

## Signal Conditioning Amplifier

### FEATURES

- Accepts all strain gage inputs (foil and piezoresistive), potentiometers, DCDT's, etc
- Selectable bridge excitation, 0.7 to 15 VDC (11 steps), plus 0.2 to 7 VDC continuously variable
- Fully adjustable calibrated gain from 1 to 11,000
- Dual-range ( $\pm 5000 \mu\epsilon$  and  $\pm 25,000 \mu\epsilon$ ) automatic bridge balance, with "keep-alive" power to preserve balance for months without external power
- All bridge completion built in, including 120- or 1000- and 350-ohm dummies
- Dual polarity two-step double shunt calibration
- Bandpass:
  - 76 kHz ( $-0.5$  dB)
  - 155 kHz ( $-3$  dB)
- Switchable active filter—a 6-pole Butterworth is standard
- Two simultaneous buffered outputs
- Playback mode to filter and observe or re-record previously recorded low-level data
- Input impedance above 100 megohms

### DESCRIPTION

The 2300 System conditions and amplifies low-level signals to high-level outputs for multiple-channel, simultaneous dynamic recording and display on external devices.

Among its features, each 2310B Module includes a built-in power supply, active filtering, two simultaneous outputs, playback mode, wide frequency response, and voltage injection bridge balance.

Up to ten 2310B Modules can be mounted in a Model 2350 Rack Adapter; or up to four modules in a Model 2360B Portable Enclosure; or, a single 2310B can serve as a standalone unit using the 2310-A20 Line Cord and Stabilizer.

The 2310B Modules may be interchanged between the 2350 Rack Adapter and the 2360B Portable Enclosure to best satisfy testing requirements.

### MODEL 2310B SIGNAL CONDITIONING AMPLIFIER

The 2310B Conditioner/Amplifier Modules accept inputs from strain gages, load/pressure/DC displacement transducers, potentiometers, RTD's and nickel temperature sensors, without any internal modification.

Controls on the 2310B are arranged in sections, permitting easy setup. Clearly marked push-button and single-purpose switches minimize the possibility of operator error during use. With the exception of the playback switch, all operational and monitor controls are on the front panel. Switches for selecting remote sense and specific shunt calibration configurations are located on the printed circuit board inside the unit.



- Calibration: Momentary two-position switches,  $\pm A$  and  $\pm B$ , control shunt calibration levels; 4 point
- LED Display: Set up indicator for amplifier balance, bridge balance and for monitoring the output polarity
- Filter Section: Push-button controls for activating appropriate low- and high-pass active filters
- Electronic Bridge Balance Section: Three-position switch—OFF, ON, RESET—for electronic bridge balance; auto ranging up to  $\pm 25\,000 \mu\epsilon$  with nonvolatile zero storage; yellow light indicates high-range operation or over range condition
- Vernier trim control is used to refine bridge balance when desired
- AC IN: Capacitive coupling in the amplifier; eliminates static component of the signal
- Bridge Excitation: ON-OFF switch for removing bridge excitation from the strain gage or transducer for noise documentation
- Amplifier Balance: Adjusts amplifier offset
- Excitation Level: Twelve-position switch; values arranged for doubling power with each step, with one 0.2 to 7 VDC continuously variable
- Amplifier Gain Section: Continuously variable potentiometer (1.00 to 11.00) plus push-button course gain multipliers control amplifier gain; direct-reading
- Battery Test: Momentary push button determines battery level for bridge zero storage
- Main Power: Turns unit on/off; LED pilot light
- Pin Jacks: Monitoring of Excitation, Unamplified Input, Amplified Output



FRONT PANEL

## Signal Conditioning Amplifier

- AC Line Switch: Selects nominal 115 or 230 VAC operation.
- Playback Section: Slide switch activates playback operating mode. Connects the input to the filter circuits and post amplifiers. BNC input connector.
- Low-level Output: Full-scale  $\pm 1.4\text{V}$  level available at this BNC connector for driving various recording devices and low-level analog-to-digital converters.
- High-Level Output: Full-scale  $\pm 10\text{V}$  level available at this BNC connector for driving an oscilloscope, digital voltmeter, analog-to-digital converter, etc.
- Input Receptacle: All sensor inputs made through this 15-pin quarter-turn connector. Pin selection determines mode of operation (mating plug included).
- Power Connector: Main power input from the rack adapter, portable enclosure or individual line plug. Additional pins for optional remote operation of shunt calibration, bridge excitation (ON/OFF), and electronic bridge balance.



