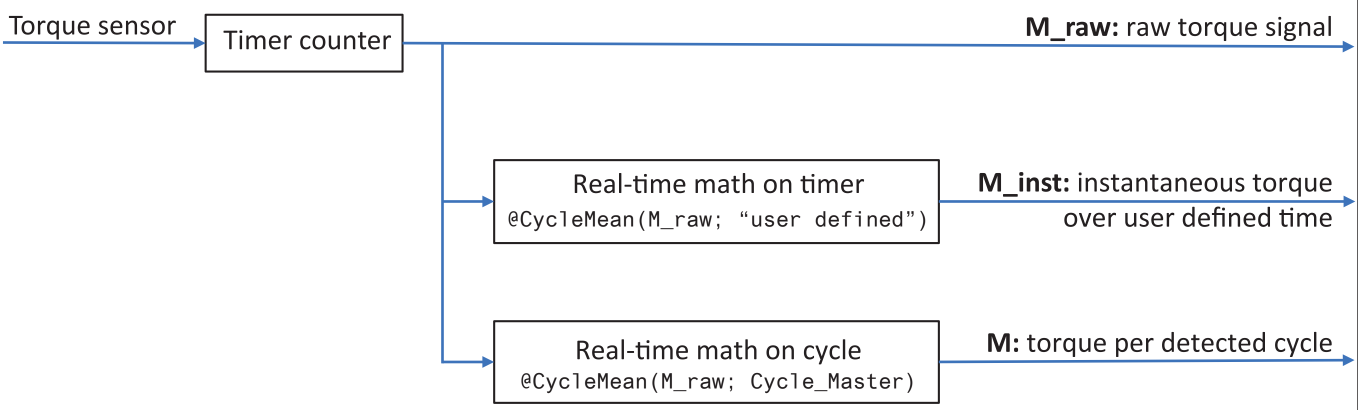


Figure 51: Simultaneous dynamic and accurate torque calculations

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, 500 MS @ 24 bits storage)
Organization	Automatic distribution amongst enabled channels
Memory diagnostics	Automatic memory test when system is powered and not recording
Storage sample size	16 bits, 2 bytes / sample 24 bits, 4 bytes / sample

Real-time Formula Database Calculators

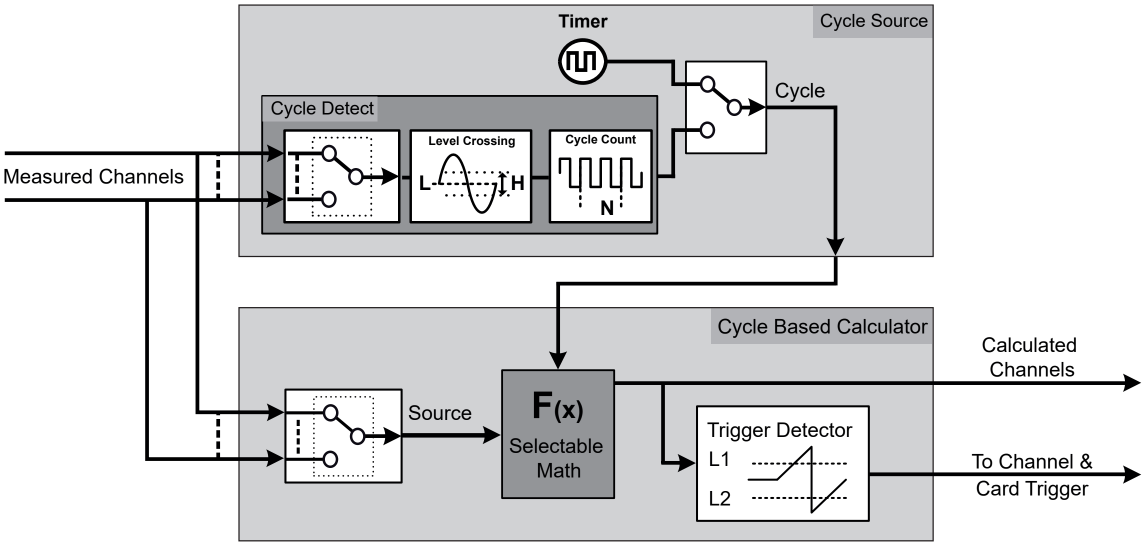


Figure 52: Real-time cycle based calculators

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

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

Real-time Formula Database Calculators (Option to be ordered separately)

The real-time formula database (RT-FDB) option offers an extensive set of math routines to enable almost any real-time mathematical challenge. The database structure enables the user to define a list of mathematical equations similar to the Perception review formula database.
The maximum supported sample rate is 2 MS/s.
Different versions of Perception can enable more or less features as described in GEN DAQ the mainframes manuals.

