

Signal Conditioning Amplifier

FEATURES

- Plug-in amplifier design; amplifiers are removable from the front panel without rear access
- Constant-voltage or constant-current excitation; 0.5 to 15 V or 0.5 to 30 mA; selectable by single internal switch
- Calibrated gain from 1 to 3300; adjustable front-panel gain switch and calibrated front-panel ten turn potentiometer
- Front-panel monitoring of: ± 10 V output; excitation; automatic balance status; and amplifier balance
- Automatic wide range-bridge balance with battery backup to retain balance in power-off condition
- Input coupling; selectable AC or DC by internal jumpers
- Fully grounded input amplifier; ± 350 VDC or peak AC common-mode operating voltage
- Full-power bandwidth of 100 kHz at all gain settings; slew rate of 6.3 V/ μ s
- Built-in four-pole Bessel low-pass filter with cutoff frequencies of 1 Hz, 10 Hz, 100 Hz, 1 kHz and 10 kHz; front-panel frequency selection switch
- Two simultaneous buffered outputs; ± 10 V and tape 1.0 VRMS; will drive up to 0.15 μ F without instability
- Stable, proprietary bridge completion module for quarter- and half-bridge 120- and 350-ohm strain gage and transducer circuits
- 120-ohm dummy easily configured for 1000-ohm completion
- Built-in shunt calibration circuits; internal user-selectable configurations to provide two-point shunting of any bridge component or two-point double shunt calibration of transducers
- Optically isolated shunt calibration relays provided as standard; built-in power supply for relay operation is provided in ten-channel rack adapter and four-channel enclosure

DESCRIPTION

The 2200 Signal Conditioning System incorporates, as standard, all the features necessary for precise conditioning of strain gage and transducer inputs in the most severe operating environments.

The 2210B Amplifiers plug in from the front of the ten-channel 2250A Rack Adapter or four-channel 2260B Portable Enclosure without removing the rear-panel input connections.

Among the features of the 2210B Amplifier are isolated constant-voltage/constant-current excitation, guarded input structure with ± 350 V common-mode capability, ± 10 V and tape outputs, automatic wide-range bridge balance and four-pole Bessel low-pass filter.

Operating controls of the 2210B Amplifier are conveniently arranged and clearly marked to minimize the possibility of operator error. Constant-voltage or constant-current excitation, calibration configuration, and



other optional operating modes are selected by easily accessible internal switches or jumpers.

TYPICAL 2200 SYSTEM CONFIGURATIONS

The 2200 Signal Conditioning Amplifier Modules can be used as stand-alone single-channel units, or can be plugged into racks for multi-channel testing.

Model 2260B Portable Enclosure accepts up to four signal conditioning/amplifier modules.

Model 2250A Rack Adapter allows assembly of signal conditioning amplifier modules for multi-channel testing. Ten-channel system shown in rack. All wiring is built-in to accept adjacent ten-channel systems.

Complete specifications are given on the following pages.

Signal Conditioning Amplifier

2210B SIGNAL CONDITIONING AMPLIFIER SPECIFICATIONS

INPUT

Input Impedance

DC-coupled: 22 M Ω shunted by 250 pF
AC-coupled: 1.1 μ F in series with 20 k Ω
low frequency cutoff (3 dB) 8 Hz norm.

Source Current

\pm 10 nA typical; \pm 20 nA maximum

Configuration

2- to 10-wire plus guard shield accepts quarter-, half-, or full-bridge strain gage or transducer inputs. Internal half-bridge, dummy 350 Ω and dummy 120 Ω completion gages, remote sense and four-wire calibration capability provided. 1000 Ω completion capability also provided. Accepts inputs from ground-referenced or isolated devices.

Differential Input

Maximum differential input voltage of \pm 50 VDC or peak AC

Common-Mode Input

Maximum common-mode input voltage of \pm 350 VDC or peak AC

Guard Impedance

Greater than 250 k Ω to output common; greater than 1000 M Ω to power and rack ground

AMPLIFIER

Gain

1 to 3300; continuously variable; direct reading. Gain steps X1, X10, X100, X300; with 10-turn counting knob, X1 to X11. Accuracy \pm 0.5%

Linearity

\pm 0.01% of full scale at DC

Frequency Response

DC to 100 kHz: 3 ± 0.2 dB at all gain settings and full output

DC to 50 kHz: 0.5dB max at all gain settings and full output

Gain Step vs Frequency Response (3 dB):

X300	100 kHz	X10	135 kHz
X100	120 kHz	X1	240 kHz

Slew Rate

6.3 V/ μ sec min at all gain settings

Noise

(350 Ω source impedance, DC-coupled)

Referred-to-Input (RTI)

1 μ V 0.1 Hz to 10 Hz p-p; 2 μ V 0.1 Hz to 100 Hz p-p
3 μ V 0.1 Hz to 100 kHz RMS

Referred-to-Output (RTO)

Output related noise is a function of the setting of the gain multiplier potentiometer

Zero Stability

\pm 2 μ V RTI, \pm 200 μ V RTO at constant temp.

