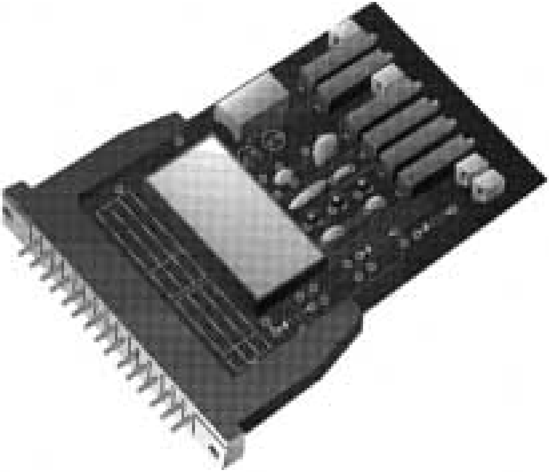
User's Guide



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OM2-160
Signal Conditioner System

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Remove the Packing List and verify that you have received all equipment, including the following (quantities in parentheses):

OM2-160 System (1)

Operator's Manual (1)

If you have any questions about the shipment, please call the OMEGA Customer Service Department.

When you receive the shipment, inspect the container and equipment for signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor damage claims unless all shipping material is saved for inspection. After examining and removing contents, save packing material and carton in event reshipment is necessary.

(13) Stability is defined after a 5 minute warm-up period and with constant line, load and ambient temperature unless otherwise specified.

(14) Quiescent current for amplifiers only, the current drawn from the bridge supply must be added to the +15 Vdc current drain for total current draw.

(15) Referred to pin J, this is a high impedance output and should not be loaded greater than 50 micro-amps. Buffer this reference with an op-amp for greatest accuracy.

NOTES

(1) Specifications referred to the filter output (Pin N).
(2) Using on board coarse and fine gain adjust trimpots.
(3) Warm-up drift is specified as the input offset drift for the first 5 minutes after the application of power with G = 1000 V/V, Bridge supply = 10V driving a 350 ohm bridge.
(4) Measured at 25°C Ambient with unit fully warmed up.
(5) Measured from -Input to +Input with respect to ground.
(6) Specified with 1 kohm source impedance imbalance, 100<Gain < 1000 V/V.
(7) Filter frequency set with DIP switches.
(8) Small signal response, switch or resistor/capacitor selectable, see Section 1.4.
(9) This is the instrumentation amplifier basic gain bandwidth product, the filtered output will provide for a constant cutoff frequency regardless of gain.
(10) The low pass filter cutoff frequency is adjustable to 10, 100 and 1000 Hz using the on board DIP switches and from 1 Hz to 10 kHz using external resistors and capacitors.
(11) Bridge supply must be operated with +Sense connected to the Bridge Supply Pin and with -Sense connected to Common.
(12) The bridge supply maximum output current is a function of input to output voltage differential and temperature. See the graphs in earlier chapters and Chapter 1 for more information.

OM2-165
Strain Gage Bridge Signal Conditioner

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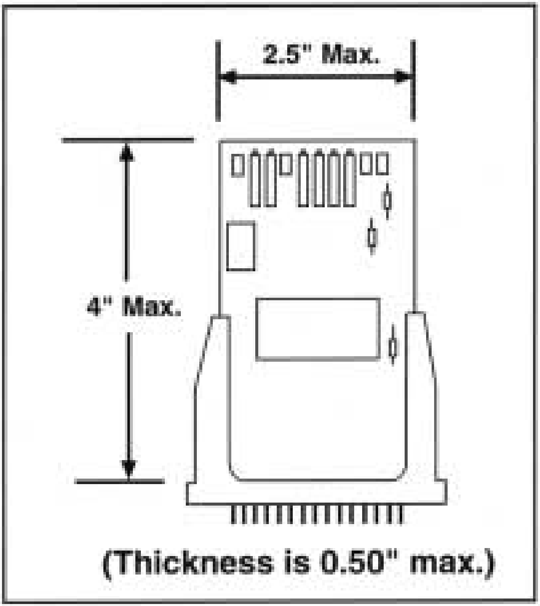