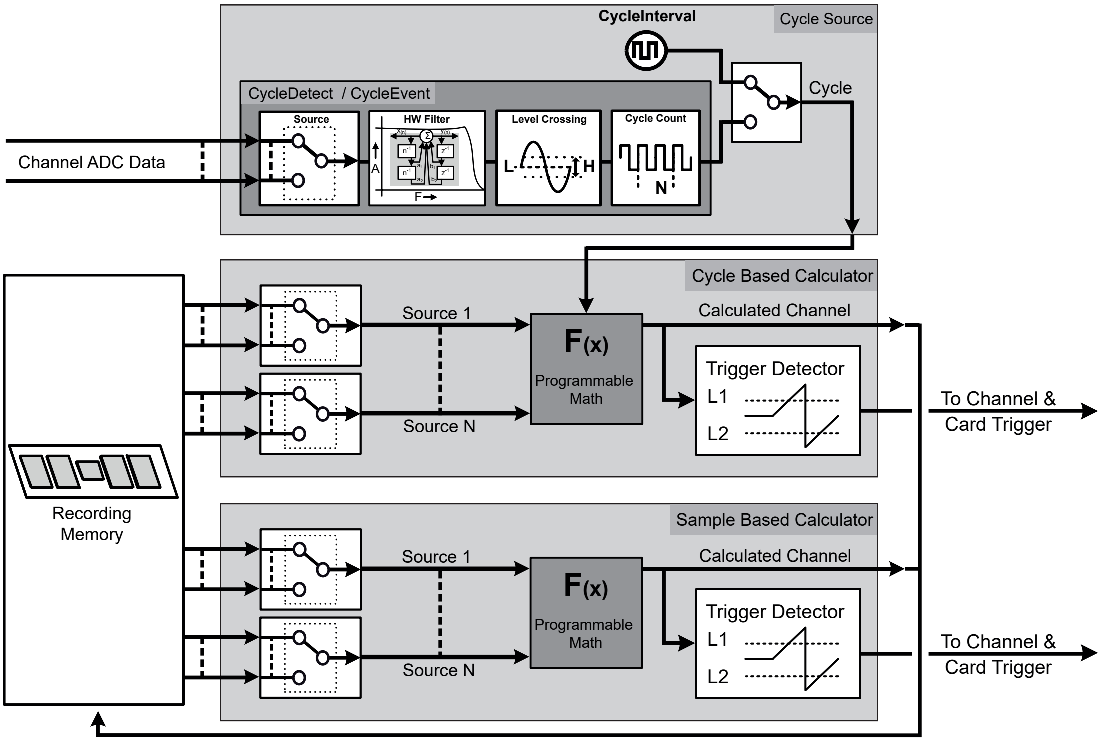


Figure 53: Real-time formula database (RT-FDB) calculators

The real-time formula database supports the following list of calculations (Details of each calculation are described in the manual).

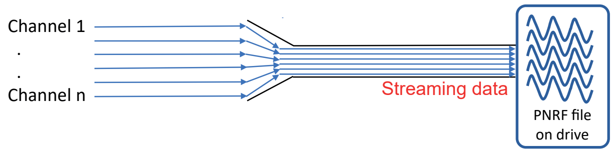
Group	**Available RT-FDB functions**		
Basic			
	`+ (add)`	`* (multiply)`	
	`- (subtract)`	`/ (divide)`	
Boolean			
	`AlarmOnLevel`	`Not`	`ToAsyncBoolean`
	`And`	`NotEqual`	`TriggerArmOnBooleanChange`
	`Equal`	`OneShotTimer`	`TriggerOnBooleanChange`
	`GreaterEqualThan`	`Or`	`TriggerOnLevel`
	`GreaterThan`	`OutsideBand`	`Xor`
	`InsideBand`	`SetAlarm`	
		`StartStopTriggerOnBooleanChange`	
		`StopTriggerOnBooleanChange`	