Temperature Coefficient of Zero

\pm 1 μ V/ $^{\circ}$ C RTI, \pm 100 μ V/ $^{\circ}$ C RTO; -10° C to 60° C

Common-Mode Rejection

Gain	CRM (dB)	Gain	CRM (dB)
X1	82	X100	122
X10	102	X300	135

Common Mode Voltage

\pm 350 VDC or peak AC, max operating

Standard Output

\pm 10V @ 10 mA max

Tape Output

1.0 VRMS @ 10 mA max, or

Output AC-coupled

\pm 10V @ 10 mA max (7 Hz, 3 dB)

Output Monitor

\pm 10V standard monitored via front-panel jacks

Output Isolation

>1000 M Ω from power and rack ground

Output Protection

Protected against continuous short

Capacitive Loading

Up to 0.15 μ F

Low Pass Filter

Four-pole Bessel low-pass filter with selectable 3 dB bandwidths of 1 Hz, 10 Hz, 100 Hz, 1 kHz and 10 kHz

CONSTANT-VOLTAGE EXCITATION

Range

0.50 to 15.0 VDC @ 85 mA max.

Noise

100 μ V + 0.002% of excitation p-p max DC to 20 kHz

Line Regulation

200 μ V + 0.01% of excitation max for line voltage change of 10% from nominal

Load Regulation

200 μ V + 0.01% of excitation max for load variation of 10% of 90% of full load

Stability

Signal Conditioning Amplifier

$\pm 0.01\%/^{\circ}\text{C}$ or $100\ \mu\text{V}/^{\circ}\text{C}$, whichever is greater

Remote Sense

Error $< 0.0005\%/\Omega$ of lead resistance

Monitoring

Front-panel monitoring jacks

Isolation

Isolated from power ground and output common; floats with guard

CONSTANT-CURRENT EXCITATION

Range

0.50 to 15.0 mA DC or 1.00 to 30.0 mA DC
Compliance voltage: 0.50 to 16.0 V

Noise

($1\ \mu\text{A} + 10\ \mu\text{V}$) p-p; DC to 20 kHz

Line Regulation

$\pm 1\ \mu\text{A} \pm 0.01\%$ max for line voltage change of $\pm 10\%$ from nominal

Load Regulation

$\pm 1\ \mu\text{A} \pm 0.01\%$ max for 100% load change

Stability

$\pm 0.01\%/^{\circ}\text{C}$ or $1\ \mu\text{A}/^{\circ}\text{C}$, whichever is greater

Monitoring

Front-panel monitoring jacks; 10 mV/mA

Isolation

Isolated from power ground and output common; floats with guard

BALANCE

Method

Electronically injected automatic balance

Range

$\pm 15,000\ \mu\epsilon$ (7.5 mV/V) RTI (X2 with internal jumper)

Resolution

$0.50\ \mu\epsilon$ RTI (X2 with internal jumper)

Balance Time

4 seconds typical; 8 seconds max.

Accuracy

$\pm 2\ \text{mV}$ RTO; $\pm 2\ \mu\epsilon$ RTI

Balance Trim

$\pm 375\ \mu\epsilon$ (188 $\mu\text{V}/\text{V}$) RTI

Storage

Digital with battery backup. Battery life 3-5 years.

Activation

Activated by front-panel switch or by optically isolated remote switch or low TTL level

CALIBRATION

Four internal shunt calibration resistors,
 $\pm 0.1\%$ tolerance

174.8K	1000 $\mu\epsilon$ (0.50 mV/V)	350 Ω bridge
874.8K	200 $\mu\epsilon$ (0.10 mV/V)	350 Ω bridge
59.94K	1000 $\mu\epsilon$ (0.50 mV/V)	120 Ω bridge

Activated by front-panel switch, or by optically isolated remote contact closure or low TTL level.