Figure 8-1. Dimensions

		Min.	Typical	Max.	Units
Output Noise, 10 Hz - 1 k Hz			200		μV p-p
Internal Reference Voltage (15)		6.46	6.80	7.14	Vdc
Half Bridge Completion					
Nominal Resistance Value			20		k ohms
Initial Accuracy				1	%
Temperature Tracking				5	ppm/°C
Balance Adjustment Range		5			%
Power Requirements					
Voltage	Rated Performance		±15		Vdc
	Operating	±12		±18	Vdc
Current (14)			±12		mA
Environmental					
Ambient	Operating	-25		70	°C
	Storage	-40		100	°C
Dimensions		See Figure 8-1			
Weight		1.5 oz (42.5 g)			

1 Introduction

1.1 Description

The OMEGA® OM2-160 BRIDGESENSOR is a complete signal conditioning system on a card designed expressly for either half or full bridge transducers. The OM2-160 consists of a high performance instrumentation amplifier, a user adjustable active filter, high stability bridge supply and reference regulator in a state-of-the-art hybrid circuit, which is mounted on a PC board mounting kit containing all of the required external circuitry, trimpots, etc., so that only point to point wiring need be made to the inputs, outputs and power to have a complete signal conditioning system up and running.

The mounting kit provides coarse and fine gain adjustment trimpots along with input and output offset adjustments, DIP switches for setting the bridge supply output and active low pass filter cutoff frequency.

Application of the OM2-160 is easy by following the detailed applications information in Section 1.4.

1.2 Functional Description

The OM2-160 is a completely self contained single channel signal conditioning system on a card. This device offers the high performance and reliability of hybrid circuitry with the completeness of a mounting kit containing all trimpots and components needed for operation, all that needs to be added is power and transducer inputs to get a conditioned output suitable for driving A/D converters, panel meters, indicators, or PC base controllers.

1.3 Features

- 1/4, 1/2 and Full Bridge Inputs
- Integral Zero and Span Adjustments
- Gain of 2 to 5000
- Adjustable Filtering
- Remote Sensing Eliminates Lead Resistance Effects
- 0.002% Linearity

	Min.	Typical	Max.	Units
Dynamic Response (8) Small Signal Bandwidth Amp Out Gain Bandwidth (9)		 Adjustable 25		 kHz MHz
Low Pass Filter (10) Number of Poles dc Gain (Pin P to N) Roll Off		2 -2 40		 V/V dB/Dec

Bridge Excitation Supply (11)

	Min.	Typical	Max.	Units
Output Adjustment Range with Trimpot with Ext. Resistor	4 4		10 12	Vdc Vdc
Output Current (12)	0		100	mA
Load Regulation ($I_{L = 0 - 100mA}$)		0.1	0.2	%
Line Regulation (V_{in} = 14.5 - 18 Vdc)		0.05	0.5	%/V
Stability (13) Short Term Long Term vs. Temperature Warm-up Drift		0.05 0.2 40 0.1	 80 	%/24 hours %/kHrs ppm/°C %
Short Circuit Protection	8 hours minimum			

		Min.	Typical	Max.	Units
Output Offset Adjusted Range		±10			V
Input Bias Current (4) vs. Temperature			10 25	50	nA pA/°C
Input Offset Current vs Temperature			5 10	20	nA pA/°C
Input Impedance (5)		4G ohms resistor in parallel with 15 pf capacitor			
Common Mode Input Voltage:	Range, Linear Response Maximum		±9.5 ±15		Vdc Vdc
CMR (6)	1kHz bw, dc-60 Hz (7) 10 Hz bw, dc-60 Hz (7)	110 110	140 140		dB dB
Input Noise Voltage	0.1 Hz - 10 Hz 10 Hz -100 Hz		0.3 1		μV p-p μV p-p
Current	0.1 Hz - 10 Hz 10 Hz - 100 Hz		60 100		pA p-p pA p-p
Rated Output	Voltage, 2k ohm load Current Load Capacitance Short Circuit	±10 ±5	 Indefinite	 1000	Vdc mA pF