Real-time Formula Database Calculators (Option to be ordered separately)			
Group	**Available RT-FDB functions**		
Cycle			
	CycleArea CycleBusDelay CycleCount CycleCrestFactor CycleDetect CycleEnergy CycleEvent CycleFrequency	CycleFundamentalPhase CycleFundamentalRMS CycleHarmonicPhase CycleHarmonicRMS CycleInterval CycleMax CycleMean CycleMin	CycleNOP CyclePeak2Peak CyclePhase CycleRMS CycleRPM CycleSampleCount CycleStdDev CycleTHD ExternalCycleEvent
eDrive			
	AronConversion DQ0Transformation EfficiencyMode	EfficiencyValue HarmonicsIEC61000 PowerLoss	SpaceVector SpaceVectorInv
Enhanced			
	Abs Atan Atan2 Cos DegreesToRadians Integrate IntegrateGated	LessEqualThan LessThan Max Min Minus Modulo PureDFT	RadiansToDegrees SampleCount Sin Sqrt Tan
Fieldbus			
	SetScalarFromFieldbus		
Filter			
	FilterBesselBP FilterBesselHP FilterBesselLP HWFilter	FilterButterworthBP FilterButterworthHP FilterButterworthLP	FilterChebyshevBP FilterChebyshevHP FilterChebyshevLP
Math			
	NumSamplesMean NumSamplesStdDev	TimedMean TimedStdDev	
Signal generation			
	Ramp Sinewave		

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

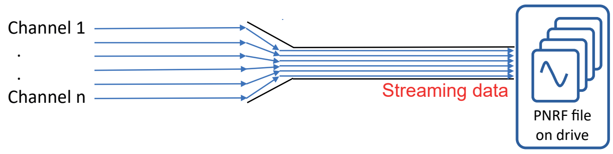
Data Recording Modes

On start of acquisition



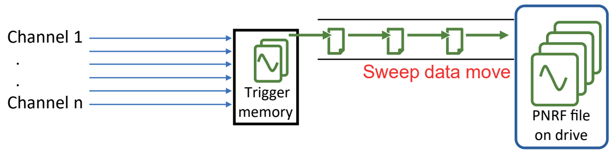
Data recording to PC or mainframe drive.
Data recording to a drive is limited by an **aggregate sample rate**, the recording time is limited by the **size of drive**.
Note: As the aggregate sample rate limit depends on Ethernet speed and storage drive used, as well as the PC and drive not being used 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



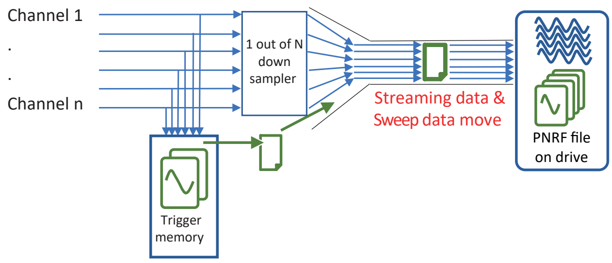
Triggered data recording to PC or mainframe drive.
Trigger data recording to a drive is limited by an **aggregate sample rate**, the recording time is limited by the size of drive.
Note: As the aggregate sample rate limit depends on Ethernet speed and storage drive used, as well as the PC and drive not 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

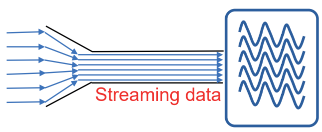


Data recording to PC or mainframe drive and simultaneous triggered data recording to trigger memory on the acquisition card.
The reduced rate data recording to a drive is limited by an **aggregate sample rate** and the recording time is limited by the **size of drive**.
The triggered data recording to 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.

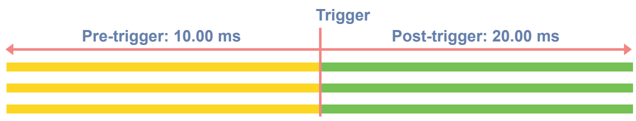
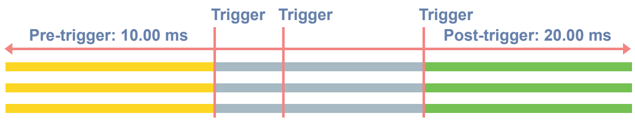
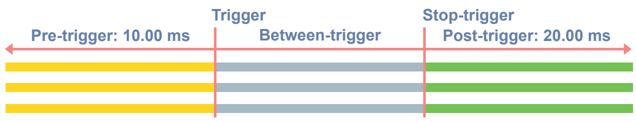
Data Recording Compared

