

# MODEL 778

## WIDEBAND AMPLIFIER/CONDITIONER



- DC to 3 MHz Bandwidth
- Gains 0.3 to 1000
- 1.2  $\mu$ s Overload Recovery
- 300 V Common-mode Voltage
- 120 dB CMR dc to 100 kHz,  
80 dB to 5 MHz
- 35 V/ $\mu$ s Slew Rate
- 7-Step 4-Pole Low-pass Filter
- Bridge Conditioner, Excitation Supply

### THE IDEAL SOLUTION WHERE A UNIVERSAL DC AMPLIFIER IS NEEDED

- Wideband dc instrumentation amplifier
- Restricted response dc instrumentation amplifier
- Transducer conditioner amplifier with wideband-to-narrow-band response
- Isolation amplifier with both wide and narrow response, transducer conditioning when required
- Pulse amplifier with high input to output isolation, common mode rejection
- Wideband level-shifting amplifier with 50  $\Omega$  output impedance, terminals for input termination components

### APPLICATIONS

- High-frequency vibration analysis
- Projectile impact studies
- Transient analysis
- Isolation of digital or high-speed impulse signals
- Explosion evaluations
- Universal amplifier



# DESCRIPTION

The Ectron Model 778 Wideband Amplifier/Conditioner is an ac-line-powered, all-solid-state, high-performance, direct-coupled, wideband differential dc amplifier with transducer conditioning and filtering capabilities. Among its features are excellent linearity, stability, low noise, extremely fast overload recovery, and unique high-frequency common-mode rejection.

Specifically designed to process wideband low-level signals, the Model 778 is ideally suited for use wherever wide bandwidth, high-frequency common-mode rejection, and outstanding overload recovery are required.

Up to ten Model 778 Amplifiers mount in the Model R718 19-inch rack-mount enclosure. Each amplifier has quick-disconnect rear-panel connectors for all inputs, outputs, and power.

## Bandwidth, Filter, and CMV

The amplifier bandwidth is dc to 3 MHz with  $\pm 300$  volts common-mode-voltage capability and 80 dB of common-mode rejection at 5 MHz. Front-panel-selectable, four-pole-Bessel, low-pass filters provide reduced bandwidths of 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 300 kHz, plus a wideband position.

As the amplifier frequency response is within 3 dB from dc to 3 MHz; at frequencies below 1 MHz, an extremely flat response is provided. For example, from dc to 100 kHz, typical amplitude response is within 0.5% and is within 1% to 1 MHz. This means that for the first time it is possible to make precise data measurements at frequencies from dc to several hundred kilohertz.

## Gain and Zero

Amplifier gain is continuously variable from 0.3 to 1000 by ten fixed gain steps from 1 to 1000 in a 1-2-5 step sequence plus a gain vernier of 1 to 0.3. Separate front-panel recessed screwdriver adjustments are provided for input and output zero.

## Output

Dual independent outputs are standard. One is a low-impedance output for general use, while the second output has a fixed 50  $\Omega$  output impedance to match long cables for high-frequency response. Both outputs are controlled by the filter switch. Output connectors are BNC.

## Calibration

Self-calibration is provided by an internally generated calibration voltage that is coordinated with the gain switch. Controls include a front-panel voltage-substitution CAL/OPER switch and a recessed multiturn screwdriver level control.

## Conditioning

Transducer conditioning provides constant-voltage excitation, front-panel variable from 0 to 15 volts and a recessed multiturn screwdriver bridge-balance control. Terminals are also provided on a separate plug-in assembly to accommodate completion resistors for one-, two-, and four-arm remote bridges, resistive temperature detectors (RTD's), or any other bridge-type transducer.