1.4 Application Example

1.4.1 Digital Scales With Remote Tare Adjustment

The OM2-160 can be used as the heart of a very effective digital scale system as shown below. The OM2-160 is interfaced to a standard 3 mV/V full bridge transducer. With the bridge excitation set to 10 Volts a gain of 333 V/V is required to get a 10 Volt full scale output. The output offset pin (K) is used here to interface to a front panel pot by the display, this pot allows a tare or dead weight adjustment to be made by the operator as a required to set the system offset to zero reading for zero weight on the scale (resistor R4 should be removed from the OM2-160 to disable any interaction of the internal output offset adjustment). The system is calibrated by applying zero weight with the output offset pin and inputs connected to ground and adjusting the input offsets to get a zero reading, then remove the inputs from ground and apply a full scale load to the scale (or simulate one with a mV calibrator) and procedure may have to be repeated several times to get the desired accuracy of gain and offset. Figure 1-2 is shown on the next page.

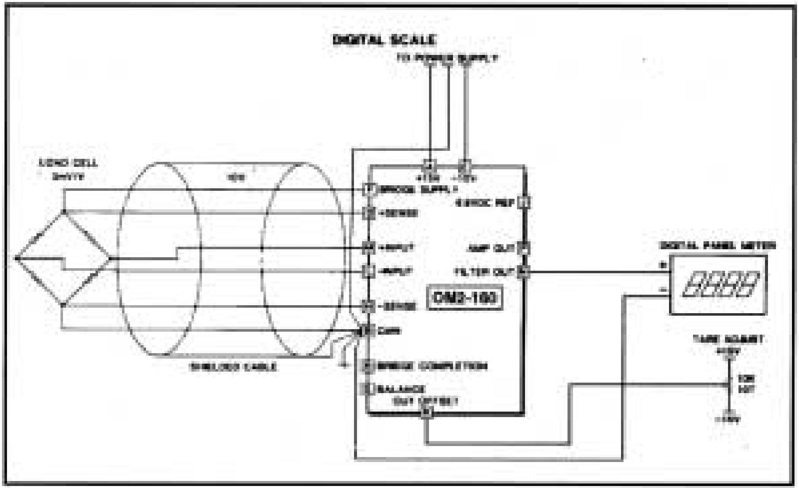

Figure 1-1. Remote Tare Adjustment

Conditions (unless noted): Ta = 25°C, V s = ±15Vdc, G = 500V/V

		Min.	Typical	Max.	Units
Amplifier Section (1)					
Gain Range	Adustable (2) with External Set Resistor	100 2		500 5000	V/V V/V
Gain Equation			Rg = 80,000/(G-2)		ohms
Gain Equation Accuracy 2<G<1000V/V			3		%
Gain Range w/ Temperature w/ Trimpots	Amplifier Alone		75 15	150	ppm/°C ppm/°C
Nonlinearity, ±10 V Output Swing			0.002	0.005	%
Offset Voltage, Input and Output			Adjustable to Zero		
Warmup Drift (3)			1		μV
vs. Temperature	G = 2V/V G = 1000V/V At other Gains, Max.		30 1 ±4 ± (100/G)	75 4	μV/°C μV/°C μV/°C
vs. Power Supply Pin K tied to Pin B			1		μV/V

3) If system offsets must be accounted for repeat Step 1 again with the inputs disconnected from the source and connected to ground, then reconnect the inputs and rezero the output with the bridge balance (if used) or the output offset adjustment.

4) Steps 1-4 above may need to be repeated several times to achieve the desired accuracy of gain and offset.

Figure 1-2 shows the schematic of the OM2-160.