	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 storage

	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	8 Ch	16 Ch	16 Ch + Event Ch(s)	1 Ch	8 Ch	16 Ch	16 Ch + Event Ch(s)	1 Ch	8 Ch	16 Ch	16 Ch + Event Ch(s)
Max. trigger memory	not used				960 MS	120 MS	60 MS	56 MS	768 MS	96 MS	48 MS	44 MS
Max. trigger sample rate	not used				500 kS/s				500 kS/s			
Max. reduced FIFO	960 MS	120 MS	60 MS	56 MS	not used				192 MS	24 MS	12 MS	11 MS
Max. (reduced) sample rate	500 kS/s				not used				Trigger Sample Rate / 2			
Max. aggregate reduced streaming rate	0.5 MS/s 1 MB/s	4 MS/s 8 MS/s	8 MS/s 16 MB/s	8.5 MS/s 17 MB/s	not used				0.3 MS/s 0.5 MB/s	2 MS/s 4 MB/s	4 MS/s 8 MB/s	4.5 MS/s 9 MB/s

24 Bit storage

	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	8 Ch	16 Ch	16 Ch + Event Ch(s) + T/C	1 Ch	8 Ch	16 Ch	16 Ch + Event Ch(s) + T/C	1 Ch	8 Ch	16 Ch	16 Ch + Event Ch(s) + T/C
Max. trigger memory	not used				480 MS	60 MS	30 MS	25 MS	384 MS	48 MS	24 MS	20 MS
Max. trigger sample rate	not used				500 kS/s				500 kS/s			
Max. reduced FIFO	480 MS	60 MS	30 MS	25 MS	not used				96 MS	12 MS	6 MS	5 MS
Max. (reduced) sample rate	500 kS/s				not used				Trigger Sample Rate / 2			
Max. aggregate reduced streaming rate	0.5 MS/s 2 MB/s	4 MS/s 16 MB/s	8 MS/s 32 MB/s	9.5 MS/s 38 MB/s	not used				0.3 MS/s 1 MB/s	2 MS/s 8 MB/s	4 MS/s 16 MB/s	4.8 MS/s 19 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) (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 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

Flexible Wire Diagram

Using the KAB2124, DIN rail breakouts (G088, G089 and/or G090) allow flexible connections to the GN1640B or GN840B.

