Technical Specifications

English

eDAQ XR

EXRCPU

compatible equipment

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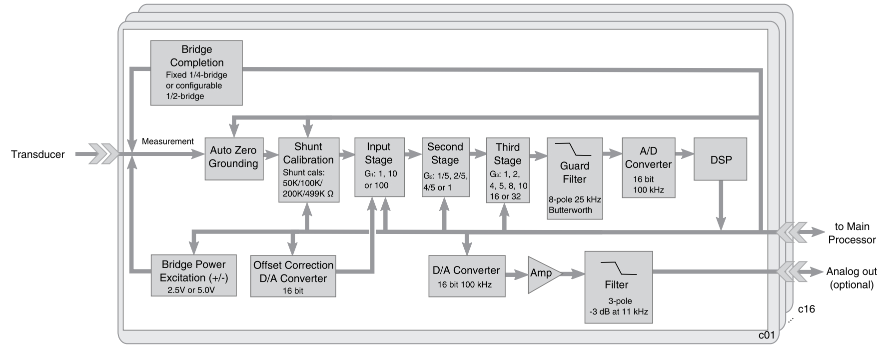
1 EBRG bridge layer

The EBRG bridge layer offers 16 simultaneously sampled low-level differential analog inputs through independent connectors. An extremely versatile layer; the EBRG layer works with both amplified and unamplified transducers including: strain gauges, accelerometers, pressure transducers, load cells and other general analog signals. The EBRG provides excellent strain gage conditioning with support for quarter-, half- and full-bridge configurations. Automatic balancing and gain settings, as well as software selectable sample rates, excitation, and digital filtering simplify set up of a strain channel. There are several calibration options including defined value, external and multipoint calibrations as well as shunt calibrations with embedded software tools. The EBRG also provides four shunt calibration resistors per channel with software selectable shunt direction for either upscale (-Sig to -Ex) or downscale (-Sig to +Ex) calibrations.

The EBRG may be ordered with an optional analog output function. Outputs are filtered analog output signals that can be used in the creation of time-domain lab durability tests. When setting up the laboratory simulation, bring the eDAQXR system into the lab with the component or vehicle. This practice is highly recommended, as it ensures that all of the transducer instrumentation and properties are identical for the lab simulation as they were for the field data collection. Instead of being recorded, the analog out signals are sent as time series data for the test rig to analyze. The controller can then develop drive files that are played into the test rig reproducing exact field dynamics in the lab.

Each output channel is associated with the corresponding (like-numbered) input channel on the EBRG board. Calibration files are provided that are compatible with popular simulation software and that scale the analog outputs to engineering units. The maximum analog output voltage is ±10 volts. Each of the 16 analog channels contain a three-pole Butterworth filter which attenuates frequencies above 25 KHz. These filters smooth out the stair-steps created by the channel’s digital to analog converter.

Block diagram



NOTE

A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

Ordering options

Order number	Description
1-EBRG-120-B-2	EBRG bridge layer – 120 Ohm Completion – Base Layer, Inputs: 16-channels, ±10V differential analog, simultaneous sampling, 16-bit resolution. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 120 Ohm ¼ -bridge completion resistor. Includes: (16) 1-SAC-TRAN-MP-2-2 cables.
1-EBRG-350-B-2	EBRG bridge layer – 350 Ohm Completion – Base Layer, Inputs: 16-channels, ±10V differential analog, simultaneous sampling, 16-bit resolution. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 350 Ohm ¼ -bridge completion resistor. Includes: (16) 1-SAC-TRAN-MP-2-2 cables.
Analog Out options	
1-EBRG-120-AO-2	EBRG bridge layer – 120 Ohm Completion – Analog Out, Inputs: 16-channels, ±10V differential analog, simultaneous sampling, 16-bit resolution. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 120 Ohm ¼ -bridge completion resistor. Installed Option: Analog Output Includes: (16) 1-SAC-TRAN-MP-2-2 cables & (1) 1-SAC-TRAN-AO-2-2 analog out cable.
1-EBRG-350-AO-2	EBRG bridge layer – 350 Ohm Completion – Analog Out, Inputs: 16-channels, ±10V differential analog, simultaneous sampling, 16-bit resolution. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 350 Ohm ¼ -bridge completion resistor. Installed Option: Analog Output Includes: (16) 1-SAC-TRAN-MP-2-2 cables, (1) 1-SAC-TRAN-AO-2-2 analog out cable.

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	cm	23 x 25 x 3.3
Weight	kg	2.0
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Relative humidity range, non-condensing	%	0 ... 90

Parameter	Unit	Value
Bridge excitation voltage voltage initial tolerance (3σ) single 5-V temperature drift (1σ) single 5-V temperature drift (3σ) single 2.5-V temperature drift (1σ) single 2.5-V temperature drift (3σ) ±5-V temperature drift (1σ) ±5-V temperature drift (3σ) ±2.5-V temperature drift (1σ) ±2.5-V temperature drift (3σ)	- V % ppm ppm ppm ppm ppm ppm ppm ppm	- ±2.5 or ±5 0.1 5 15 3.3 10 10 30 6.66 20
Quarter-bridge completion resistance resistance initial tolerance (1σ) initial tolerance (3σ) temperature drift (1σ) temperature drift (3σ)	- Ω % % ppm ppm	- 120 (1-EBRG-120-X-2) or 350 (1-EBRG-350-X-2) ±0.0033 ±0.01 ±0.3 ±0.9
Half-bridge completion resistance internal resistance typical initial tolerance (1σ) maximum initial tolerance temperature drift (1σ) temperature drift (3σ)	- kΩ % % ppm ppm	- 50-kΩ split ±0.025 ±0.05 ±0.66 ±2
Shunt calibration resistance resistance initial tolerance (1σ) initial tolerance (3σ) temperature drift (1σ) temperature drift (3σ)	- kΩ % % ppm ppm	- 49.9, 100, 200 and 499 0.033 0.1 10 30
Offset correction resolution	V mV	±5 (with 16 bit D/A converter) 0.153 ($10V/2^{16}$)
Analog out accuracy	% of full scale	0.25
Analog inputs surviving over voltage	V	±125
Maximum excitation output power per channel	mW	300
Maximum current output	mA	42
Voltage regulation efficiency (at 42 mA) ±2.5 V out ±5 V out	- % %	- 50 63

Parameter	Unit	Value
Power consumption (1	-	-
no load	W	4.55
350-Ω full bridge at ±5 V	W	11.8
350-Ω 1/2 or 1/4 bridge at ±5 V	W	8.6
350-Ω full bridge at ±2.5 V	W	7.1
350-Ω 1/2 or 1/4 bridge at ±2.5 V	W	5.8
120-Ω full bridge at ±2.5 V	W	12.1
120-Ω 1/2 or 1/4 bridge at ±2.5 V	W	8.6
Typical input offset current over temperature (2 (3	pA/°C	±8
Typical input-referred voltage drift over temperature (1σ) (2 (4 (5	µV/°C	$\pm 0,25+1.5/G_1$
Gain drift over temperature (2	-	-
typical (1σ)	ppm/°C	2.5
maximum (3σ)	ppm/°C	10
Analog output channel impedance (6	Ω	1000 ±50
Filters7)	-	-
100 samples/second	Hz	33 (FIR) or 15 (Butterworth)
200 samples/second	Hz	67 (FIR) or 30 (Butterworth)
500 samples/second	Hz	167 (FIR) or 75 (Butterworth)
1000 samples/second	Hz	333 (FIR) or 150 (Butterworth)
2000 samples/second	Hz	667 (FIR) or 300 (Butterworth)
2500 samples/second	Hz	833 (FIR) or 370 (Butterworth)
5000 samples/second	Hz	1667 (FIR) or 750 (Butterworth)
10000 samples/second	Hz	3333 (FIR) or 1500 (Butterworth)
20000 samples/second	Hz	6667 (FIR)
25000 samples/second	Hz	8333 (FIR)

(1 Power consumption measurements are taken with the stated load on all 16 channels and include the efficiency of the power supply.

(2 Quantities are given per °C temperature change from the temperature at calibration.

(3 Use change over temperature to calculate the offset voltage over temperature. Offset voltage [V] = current change over temperature [pA/°C] x change in temperature [Δ°C] x input resistance [10 kΩ].

(4 G_1 is the gain of the first stage. See the gain table in the following section for selected gain settings.

(5 The total input referred voltage drift is a combination of drift over temperature at the gain setting [µV/°C] and the drift due to the input current change over temperature (discussed in (3).

(6 The 1000-Ohm stabilization resistor in series with the op-amp at the analog output creates an RC filter in addition to the output filter. Typical cable capacitances (C_{cable}) fall within 18 to 40 picofarads per 30.48 cm, creating a pole at 1/($2\pi 1000 C_{cable}$).

(7 Both filter types have -160 dBV / decade cutoff slopes.

Standards

Category	Standard	Description
Shock	MIL-STD-810F	Method 516.5, Section 2.2.2 Functional Shock - ground vehicle
Vibration	MIL-STD-202G	Method 204D, Test condition C (10 *g* swept sine tested from 5 Hz to 2000 Hz)
EMC requirements	EN 61326-1:2006	Before July 2018, CE conformity per EN 61326-1:2006
-	EN 61326-1:2012	After June 2018, CE conformity per EN 61326-1:2012

Selected gain settings

NOTE
This table is a representative list only, not showing all available gain settings.

Desired Input Range [8] (Vpp)	Input Stage Gain, G_1 (1, 10 or 100)	Second Stage Gain, G_2 (1/5, 2/5, 4/5 or 1)	Third Stage Gain, G_3 (1, 2, 4, 5, 8, 10, 16 or 32)	Overall Gain
20	1	1/5	1	0.2
10	1	2/5	1	0.4
5	1	4/5	1	0.8
4	1	1	1	1
2	1	1	2	2
1.25	1	4/5	4	3.2
1	1	1	4	4
0.8	1	1	5	5
0.625	1	4/5	8	6.4
0.5	1	1	8	8
0.4	10	1	1	10
0.25	1	1	16	16
0.2	10	1	2	20
0.125	1	1	32	32
0.1	10	1	4	40
0.08	10	1	5	50
0.0625	10	4/5	8	64
0.05	10	1	8	80
0.04	100	1	1	100
0.025	10	1	16	160
0.02	100	1	2	200

Desired Input Range [8] (Vpp)	Input Stage Gain, G_1 (1, 10 or 100)	Second Stage Gain, G_2 (1/5, 2/5, 4/5 or 1)	Third Stage Gain, G_3 (1, 2, 4, 5, 8, 10, 16 or 32)	Overall Gain
0.0125	10	1	32	320
0.01	100	1	4	400
0.008	100	1	5	500
0.00625	100	4/5	8	640
0.005	100	1	8	800
0.004	100	1	10	1000
0.0025	100	1	16	1600
0.00125	100	1	32	3200

[8] The maximum A/D converter input, which is the product of the input stage and the overall gain, is 4.096 V_{pp}.

Channel Noise Characteristics

The input-referred noise and the signal to noise ratio (SNR) are defined by the following two equations:

$$\text{Input Referred Noise} = \frac{N}{G_O} \qquad \text{SNR} = 20_{\log}\left(\frac{4.096}{N}\right)$$

where G_O is the overall gain setting and N is the noise at the input of the A/D converter, defined by one of the following three

equations depending on the gain of the first stage (G_1):

$$N_{G_1} = 1 = \sqrt{\left(15{,}4[\text{microV}]G_2G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(37[\text{microV}]G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(45[\text{microV}]G_3\sqrt{\frac{x_2}{13[\text{kHz}]}}\right)^2 + \left(4{,}5[\text{microV}]G_3\sqrt{\ln(\frac{x_1}{0{,}1[\text{Hz}]})}\right)^2 + 83[\text{microV}^2]}$$

$$N_{G_1} = 10 = \sqrt{\left(42{,}0[\text{microV}]\text{G}_2G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(37[\text{microV}]G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(45[\text{microV}]G_3\sqrt{\frac{x_2}{13[\text{kHz}]}}\right)^2 + \left(4{,}5[\text{microV}]G_3\sqrt{\ln(\frac{x_1}{0{,}1[\text{Hz}]})}\right)^2 + 83[\text{microV}^2]}$$

$$N_{G_1} = 100 = \sqrt{\left(322{,}8[\text{microV}]G_2G_3\sqrt{\frac{x_3}{15{,}7[\text{kHz}]}}\right)^2 + \left(37[\text{microV}]G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(45[\text{microV}]G_3\sqrt{\frac{x_2}{13[\text{kHz}]}}\right)^2 + \left(4{,}5[\text{microV}]G_3\sqrt{\ln(\frac{x_1}{0{,}1[\text{Hz}]})}\right)^2 + 83[\text{microV}^2]}$$

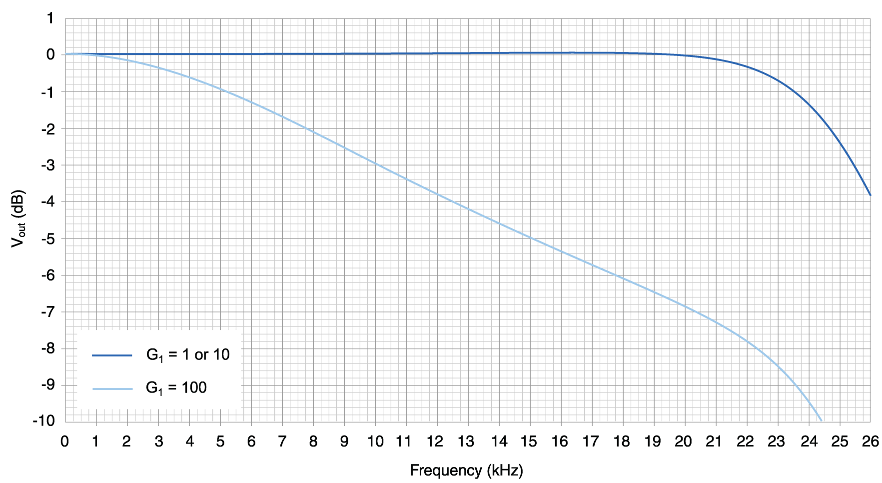
and where x_n is the cutoff frequency of the digital or analog filter to a specified maximum.

x_n	Maximum Value	Cause
x_1	24 kHz	analog filter cutoff
x_2	13 kHz	secondary filter cutoff
x_3	15.7 kHz	early rolloff of first stage when $G_1 = 100$

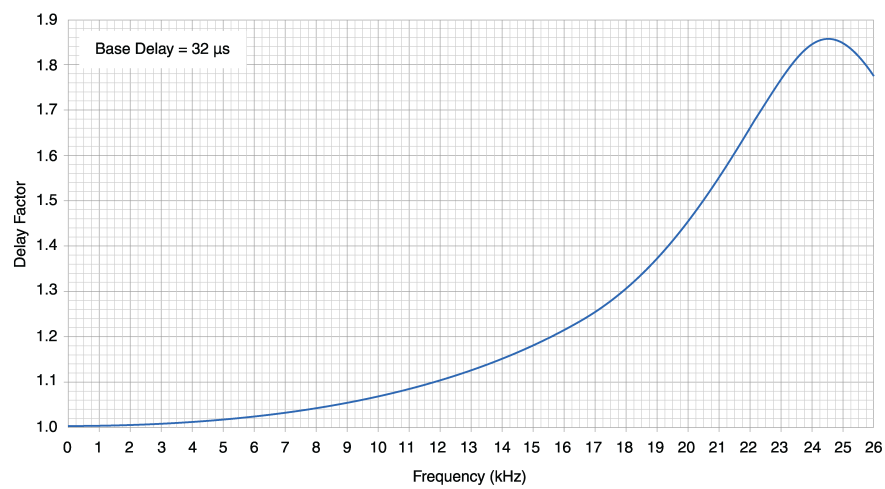
Charts

NOTE
When selecting the sampling rate in the web interface, the cutoff frequency of the selected filter is one third of the sampling rate.

