INTERTECHNOLOGY INC.
1-800-465-1600
1 Scarsdale Road, Don Mills, Ontario, M3B 2R2
Tel: 416-445-5500, Fax: 416-445-1170
Montreal: 514-333-0930, Ottawa: 613-723-1828, Winnipeg: 204-895-2037, Calgary: 403-254-0095, Vancouver: 604-270-9538
E-Mail: sales@intertechnology.com, Website: www.intertechnology.com


# 2200 System

## Signal Conditioning Amplifier

**A high-performance dynamic instrumentation system for conditioning and amplification of strain gauge and transducer inputs**

VISHAY MEASUREMENTS GROUP

# Full Features
# Extended Performance

## The 2200 Signal Conditioning Amplifier System offer high performance in the most demanding environments

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

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

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

Operating controls of the 2210A 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 are shown on the facing page. The operating controls of the basic 2210A Amplifier are illustrated and described on page 4. Complete specifications are given on page 5.

## Features

- **Plug-in amplifier design; amplifiers are removable from the front panel without rear access.**
- **Constant-voltage or constant-current excitation; 0.5 to 15V or 0.5 to 30 mA; selectable by single internal switch.**
- **Calibrated gain from 1 to 3,300; adjustable front-panel gain switch and calibrated front-panel ten-turn potentiometer.**
- **Front-panel monitoring of: ±10V 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 guarded input amplifier; ±350 Vdc or peak ac common-mode operating voltage.**
- **Full-power bandwidth of 100 kHz at all gain settings; slew rate of 6.4 V/µsec.**
- **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; ±10V and tape 1.0 Vrms; will drive up to 0.15 µF without instability.**
- **Stable, proprietary bridge completion module for quarter- and half-bridge 120- and 350-Ω strain gauge and transducer circuits.**
- **120-Ω dummy easily configured for 1,000-Ω 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 provide in ten-channel rack adapter and four-channel enclosure**

# 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.**

Single-channel conditioner amplifier with adapter for stand-alone use.

Portable enclosure accepts up to four signal conditioning/amplifier modules

Rack-mounted system 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.

# Model 2210A

## Signal Conditioning Amplifier

### Front-Panel Controls


GAIN CONTROLS: Continuously variable 1 to 3,300. Gain potentiometer 1.00 to 11.00 plus gain switch X1, X10, X100, X300.

FILTER SWITCH: Selects appropriate low-pass filter or wideband operation.

MONITOR JACKS: For ±10V output and bridge excitation.

EXCIT LED: Denotes constant-voltage (red) or constant-current (green) excitation.

EXCIT ON-OFF: Toggle switch removes excitation from the strain gauge or transducer.

EXCIT POTENTIOMETER: Sets excitation level for constant-voltage and constant-current excitation.

CAL SWITCH: Selects A or B preset calibration configuration.

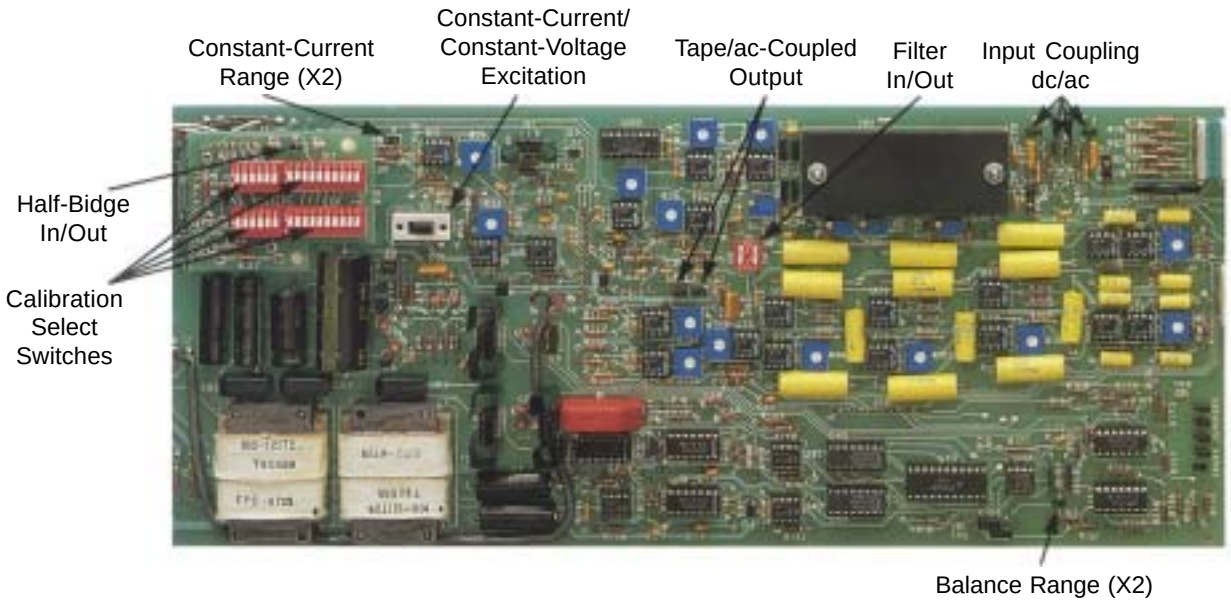
AUTO BAL SWITCH: Controls balance operation.