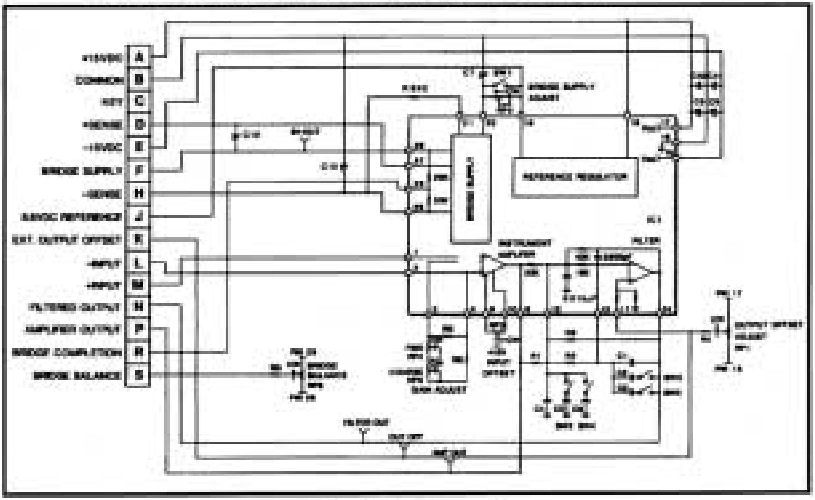

Figure 1-2. Schematic

NOTES

General Calibration Procedures

The OM2-160 comes from the factory adjusted to the following specifications:

Gain . . . . .333 V/V

Input Offset . . . . .Adjusted to 0

Output Offset . . .Adjusted to 0

Bridge Supply . . .SW1 CLOSED, Bridge Output at +10 Volts

Filter . . . . .SW2 - SW5 OFF, Filter at 1 kHz

Bridge Balance . .Pin S at 0 Volts

When adjusting the OM2-160 to other values the following methodology should be used.

1) Ground the inputs and the output offset pins and set the input offset trimpot to get 0 Volts on the output you will be using (Pins N or P). Input offset is for amplifier nulling only. Do not use the input offset for zeroing systems offset, use the bridge balance or the output offset adjustments for system offset correction.

2) Using a millivolt calibrator or the transducer output itself, set the gain so that the proper full scale output voltage is realized (the mV calibrator or transducer should be set to simulate full scale output).

NOTES

Instrumentation Amplifier

The heart of the OM2-160 is the high performance instrumentation amplifier. This amplifier features low noise, low drift and high accuracy along with trimpot adjustments for coarse/fine gain and input offset voltage . The direct instrumentation amplifier output is brought out to Pin P on the OM2-160, this signal is inverted (Vo= Gain x (-(+Input — -Input)) with respect to the input pin labeling but can be used where the full 25 MHz gain bandwidth product is required such as for mechanical vibration analysis. This output is also brought out to the test point AMP OUT at the trimpot edge of the mounting kit. The trimpots allow a gain adjustment range of 100 to 500 V/V with a course and fine gain adjuster (clockwise rotation increases gain). A user supplied resistor can be used in place of the trimpots (see equation below) to get any gain from 2 to 5000 V/V (referred to filtered output). To use an external resistor remove R6 from the mounting kit to disable the trimpots, then calculate the required value for RG and solder it on the mounting kit in the spot provided

The gain equation accuracy is ±3 percent for gains from 2 to 1000 V/V.

$$RG = \frac{80{,}000}{G-2} \text{ ohms}$$

Equation 1: User supplied resistor value required to set gain with respect to Pin N, filtered output.

$$RG = \frac{40,000}{G-1} \text{ ohms}$$

Equation 2: User supplied resistor value required to set gain with respect to Pin P, amplifier direct output (this is an inverted output). NOTE: IF a fixed resistor is used for RG, then resistor R6 should be removed from the OM2-160 to disable the gain trimpots.