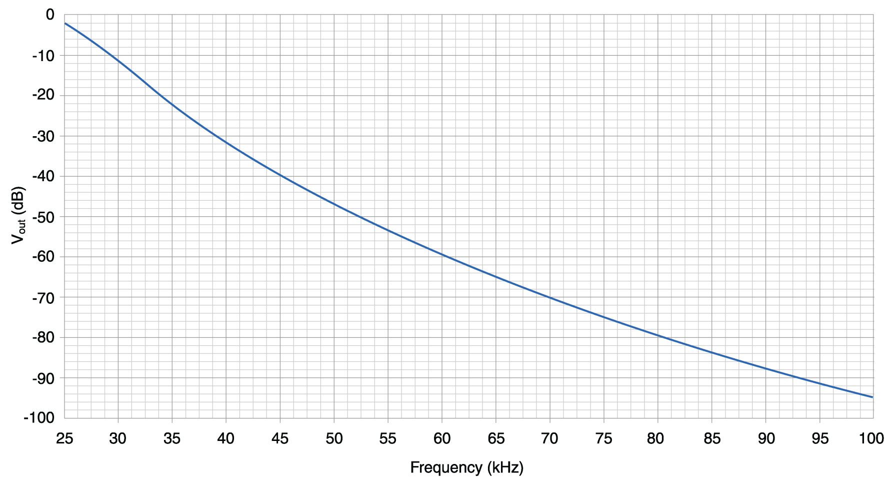
Input Filter Pass Band Frequency Response



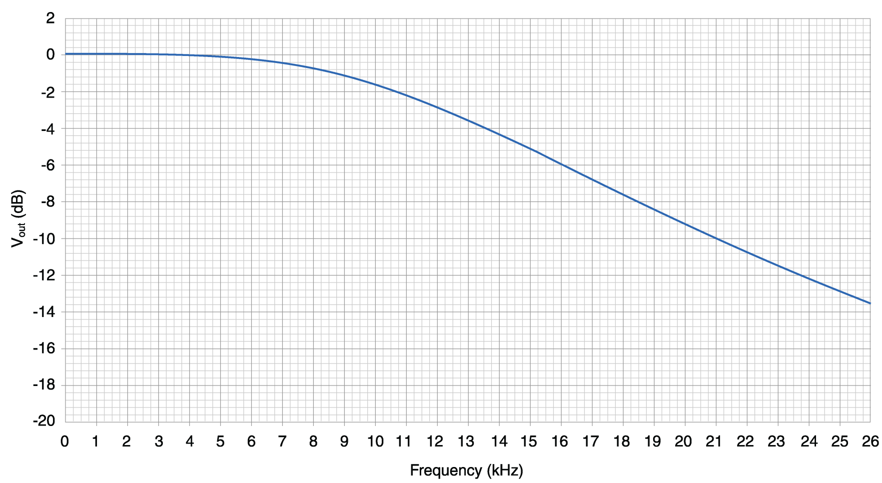
Input Filter Delay Factor



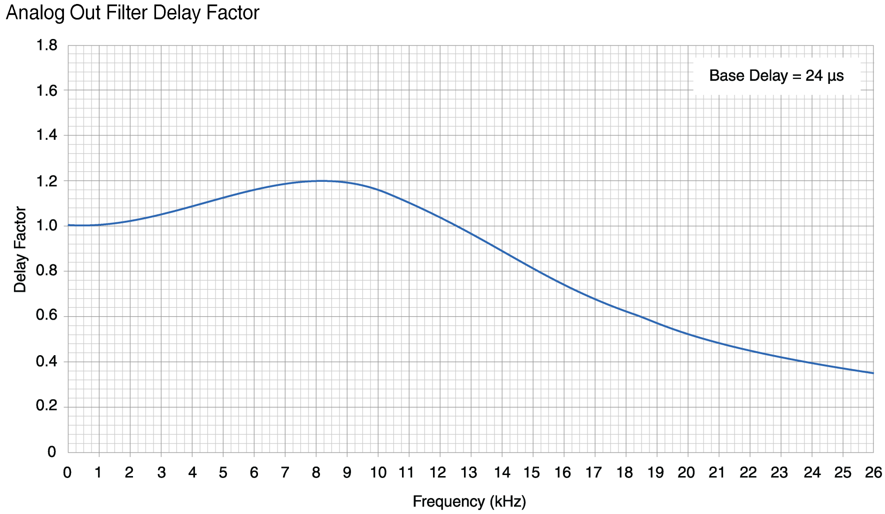
Input Filter Cut-Off Region

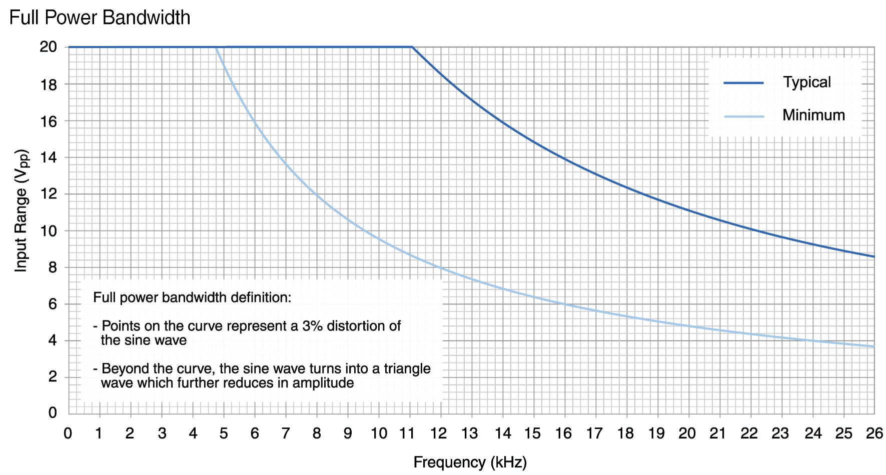


Analog Out Frequency Response



Analog Out Filter Delay Factor

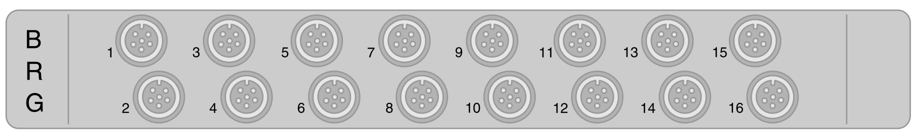




NOTE

The plot shows full power bandwidth for an overall gain of 0.2 or a 20 V_{pp} input range.

Input connectors

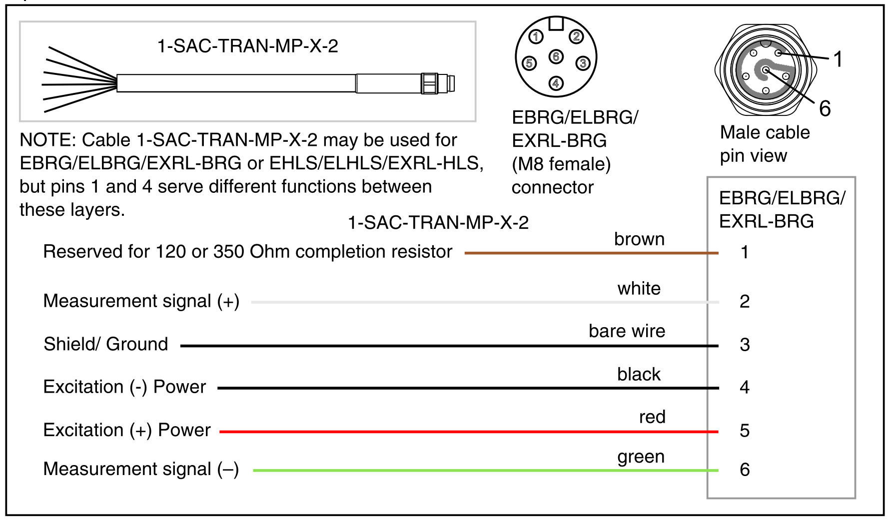


The diagram shows the M8 connectors on the EBRG layer.

Each independent channel contains programmable excitation, an eight-pole Butterworth analog guard filter, a 16-bit A/D converter, software selectable digital filtering and output sample rate options of up to 100 kHz.

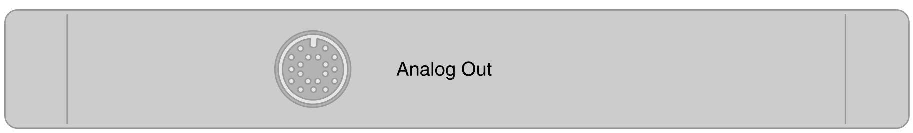
The EBRG layer supports full- and half-bridge types with a resistance from 100 to 10000 Ohms and quarter-bridges with a resistance of either 120 or 350 Ohms. All bridge configurations are accomplished using programmable switches , however, the quarter-bridge choice of 120- or 350-Ohm completion resistor is a factory installed option. A set of internal shunt resistors with selectable shunt direction is available for calibration purposes.

Input



Analog Output

The EBRG is available with an optional analog output function to provide high level analog output signal for each channel. Outputs are filtered analog output signals that can be used in the creation of time-domain lab durability tests. Each output channel is associated with the corresponding (like-numbered) input channel on the EBRG board. Connect the analog outputs to the EBRG through the Analog Output connector on the back panel shown in the diagram below.



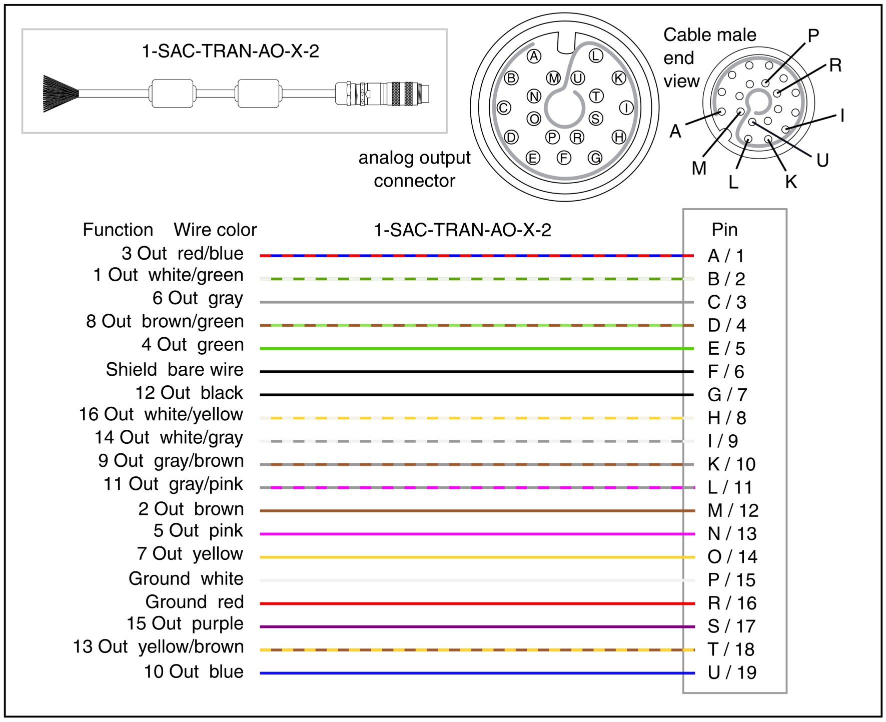
This diagram shows the analog out connector on the back panel of an EBRG layer.

The outputs are generated from a D/A converter implemented as a unity gain follower to the A/D converter. The eDAQXR uses the non-inverting unity gain follower by default. Select the Analog output inversion option in the test setup configuration to use the inverting unity gain follower when the channel calibration slope is negative.

NOTE

The EBRG uses a nominal ±2-volt A/D converter. However, do not assume that the user-defined full-scale values are even approximately equivalent to ±2 volts for any particular channel. This is primarily because eDAQXR automatically provides a minimum over range protection of 1% and the eDAQXR can set gains only at certain discrete values resulting in actual over range protection that is sometimes significantly larger than 1%.

Analog output



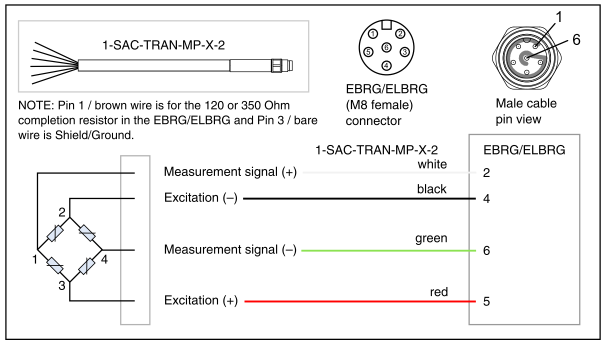
Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-EBB-AO-2	Breakout Box – Analog Output EHLS and EBRG Layers.	EHLS and EBRG
1-SAC-TRAN-MP-2-2	Transducer Cable - Male/Pigtail - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-MP-10-2	Transducer Cable - Male/Pigtail - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-AO-2-2	Transducer Cable - Analog Out - 2 Meters Length	EHLS and EBRG
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

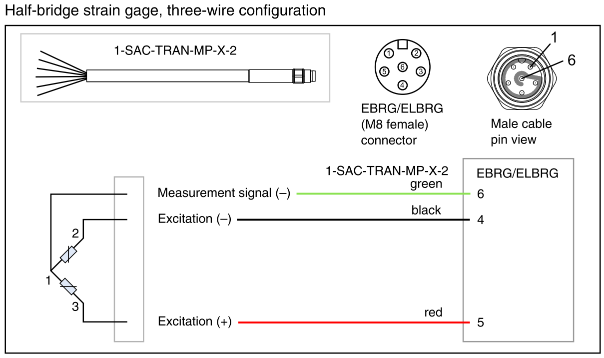
EBRG Bridge Transducers

Use the Somat SAC-TRAN-MP Transducer Cable (1-SAC-TRAN-MP-2-2 or 1-SAC-TRAN-MP-10-2) to wire EBRG bridge transducer inputs.

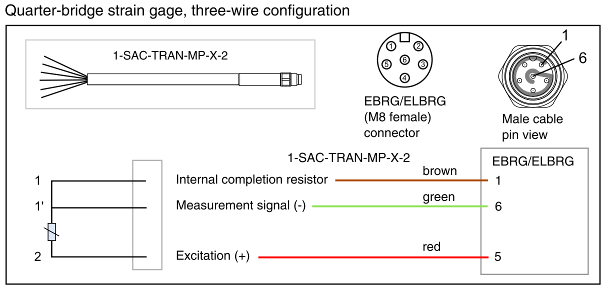
Full-bridge strain gage, four-wire configuration



Half-bridge strain gage, three-wire configuration



Quarter-bridge strain gage, three-wire configuration



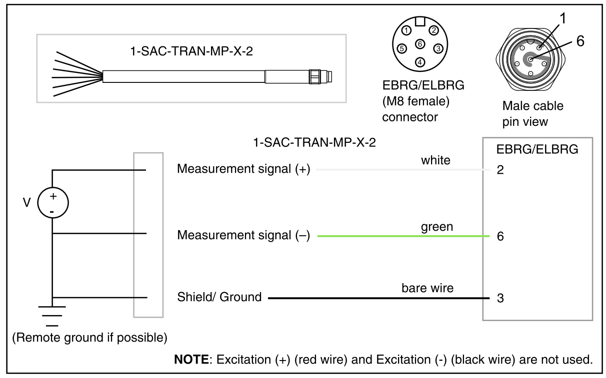
The internal completion resistor value depends on the resistor in the EBRG layer (120 or 350 Ohms).

EBRG Analog Input

Use the Somat SAC-TRAN-MP Transducer Cable (1-SAC-TRAN-MP-2-2 or 1-SAC-TRAN-MP-10-2) to wire EBRG analog inputs.

NOTE
Do not use this wiring diagram for EHLS channels.

Analog input



This diagram shows wiring for a standard analog input on an EBRG layer.

2 EDIO digital input / output layer

NOTE
EDIO layers must have the “DIO_V1_10_build_16.efd” firmware loaded. The firmware that supports Vehicle Bus modules on the original eDAQ (i.e., “DIO_2VBC_V1_10_build_16.efd”) is not supported in the eDAQXR.

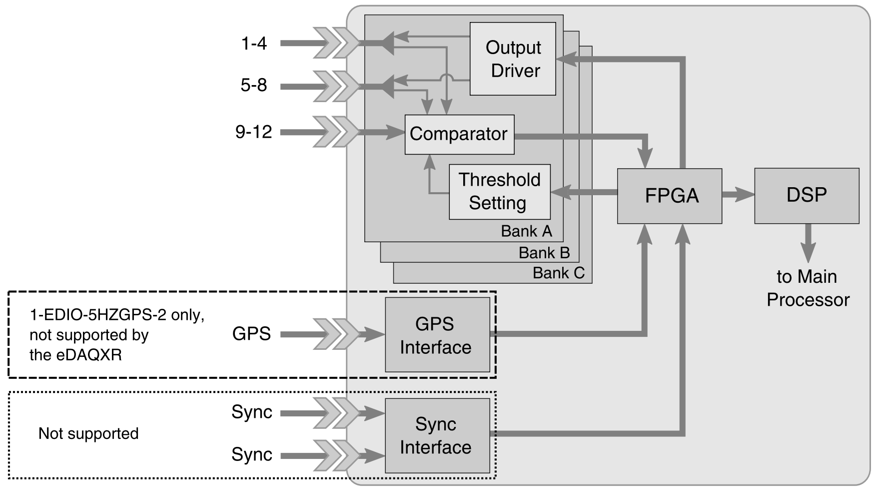
The EDIO digital input / output layer is an extremely versatile layer that supports digital input/output (I/O) and pulse counter channels. The EDIO layer offers 24 channels that can be used as digital inputs and outputs, 12 channels dedicated to wide-range inputs and 18 integrated configurable pulse counters.