AUTO BAL LED: Denotes balance mode: green during auto balance interval; red for overrange.

BALANCE TRIM POTENTIOMETER: Refines bridge balance when desirable.

BALANCE LED: Indicates bridge balance (off), positive unbalance (red), or negative unbalance (green).

AMP ZERO POTENTIOMETER: Sets electrical zero of amplifier.



# Specifications

## 2210A SIGNAL CONDITIONING AMPLIFIER

### INPUT

Input Impedance:
dc-coupled: 22 MΩ shunted by 250 pF.
ac-coupled: 1.1 µF in series with 20 kΩ ; low frequency cutoff (3 dB) 8 Hz nom.
Source Current: ±10 nA typical; ±20 nA maximum.
Configuration: 2- to 10-wire plus guard shield accepts quarter-, half- or full-bridge strain gauge or transducer inputs. Internal half-bridge, dummy 350Ω and dummy 120Ω completion gauges, remote sense and 4-wire calibration capability provided. 1,000Ω completion capability also provided. Accepts inputs from ground-referenced or isolated devices.
Differential Input: Maximum differential input voltage of ±50 Vdc or peak ac.
Guard Impedance: Greater than 250 kΩ to output common; greater than 1,000 MΩ to power and rack ground.

### AMPLIFIER

Gain: 1 to 3,300; continuously variable; direct reading. Gain steps X1, X10, X100, X300; with 10-turn counting knob, X1 to X11. Accuracy ±0.5%.
Linearity: ±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: 0.5 dB 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/µsec min at all gain settings.
Noise: (350Ω source impedance, dc-coupled)
Referred-to-Input (RTI):
1 µVt 0.1 Hz to 10 Hz p-p; 2 µV 0.1 Hz to 100 Hz p-p
3 µV 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: ±2 µV RTI, ±200 µV/°C RTI, ±100 µV/°C RTO; -10° to 60°C.
Common-Mode Rejection:

| GAIN | CMR (dB) | GAIN | CMR (dB) |
|---|---|---|---|
| X1 | 82 | X100 | X122 |
| X10 | 102 | X300 | 135 |

Common-Mode Voltage: ±350 Vdc or peak ac, max operating.
Standard Output: ±10V @ 10 mA max;
Tape Output: 1.0 Vrms @ 10 mA max; or
Output ac-coupled: ±10V @ 10 mA max (7 Hz, 3 dB).
Output Monitor: ±10V standard monitored via front-panel jacks.
Output Isolation: > 1,000 MΩ from power and rack ground.
Output Protection: Protected against continuous short.
Capacitive Loading: Up to 0.15 µF.
Low-Pass Filter: 4-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 µV +0.002% of excitation p-p max dc to 20 kHz.
Line Regulation: 200 µV +0.01% of excitation max for line voltage change of 10% from nominal.
Load Regulation: 200 µV +0.01% of excitation max for load variation of 10% of 90% of full load.
Stability: ±0.01%/°C or 100 µV/°C, whichever is greater.
Remote Sense: Error < 0.0005%/Ω of lead resistance.
Monitoring: Front-panel monitoring jacks.
Isolation: Isolation 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 µA + 10 µV) p-p; dc to 20 kHz.
Line Regulation: ±1 µA ±0.01% max for line voltage change of ±10% from nominal.
Load Regulation: ±1 µA ±0.01% max for 100% load change.
Stability: ±0.01%/°C or 1µA/°C, whichever is greater.
Monitoring: Front-panel monitoring jacks; 10 mV/mA.
Isolation: Isolation from power ground and output common; floats with guard.