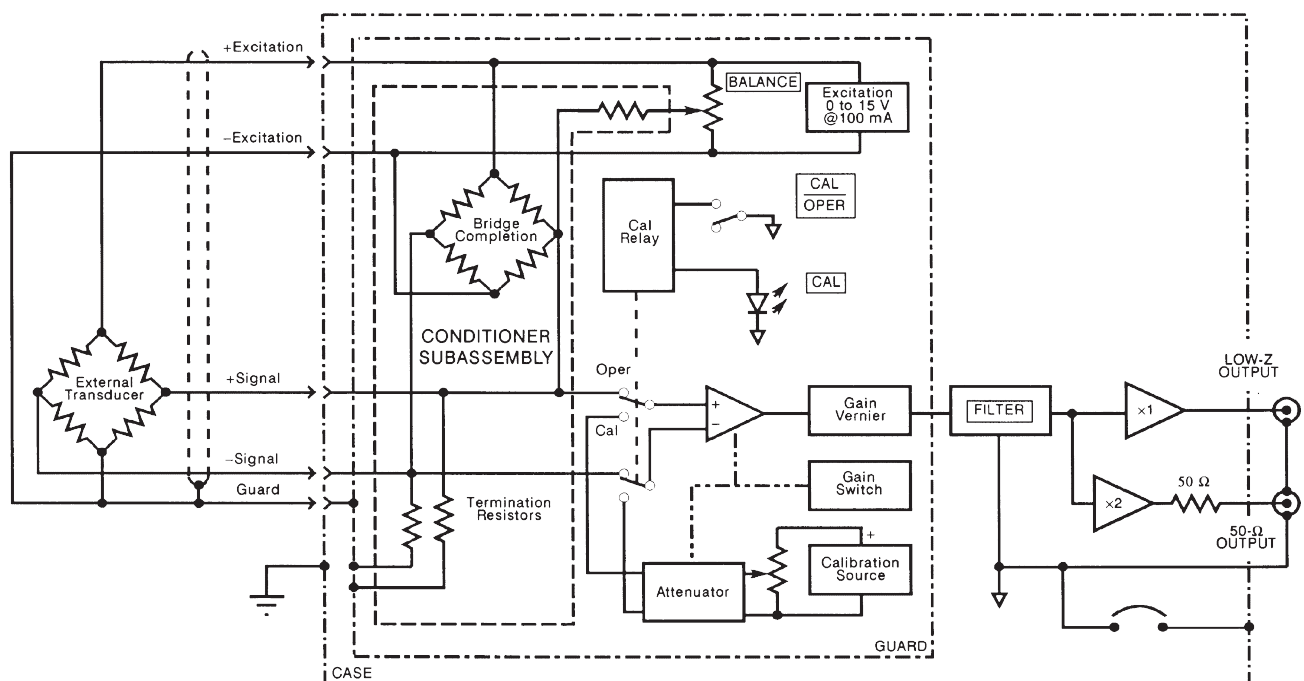
Totally isolated from the amplifier, power, and case; the excitation supply has exceptional overload protection and recovery as does the amplifier.

## Safety

For personnel safety, the frame of each amplifier/conditioner and the enclosure are connected to power ground and are isolated from all signal inputs and outputs.

## Model R718 Rack-mount Enclosure

The Model R718 enclosure provides mounting for up to ten Model 778 Amplifier/Conditioners in seven inches of vertical panel space in a standard 19-inch rack. Each amplifier is mechanically secured. Power distribution to all amplifiers is provided from a single ac line cord.



# SPECIFICATIONS

**PERFORMANCE LIMITS:** The following specifications are the maximum deviation from the ideal permitted in this Ectron instrument. Unless otherwise noted, all specifications apply at 25°C after 30 minutes warmup. RTI means referred to input; RTO, referred to output.

## INPUT CHARACTERISTICS

**Configuration:** Differential direct coupled. May be used inverting, noninverting, differential, or single ended. Input isolated from output and power.

**Input Connector:** PT02A-14-5P with mate provided.

**Input Termination:** Provision for input termination is provided.

**Impedance:**  $\geq 25 \text{ M}\Omega$ . shunted by  $< 100 \text{ pF}$ .

**Input Source Current:**  $\pm 30 \text{ nA}$ ,  $\pm 5 \text{ nA}/^\circ\text{C}$  max.

**Maximum Input Voltage:**  $\pm 100 \text{ V}$  differential and  $\pm 350 \text{ V}$  common mode without damage.

**Input Isolation:** Isolation of signal input and excitation, using guard shield, from output, power and case ground is  $> 10^{10}$  ohms in parallel with  $< 10$  femtofarads ( $10 \times 10^{-15}$  Farads).

**Common-mode Rejection:** With  $50 \text{ }\Omega$  or less source imbalance and guard at common-mode potential. Includes any dc shifts at output.

$> 60 \text{ dB}$  + gain in dB, dc to 100 kHz.

$> 40 \text{ dB}$  + gain in dB, 100 kHz to 1 MHz.

$> 20 \text{ dB}$  + gain in dB, 1 MHz to 5 MHz.

$> 10 \text{ dB}$  + gain in dB, 5 MHz to 15 MHz.

**Common-mode Voltage:**  $\pm 300 \text{ V}$  dc or peak ac, maximum operating. Voltage-frequency product not to exceed 75 V-MHz.