Example Resistor Values for Common Gains (to Filter Output):

Required Gain, Filtered Output	**RG Value**	
10	10,000ohms	
10	816 ohms	
333.33	214 ohms	(Use for 3mV/V transducers)
500	160 ohms	(Use for 2mV/V transducers)
1000	80.2 ohms	

Note: a high stability, 5 ppm/°C metal film resistor should be selected for RG maximum performance.

Half Bridge Completion/Bridge Balance

Two 20k ohm thin resistors are located in the hybrid circuit from the Bridge Output (Pin 28) to the-Sense (Pin 26). These resistors from a precision low drift voltage divider for the Bridge Supply. This circuit can be used as the other half of a Half Bridge (i.e. one leg or 3-wire) transducer to provide a common mode voltage to the voltage. This allows increased gain to be used in the instrumentation amplifier resulting in higher achievable sensitivity. This voltage divider is brought out to Pin R on the OM2-160 and can be directly connected to either the + or - Input pins.

A companion circuit on the OM2-160 controls the Bridge Balance. This circuit is a trimpot connected across the bridge balance resistors that along with a series resistor (R5) adds or subtracts a small correction or balancing voltage to the half bridge completion circuit (about ±5% adjustment range). Normally Pin S would be connected to Pin R if half bridge completion is being used. The bridge balance can also be connected directly to a full bridge transducer to allow nulling and R5 can be changed on the OM2-160 to get different zero adjustment sensitivity.

This method is useful in lowering the internal temperature rise of the hybrid circuit. A lower temperature rise will lower warmup drift and make the circuit less sensitive to air currents that might pass along the OM2-160. If very high accuracy and repeatable measurements are being attempted one of these methods should be used to lower the power (and hence temperature rise) in the hybrid circuit.

The 6.8 Vdc reference (Pin J) can be used as reference for any other circuitry or an A/D converter, comparator trip level reference or panel meter reference. The output current of this pin is limited to 50 μA maximum.

The instrumentation amplifier also has a trimpot adjustment for input offset voltage, this trimpot should be used to null the instrumentation amplifier offset only. System offset should be adjusted out using the Bridge Balance for the Output Offset feature (see Section 1.4 for more information) to retain minimum offset drift of the instrumentation amplifier.

The OM2-160 inputs should be placed as close to transducer as possible. This will minimize any possible pickup of electrostatic or electromagnetic noise into the very high impedance inputs. See Section 1.4 for information on the shielding methods.

NOTES

A method of extending the maximum safe Bridge Supply current is to use an external pass transistor. As shown in figure 5-4 this method is the ultimate for lowering internal dissipation, the OM2-160 must supply only the op-amp bias current. With the TIP31 transistor specified the maximum bridge supply current is increased to 1 Amp or more (with proper heat sinking) for any load voltage from 4 to 12 Volts. This circuit is also useful for running multiple bridges from one OM2-160 allowing ratiometric measurements to be made with one OM2-160 Bridge Supply Reference driving a common A/D converter.

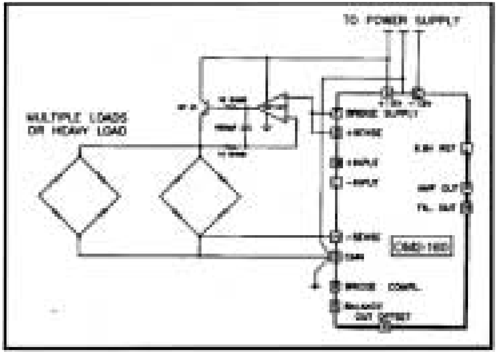

Figure 5-4. Drive Very Low Impedance Loads or Multiple Load Cells with an External Pass Transistor wired on the OM2-160's Mating Socket

The ambient temperature derating lowers the maximum safe output current above 50° ambient by 2 mA/C°. That is if the maximum ambient of the OM2-160 is 65°C the output current must be lower by 30 mA (65 - 50) x 2 = 30) over what Figure 5-2 shows as a safe maximum.