REAR PANEL

### SPECIFICATIONS

All specifications are nominal or typical at  $+23^\circ\text{C}$  unless noted. Performance may be degraded in the presence of high-level electromagnetic fields.

#### INPUT

##### Strain Gages

Quarter, half or full bridge ( $50\Omega$  to  $1000\Omega$ )  
Built-in  $120\Omega$  and  $350\Omega$  dummy gages;  $1000\Omega$  dummy capability

##### Transducers

Foil or piezoresistive strain gage types  
DCDT displacement transducers  
Potentiometers

#### EXCITATION

##### Eleven Fixed Settings

0.7, 1, 1.4, 2, 2.7, 3.5, 5, 7, 10, 12 and 15 VDC  
1% max.

##### One Variable Setting

0.2 to 7 VDC

##### Current

0–100 mA, min, limited at 175 mA, max.

#### Regulation (0–100 mA $\pm 10\%$ line change)

$\pm 0.5\text{ mV}$ ;  $\pm 0.04\%$ , max measured at remote sense points. (Local sense:  $-5\text{ mV}$ , typical, @ 100 mA, measured at plug)

#### Remote Sense Error

0.0005% per  $\Omega$  of lead resistance ( $350\Omega$  load)

#### Noise and Ripple

0.05% p-p, max (DC to 10 kHz)

#### Stability

$\pm 0.02\%/^\circ\text{C}$

#### Level

Normally symmetrical about ground; either side may be grounded with no effect on performance

### BRIDGE BALANCE

#### Method

Counter-emf injection at pre-amp; automatic electronic; dual range; can be disabled on front panel

#### Ranges (auto ranging)

$\pm 5000\ \mu\epsilon$  ( $\pm 1\%$  bridge unbalance or  $\pm 2.5\text{ mV/V}$ ), resolution  $2.5\ \mu\epsilon$  ( $0.0012\text{ mV/V}$ )  
 $\pm 25,000\ \mu\epsilon$  ( $\pm 5\%$  bridge unbalance or  $\pm 12.5\text{ mV/V}$ ), resolution  $12.5\ \mu\epsilon$  ( $0.006\text{ mV/V}$ )

#### Balance Time

2 seconds, typical

#### Manual Vernier Balance Range

$100\ \mu\epsilon$  ( $0.050\text{ mV/V}$ )

#### Interaction

Essentially independent of excitation and amplifier gain

#### Storage

Non-volatile digital storage without line power for up to two years

### SHUNT CALIBRATION

#### Circuit (two-level, dual polarity)

Single-shunt (for stress analysis) across any bridge arm, including dummy gage

Double-shunt (for transducers) across opposite bridge arms

Provision for four dedicated leads to shunt external arms

CAL circuit selected by switches on PC board

#### Standard Factory-Installed Resistors ( $\pm 0.1\%$ ) Simulate

$\pm 200$  and  $\pm 1000\ \mu\epsilon$  @  $\text{GF}=2$  across dummy half bridge;  $\pm 1000\ \mu\epsilon$  @  $\text{GF}=2$  across dummy gage ( $120\Omega$  and  $350\Omega$ ).

$\pm 1\text{ mV/V}$  (double shunt) for  $350\Omega$  transducer

## Signal Conditioning Amplifier

**Remote-Operation Relays (Option Y)**

Four relays (plus remote-reset relay for bridge balance and relay for excitation on/off). Each relay requires 10 mA @ 5 VDC except excitation on/off 25 mA

**AMPLIFIER****Gain**

1 to 11, 000 continuously variable. Direct reading,  $\pm 1\%$  max. 10-turn counting knob (X1 to X11) plus decade multiplier (X1 to X1000)

**Frequency Response, All Gains Full Output**

DC coupled: DC to 145 kHz,  $-3$  dB max.

DC to 60 kHz,  $-0.5$  dB max.

AC coupled: 1.7 Hz typ. to 150 kHz,  $-3$  dB max.