**Zero Adjustment:** Recessed front-panel controls are provided for input-zero (RTI) and output-zero (RTO) adjustments. RTI zero range is greater than  $\pm 100 \text{ }\mu\text{V}$ . RTO zero range is greater than  $\pm 1\%$  of full scale, with 0.02% resolution. Zero shift does not exceed  $\pm 2 \text{ mV}$  RTO when switching gain over the full range.

**Zero Stability:** Within  $\pm 10 \text{ }\mu\text{V}$  RTI,  $\pm 3 \text{ mV}$  RTO for 24 hours at constant temperature; within  $\pm 3 \text{ }\mu\text{V}$  RTI,  $\pm 1 \text{ mV}$  RTO/ $^\circ\text{C}$ .

## DYNAMIC RESPONSE

**Bandwidth:** DC to 3 MHz (-3 dB).

**Settling Time:**  $< 500 \text{ ns}$  to within 1% of final value.

**Overload Recovery:**  $< 1.2 \text{ }\mu\text{s}$  to within 5% and  $< 5 \text{ }\mu\text{s}$  to within 0.1% of full scale from  $\pm 100 \text{ V}$  normal-mode or  $\pm 350 \text{ V}$  common-mode input overload at any gain.

**Slew Rate:**  $> 15 \text{ V}/\mu\text{s}$  RTI and  $> 35 \text{ V}/\mu\text{s}$  RTO.

**Rise Time:** 150 ns for a full-scale step (10 to 90%) subject to slew-rate limitations.

**Noise:**

$\leq 1 \text{ }\mu\text{V}$  RTI + 0.5 mV RTO peak, 0.1 Hz to 10 Hz.

$\leq 3 \text{ }\mu\text{V}$  RTI + 0.3 mV RTO rms, 0.1 Hz to 10 kHz.

$\leq 7 \text{ }\mu\text{V}$  RTI + 0.6 mV RTO rms, 0.1 Hz to 100 kHz.

$\leq 40 \text{ }\mu\text{V}$  RTI + 3.5 mV RTO rms, 0.1 Hz to 3 MHz.

**Filter (Both Outputs):** Seven-position front-panel switchable filter provides selection of fourth-order (nominally, 24 dB/octave) Bessel low-pass filters with cutoff frequencies ( $-3\pm 1 \text{ dB}$ ) of 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 300 kHz, plus a wideband position.

## OUTPUT CHARACTERISTICS

**Outputs:** Dual independent outputs; a low-impedance output for general use and a  $50 \text{ }\Omega$  output to match output cabling.

**Output Connectors:** Floating BNC's.

**Output Capability:** Greater than  $\pm 5 \text{ V}$  at up to 100 mA (low-impedance output), greater than  $\pm 5 \text{ V}$  ( $50 \text{ }\Omega$  output when terminated into  $50 \text{ }\Omega$ ). Combined output current 110 mA maximum. Peak current limited to approximately 280 mA. Short-circuit protected.

**Output Impedance (dc):** Low-impedance output is  $< 0.1 \text{ }\Omega$ ;  $50 \text{ }\Omega$  output is  $50 \text{ }\Omega$ ,  $\pm 2\%$ .

**Capacitance Loading:** Stable for all values of capacitance up to  $0.1 \text{ }\mu\text{F}$ .

**Output Isolation:** Leakage current is  $< 100 \text{ nA}$  at 60 Hz between output common and case or power ground.

**Gain Range:** 1 to 1000 in a 1-2-5 step sequence. Selectable gain vernier varies gain downward between step values.

**Gain Accuracy:** Within  $\pm 0.1\%$  of indicated gain with vernier switched out (low-impedance output).

**Gain Stability:** Within  $\pm 0.025\%$  for six months; within  $\pm 0.01\%/^\circ\text{C}$  (low-impedance output).

**Linearity:** Within  $\pm 0.01\%$  of best straight line.

## CALIBRATION

**Voltage Substitution:** Internally generated calibration voltage with front-panel CAL/OPER (Calibrate/operate) switch.

**Voltage Level:** 25 to 110% of full-scale output by screwdriver control with 0.02% resolution.

**Stability:** Within  $\pm 0.01\%$  for 8 hours at constant temperature; within  $\pm 0.005\%/^\circ\text{C}$ .

## TRANSDUCER CONDITIONING

**Constant-voltage Excitation Supply:** 0 to 15 V continuously adjustable by a front-panel screwdriver control with better than 5 mV resolution.