### BALANCE

Method: Electronically injected automatic balance.
Range: ±15,000µε (7.5 mV/V) RTI (X2 with internal jumper).
Resolution: 0.50µε RTI (X2 with internal jumper).
Balance Time: 4 seconds typical; 8 seconds max.
Accuracy: ±2 mV RTO; ±2µε RTI.
Balance Trim: ±375µε (188 µV/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, ±0.1% tolerance:

| | | |
|---|---|---|
| 174.8K | 1,000µε (0.50 mV/V) | 350Ω bridge; |
| 874.8K | 200µε (0.10 mV/V) | 350Ω bridge; |
| 59.94K | 1,000µε (0.50 mV/V) | 120Ω bridge. |

Activated by front-panel switch, or by optically isolate 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 & WEIGHT

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

## 2231 DIGITAL READOUT MODULE

### DISPLAY

LED's with ±19,999 counts full scale.
Overload Indications: Flashing zeroes and polarity.

### SENSITIVITY/RESOLUTION

1 mV per count.

### INPUT CIRCUIT

Amplifier Configuration: Single-ended floating common.
Input Impedance: 2 MΩ nominal.
Rear Connectors: 8 channel via two INPUT connectors on the 2250A Rack Adapter or 2260A Portable Enclosure.
Front Connections: 1 channel standard banana jacks.
Input Selection: 9-position switch.

### PEAK RETENTION CAPABILITY

Both positive-going (MAX) and negative-going (MIN) peaks are stored in two separate circuits independent of DISPLAY MODE selection. (The storage capability is always active.)

### DISPLAY MODES

TRACK: Display follows input voltage.
PEAK HOLD: Displays one of the stored peak values.
MAX: Selects the MAX stored value.
MIN: Selects the MIN stored value.

### ACCURACY

Step Input: ±0.1% ±4 counts for step input up to 15V >4 msec duration.
Repetitive Step Input: ±0.1% ±4 counts for repetitive step inputs of >300 µsec duration. Minimum number of steps required: 4 msec ÷ pulse duration.
Repetitive Sine Wave: ±5% ±4% counts for repetitive sine wave input of <1,000 Hz. ±0.5% ±4 counts for repetitive sine wave input of <100 Hz.

### HOLD STABILITY

<1 count/minute typical, 2 counts/minute maximum at +75°F (+23°C), averaged over 5-minute period.

### RESET CAPABILITY

Manual or automatic timed reset of MAX and MIN peaks. Optiosolator input requires 2 to 30V (<5 mA @ 5V) for 0.1 msec minimum.

### POWER

115/230 Vac, 50-60 Hz, 10W max.