The digital I/O channels are grouped into three (3) functionally identical banks (A, B and C). Each bank contains three (3) M8 female bulkhead connectors of four (4) digital I/O channels (i.e., bits). The eight (8) channels on connectors |1-4| and |5-8| are individually configurable to be either inputs or outputs. The four (4) channels on connector |9-12| are dedicated wide-range input channels. Each connector also provides two (2) pulse counter channels for a total of six (6) pulse counter channels per bank.

The pulse counters support pulse time period, pulse on time period, pulse rate counting and quadrature decoder.

Use of the GPS connector on the 1-EDIO-5HZGPS-2 is not compatible with the eDAQXR CPU. The GPS features of this EDIO layer are superseded by the GPS port on the eDAQXR CPU.

Block diagram



NOTE
A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

Ordering options

Order number	Description
1-EDIO-B-2	EDIO digital input / output layer – Base Layer Inputs: (24) digital I/O, (12) wide range (+/- 45V) digital inputs, (18) pulse counters. Includes: (9) 1-SAC-TRAN-MP-2-2 cables.

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	cm	23 x 25 x 3.3
Weight	kg	2.0
Temperature range	°C [°F]	-20 … +65 [-4 … +149]
Relative humidity range, non-condensing	%	0 … 90
Power consumption, no load[1]	W	2.44
Digital inputs		
Steady-state input voltage (V_{in}) limits minimum (channels 1–8) minimum (channels 9–12) maximum (channels 1–8 and 9–12)	- V V V	- -0.2 -45 +45
Transient input voltage (V_{in}) limits minimum (channels 1–8) minimum (channels 9–12) maximum (channels 1–8 and 9–12)	- V V V	- -0.3 -100 +100

Parameter	Unit	Value
Input channel V_{in}< 5.5 V (channels 1–8) V_{in}< 5.5 V (channels 9–12) V_{in}≥ 5.5 V (channels 1–8) V_{in}≥ 5.5 V (channels 9–12)	- µA µA mA mA	- 110 10 (V_{in}-5.5)/10+0.110 (V_{in}-5.5)/10+0.010
Threshold voltage upper threshold ($V_{th,upper}$) range lower threshold ($V_{th,upper}$) accuracy	- V V V	- 0.001 ... 4.8 $V_{th,upper}$-1 ±0.02
Minimum hysteresis voltage	mV	±20
Pulse counters		
Pulse rate mode maximum input frequency maximum counts per sample period	- MHz counts	- 1 > 4 billion
Quadrature decoder mode minimum maximum	- V V	- 0.98 1.02
Pulse time period mode resolution accuracy minimum input frequency	- nsec % Hz	- 200 ±0.01 0.001176
Pulse on time period mode resolution accuracy	- nsec %	- 200 ±0.01
Digital Outputs		
Logic 0 provided current to ground (at 100 mA) maximum typical	- V V	- 1.1 0.9
Maximum allowable output current sink (single output) [(2]	mA	400
Logic 1 output voltage (V_{out}) (with no pull-up)	V	5
Maximum allowable pull-up voltage (channels 1–8)	V	45
Output power [(3] 5 V output 12 V output voltage tolerance	- A A %	- 1 1 ±10

[(1] Power consumption measurements include the efficiency of the power supply.

[(2] For multiple outputs, see allowable output sink current plot below.

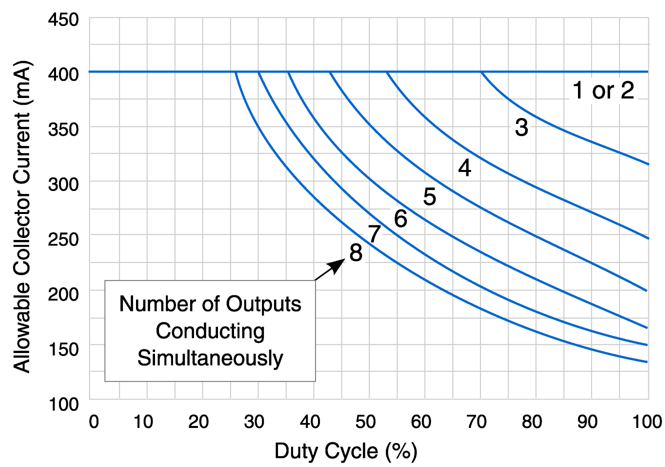
[(3] The 12-volt option operates correctly only if the input power to the eDAQXR is above 16 volts. Otherwise, the output may be less than 12 volts.

Standards

Category	Standard	Description
Shock	MIL-STD-810F	Method 516.5, Section 2.2.2 Functional Shock - ground vehicle
Vibration	MIL-STD-202G	Method 204D, Test condition C (10 g swept sine tested from 5 Hz to 2000 Hz)
Radiated emissions and susceptibility	EN 61326-1:2006	

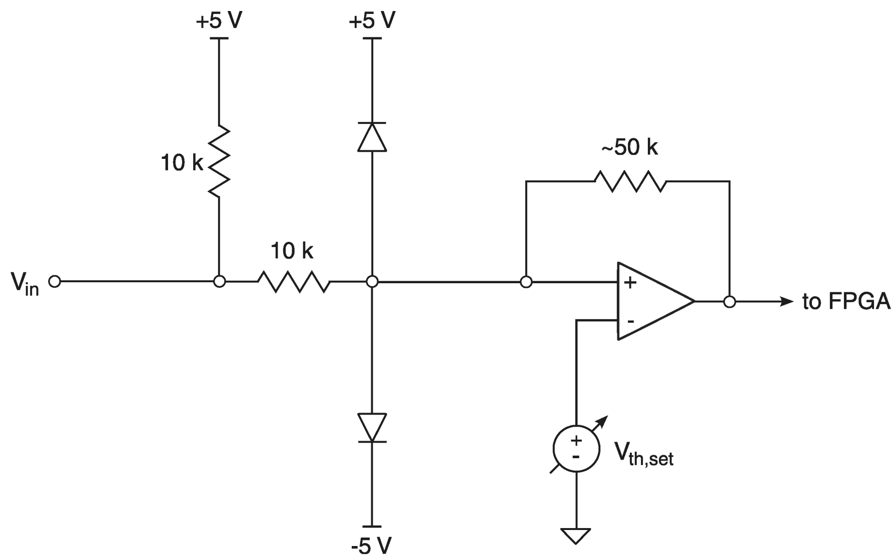
Allowable Output Sink Current

The following graph shows the allowable collector current at 50 °C depending on the number of simultaneous outputs. The data applies to the eight (8) output channels on one (1) EDIO bank.



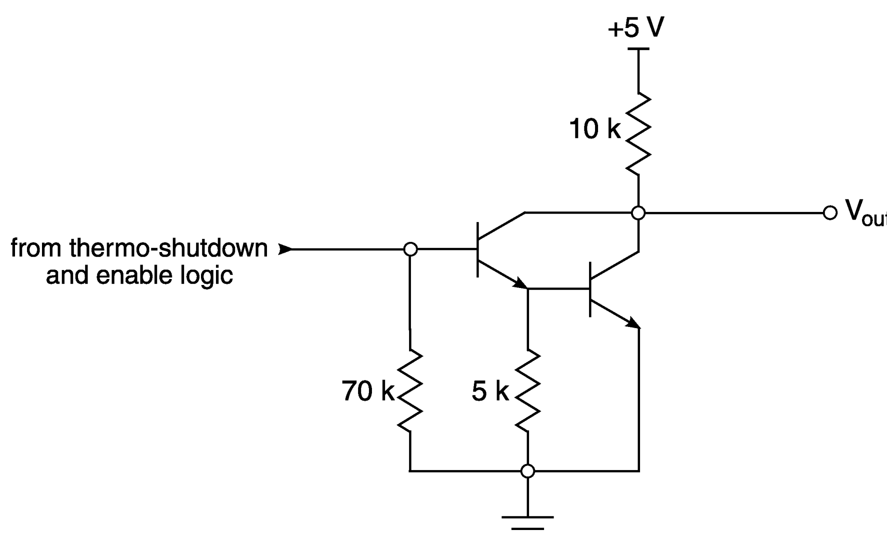
Digital Input Line Equivalent Circuit

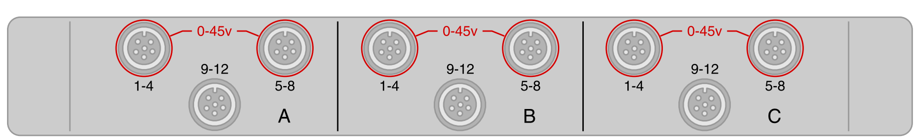
The digital input circuitry sets the threshold voltages and determines the input as a logic 1 or 0. The input equivalent circuit is the same for all input channels.



Digital Output Line Equivalent Circuit

The output circuitry is applicable to the first two (2) connectors (channels 1–8) for each bank. Note that since the outputs share common I/O lines with the digital inputs, the lines are not allowed a DC voltage level lower than -0.3 volts.





This diagram shows the M8 connectors on an EDIO layer.

EDIO Available Inputs and Outputs

The digital I/O channels are grouped into three (3) functionally identical banks (A, B and C). Each bank contains three connectors of four (4) digital I/O channels (i.e., bits). The eight (8) channels on connectors |1-4| and |5-8| are individually configurable to be either inputs or outputs. The four (4) channels on connector |9-12| are dedicated wide-range input channels. Each connector also provides two (2) pulse counter channels for a total of six (6) pulse counter channels per bank.

EDIO Digital Input/Output

There are 12 digital input/output lines available for each bank on the EDIO. Use the web interface to configure the lines on the |1-4| and |5-8| connectors as either inputs or outputs. The input lines can be sampled individually to generate logical (i.e., Boolean) data streams for triggering or other logical operations.

Use the EDIO bank configuration options to program the input threshold mode and limits for determining the Boolean state of the input channels. Connect channels to the EDIO using the numbered M8 connectors on the front panel of the layer.

The output lines are updated at a low rate based on the user-defined pipe frame size and are designed to drive LED indicators, remote switches, etc.

EDIO Pulse Counter

The pulse counter channels share the same input lines as the digital input/output channels. Two (2) pulse counter channels are provided on each connector (|1-4|, |5-8| and |9-12|). Pulse counter channels can measure pulse width, count pulses or used in pairs as quadrature encoder inputs typically used to track angular or linear position. Connect pulse counter channels to the EDIO using the numbered M8 connectors on the front panel.

NOTE
Input bits (i.e., channels) used for pulse counters can simultaneously be used for digital input channels.

Limits on EDIO Input Voltages

The four (4) channels on connector |9-12| on each bank of the EDIO are wide range inputs that can accept steady state voltages in the range of ±45 volts. These channels can also tolerate short duration spikes up to +100 volts (as can be encountered using inductive pickup devices).

The eight (8) channels on connectors |1-4| and |5-8| on each bank of the EDIO are configurable as either inputs or outputs and can accept steady state voltages in the range of -0.2 to +45 volts. These channels can also tolerate short duration spikes up to +100 volts. In general, it is advised that these channels be used only with positive voltage input sources.

Exceeding the input ranges described above can result in component damage, requiring factory repair. Layer damage caused by exceeding input voltage limits is not covered by HBM warranty.

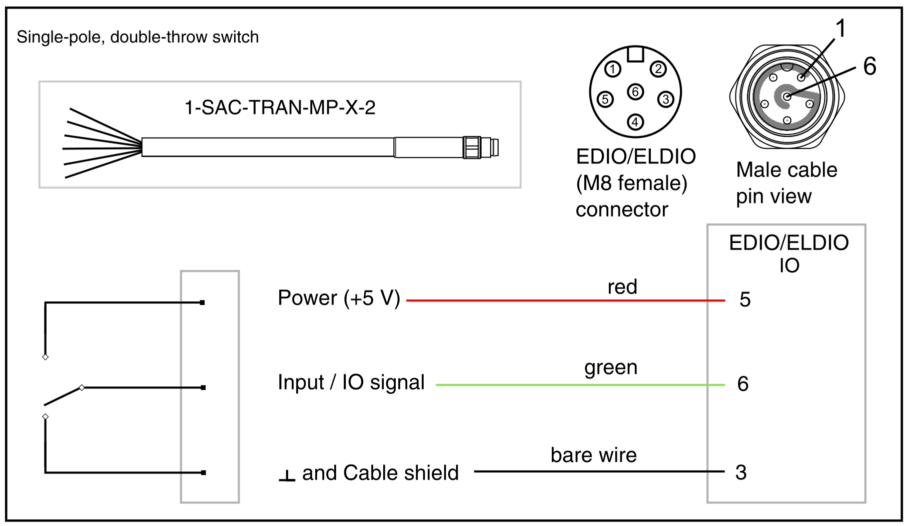
Wiring diagrams

EDIO digital input

Use the Somat SAC-TRAN-MP Transducer Cable (1-SAC-TRAN-MP-2-2 or 1-SAC-TRAN-MP-10-2) to wire EDIO digital inputs.

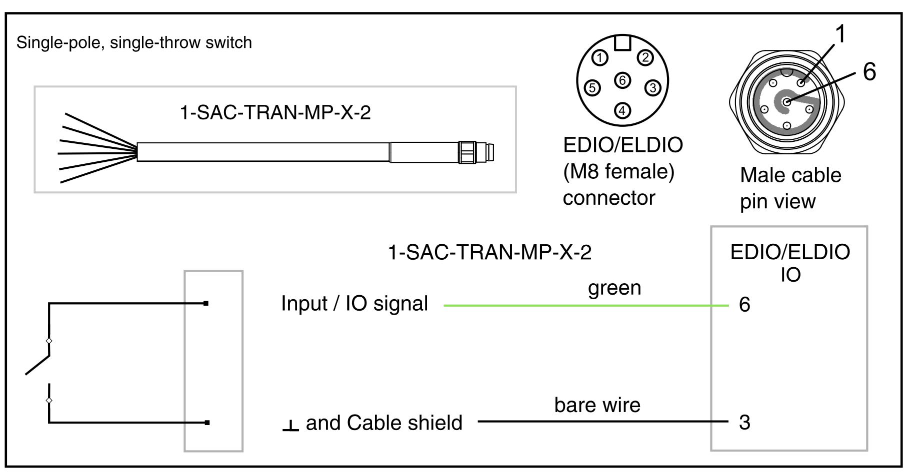
Preferred switch

Whenever possible, a single-pole, double-throw switch, wired as shown below, should be used for switched inputs. This circuit solidly switches the input line to either ground or +5 volts and prevents coupling of the input line to other digital input lines. Moving the switch to the ground side is identified as FALSE.



Alternate switch

The following diagram shows the circuit wiring for an alternate digital input involving a switch closure function. An open switch as shown is TRUE; a closed switch is FALSE. This circuit is adequate for most applications.

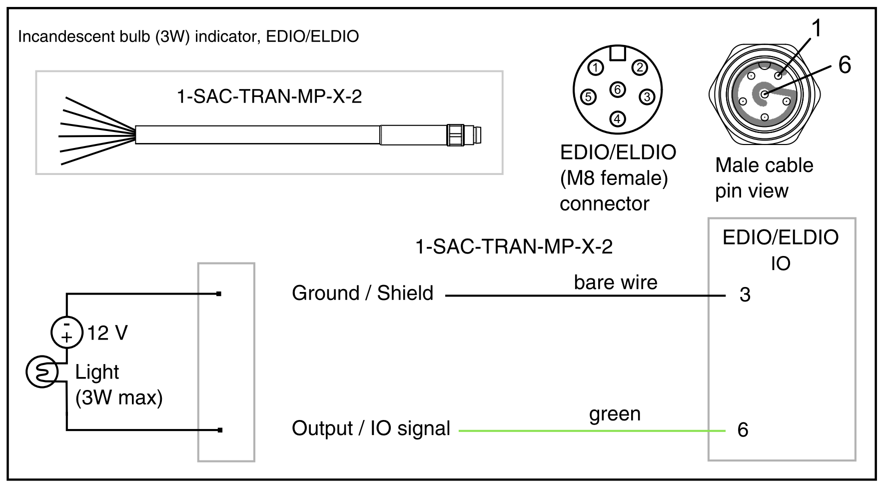


EDIO digital output

Use the Somat SAC-TRAN-MP Transducer Cable (1-SAC-TRAN-MP-2-2 or 1-SAC-TRAN-MP-10-2) to wire EDIO digital outputs.