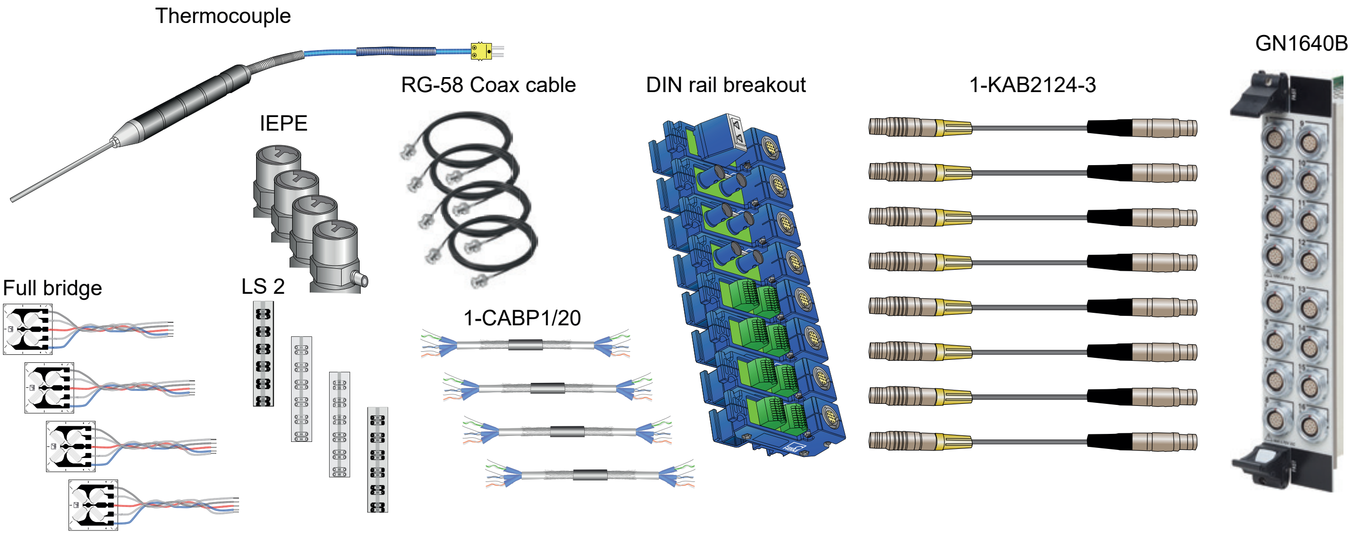


Figure 54: Flexible wire diagram

KAB183: Push-Pull Sensor Cable

Sensor line for connection of sensors to card. 14 wires with open ends, lengths 1 m (3.3 ft) or 10 m (33 ft) using ODU 14 pin push-pull plug

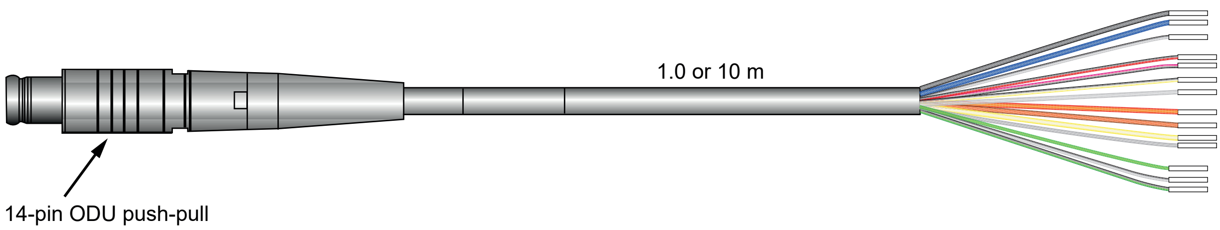


Figure 55: Push-pull sensor cable

Cable length	1 m (3.3 ft) or 10 m (33 ft)
Cable type	14 wires, 7 * 2 pair twisted, with cable shield
Cable impedance	Maximum 79 Ω/km
Capacity A/A nom.	93 pF/m
Capacity A/S nom.	170 pF/m
Inductance nom.	0.5 mH/km

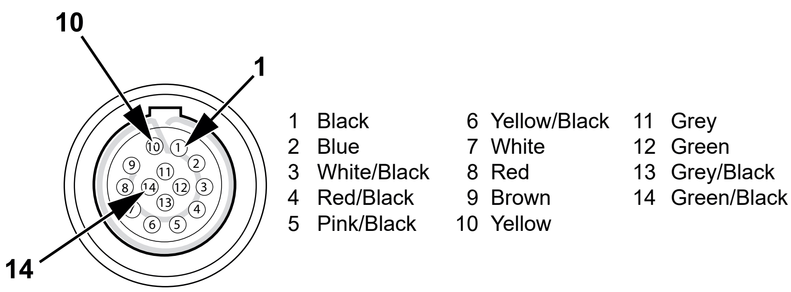


Figure 56: Pin number and wire colors (front view)