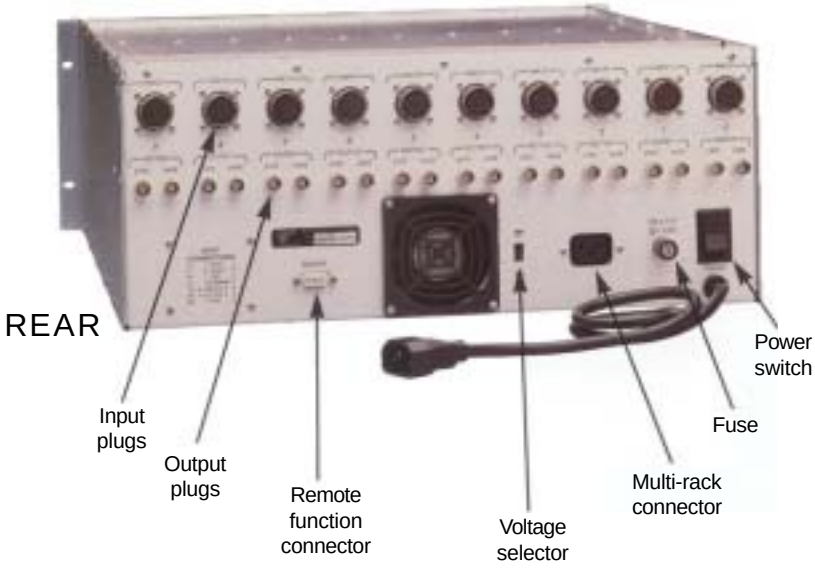
### SIZE & WEIGHT

7 H x 3.44 W x 17.88 D in *(178 x 87.5 x 454 mm)*. 4.4 lb. *(2.0 kg)*.

*All references to microstrain assume a gauge factor of 2.00.*

*All specifications are nominal or typical at +23°C unless noted.*

# Model 2250A Rack Adapter


A prewired rack adapter which accepts up to ten Model 2210A 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

| | |
|---|---|
| INPUT: | Input plugs are provided for up to ten channels; Bendix PT06A-14-15 (SR). |
| OUTPUT: | Standard ±10V, BNC receptacle (10 ea). Tape 1.0 Vrms, BNC receptacle (10 ea). |
| REMOTE: | Provides access to remote calibration and remote balance functions of 2210A Amplifiers. The required +5V power supply in an integral part of the 2250A Rack Adapter. |
| POWER: | 115/230 Vac, 50-60 Hz, 120W max. Fuse: 1.5A, 3AG (115V) or 3/4A, 3 AG (230V). |
| SIZE: | 7 H x 19 W x 18.87 D in *(178 x 483 x 479 mm)*. |
| WEIGHT: | 13.8 lbs *(6.25 kg)*. |

# Model 2255 Enclosure

An attractive sturdy cabinet for enclosing the rack-mounted multi-channel 2200 System. The 2255 enclosure provides additional mechanical protection for the assembled system and also permits increased portability.

## Specifications

| | |
|---|---|
| SIZE: | 7.62 H x 19.75 W x 21.62 D in *(193 x 501 x 549 mm)*. |
| WEIGHT: | 20.2 lbs *(9 kg)*. |

# Model 2260A Portable Enclosure

A self-contained prewired rack/enclosure which accepts up to four 2210A 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 2260A 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 ±10V, BNC receptacle (4 ea). Tape 1.0 Vrms, BNC receptacle (4 ea). |
| REMOTE: | Provides access to remote calibration and remote balance functions of 2210A Amplifiers. The required +5V power supply is an integral part of the 2260A Portable Enclosure. |
| POWER: | 115/230 Vac, 50-60 Hz, 50W max. Fuse: 3/4A, 3AG (115V) or 3/8A, 3 AG (230V). |
| SIZE: | 7.31 H x 7.20 W x 20.16 D in *(186 x 183 x 512 mm)*. |
| WEIGHT: | 8.1 lbs *(3.67 kg)*. |

# Model 2270A Single-Channel Adapter

Permits use of a stand-alone single-channel 2210A Amplifier. The plug-in adapter provides for the power and input/output connectors.

Single-channel adapter connected to 2210A Amplifier

## Specifications

| | |
|---|---|
| INPUT: | Input plug is provided; Bendix PT06A-14-15 (SR). |
| OUTPUT: | Standard ±10V, BNC receptacle. Tape 1.0 Vrms, BNC receptacle. |
| REMOTE: | Provides access to remote calibration and remote balance functions of 2210A Amplifier. The required +5V power supply must be provided by the user. |
| POWER: | 115/230 Vac, 50-60 Hz, 12W max. Fuse: 3/8A, 3AG. |
| SIZE: | 7.06 H x 3.20 W x 4.90 D in *(180 x 81 x 125 mm)*. |
| WEIGHT: | 0.8 lbs *(0.36 kg)*. |

# The 2200 System . . .

***2200 System shown with optional Model 2231 Digital Readout Module***

## . . . provides better data.

A **floating, guarded input** environment maximizes the rejection of common-mode voltages up to **±350V** (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 services 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** (±10V). This characteristic ensures that integrity of the system's performance is not compromised when high gain settings are required.

A **standard** (±10V) 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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