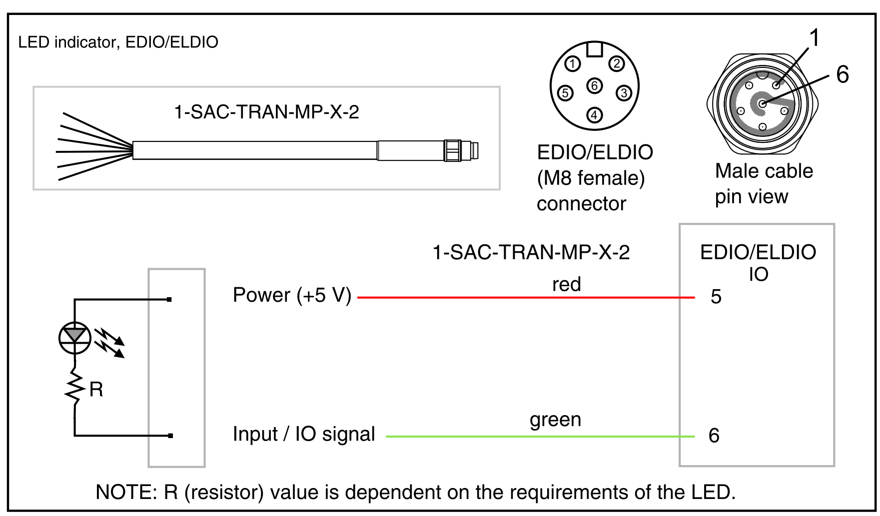
Operating a 12-volt incandescent bulb

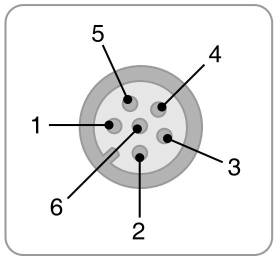
The following diagram shows an incandescent bulb (3 watts maximum) used as an indicator in the digital output circuit. An external 12-volt DC power supply provides power for the bulb. The light turns on when the output is set to FALSE.



Operating a Light Emitting Diode (LED)

The following diagram shows the use of an LED as an indicator in the digital output circuit. A FALSE output causes the diode to light. The total of all diode currents must be less than 250 mA for an EDIO bank. The resistor R limits the current through the diode when the LED is on. The resistor value is dependent on the requirements of the illumination device. For more information on output current limitations, refer to the EDIO **Specifications** table above.





The following table lists the pinouts for the SAC-TRAN-MP cable when used for EDIO inputs. The I/O pin depends on the bank connector (i.e., |1-4|, |5-8| or |9-12|).

NOTE
The quadrature encoder outputs as specified are for default signal polarity which assigns the positive direction to clockwise rotation. To reverse polarity, interchange encoder outputs A and B.

Pin	Function	Wire color	Quad encoder use
1	I/O 4, 8 or 12	Brown	Encoder 2, output B
2	I/O 3, 7 or 11	White	Encoder 2, output A
3	GND/Shield	Bare wire	Return
4	I/O 1, 5 or 9	Black	Encoder 1, output A
5	Power	Red	Power
6	I/O 2, 6 or 10	Green	Encoder 1, output B

$A = f_1(+)$; $B = f_2(+)$

Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-EPCM-2	Pulse Conditioning Module In-line signal conditioning module. Amplifies and isolates incoming pulse signals to TTL levels compatible with the EDIO layers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EDIO
1-SAC-TRAN-MP-2-2	Transducer Cable - Male/Pigtail - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-MP-10-2	Transducer Cable - Male/Pigtail - 10 Meters Length	EDIO, EBRG and EHLS

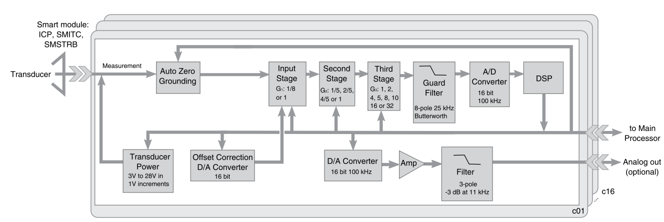
Order Number	Description	Compatible Layers
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

3 EHLS high level analog layer

The EHLS high level analog layer offers 16 simultaneously sampled high-level differential analog inputs through independent connectors. The EHLS can inherently handle any analog input from ±74.9 volts and, together with the Somat SMART conditioning modules, constitutes a real multi-purpose layer. The EHLS is compatible with practically any input including thermocouples, strain gages, accelerometers, microphones and amplified and un-amplified transducers. Software selectable sample rates, transducer power and digital filtering simplify set up of any channel. There are also several calibration options including defined value, external value and multipoint calibrations.

The EHLS may be ordered with an optional analog output function. Outputs are filtered analog output signals that can be used in the creation of time-domain lab durability tests. When setting up the laboratory simulation, bring the eDAQXR system into the lab with the component or vehicle. This practice is highly recommended, as it ensures that all of the transducer instrumentation and properties are identical for the lab simulation as they were for the field data collection. Instead of being recorded, the analog out signals are sent as time series data for the test rig to analyze. The controller can then develop drive files that are played into the test rig reproducing exact field dynamics in the lab. Each output channel is associated with the corresponding (like-numbered) input channel on the EHLS board. Calibration files, directly compatible with popular simulation software, that scale the analog outputs to engineering units are provided. The maximum analog output voltage is ±10 volts. Each of the 16 analog channels contain a three-pole Butterworth filter which attenuates frequencies above 12 KHz. These filters smooth out the stair-steps created by the channel’s digital to analog converter.

Block diagram



NOTE

A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

Ordering options

Order number	Description
1-EHLS-B-2	EHLS high level analog layer – Base Layer Inputs: 16-channels, ±74.9V differential analog, simultaneous sampling, 16-bit resolution. With the addition of SMART Conditioning Modules this layer can also be used to measure strain gage based transducers, thermocouples and ICP devices. Includes: (16) 1-SAC-TRAN-MP-2-2 cables.
1-EHLS-AO-2	EHLS high level analog layer – Analog Out Inputs: 16-channels, ±74.9V differential analog, simultaneous sampling, 16-bit resolution. Installed Option: Analog Output With the addition of SMART Conditioning Modules this layer can also be used to measure strain gage based transducers, thermocouples and ICP devices. Includes: (16) 1-SAC-TRAN-MP-2-2 cables, (1) 1-SAC-TRAN-AO-2-2 analog out cable.

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	cm	23 x 25 x 3.3
Weight	kg	2.0
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Relative humidity range, non-condensing	%	0 ... 90
Initial accuracy at 125 mV or 250 mV full scale other	- % of full scale % of full scale	- 0.2 0.1
Analog out accuracy	% of full scale	0.25
Common mode range plus signal G_1=1/8 G_1=1	- V V	- ±74.9 ±10
Analog inputs surviving over voltage	V	±125
Transducer power supply voltage range	V	3 ... 28 in 1 V steps
Transducer power supply output power	mW	400
Transducer power supply voltage change over temperature	%	±1
Voltage regulation 4 V out, 2 mA to 150 mA 10 V out, 2 mA to 60 mA 15 V out, 2 mA to 40 mA 20 V out, 2 mA to 30 mA	- mV mV mV mV	- 40 30 30 30
Voltage regulation efficiency	%	70
Ripple (at 1.4 MHz)	mV_{pp}	100

Parameter	Unit	Value
Power consumption[1	-	-
no load	W	5.7
SBSTRB4-120-QB (5 V out)	W	9.5
SBSTRB4-120-HB (5 V out)	W	9.5
SBSTRB4-120-FB (5 V out)	W	13.3
SBSTRB4-350-QB (5 V out)	W	6.6
SBSTRB4-350-HB (5 V out)	W	6.6
SBSTRB4-350-FB (5 V out)	W	8.3
SBSTRB4-120-QB (10 V out)	W	13.8
SBSTRB4-350-HB (10 V out)	W	13.8
SBSTRB4-350-FB (10 V out)	W	15.4
SMITC	W	10.5
IEPE plus accelerometer	W	14.83
40 mA load (12 V out)	W	14.9
Common mode range plus signal	-	-
G_1=1/8	GΩ	2
G_1=1	kΩ	108
Analog output channel impedance[2	Ω	1000 ±50
Gain drift from the mean (-20 to 65 °C) [3	-	-
G_3G_4=1 (typical)	%	±0.069
G_3G_4=1 (maximum)	%	±0.138
G_3G_4=2 (typical)	%	±0.061
G_3G_4=2 (maximum)	%	±0.123
G_3G_4=4 (typical)	%	±0.045
G_3G_4=4 (maximum)	%	±0.090
G_3G_4=8 (typical)	%	±0.079
G_3G_4=8 (maximum)	%	±0.159
G_3G_4=16 (typical)	%	±0.088
G_3G_4=16 (maximum)	%	±0.176
G_3G_4=32 (typical)	%	±0.097
G_3G_4=32 (maximum)	%	±0.195
DC offset drift (-20 to +65 °C unless otherwise indicated) [3	-	-
G3G4=1 (typical)	% of full scale	±0.052
G3G4=1 (maximum)	% of full scale	±0.105
G3G4=1 (typical, -10 to +50 °C)	% of full scale	±0.017
G3G4=1 (maximum, -10 to +50 °C)	% of full scale	±0.034
G3G4=2 (typical)	% of full scale	±0.039
G_3G_4=2 (maximum)	% of full scale	±0.077
G_3G_4=4 (typical)	% of full scale	±0.070
G_3G_4=4 (maximum)	% of full scale	±0.141
G_3G_4=8 (typical)	% of full scale	±0.014
G_3G_4=8 (maximum)	% of full scale	±0.028
G_3G_4=16 (typical)	% of full scale	±0.030
G_3G_4=16 (maximum)	% of full scale	±0.059
G_3G_4=32 (typical)	% of full scale	±0.112
G_3G_4=32 (maximum)	% of full scale	±0.223

(1 Power consumption measurements are taken with the stated load on all 16 channels and include the efficiency of the power supply.

(2 The 1000-Ohm stabilization resistor in series with the op-amp at the analog output creates an RC filter in addition to the output filter. Typical cable capacitances (C_{cable}) fall within 18 to 40 picofarads per foot, creating a pole at $1/(2\pi 1000 C_{cable})$.

(3 The drift values depend on the gain of only the last two stages (G_3 and G_4); the attenuation of the first two stages (G_1 and G_2) may be at any setting.

Standards

Category	Standard	Description
Shock	MIL-STD-810F	Method 516.5, Section 2.2.2 Functional Shock - ground vehicle
Vibration	MIL-STD-202G	Method 204D, Test condition C (10 g swept sine tested from 5 Hz to 2000 Hz)

Selected gain settings

NOTE

This table is a representative list only and does not show all available gain settings. To check the gain settings for a defined channel, see the Test configuration Channel settings in the TCE transducer setup window or the eDAQXR web interface. “Atten1” is the input stage gain, “Atten2” is the second stage gain, “Gain1” is the third stage gain and “Gain2” is the fourth stage gain.

Desired Input Range (4 (V_{pp})	Input Stage Gain, G_1 (1/8 or 1)	Second Stage Gain, G_2 (1/5, 2/5, 4/5 or 1)	Third Stage Gain, G_3 (1, 2 or 4)	Fourth Stage Gain, G_4 (1 or 8)	Overall Gain
149.8	1/8	1/5	1	1	0.025
80	1/8	2/5	1	1	0.05
40	1/8	4/5	1	1	0.1
32	1/8	1	1	1	0.125
20	1	1/5	1	1	0.2
10	1	2/5	1	1	0.4
5	1	4/5	1	1	0.8
4	1	1	1	1	1
2	1	1	2	1	2
1	1	1	4	1	4
0.5	1	1	1	8	8
0.25	1	1	2	8	16
0.125	1	1	4	8	32

(4 The maximum A/D converter input, which is the product of the input stage and the overall gain, is 4.096 V_{pp}.

Channel Noise Characteristics

The input-referred noise and the signal to noise ratio (SNR) are defined by the following two equations:

$$\text{InputReferred Noise} = \frac{N}{G_O}$$

$$\text{SNR} = 20_{\log}\left(\frac{4.096}{N}\right)$$

where G_O is the overall gain setting and N is the noise at the input of the A/D converter, defined by one of the following three

equations depending on the third and fourth stage gains (G_3 and G_4, respectively):

$$N_{G_4} = 1 = 514.1[\mu\,\mathrm{V}]$$

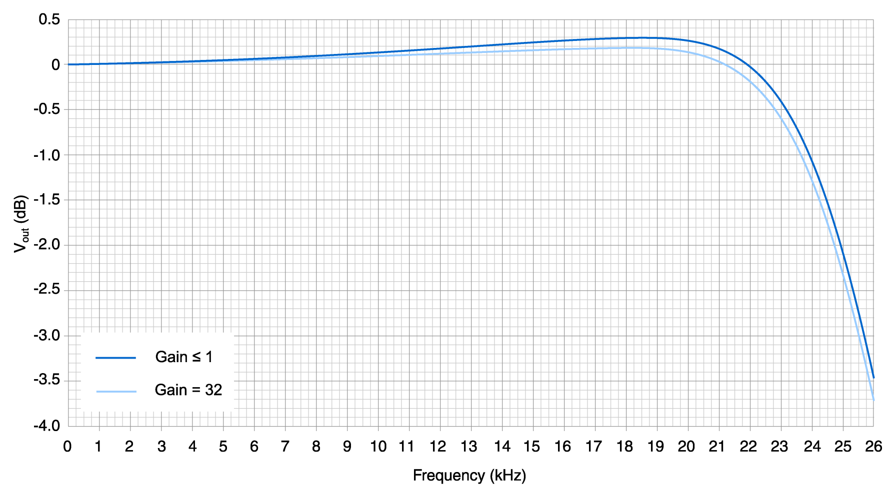
$$N_{G_3} = 1, G_4 = 8 = \sqrt{\left(240[\mu\,\mathrm{V}]\sqrt{\frac{\mathrm{x}}{24[\mathrm{kHz}]}}\right)^2 + \left(510[\mu\,\mathrm{V}]\right)^2}$$

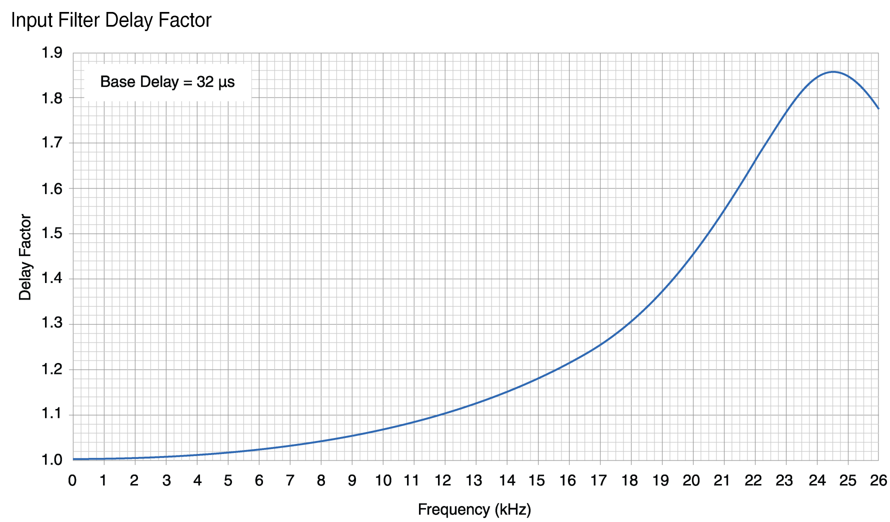
$$\mathrm{N}_{G_3} = 2, G_4 = 8 = \sqrt{\left(496[\mu\,\mathrm{V}]\sqrt{\frac{\mathrm{x}}{24[\mathrm{kHz}]}}\right)^2 + \left(510[\mu\,\mathrm{V}]\right)^2}$$

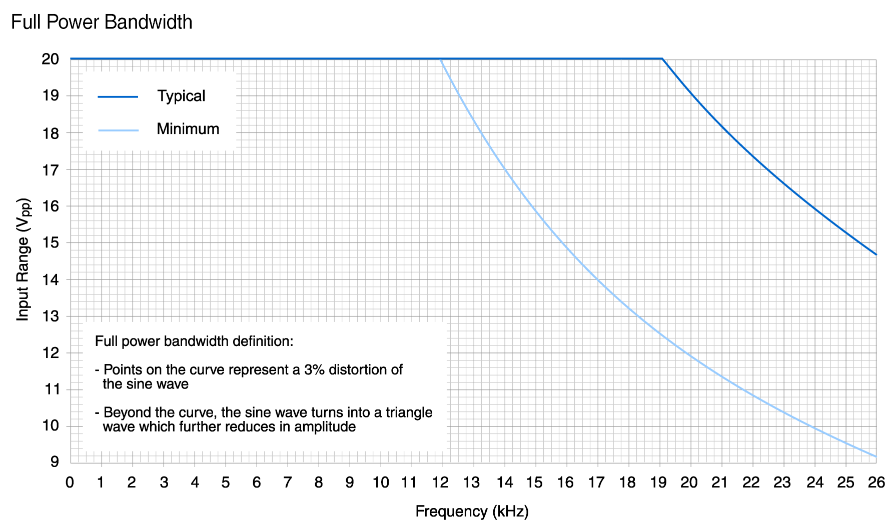
$$N_{G_3} = 4, G_4 = 8 = \sqrt{\left(933[\mu\,\mathrm{V}]\sqrt{\frac{\mathrm{x}}{24[\mathrm{kHz}]}}\right)^2 + \left(510[\mu\,\mathrm{V}]\right)^2}$$

and where *x* is the cutoff frequency of the digital or analog filter to a maximum value of 24 kHz. Note that when selecting the sampling rate in the web interface, the cutoff frequency of the selected filter is a third of the sampling rate.