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

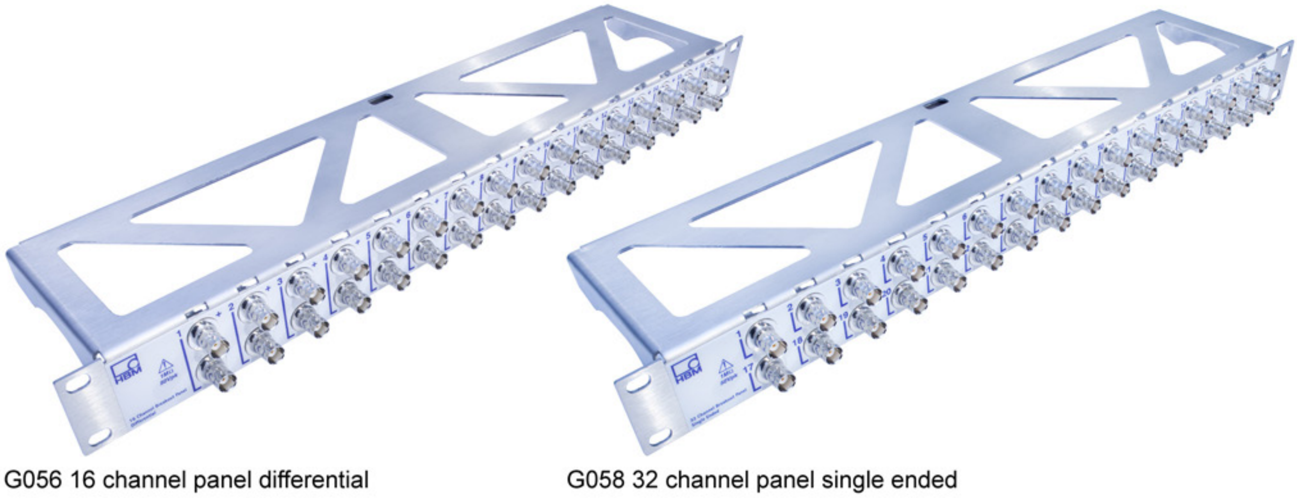


Figure 57: G056/G058 Breakout panel

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

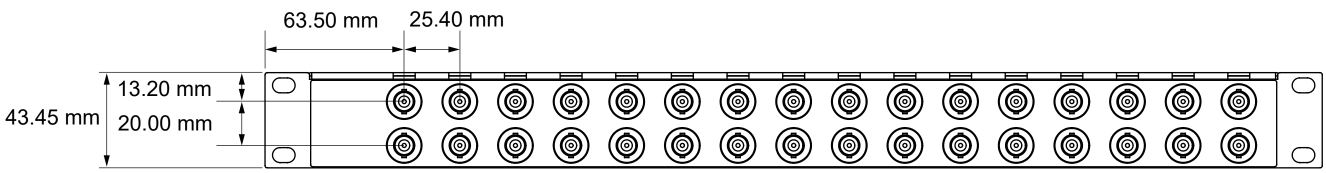


Figure 58: Breakout panel dimensions

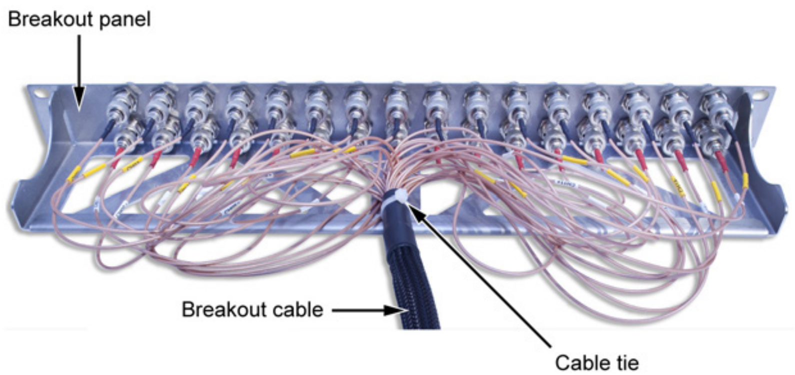
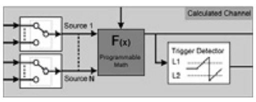


Figure 59: Breakout cable connected to breakout panel

Ordering Information

Article		Description	Order No.
8 Channel, Universal/Sensor Isolated 500 kS/s		Universal input card, 8 channels; 500 kS/s, 24 bit, 2 GB RAM. **Features:** • Isolated • ± 1 mV to ± 10 V input range • 33 V RMS isolated balanced diff bridge input • ODU input connector for each channel • Strain gauge quarter/half/full bridges • 6 wire configuration • Voltage excited sensors • IEPE sensors • Piezoelectric/charge sensors • 4 to 20 mA output sensors • Pt10, Pt100, Pt500, Pt1000, Pt2000 (3/4 wire RTD) • Thermocouples types K, J, T, B, E, N, R, S, C • Supports real-time formula data base option (1-GEN-OP-RT-FDB) **Requirements:** Tethered mainframes: GEN2tB, -3t, -4tB, -7tA, -7tB, -17tA, -17tB Mainframes with integrated PC: GEN3i, -3iA, -7i, -7iA, -7iB	1-GN840B
16 Channel, Universal/Sensor Isolated 500 kS/s		Universal input card, 16 channels, 2 slots width; 500 kS/s, 24 bit, 2 GB RAM. **Features:** • Isolated • ± 1 mV to ± 10 V input range • 33 V RMS isolated balanced diff bridge input • ODU input connector for each channel • Strain gauge quarter/half/full bridges • 6 wire configuration • Voltage excited sensors • IEPE sensors • Piezoelectric/charge sensors • 4 to 20 mA output sensors • Pt10, Pt100, Pt500, Pt1000, Pt2000 (3/4 wire RTD) • Thermocouples types K, J, T, B, E, N, R, S, C • Supports real-time formula data base option (1-GEN-OP-RT-FDB) **Requirements:** Tethered mainframes: GEN2tB, -3t, -4tB, -7tA, -7tB, -17tA, -17tB Mainframes with integrated PC: GEN3i, -3iA, -7i, -7iA, -7iB.	1-GN1640B

