



MODEL 416

RUGGEDIZED
CONDITIONER-AMPLIFIER

Model 416 front view.
See specifications for size.

GENERAL

The Model 416 is a transducer conditioner with a precision instrumentation amplifier for use in poor environmental conditions. Designed for use with almost any transducer, this conditioner-amplifier provides outstanding performance despite temperature extremes and high levels of shock and vibration.

Featuring complete ohmic isolation between the signal input, output, excitation, power supply, and case, it is a solid-state chopper-stabilized differential dc amplifier with an internal excitation voltage supply. The high input impedance permits operation with a large variety of signal sources; and the low output impedance allows operation into highly reactive loads, telemetry equipment and most recording and/or storage devices.



Model 416 rear view, with mating
DAM-15S connector

STANDARD FEATURES

- The Model 416 conditioner-amplifier comes standard with the following features:
- Ruggedized for environmental extremes.
- ± 10 -V amplifier output.
- ± 40 -mV input zero suppression.
- Continuous gain in a 1-2-5 sequence from 10 to >2500 .
- Customer-selectable excitation voltage.
- EMI/RFI filtering on all connector pins.
- Operation from any dc voltage from $+10.5$ to $+32$ V dc.
- All units 100% temperature tested over full operating range.

OPTIONAL FEATURES

There are two options for the Model 416:

- Option B
The output is limited to 0 to $+5$ V.
- Option G
The gain sequence is changed to binary (2-4-8 sequence) with gains from 16 to >2500 .

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All specifications apply with a fixed source resistance of 0 to 500 Ω in any unbalance over the temperature range of -25°C to $+85^{\circ}\text{C}$ unless otherwise specified. The following specifications are the maximum deviation allowed from ideal unless otherwise noted.

RTI = Referred to Input
RTO = Referred to output

INPUT

CONFIGURATION

True differential with guard, transformer isolated. Can operate from isolated source.

IMPEDANCE: $\geq 1 \text{ M}\Omega$

SIGNAL SOURCE

Normal-mode voltage (without damage)

$\pm 17 \text{ V}$ dc or peak ac maximum.

Common-mode voltage (operating)

$\pm 100 \text{ V}$ dc or peak ac.

Common-mode rejection (CMR)

Dc, 100- Ω unbalance: $\geq 140 \text{ dB}$.

Ac, 60 Hz, balanced: $\geq 120 \text{ dB}$.

Ac, 60 Hz, 100- Ω

unbalance: $\geq 100 \text{ dB}$.

Ac, 400 Hz, balanced: $\geq 100 \text{ dB}$.

Ac, 400 Hz, 100- Ω

unbalance: $\geq 90 \text{ dB}$.

NOISE

Noise specifications are stated with a statistical confidence of 3 sigma in peak voltage when measured in a first-order band-pass circuit with a lower frequency limit of 0.1 Hz and an upper limit as stated:

Frequency	RTI	RTO
10 Hz	$\leq 1 \mu\text{V}$	$\leq 1 \text{ mV}$
300 kHz	$\leq 5 \mu\text{V}$	$\leq 2.5 \text{ mV}$

GAIN

CONFIGURATION

Decade

Continuous gain from 10 to > 2500 .

Screwdriver-adjustable front-panel rotary-gain-switch steps of 10, 20, 50, 100, 200, 500, and 1000.

Vernier (always active):

$\times 1$ to $> \times 2.5$.

Binary (Option G)

Continuous gain

from 16 to > 2560 .

Screwdriver-adjustable front-panel rotary-gain-switch steps of 16, 32, 64, 128, 256, 512, and 1024.

Vernier (always active):

$\times 1$ to $> \times 2.5$.

ACCURACY

$\pm 0.2\%$ typical with gain-vernier potentiometer fully counterclockwise.

STABILITY

Time (200 hours) $\pm 0.02\%$.

Temperature $\pm 0.005\%/^{\circ}\text{C}$.

DYNAMIC RESPONSE

FREQUENCY RESPONSE

(5-pole Butterworth)

Dc to 3 kHz: $\pm 5\%$.

Dc to 5 kHz: $-3 \pm 1 \text{ dB}$.

LINEARITY

$\pm 0.04\%$ of full-scale output maximum deviation from the best straight line through zero.

OVERLOAD RECOVERY

$\leq 5 \text{ ms}$ recovery from a "10 \times full scale" input (up to the maximum normal-mode voltage allowed) to 0 V $\pm 0.1\%$ of the rated full-scale output.

ZERO

STABILITY

Time (200 hours)

$\pm 4 \mu\text{V}$ RTI $\pm 200 \mu\text{V}$ RTO.

Temperature

$\pm 1 \mu\text{V}/^{\circ}\text{C}$ RTI $\pm 50 \mu\text{V}/^{\circ}\text{C}$ RTO.

Dynamic temperature (20°C step change)

$\pm 8 \mu\text{V}$ RTI $\pm 400 \mu\text{V}$ RTO.

Power-line change (30%)

$\pm 0.5 \mu\text{V}$ RTI $\pm 200 \mu\text{V}$ RTO.

ADJUSTMENT RANGE

(Affects amplifier input)

More than $\pm 40 \text{ mV}$ RTI.

CONTROLS

Coarse: 20-turn potentiometer.

Fine: 20-turn potentiometer with a nominal range of $\pm 1 \text{ mV}$ RTI.

OUTPUT

ISOLATION

The output is isolated by transformer from the input and power supply. The output-to-case voltage can be up to $\pm 50 \text{ V}$ dc or peak ac. The capacitance from output low to case and to power common is 0.22 μF .

LINEAR RANGE

Voltage

Standard:

From -10.0 V to $+10.0 \text{ V}$.

Option B: From 0 V to $+5.0 \text{ V}$

(-0.8 V to $+6 \text{ V}$ maximum).

Current: 10 mA minimum.

IMPEDANCE

At dc: $\leq 1 \Omega$.

At 5 kHz: $\leq 2 \Omega$.

CAPACITIVE LOAD

The output will be stable under all normal signal conditions with a capacitive load of up to 0.02 μF .

PROTECTION

No damage will occur with a continuous short on the output.

EXCITATION VOLTAGE

VOLTAGES AVAILABLE

5, 7, or 10 V dc (set at the factory).

ACCURACY: $\pm 1\%$.

OUTPUT CURRENT

$\geq 100 \text{ mA}$ with input power from 10.5 to 15 V dc, then decreasing linearly to 50 mA with input power of 32 V dc.

Current Limit

Output current limit is 120 mA nominal with $< 10\%$ change over full temperature range.

REGULATION

Load: $\pm 0.1\%$ no load to full load.

Power: $\pm 0.05\%$ for a line variation of 30%.

NOISE

$\leq 1 \text{ mV}$ rms, 0.1 Hz to 1 MHz.

TEMPERATURE COEFFICIENT

$\pm 0.005\%/^{\circ}\text{C}$.

ISOLATION

Excitation low is connected directly to input-power common.

INPUT POWER

RANGE: ≥ 10.5 to $\leq 32 \text{ V}$ dc.

OVERVOLTAGE PROTECTION

$+60 \text{ V}$: For 15 s maximum.

-50 V : Continuous.

CURRENT

Model 416: 80 mA nominal, + excitation load + 1.2 times amplifier load.

Noise: The maximum current noise reflected back to the source is 5 mA peak as measured across a 1- