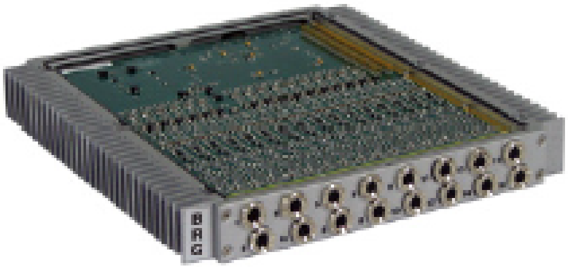
Data sheet

EBRG

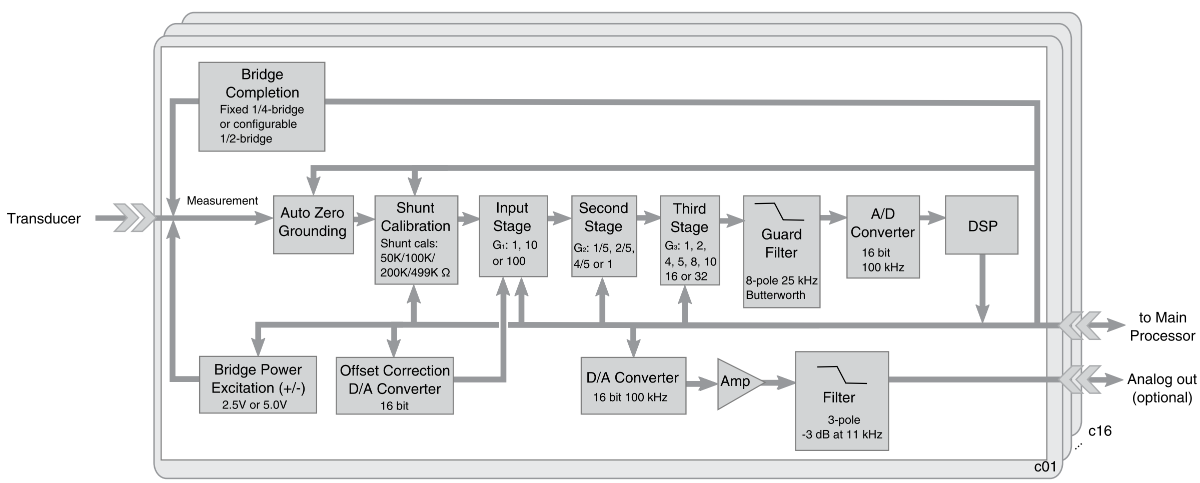
eDAQ Bridge Layer



Special Features

- 16 simultaneously-sampled, low-level differential analog inputs from ±0.000625 to ±10 V
- 96 automatic gain states ensuring use of the fullest possible A/D converter range
- Sampling rates up to 100 kHz
- 16-bit A/D converter per channel across full-scale range
- 25 kHz, 8-pole analog Butterworth low-pass filter
- Software selectable sample rates, digital filtering, excitation voltage and shunt resistance
- Bipolar shunt calibration (Excitation (+) or (-)), Bridge voltage (±2.5V or ±5.0V)

Block diagram



NOTE

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

Detailed Description

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 eDAQ or 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, 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 25 KHz. These filters smooth out the stair-steps created by the channel's digital to analog converter.

Ordering Options

Order No.	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.

Cables and Accessories (Order Separately)

Order No.	Description
1-HDW-0034-00-2	M8 Hex Nut Wrench
1-EBB-AO-2	Breakout Box – Analog Output EHLS and EBRG Layers
1-SAC-TRAN-MP-2-2	Transducer Cable - Male/Pigtail - 2 Meters Length
1-SAC-TRAN-MP-10-2	Transducer Cable - Male/Pigtail - 10 Meters Length
1-SAC-TRAN-AO-2-2	Transducer Cable - Analog Out - 2 Meters Length
1-SAC-EXT-MF-0.4-2	Extension Cable - Male/Female Connectors - 0.4 Meters Length
1-SAC-EXT-MF-2-2	Extension Cable - Male/Female Connectors - 2 Meters Length

Order No.	Description
1-SAC-EXT-MF-5-2	Extension Cable - Male/Female Connectors - 5 Meters Length
1-SAC-EXT-MF-10-2	Extension Cable - Male/Female Connectors - 10 Meters Length
1-SAC-EXT-MF-15-2	Extension Cable - Male/Female Connectors - 15 Meters Length

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
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

Parameter	Unit	Value
Voltage regulation efficiency (at 42 mA) ±2.5 V out ±5 V out	- % %	- 50 63
Power consumption [1] no load 350-Ω full bridge at ±5 V 350-Ω 1/2 or 1/4 bridge at ±5 V 350-Ω full bridge at ±2.5 V 350-Ω 1/2 or 1/4 bridge at ±2.5 V 120-Ω full bridge at ±2.5 V 120-Ω 1/2 or 1/4 bridge at ±2.5 V	- W W W W W W W	- 4.55 11.8 8.6 7.1 5.8 12.1 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	±0,25+1.5/G_1
Gain drift over temperature [2] typical (1σ) maximum (3σ)	- ppm/°C ppm/°C	- 2.5 10
Analog output channel impedance [6]	Ω	1000 ±50
Filters[7] 100 samples/second 200 samples/second 500 samples/second 1000 samples/second 2000 samples/second 2500 samples/second 5000 samples/second 10000 samples/second 20000 samples/second 25000 samples/second	- Hz Hz Hz Hz Hz Hz Hz Hz Hz Hz	- 33 (FIR) or 15 (Butterworth) 67 (FIR) or 30 (Butterworth) 167 (FIR) or 75 (Butterworth) 333 (FIR) or 150 (Butterworth) 667 (FIR) or 300 (Butterworth) 833 (FIR) or 370 (Butterworth) 1667 (FIR) or 750 (Butterworth) 3333 (FIR) or 1500 (Butterworth) 6667 (FIR) 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 EN 61326-1:2012	Before July 2018, CE conformity per EN 61326-1:2006 After June 2018, CE conformity per EN 61326-1:2012

Selected gain settings

NOTE

This table is a representative list only and does not show all available gain settings. In the TCE, to check the gain settings for a defined channel, click the Ampl button in the TCE transducer setup window. “Gain 1” is the input stage gain, “Atten2” is the second stage gain and “Gain2” is the third stage gain.

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
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:

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

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):

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

$$N_{G_1} = 10 = \sqrt{\left(42{,}0[\text{microV}]G_2G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(37[\text{microV}]G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(45[\text{microV}]G_3\sqrt{\frac{x_2}{13[\text{kHz}]}}\right)^2 + \left(4{,}5[\text{microV}]G_3\sqrt{\ln(\frac{x_1}{0{,}1[\text{Hz}]})}\right)^2 + 83[\text{microV}]}$$

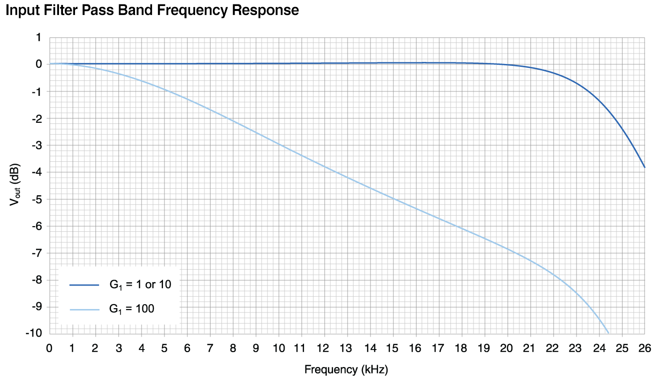
$$N_{G_1} = 100 = \sqrt{\left(322{,}8[\text{microV}]G_2G_3\sqrt{\frac{x_3}{15{,}7[\text{kHz}]}}\right)^2 + \left(37[\text{microV}]G_3\sqrt{\frac{x_1}{24[\text{kHz}]}}\right)^2 + \left(45[\text{microV}]G_3\sqrt{\frac{x_2}{13[\text{kHz}]}}\right)^2 + \left(4{,}5[\text{microV}]G_3\sqrt{\ln(\frac{x_1}{0{,}1[\text{Hz}]})}\right)^2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