Figure 5-3 combines the above information into a single graph of maximum internal power dissipation vs. ambient temperature.

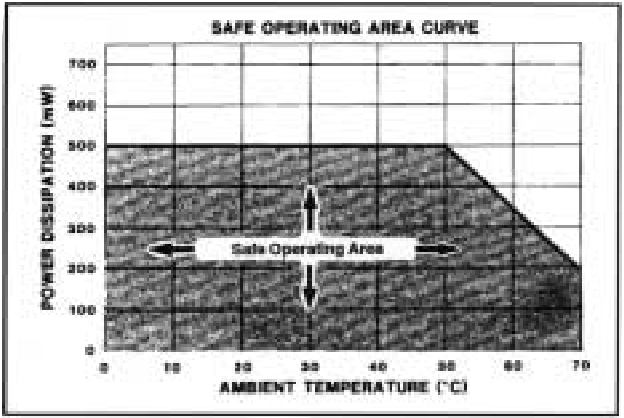

Figure 5-3. Graph of Maximum Internal Power Dissipation vs Ambient Temperature

The output of the instrumentation amplifier is internally connected to the input of a 2 pole, inverting gain (-2V/V) active filter. This filter has an adjustable filter cutoff frequency of 10, 100 and 1kHz by the use of on board DIP switches and can be set to any frequency from 10 Hz to 10 kHz by the use of user supplied resistors and capacitors. The filters output is brought out to Pin N and to test point FIL OUT at the trimpot end of the board on OM2-160. Pin N is the standard output for most strain gage and instrumentation applications, by using the filtered output extraneous noise above the useful signal frequency is removed at a rate of 40 dB/decade above the filter cutoff frequency allowing very precise and low noise measurements to be made. Figure 3-1 details the DIP switch settings and the equations required to set the filter cutout to any other frequency.

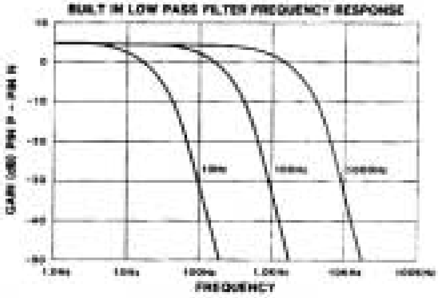

Figure 3-1. DIP Switch Settings and Equations Required to Set the Filter Cutoff Frequency

The filter stage is also the input for the output offset voltage adjustment. The output offset may be adjusted with the on board trimpot or by driving the output offset input (Pin K) with a low impedance source or the wiper of a trimpot (see Section 1.4 for more information on using this feature). If an external trimpot is to be used, R4 should be removed from the OM2-160. This will disconnect the internal trimpot from any loading or interaction with the external trim. If the output offset feature is not desired then connect the External Output Offset (Pin K) to Common (Pin B) directly at the mounting kit. The gain from the External Output Offset pin (Pin K) to the filtered output (Pin N) is approximately 0.7V/V (i.e. if Pin K is changed by 1 Volt in a positive direction then Pin N will also change by 0.7 Volts in a positive direction).

The maximum safe bridge supply current is affected by the regulator input to output voltage differential and ambient temperature. The maximum input-output vs. current is shown in Figure 5-2. This graph is for ambient temperatures of 25°C or below.

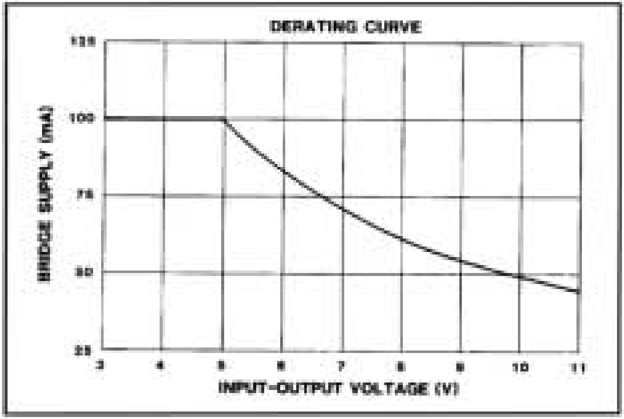

Figure 5-2. Graph of Bridge Supply Maximum Output Current vs. input to Output Voltage Differential