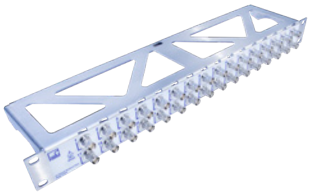
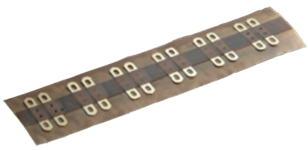
Option, to be ordered separately

Article		Description	Order No.
GEN DAQ real-time formula database calculators		Option to enable enhanced real-time calculators. Setup uses a user configurable formula database similar to the Perception formula database. All calculations are performed by the DSP of the acquisition card. Triggering possible on many of the results of the calculations. Calculated cycle based results can be real-time transferred to the GEN DAQ API, USB-to-CAN-FD or EtherCAT® option. EtherCAT® output supports true real-time 1 ms latency.	1-GEN-OP-RT-FDB

Cables and Connectors, to be ordered separately			
Article		**Description**	**Order No.**
CON-P1007		Push-pull plug (ODU 14p) for sensor connection to card.	1-CON-P1007
ODU to BNC breakout cable		Single-ended BNC voltage input to card coaxial cable including a female to female BNC adapter. Length 2 m (6.6 ft). Typical cable capacity 200 pF. Supports single-ended voltage, IEPE and charge measurements.	1-KAB433-2
Cable 14 pin ODU to ODU		Cable to connect channel ODU connector to DIN rail breakout blocks. All 14 pins are connected. Cable length 3 m (9.9 ft). To be used with GN1640B and GN840B.	1-KAB2124-3
ODU All wire breakout cable		Sensor line for connection of sensors to card Plug: ODU 14p push-pull. Cable: 14 wire with open ends, lengths 1 m (3.3 ft) or 10 m (33 ft)	1-KAB183-1 1-KAB183-10
Piezoelectric sensor cable		Coaxial-cable for connection of a piezoelectric sensor to a piezoelectric amplifier. Connectors 10 - 32 UNF and BNC Cable coaxial, lengths 1 m (3.3 ft), 2 m (6.6 ft) or 3 m (9.9 ft)	1-KAB176-1 1-KAB176-2 1-KAB176-3
Coax cable, RG-58, 50 Ω impedance		Black coax cable RG-58. 1 shielded signal wire @ 0.14 mm^2. Impedance 50 Ω, 82 pF/m (25 pF/ft). Outside diameter 5 mm^2 (0.2").	Ordered from custom systems(1)
Measuring cable 6 wires, PFA, 20 m		Shielded measurement cable AWG 32 (19 x 0.05 mm) 6-core cable, stranded wire sheath; Color: white; sheath material: PFA; Outside diameter: 1.9 mm; Wire insulation: PFA; Wire diameter: 0.45 mm, Resistance: 0.492 Ω/m; Capacitance wire-wire: 43 pF/m Thermal stability: -200 °C to +200 °. For connection of strain gauge bridge circuits 20 m on reel.	1-CABP1/20

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

Accessories, to be ordered separately

Article		Description	Order No.
32 channel single-ended breakout 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
DIN rail breakout block push-in connector		DIN rail mountable breakout block. Converts ODU input connector to 12 pin spring/push-in connector.	1-G088
DIN rail thermocouple with cold juntion and TEDS		DIN rail mountable breakout block. Converts ODU input connector to universal mini thermocouple connector. Includes digital cold junction temperature measurement and TEDS ID (class 2).	1-G089
DIN rail BNC breakout		DIN rail mountable breakout block. Converts ODU input connector to dual BNC differential output.	1-G090
Soldering terminal LS2		Bronze soldering tag on polyimide carrier suitable for dynamic loads; Attachment to test object: Bonding can be used up to 180 °C (356 °F), briefly up to 260 °C (500 °F)	1-LS 2

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B04170_05_E00_00 31/10/2023