

MODEL 751ELN PRECISION WIDEBAND DIFFERENTIAL DC AMPLIFIER



Model 751ELN

SENSOR COMPATIBILITY

- Conditioned Strain Gages
- High-accuracy Pressure Transducers
- High-accuracy Load Cells
- Thermocouples with Model 201 T/cMate™
- Accelerometers
- Chromatograph Data
- Piezoresistive Sensors

APPLICATIONS

- Precision Strain-gage Measurements
- Large Centrifuge Systems
- Wind-tunnel Instrumentation
- Railroad-track Analysis
- Vehicle Testing
- Dynamic-vibration Analysis

PERFORMANCE HIGHLIGHTS

- Bandwidth Dc to 100 kHz
- 5-step Selectable Filter
- Gains from 0.01 to >2500
- 140 dB Common-mode Rejection



**Model R712-3-12
 Twelve-channel Rack-mount Enclosure**

The Ectron Model 751ELN is a precision wideband dc amplifier, featuring true differential input circuits, high common-mode-voltage rating, and excellent stability and linearity. The basic amplifier is a direct-coupled design providing high input impedance, excellent common-mode rejection, and low output noise. Each amplifier has its own independent internal power supply which operates directly from standard 50 Hz to 400 Hz power lines. Amplifier gain is front-panel selectable from $\times 0.01$ to $\times 1000$ with gain accuracy of $\pm 0.01\%$. Amplifier bandwidth is front-panel selectable with three-pole low-pass filters having -3 dB cut-offs of 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, and wideband. Full-power bandwidth exceeds 50 kHz.



Model 751ELN Precision Wideband Differential Dc Amplifier

LINEARITY AND GAIN ACCURACY

Since there are no modulators, demodulators, or transformers in the signal or feedback paths, it is possible to operate the Model 751ELN amplifier with very high loop gains. This results in improved linearity (0.005%) and permits gain accuracy of $\pm 0.01\%$ without degradation on the higher gains. Competitive units often specify $\pm 0.01\% \pm 3 \mu\text{V RTI}$, which is in fact $\pm 0.04\%$ at a gain of 1000. The 0.01% gain specification of the Model 751ELN amplifier applies at all gains.

SIMPLIFIED DESIGN

The internal circuitry uses both discrete and integrated components, providing state-of-the-art performance while keeping cost and complexity to a minimum. The unit's low power consumption reduces warm-up time and component aging due to internally generated temperature rise.

The simplified circuitry contributes to an uncrowded mechanical design allowing up to 12 amplifiers to be installed in a single 5.25-inch-high enclosure. Although small, the amplifiers include selectable bandwidth and two outputs with a combined output capability of 110 mA.

ISOLATION

The Model 751ELN contains a high-impedance common-mode amplifier (CMA), which senses the CMV level from the signal input terminals.

Operation with high common-mode voltages (CMV) is achieved by driving the input amplifier at the common-mode voltage and then attenuating the output to a CMV level of 10 volts or less. The CMV is then rejected by a precision, direct-coupled, differential amplifier.

The guard-to-ground impedance is $56 \text{ M}\Omega$ in parallel with 1000 pF .

As illustrated in Figures 1 and 2, there are two ways to handle the guard in a direct-coupled instrumentation amplifier.

The amplifier in Figure 1 ties the guard directly to the preamplifier section and, therefore, depends on the external shield connection to drive the power supplies and circuitry of this section of the amplifier. This design approach has been termed a guard-dragger amplifier.

Figure 2 illustrates the superior design of the Model 751ELN, which uses a common-mode amplifier (CMA) to drive the preamplifier. This approach eliminates much of the loading problem on the external shield.

Also, since in the Ectron design the CMA signal is actually obtained from the two signal leads through a high-impedance divider, the amplifier will operate without the guard connected with little change in performance.

In the Model 751ELN amplifier, the load resistance between guard and output common is over $50 \text{ M}\Omega$. For the typical guard-dragger amplifier this resistance is approximately $500 \text{ k}\Omega$. At a common-mode voltage of 300 V this requires a load current of 0.6 mA or 0.18 W. Although loading the external shield circuit to this extent can cause application problems, an even greater problem is

that current flowing into the guard of the guard-dragger amplifier must flow through the signal-carrying resistors that connect the preamplifier to the output amplifier. As a result, high-frequency CM signals that would be filtered out in the Model 751ELN amplifier will be mixed with the desired signal in these interconnecting resistors. Consequently, high-frequency common-mode rejection (CMR) is usually poor in the guard-dragger amplifier. (CMR for the Model 751ELN at $\times 1000$ gain and 60 Hz is 124 dB and at 10 kHz is 74 dB.) Guard-dragger amplifiers typically do not specify CMR above 60 Hz.