A location is provided for damping capacitors C12 and C13 on the OM2-160 to provide ac coupling and compensate for parasitics in especially long cable runs to the transducer. It is suggested that if the transducer load is more than 3 feet away from the OM2-160 that a 1 to 10 μF, 35 Volt Tantalum capacitor be used for C12 and C13 to ensure stability.

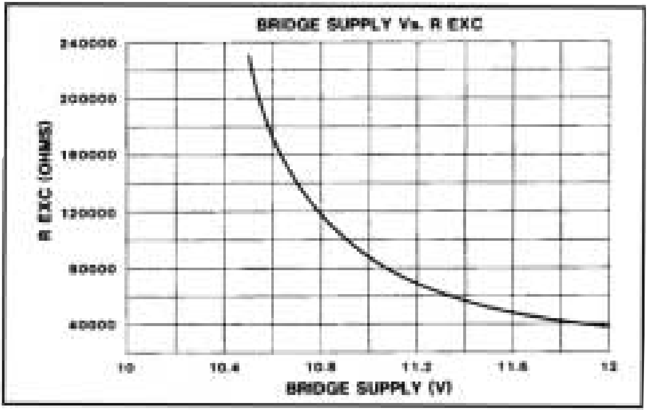

Figure 5-1. Graph of R EXC vs Bridge SupplyVoltage for Excitation Voltage from 10 to 12Vdc

Filter Cutoff Frequency Adjustment

Table 4-1. Cutoff Frequency

Cutoff Frequency	SW2	SW3	SW4	SW5
10Hz	ON	ON		
100Hz			ON	ON
1000 Hz or user Select	All OFF			

Cutoff frequency < 1000 Hz

$$C1 = 0.0022\ \mu F \left[\frac{1000}{F_c} -1 \right]$$

$$C4 = 0.015\ \mu F \left[\frac{1000}{F_c} -1 \right]$$

Cutoff frequency > 1000 Hz

$$R1 = 20{,}000 \ / \left[\frac{F_c}{1000} -1 \right]$$

$$R1 = 16{,}000 \ / \left[\frac{F_c}{1000} -1 \right]$$

$$R1 = 40{,}000 \ / \left[\frac{F_c}{1000} -1 \right]$$

NOTES

5 Bridge Supply

The bridge excitation supply is a very well regulated low noise output designed to drive either full or half bridge transducers from 0 to 100 mA output current. The output can be set to a fixed +10V by setting DIP switch SW1 ON. By setting SW1 OFF the output can be adjusted from +4 to +10 Volts by adjusting the bridge supply adjust trimpot. If a bridge supply output in the range of +10 to +12 Volts is desired a user supplied resistor can be installed for R EXC (SW1 should be set ON). See Figure 5-1 for proper values of R EXC to use.

The bridge supply uses + and - sense connections to compensate for any line drops that might be present when using remote transducers, see the applications examples in Section 1.4 for more information on properly using the + and - sense pins. If remote sensing is not required connect + Sense (Pin D) to Bridge Supply (Pin F) and - Sense (Pin H) to Common (Pin B) directly at the mounting kit socket. The maximum voltage difference between the Bridge Supply, Pin F and the + Sense, Pin D, is 0.4 V.

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- ☑ Industrial pH & Conductivity Equipment

DATA ACQUISITION

- ☑ Data Acquisition & Engineering Software
- ☑ Communications-Based Acquisition Systems
- ☑ Plug-in Cards for Apple, IBM & Compatibles
- ☑ Datalogging Systems
- ☑ Recorders, Printers & Plotters

HEATERS

- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments

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