**Output Current:**  $> 150 \text{ mA}$  limited to less than 250 mA. Short-circuit protected.

**Output Resistance:**  $< 0.1 \text{ }\Omega$

**Line Regulation:**  $\pm 0.01\%$ ,  $\pm 200 \text{ }\mu\text{V}$  for a 10% line-voltage change.

**Noise:**  $< 1 \text{ mV}$  rms, 1 Hz to 3 MHz bandwidth.

**Stability:** Within  $\pm 0.01\% \pm 500 \text{ }\mu\text{V}$  for 8 hours at constant temperature; within  $\pm 0.005\%/^\circ\text{C}$ .

**Overload Recovery:**  $< 5 \text{ }\mu\text{s}$  to within 5% and  $< 30 \text{ }\mu\text{s}$  to within 0.1% of full scale from maximum normal-mode voltage.

**Bridge Balance:** A front-panel screwdriver control with better than 0.02% resolution is provided.

**Bridge Completion:** Terminals for  $1/4$ -,  $1/2$ -, and full-bridge configuration are provided.

## FRONT-PANEL CONTROLS AND INDICATORS

**Gain:** Ten-position rotary switch.

**Gain Vernier:** Recessed multiturn screwdriver control with separate in-out toggle switch.

**RTI Zero:** Recessed multiturn screwdriver control.

**RTO Zero:** Recessed multiturn screwdriver control.

**Calibration:** Recessed multiturn screwdriver control with separate CAL/OPER switch.

**Filter:** Seven-position rotary switch.

**Excitation:** Recessed multiturn screwdriver control.

**Bridge Balance:** Recessed multiturn screwdriver control.



## ENVIRONMENT, POWER, and DIMENSIONS:

These instruments are designed to be used in a controlled environment and subject to the normal handling of electronic test equipment. They are ruggedly constructed to withstand removal and transportation for routine calibration and service. The following are minimum environmental specifications:

**Temperature Range:** 0°C to 55°C operating. Storage from -25°C to +71°C.

**Humidity:** 5 to 95% noncondensing.

**Shock:** 5 g vertical, 2 g horizontal without damage.

**Power:** 120 V ac +5%, -10%, 50 to 60 Hz.

### Dimensions and Weight:

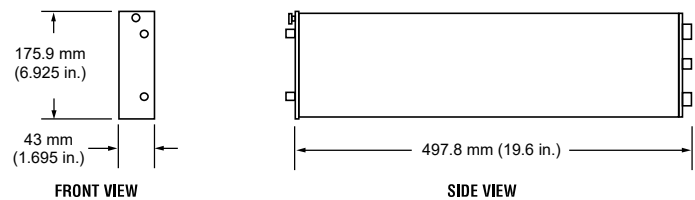
#### Model 778

175.9 mm (6.925") H x 43 mm (1.695") W x 497.8 mm (19.6") D.

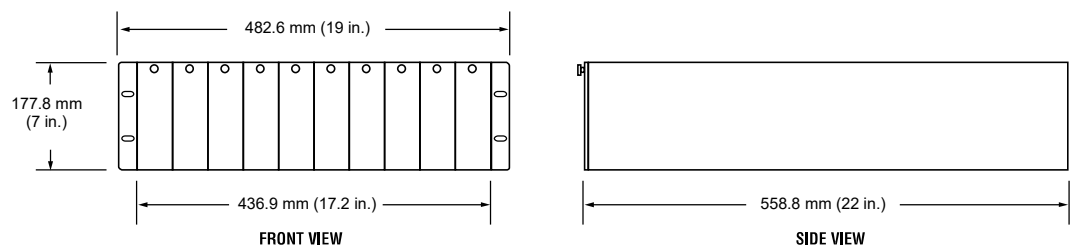
Weight: 2.3 kg (5 lb.) nominal.

#### Model R718

177.8 mm (7") H x 482.6 mm (19") W x 558.8 mm (22") D.  
Weight: 4.6 kg (10 lb.) nominal.



### MODEL R718 TEN-CHANNEL CABINET OUTLINE DIMENSIONS



## ORDERING INFORMATION

MODEL 778 AMPLIFIER/CONDITIONER  
MODEL R718 RACK-MOUNT ENCLOSURE

P/N 778-518-01 SINGLE UNIT POWER CABLE  
P/N 765-519-01 SINGLE UNIT BENCH MOUNT  
P/N 718-502-01 ENCLOSURE FILLER PANEL (1 channel)

Specifications subject to change without notice.

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8159 Engineer Road  
San Diego, CA 92111  
☎ (858) 278-0600  
✉ sales@ectron.com

[www.ectron.com](http://www.ectron.com)



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