DYNAMIC RESPONSE

The Model 751ELN amplifiers have wide bandwidth, fast settling time, and fast overload recovery. Due to the low input capacitance, the specifications in these areas are typically met with source impedances considerably greater than the 1000Ω listed in the specifications. Another inherent characteristic which enhances speed and accuracy in many applications is the low capacitance between input guard and output and power-line commons.

Although this capacitance has a moderate effect on several types of measurements, the most common application involves two-wire input scanning. In these applications, the guard is connected to one of the input lines at the scanner, and its capacitance to ground can then affect settling time and accuracy. The error factor occurs when the guard capacitance partially discharges a "flying capacitor" scanner or filters on the input side of a conventional scanner. The guard-to-ground capacitance of the standard amplifier is less than 1000 pF .

GAIN CONTROL

The Model 751ELN has switch-selectable fixed gain steps and a vernier gain control with a multiplying range of 1:1 to $>2.5:1$. Additionally, the front-panel-mounted 100:1 input divider switch provides continuous gain from $\times 0.01$ to $>\times 2500$ with vernier gain in. The Model 751ELN has a front-panel switch to deactivate the vernier gain when highest accuracy and stability are required.

ADDITIONAL FEATURES

A "0" gain position is provided at each end of the gain switch to aid in zeroing the amplifier. When the gain switch is placed in a "0" position, the amplifier input is disconnected from the input signal, shorted, and the amplifier gain is set to a gain of $\times 1$ or $\times 1000$ as indicated on the front panel.

SPECIFICATIONS

The following specifications are the maximum deviation from the ideal permitted in this Ectron instrument. Unless noted, all specifications apply at 25°C after 30 minutes warm-up with 0Ω to 1000Ω source in any unbalance. RTI means referred to input; RTO, referred to output.

INPUT

Configuration: differential, direct-coupled, isolated from output and ground; may be used inverting, noninverting, differential, or single-ended. Connection of guard to input source provides adequate return path.

(Continued on following page)

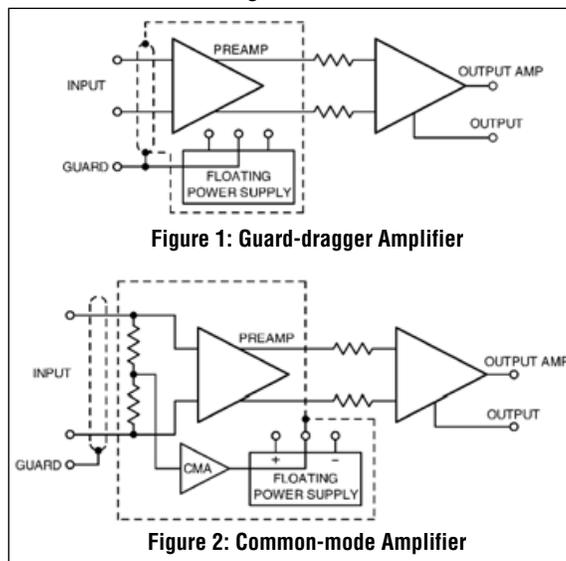


Figure 1: Guard-dragger Amplifier

Figure 2: Common-mode Amplifier

SPECIFICATIONS *(Continued from previous page)*

Impedance: >20 M Ω , parallel with 200 pF.
Source Current, Gain <10: ± 30 nA at 25°C.
Source Current, Gain >10: ± 1 nA at 25°C.

Impedance, 100:1 divider switched in:
1 M Ω , parallel with 200 pF.

Max. Input Overload: ± 30 V without damage, ± 300 V with 100:1 divider switched in.

Guard Impedance to Common: 56 M Ω parallel with 1000 pF.

ZERO

Front-panel Control: ± 100 μ V RTI range, nominal 0.01% full scale resolution.

Stability

Voltage: ± 2 μ V RTI ± 0.25 mV RTO for 200 hrs.

Source Current: ± 1 nA for 200 hrs.

Temperature Coefficient

Voltage: ± 0.4 μ V/°C RTI; ± 0.2 mV/°C RTO.

Source Current: ± 0.5 nA/°C.

GAIN

Gain Steps: Switch-selectable gains of 0, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000. With 100:1 input divider gains become 0, 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10.

Gain Step Accuracy: $\pm 0.01\%$.

Front-panel Vernier: Multiplier $\times 1$ to $\times 2.5$.

Stability, Time (Vernier Out): $\pm 0.01\%$ for 6 months.