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

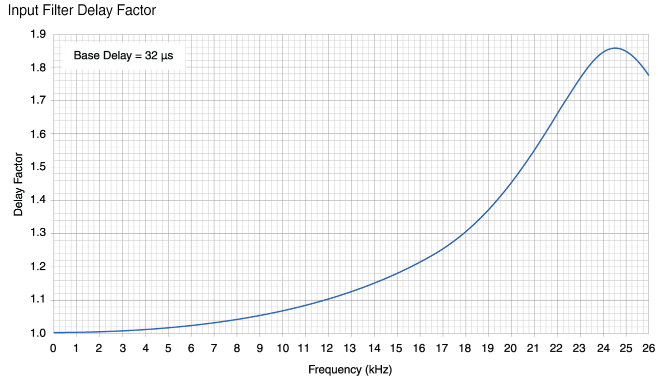
x_n	Maximum Value	Cause
x_1	24 kHz	analog filter cutoff
x_2	13 kHz	secondary filter cutoff
x_3	15.7 kHz	early rolloff of first stage when $G_1 = 100$

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

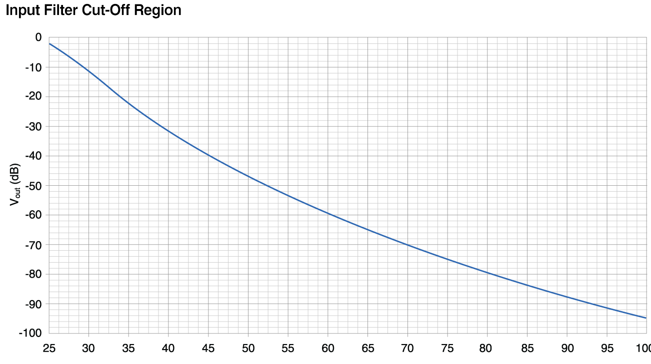
Input Filter Pass Band Frequency Response