Input Filter Pass Band Frequency Response



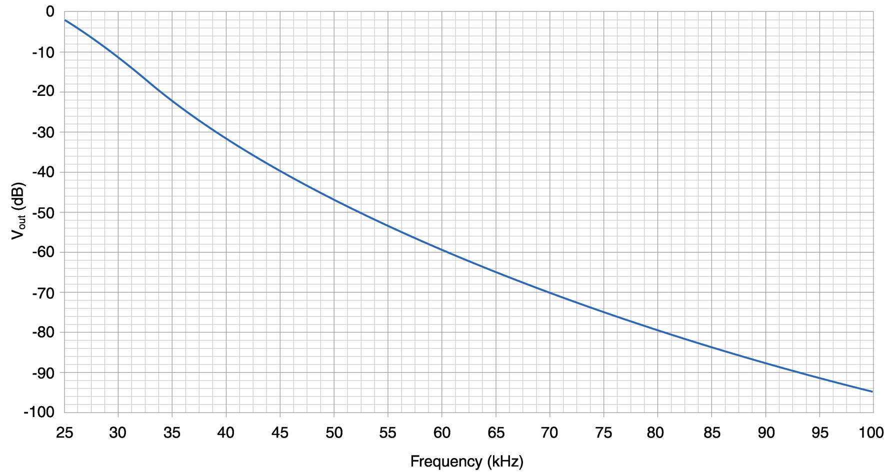




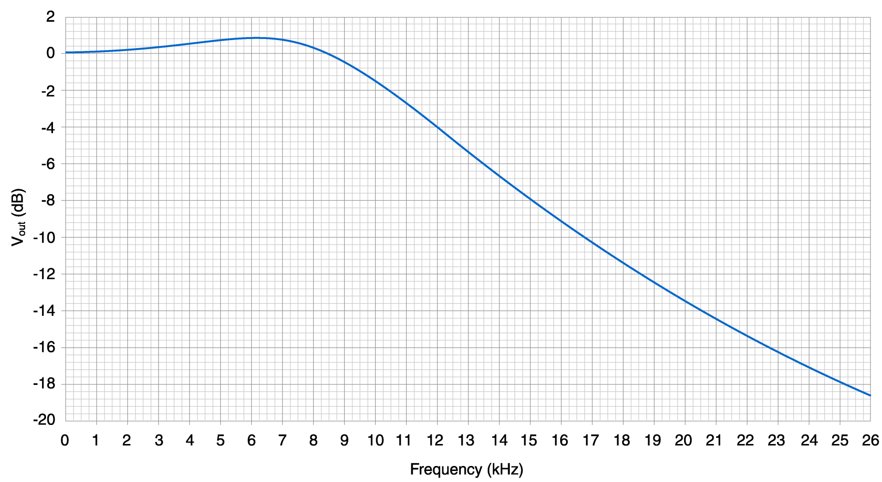
NOTE

The plot of full power bandwidth is for an overall gain of 0.2 or a 20 V_{pp} input range. For other gain settings, scale the input range by the appropriate value. For example, for an overall gain of 0.05, multiply the 20 V_{pp} scale by 4 for a 80 V_{pp} input range.

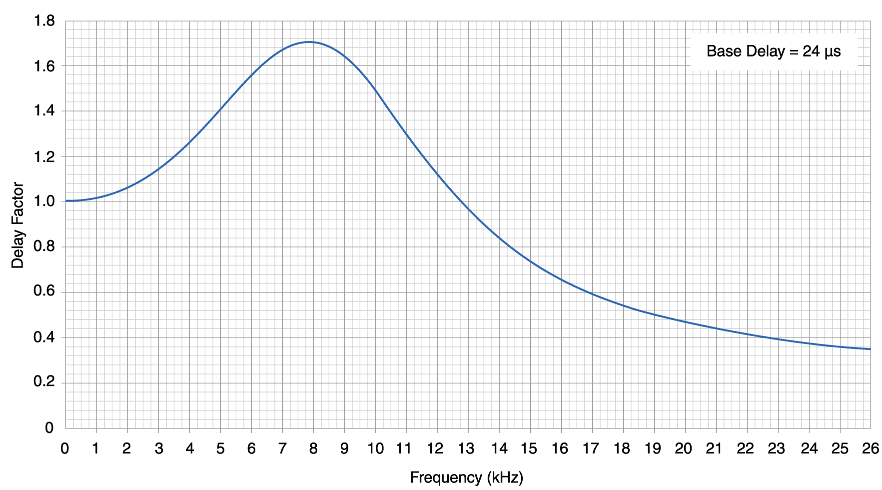
Input Filter Cut-Off Region

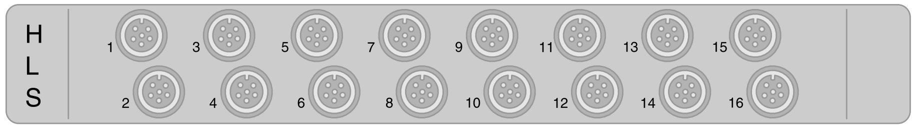


Analog Out Frequency Response



Analog Out Filter Delay Factor



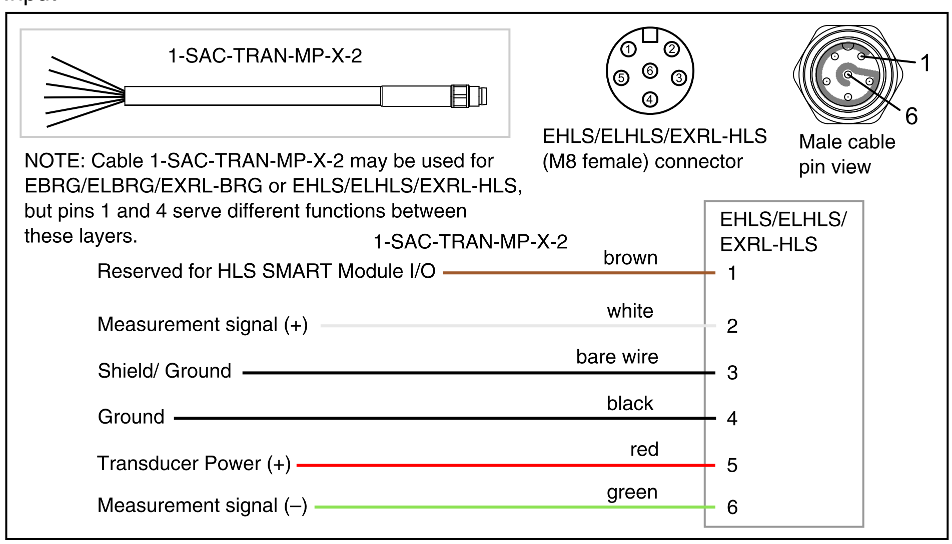


This diagram shows the M8 connectors on an EHLS layer.

Each independent channel contains programmable transducer power, an eight-pole Butterworth analog guard filter, a 16-bit A/D converter, software selectable digital filtering and output sample rate options of up to 100 kHz. The EHLS also provides 400 milliwatts of transducer power supply with an adjustable supply voltage of 3-28 volts for every channel. Use the transducer power supplies in parallel for larger loads.

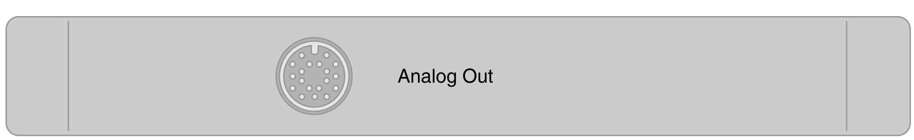
NOTE
The analog guard filters on the EHLS channels result in some gain amplification for high frequency inputs. Some selected gain settings are shown above.

Input



Analog Output

The EHLS is available with an optional analog output function to provide high level analog output signal for each channel. Outputs are filtered analog output signals that can be used in the creation of time-domain lab durability tests. Each output channel is associated with the corresponding (like-numbered) input channel on the EHLS board. Connect the analog outputs to the EHLS through the Analog Output connector on the back panel shown in the diagram below.



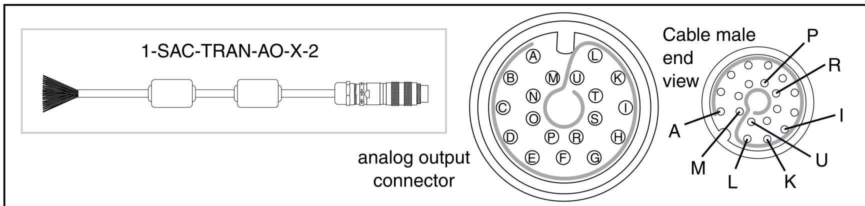
This diagram shows the analog out connector on the back panel of an EHLS layer.

The outputs are generated from a D/A converter implemented as a unity gain follower to the A/D converter. The EHLS uses the non-inverting unity gain follower by default. Select the Analog output inversion option in the test setup configuration to use the inverting unity gain follower when the channel calibration slope is negative.

NOTE

The EHLS uses a nominal ±2-volt A/D converter. However, do not assume that the user-defined full-scale values are even approximately equivalent to ±2 volts for any particular channel. This is primarily because the eDAQXR automatically provides a minimum over range protection of 1% and the eDAQXR can set gains only at certain discrete values resulting in actual over range protection that is sometimes significantly larger than 1%.

Analog output



1-SAC-TRAN-AO-X-2

Function	Wire color	Pin
3 Out	red/blue	A / 1
1 Out	white/green	B / 2
6 Out	gray	C / 3
8 Out	brown/green	D / 4
4 Out	green	E / 5
Shield	bare wire	F / 6
12 Out	black	G / 7
16 Out	white/yellow	H / 8
14 Out	white/gray	I / 9
9 Out	gray/brown	K / 10
11 Out	gray/pink	L / 11
2 Out	brown	M / 12
5 Out	pink	N / 13
7 Out	yellow	O / 14
Ground	white	P / 15
Ground	red	R / 16
15 Out	purple	S / 17
13 Out	yellow/brown	T / 18
10 Out	blue	U / 19

Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-EBB-AO-2	Breakout Box – Analog Output EHLS and EBRG Layers.	EHLS and EBRG
1-EICP-B-2	IEPE-Type Conditioning Module – BNC Connector In-line signal conditioning module for EHLS Layers. Inputs: IEPE (Integrated Electronics Piezoelectric) Transducers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-EICP-M-2	IEPE-Type Conditioning Module – Microdot Connector In-line signal conditioning module for EHLS Layers. Inputs: IEPE (Integrated Electronics Piezoelectric) Transducers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMSTRB4-120-2	Strain SMART Module – 120 Ohm Completion In-line signal conditioning module for EHLS Layers. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 120 Ohm ¼ -bridge completion resistor. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMSTRB4-350-2	Strain SMART Module – 350 Ohm Completion In-line signal conditioning module for EHLS Layers. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 350 Ohm ¼ -bridge completion resistor. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMITC-2	Thermocouple SMART Module In-line signal conditioning module for EHLS Layers. Inputs: Isolated Thermocouple, 500 V Isolation, Software selectable J, K, T and E Thermocouple Calibrations. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SAC-TRAN-MP-2-2	Transducer Cable - Male/Pigtail - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-MP-10-2	Transducer Cable - Male/Pigtail - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-AO-2-2	Transducer Cable - Analog Out - 2 Meters Length	EHLS and EBRG

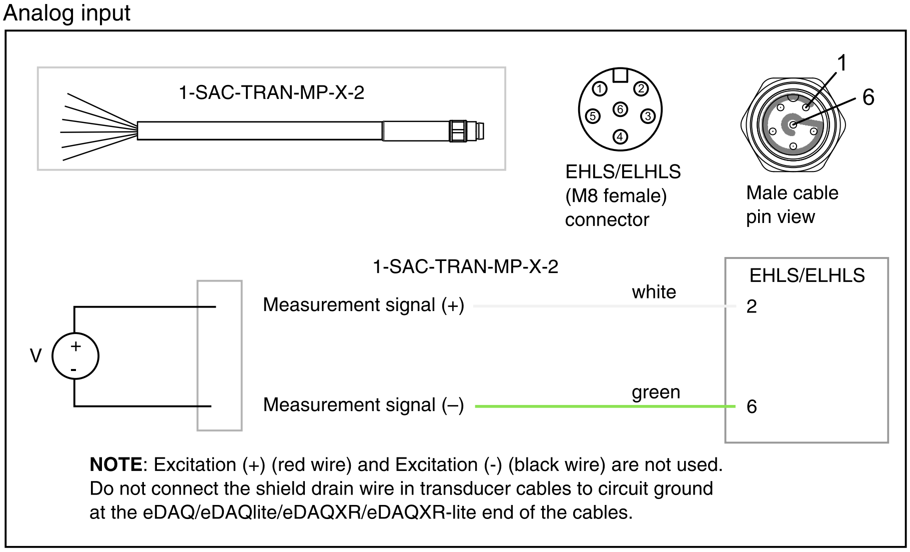
Order Number	Description	Compatible Layers
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

EHLS Analog Input

Use the Somat SAC-TRAN-MP Transducer Cable (1-SAC-TRAN-MP-2-2 or 1-SAC-TRAN-MP-10-2) to wire EHLS analog inputs.

NOTE
Do not use this wiring diagram for EBRG channels.

Analog input

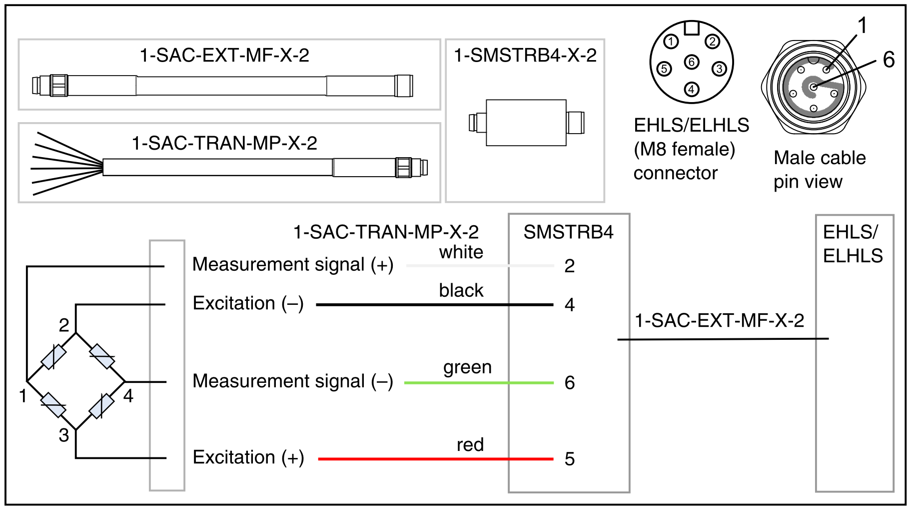


This diagram shows wiring for a standard analog input on an EHLS layer.

SMSTRB4 (Strain SMART Module)

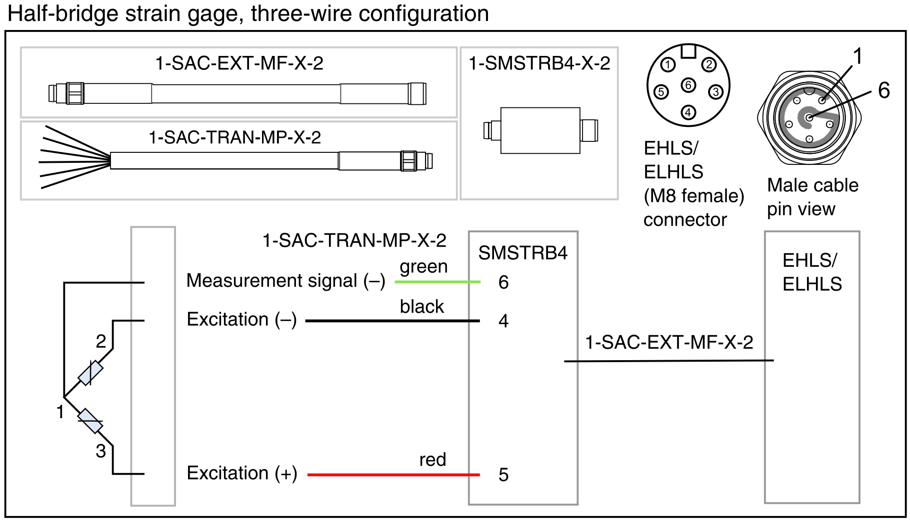
Use the Somat SAC-TRAN-MP Transducer Cable (1-SAC-TRAN-MP-2-2 or 1-SAC-TRAN-MP-10-2) to wire SMSTRB4 inputs. See Strain SMART modules for pin assignments on the SMSTRB4.