Internal selector switches for selection of two-point unipolar, bipolar, or two-point double shunt calibration circuits

Calibration resistors plug into fixed terminals (no soldering)

SIZE AND WEIGHT

7 H x 1.71 W x 17.88 D in (178 x 43 x 454 mm)
3.7 lb (1.67 kg)

MODEL 2250A RACK ADAPTER

A prewired rack adapter which accepts up to ten Model 2210B plug-in amplifier modules. The Model 2250A also fits standard 19-in (483-mm) mainframe electronic equipment racks so that multi-channel system configurations can be conveniently housed. The Model 2250A contains all built-in wiring for connecting one rack adapter to another.

SPECIFICATIONS

All references to microstrain assume a gage factor of 2.00.

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

Input plugs are provided for up to ten channels; Bendix PT06A-14-15 (SR)

OUTPUT

Standard $\pm 10\ \text{V}$, BNC receptacle (10 ea)
Tape 1.0 VRMS, BNC receptacle (10 ea)

REMOTE

Provides access to remote calibration and remote balance functions of 2210B Amplifiers. The required +5 V power supply is an integral part of the 2250A Rack Adapter.

POWER

115/230 VAC, 50-60 Hz, 120 W max.
Fuse: 1.5A, 3 AG (115 V) or 3/4 A, 3 AG (230 V)

SIZE AND WEIGHT

7 H x 19 W x 18.87 D in (178 x 483 x 479 mm)
13.8 lb (6.25 kg)

Signal Conditioning Amplifier

MODEL 2260B PORTABLE ENCLOSURE

A self-contained prewired rack/enclosure which accepts up to four 2210B Amplifiers. All input/output connectors are provided on the rear panel of the enclosure. A carrying handle allows convenient portability, and a snap-down bail support on the bottom is used to elevate the 2260B for work efficiency during bench-top operation.

**SPECIFICATIONS****INPUT**

Input plugs are provided for up to four channels Bendix PT06A-14-15 (SR)

OUTPUT

Standard ± 10 V, BNC receptacle (4 ea)
 Tape 1.0 VRMS, BNC receptacle (4 ea)

REMOTE

Provides access to remote calibration and remote balance functions of 2210B Amplifiers. The required +5 V power supply is an integral part of the 2260B Portable Enclosure

POWER

115/230 VAC, 50/60 Hz, 50 W max.
 Fuse: 3/4 A, 3 AG (115 V) or 3/8 A, 3 AG (230 V)

SIZE AND WEIGHT

7.31 H x 7.20 W x 20.16 D in (186 x 183 x 512 mm)
 8.1 lb (3.67 kg)

THE 2200 SYSTEM PROVIDES BETTER DATA

A **floating, guarded input** environment maximizes the rejection of common-mode voltages up to ± 350 V (operating). The input amplifier can also be AC-coupled for situations where only dynamic signals are of interest.

The **independent, isolated bridge excitation** system provides either **constant-voltage** or **constant-current** excitation. A front-panel LED serves as a supervisory indicator, and a front-panel switch removes bridge excitation to assist in evaluation of circuit integrity.

An **automatic balance** circuit is used to provide wide balance range and **electronic injection** of balance voltage. This feature eliminates transducer loading and assures sufficient balance capability for practically all input configurations. The automatic balance circuit can be disabled from the front panel to allow measurement of initial unbalance, input noise, thermal offsets or zero shifts.

The **four-pole Bessel low-pass filter** provides five selectable bandwidths from **1 Hz to 10 kHz**. The 1 Hz or 10 Hz positions can be used for quasi-static data with excellent rejection of line frequency (60 Hz) noise. The output of the low-pass filter can be routed to either the standard or tape output, or either output can be wideband.

Wide bandwidth and **high slew rate** at all gain settings and at **full output** (± 10 V). This characteristic ensures that integrity of the system's performance is not compromised when higher gain settings are required.

A **standard** (± 10 V) and a **tape** (1.0 VRMS) output are provided for each channel. The outputs are **isolated** from the guarded input and from chassis (system) ground. This feature gives the user complete independence to establish a high-quality instrumentation ground system at the recording or data acquisition site. Both outputs can drive long (high capacitance) coaxial cables without instability.

The system provides **optically isolated shunt calibration circuits** on each channel. Any desired calibration configuration can be selected by internal switches. External contact closures are also accessible via the input connector to facilitate double-shunt (two-level) transducer calibration. Calibration resistors can easily be changed to any special values. No soldering is required.

Individual amplifiers are **removable from the front panel** without disconnecting the input or output wiring. This gives the user the option of dedicated rack or enclosure wiring, sharing of amplifiers, and ease of amplifier replacement under emergency conditions.



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