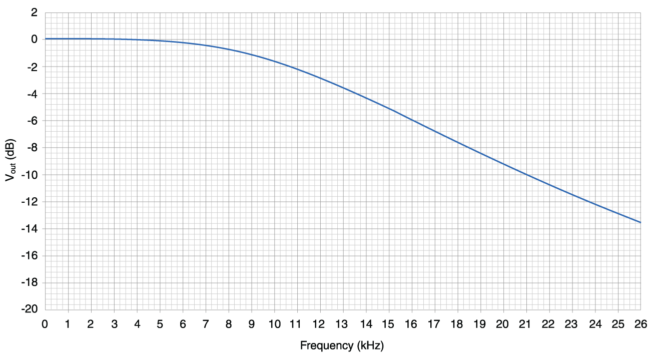
Input Filter Delay Factor



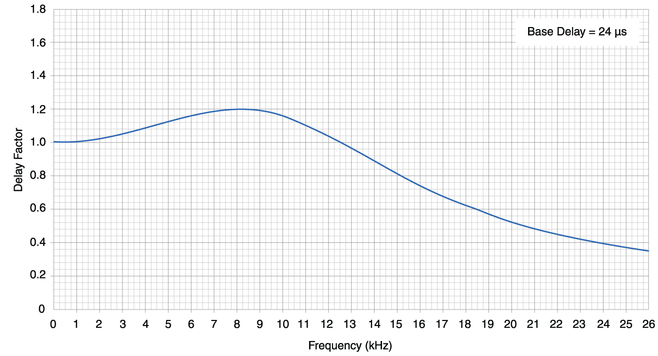
Input Filter Cut-Off Region



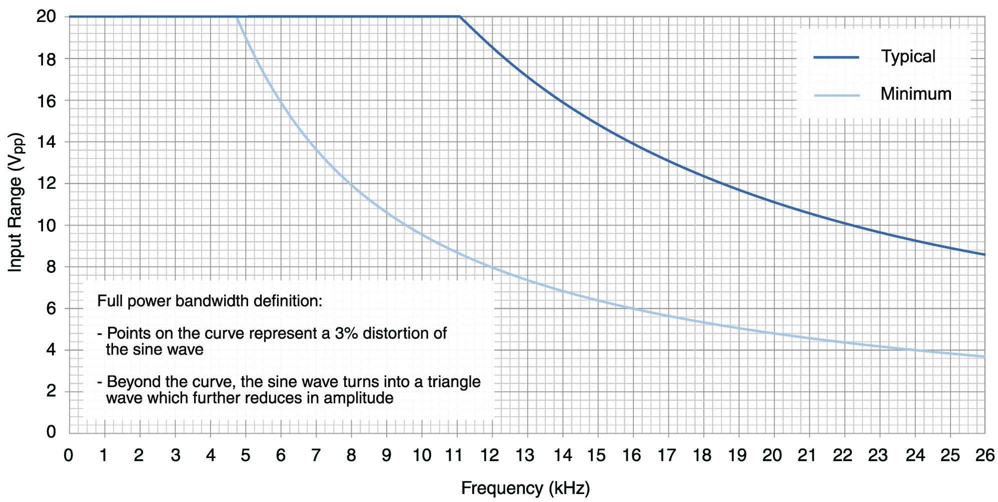
Analog Out Frequency Response



Analog Out Filter Delay Factor



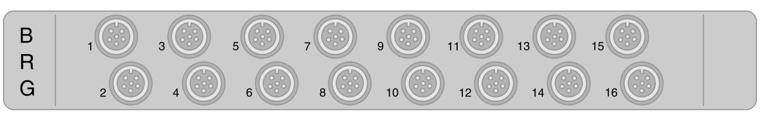
Full Power Bandwidth



NOTE

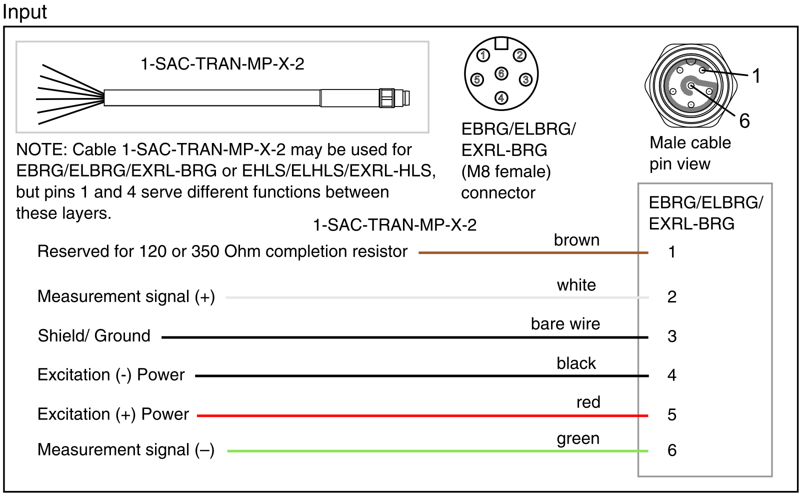
The plot shows full power bandwidth for an overall gain of 0.2 or a 20 V_{pp} input range.

Input connectors



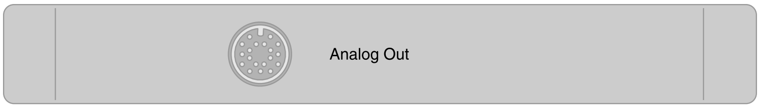
The diagram shows the M8 connectors on the EBRG layer.

Input



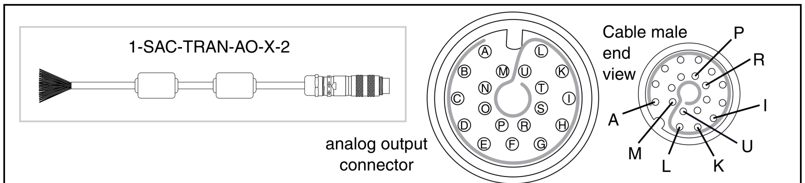
Analog Output Option

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 optional analog out connector on the back panel of an EBRG layer, installed only at the factory.

Analog output



Function	Wire color	1-SAC-TRAN-AO-X-2 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

CE

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