Stability, Temperature (Vernier Out): $\pm 0.003\%/^{\circ}\text{C}$.

DYNAMIC RESPONSE

Bandwidth: <3 dB down at 100 kHz.

Settling Time

Output #1 (Wideband): 30 μ s to $\pm 0.1\%$ of step value.

Output #2 (Filtered): 100 μ s + 1.8 s/ f_{co} to $\pm 0.1\%$ of step value.

Overload Recovery, Output #1, from 1000% F.S. but <30 V: 50 μ s to $\pm 0.1\%$ of F.S.

Slewing Rate, Output #1

Balanced, Differential Signal: 3.2 V/ μ s.

Fully Unbalanced Signal: Gains above 20, 3.2 V/ μ s. Gains through 20, 1.5 V/ μ s.

Linearity

Dc: $\pm 0.005\%$ of full scale.

Dc to 2 kHz: $\pm 0.01\%$ of full scale.

OUTPUTS (Wideband and Filtered)

Voltage: ± 10 V dc or peak ac.

Current: ± 100 mA (110 mA max, combined wideband and filtered).

Output Impedance: 0.1 Ω at dc.

Nominal Overrange: 20%.

Capacitance Loading: >1.0 μ F without instability.

Output Isolation: No load to full load on one output affects the other less than 0.03%.

Short circuit: No damage with sustained short circuit on either or both outputs.

NOISE

Noise specifications apply when measured with a bandpass system with first-order rolloffs adjusted for -3 dB at the upper and lower frequencies listed.

Peak, 3 sigma

0.1 Hz to 10 Hz: 0.75 μ V RTI + 0.1 mV RTO.

0.1 Hz to 100 Hz: 2 μ V RTI + 0.25 mV RTO.

0.1 Hz to 1 kHz: 4 μ V RTI + 0.5 mV RTO.

0.1 Hz to 10 kHz: 8 μ V RTI + 1 mV RTO.

Rms

0.1 Hz to 10 kHz: 2 μ V RTI + 0.5 mV RTO.

0.1 Hz to 100 kHz: 5 μ V RTI + 2 mV RTO.

FILTER

Filter Characteristics: Three-pole Bessel.

Cutoff Frequencies ($f_{co} = -3$ dB): Switch selectable: 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, W.B. (Filter Out)

COMMON MODE

Common-mode Voltage (CMV): ± 300 V dc or peak ac.

Maximum CMV Rise Time: No limit within CMV rating.

Common-mode Rejection: 80 dB plus gain in dB at dc.

Dc to 60 Hz, 1 k Ω unbal.: 124 dB or 64 dB plus gain in dB, whichever is lower.

Dc to 10 kHz, 350 Ω unbal.: 74 dB or 14 dB plus gain in dB, whichever is lower.

POWER, DIMENSIONS, ENVIRONMENT

Power Requirements: 105 V ac to 125 V ac, 50 Hz to 400 Hz, 8 W nominal. 220 V ac, 240 V ac, and 100 V ac available for export.

Dimensions: 5.25" high \times 1.4" wide \times 16" deep (133 mm \times 36 mm \times 406 mm).

Operating Temperature: 0°C to 55°C.

Relative Humidity: Up to 90% RH at 40°C.

Storage Temperature: -25°C to $+70^{\circ}\text{C}$.

ENCLOSURE AND ACCESSORIES

ENCLOSURE

The Model E712-3-12 rack-mount enclosure accommodates up to twelve amplifiers. Rear-panel connectors, with mates, are provided for each amplifier input. The input connectors are MS3102A-14S-7P, and their mates are MS3106A-14S-7S supplied with clamps and bushings. The output connectors are BNC; mates are not supplied unless requested. Enclosure dimensions are 5.25" high, 19" wide, and 20" deep (133 mm \times 483 mm \times 508 mm).

Different input/output connectors are available on special order.

ACCESSORIES

Model 720 Cable Assembly provides all input, output, and power cables for bench operation of a single amplifier.

Model 721 Mount provides a bench mount for a single amplifier.

P/N 750-504-01 Single-channel filler panel for E712 Enclosure.

P/N 750-504-12 Four-channel filler panel for E712 Enclosure.

For price and delivery information, please contact the factory or the Ectron representative in your area.



Rear view of Model E712-3-12 Enclosure

Model 720
Single-unit
Cable Assembly



Telephone: (858) 278-0600

Fax: 858-278-0372

E-mail: sales@ectron.com

http://www.ectron.com

For quick response, call
1-800-732-8159



8159 Engineer Road, San Diego, CA 92111, U.S.A.

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