**Frequency Response Versus Gain, Full Output:**

Gain	$-0.5$ dB	$-3$ dB
1-11	130 kHz	300 kHz
10-110	110 kHz	250 kHz
100-1100	80 kHz	160 kHz
1000-11000	76 kHz	155 kHz

**Slew Rate**

7.8 V/ $\mu$ s typical

**Input Impedance**

100 m $\Omega$ , min, differential or common-mode, including bridge balance circuit

**Bias Current**

$\pm 40$  nA, typical max., each input

**Source impedance**

0 to 1000 $\Omega$  each input

**Common-Mode Voltage**

$\pm 10$ V

**Common-Mode Rejection (gain over X100)**

Shorted input: 100 dB, min, at DC to 60 Hz;

90 dB, min, DC to 1 kHz;

350 $\Omega$  balanced input: 90 dB, typical, DC to 1 kHz

**Stability (gain over X100)**

$\pm 2$   $\mu$ V/ $^{\circ}$ C, max, RTI (referred to input)

**Noise (gain over X100, all outputs)**

0.01 to 10 Hz: 1  $\mu$ V p-p RTI

0.5 to 125 kHz: 6 $\mu$  VRMS, max, RTI

**FILTER****Characteristic**

Low-pass active six-pole Butterworth standard

**Frequencies ( $-3 \pm 1$  dB)**

10, 100, 1000 and 10,000 Hz and wide-band

**Outputs Filtered**

Either one or both (switch-selected on printed circuit board)

**AMPLIFIER OUTPUTS****Standard Output**

$\pm 10$ V @ 5 mA, min.

Slew Rate: 7.8 V/ $\mu$ s (typical)

**Low-Level Output**

$\pm 1.414$ V (1 VRMS) @ 5 mA, min.

**Linearity @ DC**

$\pm 0.02\%$ ;

Either output can be short-circuited with no effect on the other

**PLAYBACK****Input**

$\pm 1.414$ V full scale; input impedance 20 k $\Omega$

**Gain**

X1 to low-level output; X7.07 to standard output

**Filter Selection**

As specified above

**Outputs**

Both as specified above

**OPERATING ENVIRONMENT****Temperature**

0 $^{\circ}$ C to +50 $^{\circ}$ C

**Humidity**

10% to 90%, noncondensing

**POWER**

105V to 125V or 210V to 250V (switch-selected), 50/60 Hz, 10 watts, max.

**Keep-Alive Supply (for bridge balance)**

Lithium 3.6V, 1/2 AA or equal

Shelf life approximately two years

**SIZE AND WEIGHT****Panel**

8.75 H x 1.706 W in (222.2 x 43.3 mm)

**Case Depth Behind Panel**

15.9 in (404 mm)

**Weight**

6 lb (2.7 kg)

Signal Conditioning Amplifier

**MODEL 2350 RACK ADAPTER**



A prewired rack adapter which accepts up to ten Model 2310B plug-in amplifier modules. The Model 2350 also fits standard 19-in (483-mm) mainframe electronic equipment racks so that multi-channel system configurations can be conveniently housed.

**SPECIFICATIONS**

**APPLICATION**

- Fits standard 19-in (483-mm) electronic equipment rack
- Accepts up to ten 2310B Amplifiers
- AC line completely wired
- Wiring for remote calibration with Option Y

**POWER**

115 or 230 VAC switch selected in amplifiers, 50/60 Hz, 100 Watts max.

**SIZE AND WEIGHT**

8.75 H x 19 W x 19.06 D overall (222 x 483 x 484 mm)  
 13.5 lb (6.1 kg)

**MODEL 2360B 4-CHANNEL ENCLOSURE**



Model 2360B Portable Enclosure includes all AC wiring. Accepts up to four amplifier modules.

**SPECIFICATIONS**

**APPLICATION**

- Enclosure to accept up to four 2310B Amplifiers
- AC wiring complete
- Wiring for remote calibration with Option Y

**POWER**

115 or 230 VAC (switch selected in amplifiers), 50/60 Hz, 100 Watts max.

**SIZE AND WEIGHT**

9.06 H x 7.20 W x 18.90 D in (229 x 183 x 480 mm)  
 6.75 lb (3.1 kg)

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