Full-bridge strain gage, four-wire configuration



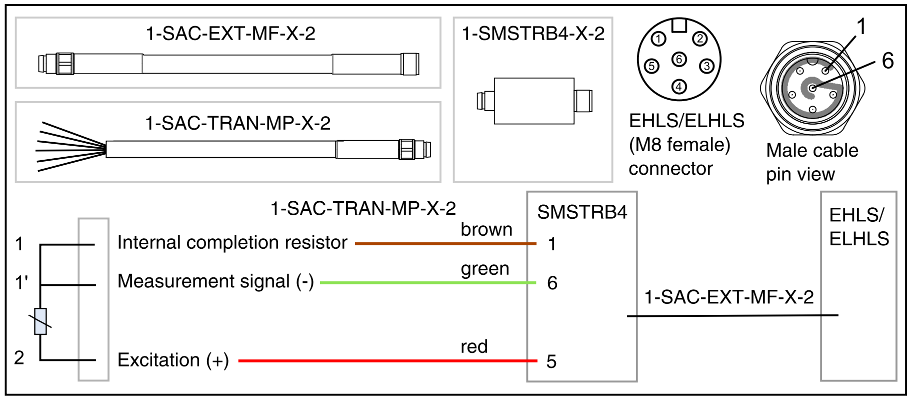
This diagram shows a full-bridge configuration using a Strain SMART Module.

Half-bridge strain gage, three-wire configuration



This diagram shows a half-bridge configuration using a Strain SMART Module.

Quarter-bridge strain gage, three-wire configuration



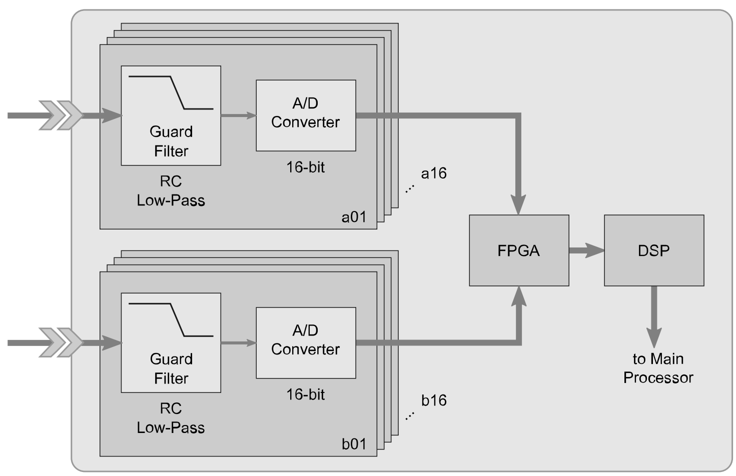
This diagram shows a quarter-bridge configuration using a Strain SMART Module.

4 ENTB non-isolated thermocouple layer

The ENTB non-isolated thermocouple layer measures temperatures on 32 channels of non-isolated thermocouple signal conditioning through two 37-pin high density D-sub connectors of 16 channels each. The ENTB is compatible with the four most common thermocouple calibration types: K, J, T and E. Each channel is independently software-selectable between these calibration types. Since each bank of 16 channels share a common cold junction, the ENTB has excellent channel-to-channel accuracy. This is particularly useful when measuring thermal gradients.

The ENTB requires two ECJTB cold junction thermocouple boxes for thermocouple termination.

Block diagram



NOTE
A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

Ordering options

Order number	Description
1-ENTB-2	Non-Isolated Thermocouple Layer Inputs: 32-channels, Software selectable J, K, T and E Thermocouple Calibrations. Requires: Cold Junction Thermocouple Boxes (not included). Includes: (2) 1-CBL-0007-00-2 cables.

Specifications

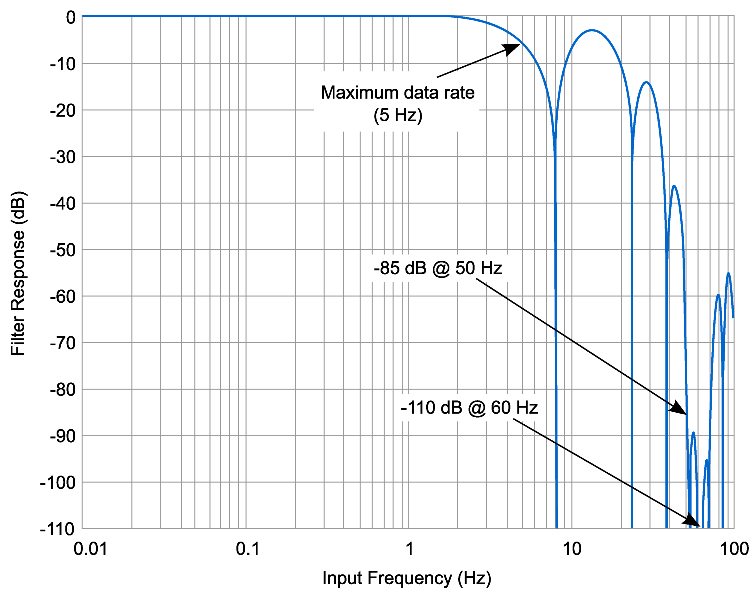
Parameter	Unit	Value
Dimensions: width x length x height	cm	23 x 25 x 3.3
Weight	kg	2.0
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Relative humidity range, non-condensing	%	0 ... 90
Overall accuracy[(1]	°C	0.5
Maximum thermo-equilibrium temperature change rate[(1]	°C/min	2
Channel-to-channel thermocouple accuracy[(2]	°C	0.1
Input temperature range K-type thermocouple J-type thermocouple T-type thermocouple E-type thermocouple	- °C [°F] °C [°F] °C [°F] °C [°F]	- -100 ... +1350 [-148 ... +2462] -100 ... +760 [-148 ... +1400] -100 ... +400 [-148 ... +752] -270 ... +1000 [-454 ... +1832]
Typical thermocouple response time constant 30 AWG 12 AWG 10 AWG	- s s s	- 0.3 6.0 9.0
Sample rate range	Hz	0.1 ... 5
Power consumption with thermocouples[(3]	W	0.66

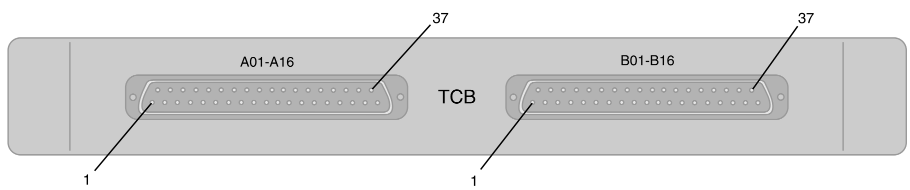
[(1] The overall accuracy specification is not valid if the maximum thermo-equilibrium temperature change rate is exceeded. Maximum accuracy is obtained when the ENTB layer is calibrated at a steady-state operating temperature. Due to tolerance and temperature characteristics of the components, a change in temperature may cause an offset to the temperature measurement which can be eliminated by channel recalibration.
[(2] Channel-to-channel thermocouple accuracy does not include inaccuracies in the thermocouples themselves.
[(3] Power consumption measurements are taken with the stated load on all 32 channels and include the efficiency of the power supply.

Standards

Category	Standard	Description
Shock	MIL-STD-810F	Method 516.5, Section 2.2.2 Functional Shock - ground vehicle
Vibration	MIL-STD-202G	Method 204D, Test condition C (10 g swept sine tested from 5 Hz to 2000 Hz)

Input Filter Frequency Response





This diagram shows the two 37-pin D-Sub connectors on an ENTB layer.

Each channel uses a notched filter processor that generates about seven samples per second. Since these channels are not isolated from each other, they can only be used in applications where the individual thermocouples are electrically isolated from each other. A cold junction box is required for each bank and is connected to the ENTB with the cables provided using the connectors labeled “A01-A16” or “B01-B16” located on the front panel. Each thermocouple is connected to the miniature barrier strip type paired inputs in the junction box.

The ENTB non-isolated thermocouple layer (1-ENTB-2) measures temperatures on 32 channels of non-isolated thermocouple signal conditioning through two 37-pin high density D-sub connectors of 16 channels each. The ENTB is compatible with the four most common thermocouple calibration types: K, J, T and E. Each channel is independently software-selectable between these calibration types. Since each bank of 16 channels share a common cold junction, the ENTB has excellent channel-to-channel accuracy. This is particularly useful when measuring thermal gradients. The ENTB requires two ECJTB Cold Junction Thermocouple Boxes (sold separately) for thermocouple termination.

NOTE
Thermocouple leads should not exceed 30 meters in length from connector to tip.

The ENTB uses the industry standard software compensation algorithm to generate the temperature data samples. The ENTB first measures the cold-junction compensation (CJC) temperature and converts it to the equivalent microvolt value using a high-resolution lookup table. The ENTB then subtracts the CJC equivalent microvolt value from the thermocouple’s output microvolt value. The temperature is found using another high-resolution lookup table. The lookups are based on the ITS-90 Thermocouple Direct and Inverse Polynomials.

Application Note on Measuring Differential Temperatures

To measure differential temperatures using the ENTB layer, select two or more adjacent channels on the same bank. Use matched thermocouples for optimum differential accuracy.

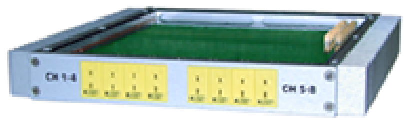
Due to instrumentation noise, it is recommended that the maximum sample rate (e.g., 5 Hz for the 100 KHz MSR option) and a Smoothing Filter computed channel be used for each input channel. Using a five- or seven-tap Smoothing Filter typically reduces the instrumentation noise to below 0.2° C peak to peak (for all thermocouple types). Using more taps can further reduce the noise.

To generate the differential temperature, use a simple Signal Calculator computed channel. Use a Down Sampler computed channel to achieve the desired data storage rate.

Cables and accessories (sold separately)

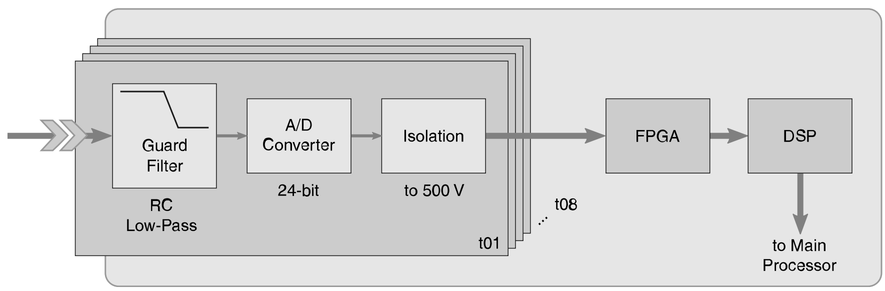
Order number	Description	Compatible Layers
1-CBL-0007-00-2	Extension Cable - ENTB Layer - 2 Meters Length	ENTB
1-ECJTB-2	Cold Junction Thermocouple Box, Compatible with J, K, T and E Calibrations	ENTB
1-ECJTB-E-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type E Thermocouple Connectors.	ENTB
1-ECJTB-K-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type K Thermocouple Connectors.	ENTB
1-ECJTB-T-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type T Thermocouple Connectors.	ENTB
1-ECJTB-J-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type J Thermocouple Connectors.	ENTB
1-ECJTB-K-32-2	Cold Junction Thermocouple Box, Inputs: 32-channels, thermocouples are terminated using (32) miniature spade Type K Thermocouple Connectors.	ENTB

5 EITB isolated thermocouple layer



The EITB isolated thermocouple layer measures temperatures on eight channels of isolated thermocouple signal conditioning through eight miniature spade thermocouple connectors. The EITB is available for the four most common thermocouple calibration types: K, J, T or E. Each channel has individual cold junction compensation with isolation up to 500 volts.

Block diagram



NOTE

A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

Ordering options

Order number	Description
1-EITB-K-2	EITB isolated thermocouple layer – Type K. Inputs: 8-channels, 500 V Isolation, K-Type thermocouple calibration. Includes: (8) Miniature Spade Type K Connectors-Male.
1-EITB-J-2	EITB isolated thermocouple layer – Type J. Inputs: 8-channels, 500 V Isolation, J-Type thermocouple calibration. Includes: (8) Miniature Spade Type J Connectors-Male.
1-EITB-T-2	EITB isolated thermocouple layer – Type T. Inputs: 8-channels, 500 V Isolation, T-Type thermocouple calibration. Includes: (8) Miniature Spade Type T Connectors-Male.
1-EITB-E-2	EITB isolated thermocouple layer – Type E. Inputs: 8-channels, 500 V Isolation, E-Type thermocouple calibration. Includes: (8) Miniature Spade Type E Connectors-Male.

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	cm	23 x 25 x 3.3
Weight	kg	2.0

Parameter	Unit	Value
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Relative humidity range, non-condensing	%	0 ... 90
Accuracy(1	°C	1.0
Maximum thermo-equilibrium temperature change rate(1	°C/min	2
Isolation	V	500
Input temperature range K-type thermocouple J-type thermocouple T-type thermocouple E-type thermocouple	- °C [°F] °C [°F] °C [°F] °C [°F]	- -100 ... +1350 [-148 ... +2462] -100 ... +760 [-148 ... +1400] -100 ... +400 [-148 ... +752] -270 ... +1000 [-454 ... +1832]
Typical thermocouple response time constant (2 30 AWG 12 AWG 10 AWG	- s s s	- 0.3 6.0 9.0
Sample rate range	Hz	0.1 ... 5
Power consumption with thermocouples(3	W	1.77

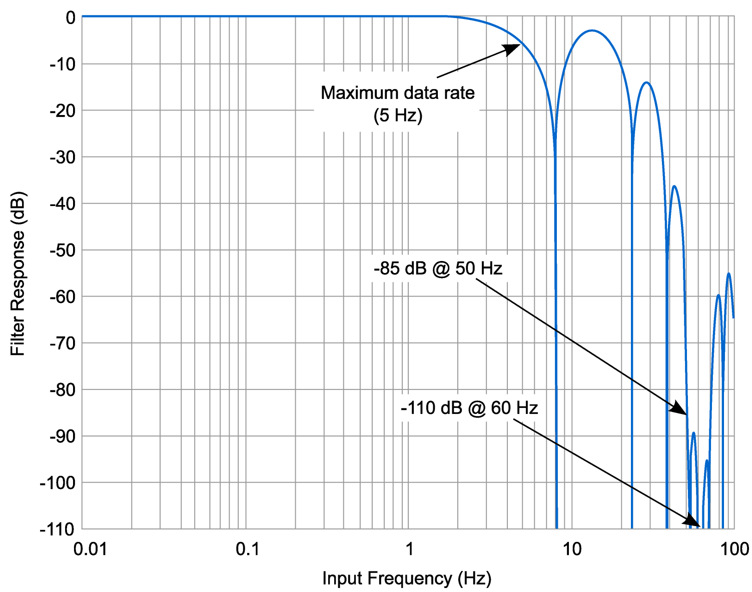
(1 The overall accuracy specification is not valid if the maximum thermo-equilibrium temperature change rate is exceeded.

(2 Power consumption measurements are taken with the stated load on all eight channels and include the efficiency of the power supply.

Standards

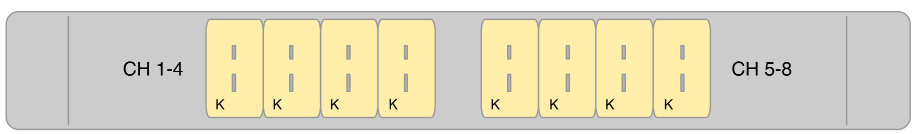
Category	Standard	Description
Shock	MIL-STD-810F	Method 516.5, Section 2.2.2 Functional Shock - ground vehicle
Vibration	MIL-STD-202G	Method 204D, Test condition C (10 g swept sine tested from 5 Hz to 2000 Hz)

Input Filter Frequency Response



NOTE

Thermocouple leads should not exceed 30 meters in length from connector to tip.



This diagram shows the thermocouple connectors on an EITB layer configured for K-type thermocouples.

The EITB uses the industry standard software compensation algorithm to generate the temperature data samples. The EITB first measures the cold-junction compensation (CJC) temperature and converts it to the equivalent microvolt value using a high-resolution lookup table. The EITB then subtracts the CJC equivalent microvolt value from the thermocouple's output microvolt value. The temperature is found using another high-resolution lookup table. The lookups are based on the ITS-90 Thermocouple Direct and Inverse Polynomials.

6 eDAQXR compatible layer accessories

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-EBB-AO-2	Breakout Box – Analog Output EHLS and EBRG Layers.	EHLS and EBRG
1-EPCM-2	Pulse Conditioning Module In-line signal conditioning module. Amplifies and isolates incoming pulse signals to TTL levels compatible with the EDIO layers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EDIO
1-EICP-B-2	IEPE-Type Conditioning Module – BNC Connector In-line signal conditioning module for EHLS Layers. Inputs: IEPE (Integrated Electronics Piezoelectric) Transducers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-EICP-M-2	IEPE-Type Conditioning Module – Microdot Connector In-line signal conditioning module for EHLS Layers. Inputs: IEPE (Integrated Electronics Piezoelectric) Transducers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMSTRB4-120-2	Strain SMART Module – 120 Ohm Completion In-line signal conditioning module for EHLS Layers. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 120 Ohm ¼ -bridge completion resistor. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMSTRB4-350-2	Strain SMART Module – 350 Ohm Completion In-line signal conditioning module for EHLS Layers. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 350 Ohm ¼ -bridge completion resistor. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMITC-2	Thermocouple SMART Module In-line signal conditioning module for EHLS Layers. Inputs: Isolated Thermocouple, 500 V Isolation, Software selectable J, K, T and E Thermocouple Calibrations. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS

Order Number	Description	Compatible Layers
1-ECJTB-2	Cold Junction Thermocouple Box, Compatible with J, K, T and E Calibrations	ENTB
1-ECJTB-E-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type E Thermocouple Connectors.	ENTB
1-ECJTB-K-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type K Thermocouple Connectors.	ENTB
1-ECJTB-T-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type T Thermocouple Connectors.	ENTB
1-ECJTB-J-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type J Thermocouple Connectors.	ENTB
1-ECJTB-K-32-2	Cold Junction Thermocouple Box, Inputs: 32-channels, thermocouples are terminated using (32) miniature spade Type K Thermocouple Connectors.	ENTB

Cables (sold separately)

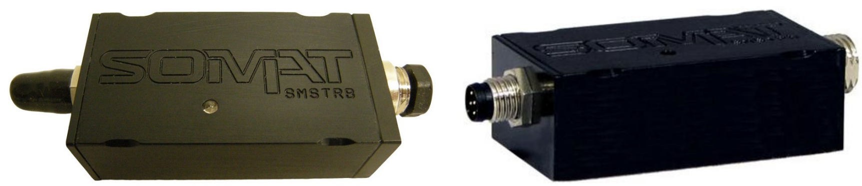
Order Number	Description	Compatible Layers
1-CBL-0007-00-2	Extension Cable - ENTB Layer - 2 Meters Length	ENTB
1-SAC-TRAN-MP-2-2	Transducer Cable - Male/Pigtail - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-MP-10-2	Transducer Cable - Male/Pigtail - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-AO-2-2	Transducer Cable - Analog Out - 2 Meters Length	EHLS and EBRG

Order Number	Description	Compatible Layers
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

GPS accessories

See the GPS modules topic in the eDAQXR user manual for more information about supported GPS accessories for the EXRCPU layer.

7 Strain SMART modules



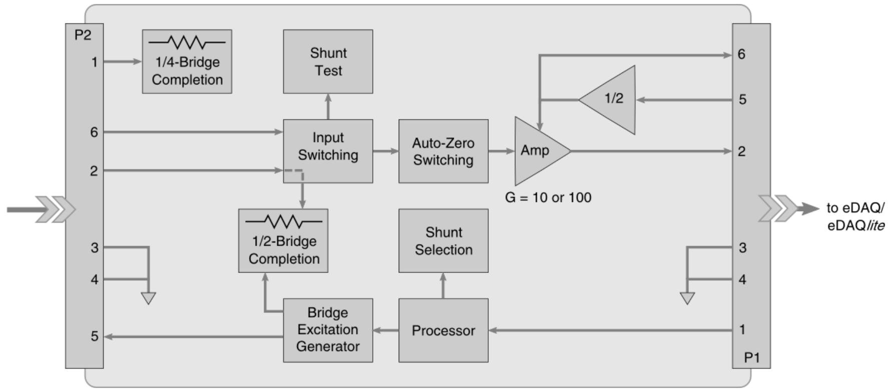
The SMSTRB Strain SMART modules condition signals for the EHLS layer. The SMSTRB provides excellent strain gage support with support for quarter-, half- and full-bridge configurations. As an external module, the SMSTRB is like taking a piece of the eDAQXR hardware and placing it next to the application. A digital line communicates with the eDAQXR for setup and calibration and the module conditions and amplifies the output to a high level signal. Sending a high level signal has several advantages, including the elimination of lead wire resistance and protection of the signal integrity from noise. These benefits are numerous across many applications from bridge monitoring with 50-meter leads over a structure to heavy equipment with long leads in a noisy environment. The SMSTRB also provides two shunt calibration resistors per channel with software selectable shunt direction for either upscale (-Sig to -Ex) or downscale (-Sig to +Ex) calibrations.

Additionally, as a SMART Module, the SMSTRB can be programmed to store transducer identification and calibration information. A hardware query automatically identifies the module and loads the channel and its calibration in the web interface. The module also contains a partition in its flash memory for storing pass-through information such as physical location or associated vehicle for the transducer. The external LED allows for easy module identification when queried from the software.

The SMSTRB module has male and female M8 connectors. Use of the module requires an Extension Cable (1-SAC-EXT-MF-x-2).

See EHLS high level analog layer for quarter-, half- and full-bridge strain gage configuration wiring diagrams for use of a SMSTRB module with an EHLS conditioning layer.

Block Diagram



NOTE
A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

These strain SMART modules are available.

Order Number	Description	Compatible Layers
1-SMSTRB4-120-2	Strain SMART Module – 120 Ohm Completion In-line signal conditioning module for EHLS Layers. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 120 Ohm ¼ -bridge completion resistor. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x is different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-SMSTRB4-350-2	Strain SMART Module – 350 Ohm Completion In-line signal conditioning module for EHLS Layers. Strain Gage Conditioning: Supports ¼, ½, and Full-bridge Strain Gage configurations. Integrated 350 Ohm ¼ -bridge completion resistor. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x is different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	mm	31.9 x 76.9 x 19.3
Weight	g	69.2
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Relative humidity range, non-condensing	%	0 ... 90
Excitation voltage (V_{ex}) [1] <350-Ω bridge resistance ≥350-Ω bridge resistance initial accuracy ripple maximum change over temperature (3σ)	- V V % mV ppm/°C	- 5 5 or 10 0.05 < 1 15
Excitation current (I_{ex}) short circuit limiting short circuit duration (at 25 °C)	- mA s	- 46 5
Module power consumption 5-volt excitation 10-volt excitation	- W W	- I_{ex}*2.65[V]+0.234[W] I_{ex}*2.65[V]+0.144[W]
Quarter-bridge completion resistance resistance (specified at production) accuracy change over temperature (3σ)	- kΩ % ppm/°C	- 120 or 350 0.01 ±1
Half-bridge completion resistance internal resistance accuracy change over temperature (3σ)	- kΩ % ppm/°C	- 12.5 (50-kΩ split) 0.05 ±2
Shunt calibration resistance resistance accuracy maximum change over temperature (3σ)	- kΩ % ppm/°C	- 49.9 or 100 0.1 ±10
Amplifier gain gain, G initial accuracy (on calibration) typical drift over temperature maximum drift over temperature	- - % of full scale ppm/°C ppm/°C	- 10 or 100 ±0.1 -1 ±5
Maximum amplifier input voltage	V	33
Amplifier input current range typical input offset change over temperature [2] maximum input offset change over temperature [2] input protection resistance (in series)	- nA pA/°C pA/°C kΩ	- 0.5 ... 1.5 0.3 1.5 10

Parameter	Unit	Value
Amplifier input-referred voltage	-	-
typical offset (G=10)	µV	±50
maximum offset (G=10)	µV	±150
typical offset (G=100)	µV	±25
maximum offset (G=100)	µV	±50
typical drift over temperature (G=10) (3	µV/°C	±0.6
maximum drift over temperature (G=10) (3	µV/°C	±1.5
typical drift over temperature (G=100) (3	µV/°C	±0.1
maximum drift over temperature (G=100) (3	µV/°C	±0.6
Bandwidth	-	-
ultra-flat bandwidth	kHz	70
3-dB bandwidth (G=10)	kHz	800
3-dB bandwidth (G=100)	kHz	200
Output noise, N	-	-
G=10 (to 25 kHz)	µV	36.4
G=10 (with filter cutoff of *x* kHz) (4	µV	$36.4\,(x/25)^{½}$
G=100 (to 25 kHz)	µV	333
G=100 (with filter cutoff of *x* kHz)(5	µV	$333\,(x/25)^{½}$
Input referred noise	µV	N/G
Signal to noise ratio, SNR(6	-	$20_{log}(V_{in,max}$ / InputReferredNoise)
Common mode input range	-	-
minimum	V	Ground + 2.1
maximum (5-volt excitation)	V	6.6
maximum (10-volt excitation)	V	11.6
Maximum input signal range (7	-	-
5-volt excitation (G=10)	V	-0.24 ... 0.25
5-volt excitation (G=100)	V	-0.024 ... 0.025
10-volt excitation (G=10)	V	-0.49 ... 0.35
10-volt excitation (G=100)	V	-0.049 ... 0.035
Initial accuracy in conjunction with the EHLS layer	%	0.1

(1 Excitation voltage can be set at zero volts.

(2 Use change over temperature to calculate the offset voltage over temperature to the EHLS layer. Offset voltage [V] = current change over temperature [pA/°C] x change in temperature [Δ°C] x input resistance [10 kΩ].

(3 The total input referred voltage drift is a combination of drift over temperature at the gain setting [µV/°C] and the drift due to the input current change over temperature (discussed in (2).

(4 The filter can be either analog or digital and has a maximum cutoff frequency of 976 kHz. Note that when selecting the sampling rate, the cutoff frequency of the selected filter is one third of the sampling rate.

(5 The filter can be either analog or digital and has a maximum cutoff frequency of 244 kHz. Note that when selecting the sampling rate, the cutoff frequency of the selected filter is one third of the sampling rate.

(6 $V_{in,max}$ is set in the web interface when used with an EHLS layer.

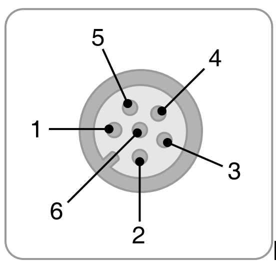
[7] The maximum input range is irrespective of the EHLS gain settings and reflect the output saturation of the SMSTRB module or the input saturation of the EHLS layer.

SMART module flash memory

All SMART modules (1-SMSTRB4-120-2, 1-SMSTRB4-350-2 and 1-SMITC-2) have three logical segments of flash memory. Two are reserved for factory use; one to store the microprocessor execution code and the other to store serial number and factory calibration parameters. The third area is the user data segment broken into two logical partitions.

1. The first partition holds device parameters that can completely configure the transducer channel setup when the SMART module is installed. If no information exists in this partition, the web interface sets up the transducer channel in a default mode when the module is added.
2. The second partition is designed for pass-through information not used by the web interface. Add any desired information such as physical locations of transducers or associated vehicle or system identifications. All pass-through keywords must start with the prefix “UI_” (“UI” followed by the underscore character).

Strain SMART module connector pin assignments



Pin diagrams are shown from the pin side of the cable connector.

Connector and Pin	Function
P1 (EHLS channel) 1	HLS Module I/O
P1 (EHLS channel) 2	+ Signal input
P1 (EHLS channel) 3	Shield to PCB ground
P1 (EHLS channel) 4	PCB ground
P1 (EHLS channel) 5	Power
P1 (EHLS channel) 6	- Signal input
P2 (Bridge) 1	Quarter-bridge completion resistor
P2 (Bridge) 2	+ Signal input
P2 (Bridge) 3	Open
P2 (Bridge) 4	- Excitation[1]
P2 (Bridge) 5	+ Excitation
P2 (Bridge) 6	- Signal input

(1The negative excitation on pin 4 of the Bridge connector is the ground on pin 4 of the EHLS channel connector.

Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-SAC-TRAN-MP-2-2	Transducer Cable - Male/Pigtail - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-TRAN-MP-10-2	Transducer Cable - Male/Pigtail - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

8 SMITC thermocouple SMART module

The SMITC Thermocouple SMART Module (1-SMITC-2) is a part of a family of signal conditioners for the EHLS layers. The SMITC provides isolated thermocouple conditioning with software selectable linearization tables for J-, K-, T- and E-type calibrations. The module has universal cold-junction compensation and is fully isolated to 500 volts. Data can be configured to °C or °F.

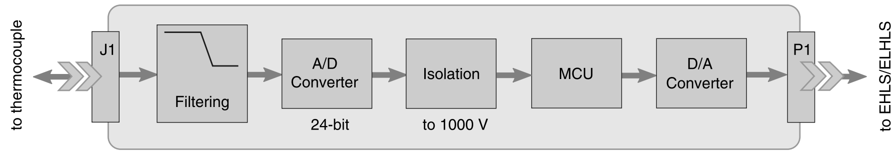
Additionally, as a SMART Module, the SMITC can be programmed to store transducer identification and calibration information. An eDAQXR hardware query automatically identifies the module and loads the channel and its calibration in the eDAQXR web interface. The module also contains a partition in its flash memory for storing pass-through information such as physical location or associated vehicle for the transducer. The external LED allows for easy module identification when queried from the software.

The SMITC module includes a male M8 connector and a universal miniature spade thermocouple connector. Use of the module requires an Extension Cable (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).

This thermocouple SMART module is available.

Order Number	Description	Compatible Layers
1-SMITC-2	Thermocouple SMART Module In-line signal conditioning module for EHLS Layers. Inputs: Isolated Thermocouple, 500 V Isolation, Software selectable J, K, T and E Thermocouple Calibrations. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS

Block Diagram



NOTE
A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

NOTE
The eDAQXR uses the full-scale min and max values defined in the EHLS parent channel to configure the converter that outputs analog voltage as a function of computed thermocouple temperature. To optimize the temperature measurement accuracy, set the full-scale values as close as possible to the temperature extremes expected in the test.

Thermocouple Type

Select the type of thermocouple as T, J, K or E. If the channel is calibrated, delete the calibration before selecting a different thermocouple type.

Hardware Configuration

In Test configuration Hardware view the SMART module user data parameters as they are defined in the hardware setup configuration. Parameters may not update reprogrammed SMART modules until a hardware query is performed.

SMART module flash memory

All SMART modules (1-SMSTRB4-120-2, 1-SMSTRB4-350-2 and 1-SMITC-2) have three logical segments of flash memory. Two are reserved for factory use; one to store the microprocessor execution code and the other to store serial number and factory calibration parameters. The third area is the user data segment broken into two logical partitions.

1. The first partition holds device parameters that can completely configure the transducer channel setup when the SMART module is installed. If no information exists in this partition, the web interface sets up the transducer channel in a default mode when the module is added.
2. The second partition is designed for pass-through information not used by the web interface. Add any desired information such as physical locations of transducers or associated vehicle or system identifications. All pass-through keywords must start with the prefix “UI_” (“UI” followed by the underscore character).

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	mm	32 x 80 x 19

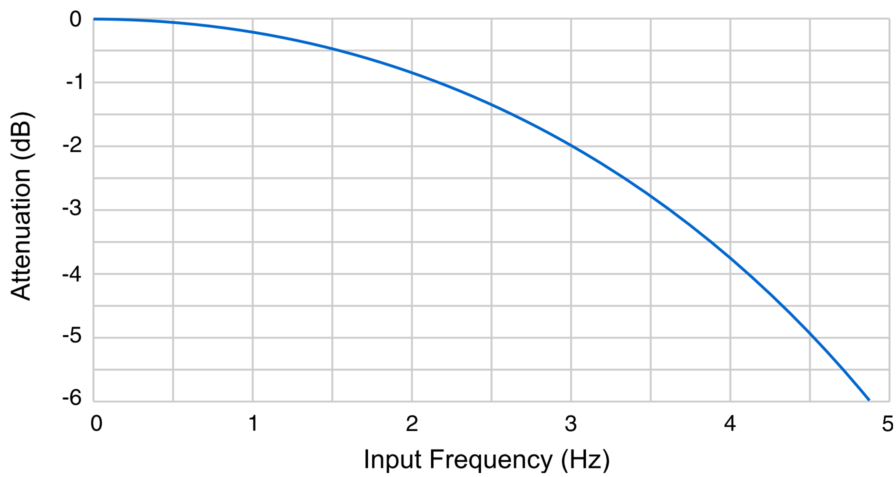
Parameter	Unit	Value
Weight	g	68
Operating temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Storage temperature range	°C [°F]	-20 ... +125 [-4 ... +257]
Relative humidity range, non-condensing	%	0 ... 90
Input voltage	V	5.5 ... 7
Accuracy(1	°C	±1.0
Maximum thermo-equilibrium temperature change rate(1	°C/min	2
Isolation (at 1 minute)	V	500
Input temperature range K-type thermocouple J-type thermocouple T-type thermocouple E-type thermocouple	- °C [°F] °C [°F] °C [°F] °C [°F]	- -260 ... +1372 [-436 ... +2501.6] -200 ... +1200 [-328 ... +2192] -260 ... +400 [-436 ... +752] -260 ... +1000 [-436 ... +1832]
Typical thermocouple response time constant (in air) 30 AWG 12 AWG 10 AWG	- s s s	- 0.3 6.0 9.0
Output data rate	Hz	7.5
Filtering break frequency (3 dB point) analog filter (common model) digital filter	- Hz Hz	- 159 3.63
Notch filter attenuation 50 Hz notch 60 Hz notch	- dB dB	- 80 110
Power consumption with thermocouple	W	0.51
Input resistance (from thermocouple end to chassis ground)	MΩ	50

(1 The overall accuracy specification is not valid if the maximum thermo-equilibrium temperature change rate is exceeded.

Pin assignments

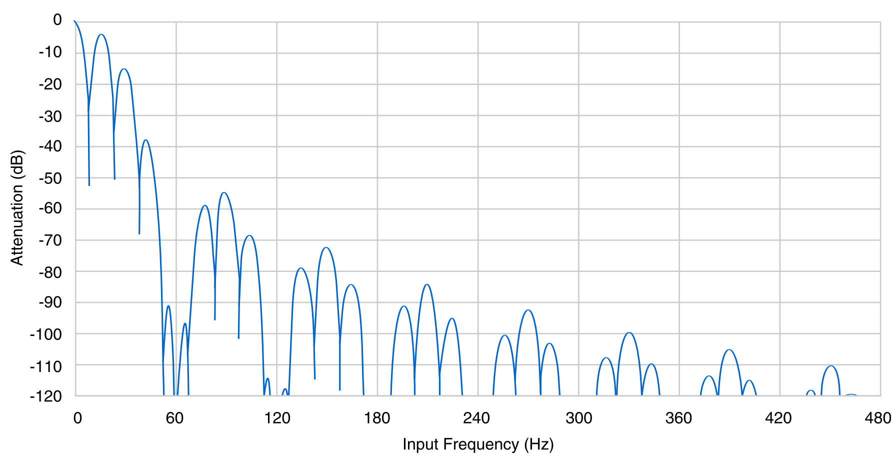
M8 Connector Pin	P1 (to EHLS/ELHLS channel) Function
1	EHLS/ELHLS Module I/O
2	+ Signal Input
3	Shield to PCB Ground
4	Ground
5	Power
6	- Signal Input

Digital filter attenuation



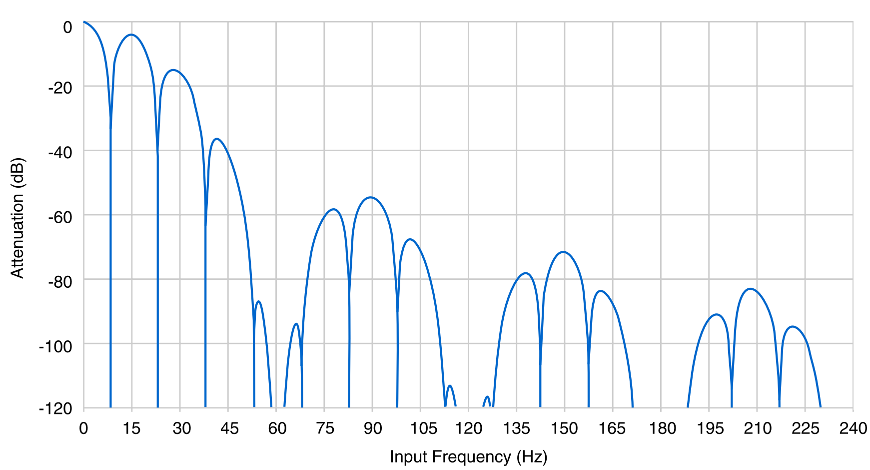
Digital Filter Primary Band Stop

The primary band stop is at multiples of 60 Hz, the notch frquency F_N.



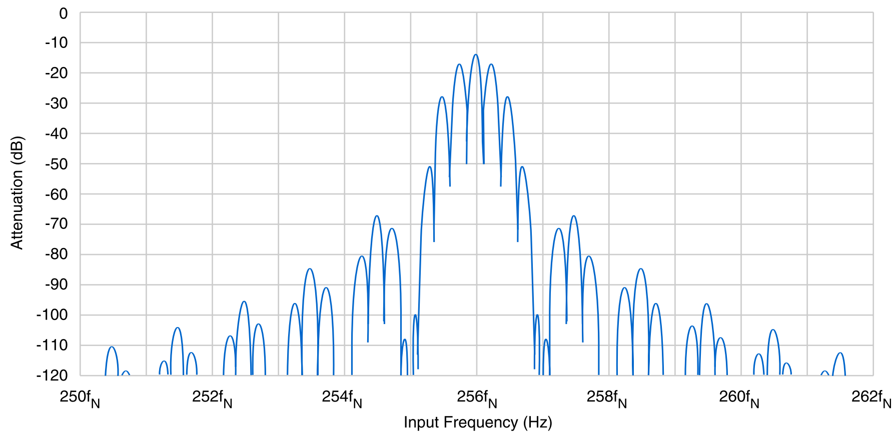
Digital filter secondary band stop

The secondary band stop to band peak is in 7.5-Hz intervals.



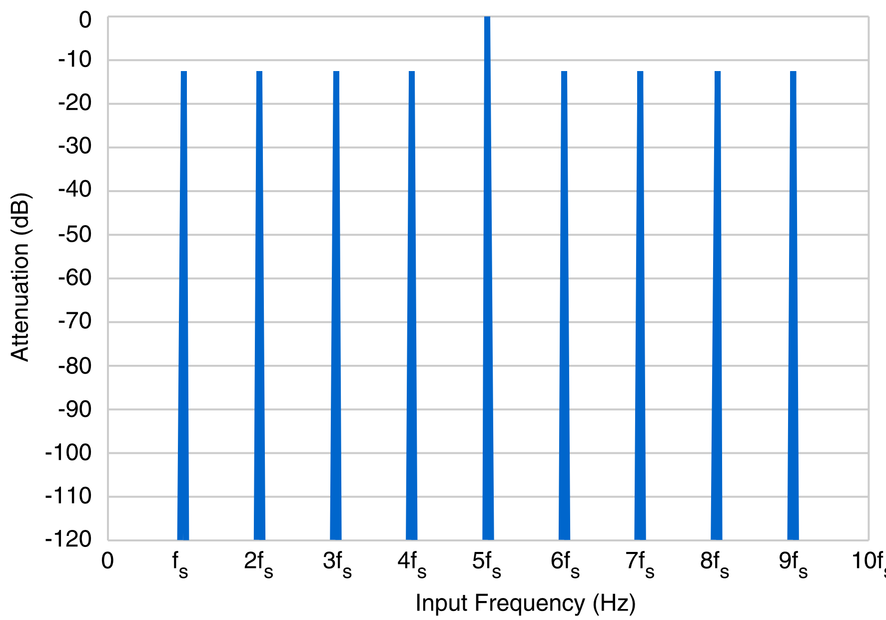
Digital Filter Modulator Sampling Frequency

The modulator sampling frequency F_s is at 15,360 Hz, which is $256F_N$ where F_N is the notch frequency 60 Hz.

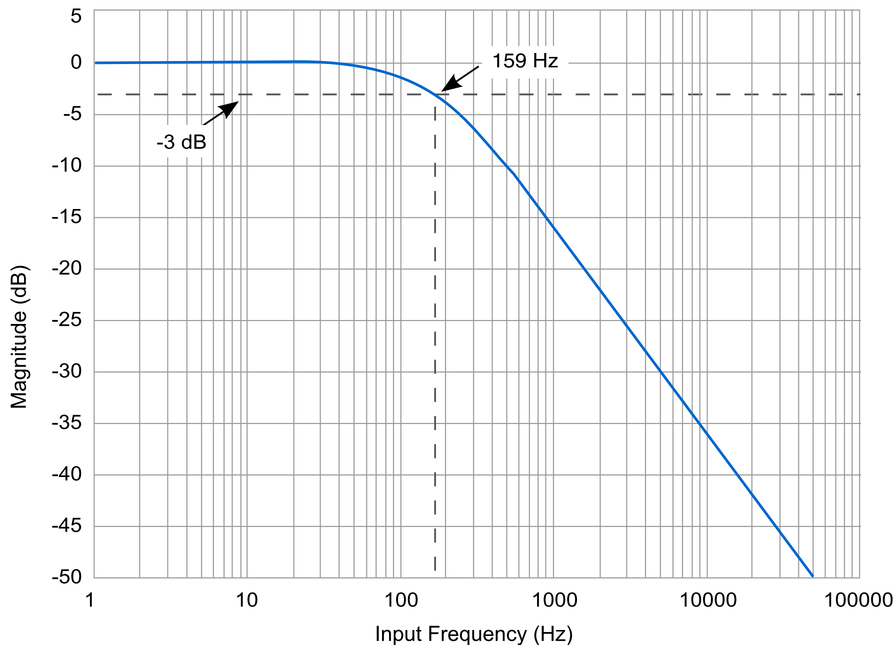


Digital Filter Multiples of Modulator Sampling Frequency

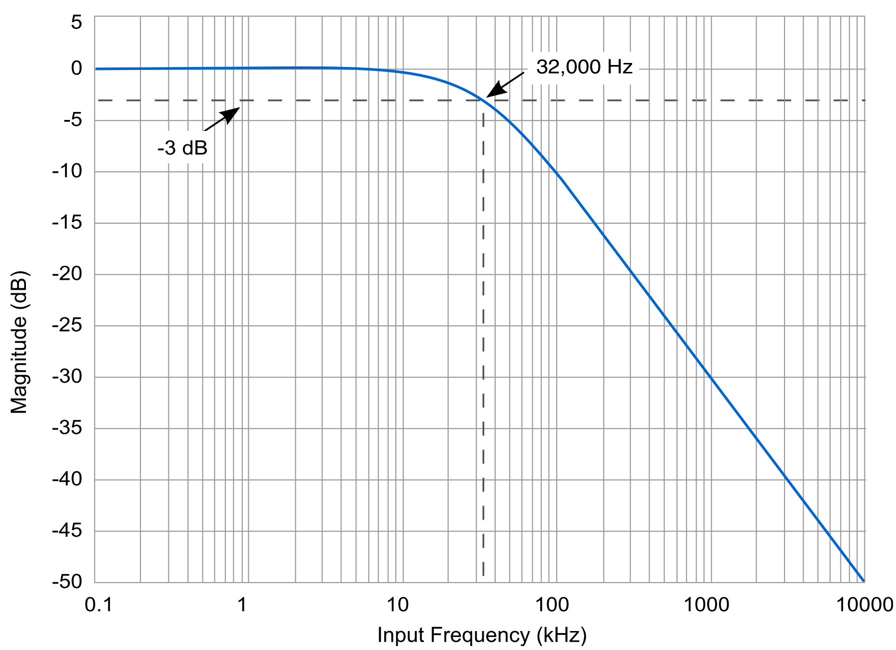
Note that there is zero attenuation at 78,000 Hz, which is $5F_s$ where F_s is the modulator sampling frequency.



Analog Input Filter (Common Mode)



Analog Input Filter (Differential Mode)



Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

9 IEPE-type conditioning module

Two IEPE-type conditioning modules support use of integrated electronics piezoelectric transducers with an EHLS layer. The module is available with either a BNC or microdot mating connector for compatibility with the two most popular types of ICP-type transducer cables.

Two modules are available.

Order Number	Description	Compatible Layers
1-EICP-B-2	IEPE-Type Conditioning Module – BNC Connector In-line signal conditioning module for EHLS Layers. Inputs: IEPE (Integrated Electronics Piezoelectric) Transducers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS
1-EICP-M-2	IEPE-Type Conditioning Module – Microdot Connector In-line signal conditioning module for EHLS Layers. Inputs: IEPE (Integrated Electronics Piezoelectric) Transducers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EHLS

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	mm	8 x 66 x 6
Weight	g	90
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Relative humidity range, non-condensing	%	0 ... 90

Parameter	Unit	Value
Current source current initial tolerance change over temperature	- mA % ppm/°C	- 4 ±1.2 100
Input power (at 4 mA)	Vdc	15 ... 24
Linear gain	-	1
Load	MΩ	1
Specifications environmental	- -	- IP67

Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

10 Pulse conditioning module

The pulse isolation module is ideal for magnetic pickup type transducers. Simply, this conditioning module amplifies and isolates incoming pulse signals to TTL levels compatible with the EDIO layers. The module dynamically changes the threshold which determines the true and false state based on the incoming signal. This signal can range from ±200mV to ±100 Volts. Each module supports two pulse counter channels from a single EDIO connector. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).

This module is available.

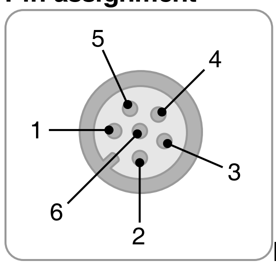
Order Number	Description	Compatible Layers
1-EPCM-2	Pulse Conditioning Module In-line signal conditioning module. Amplifies and isolates incoming pulse signals to TTL levels compatible with the EDIO layers. Requires: (1) 1-SAC-EXT-MF-x-2 Extension Cable (not included) (x notes different lengths in meters (0.4, 2, 5, 10, 15)).	EDIO

Specifications

Parameter	Unit	Value
Dimensions: width x length x height	cm	6.03 x 11.11 x 3.49
Weight	g	140
Temperature range	°C [°F]	-20 ... +65 [-4 ... +149]

Parameter	Unit	Value
Available channels	-	-
Bit 1	-	Pulse counter conditioning
Bit 2	-	Input/output
Bit 3	-	Pulse counter conditioning
Bit 4	-	Input/output
Bit 5	-	Isolated power
Bit 6	-	Isolated power

Pin assignment



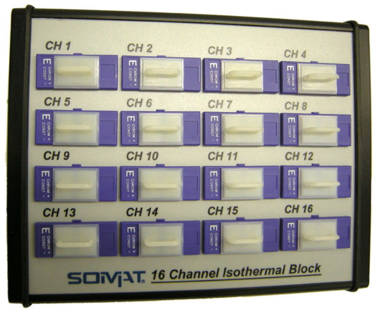
Pin diagrams are shown from the pin side of the cable connector.

M8 Connector Pin	P1 (to EHLS/ELHLS channel) Function	Wire color
1	Channel 4, 8 or 12	Brown
2	Channel 3, 7 or 11	White
3	ISO GND (Shield)	Blue
4	Channel 1, 5 or 9	Black
5	ISO PWR, 12Vdc	Red
6	Channel 2, 6 or 10	Green

Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-HDW-0034-00-2	M8 Hex Nut Wrench	EDIO, EBRG and EHLS
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length	EDIO, EBRG and EHLS
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length	EDIO, EBRG and EHLS

11 Cold junction thermocouple boxes



The ENTB Non-Isolated Thermocouple Layer measures temperatures on 32 channels of non-isolated thermocouple signal conditioning through two 37-pin high density D-sub connectors of 16 channels each. The ENTB conditioning layer requires two ECJTB Cold Junction Thermocouple Boxes for thermocouple termination. An extension cable (1-CBL-0007-00-2) is required to connect an ENTB layer to a cold junction thermocouple box.

These cold junction thermocouple boxes are available.

Order Number	Description	Compatible Layers
1-ECJTB-2	Cold Junction Thermocouple Box, Compatible with J, K, T and E Calibrations	ENTB
1-ECJTB-E-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type E Thermocouple Connectors.	ENTB
1-ECJTB-K-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type K Thermocouple Connectors.	ENTB
1-ECJTB-T-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type T Thermocouple Connectors.	ENTB
1-ECJTB-J-16-2	Cold Junction Thermocouple Box, Inputs: 16-channels, thermocouples are terminated using (16) universal (combination standard and miniature) Type J Thermocouple Connectors.	ENTB
1-ECJTB-K-32-2	Cold Junction Thermocouple Box, Inputs: 32-channels, thermocouples are terminated using (32) miniature spade Type K Thermocouple Connectors.	ENTB

Cables and accessories (sold separately)

Order Number	Description	Compatible Layers
1-CBL-0007-00-2	Extension Cable - ENTB Layer - 2 Meters Length	ENTB

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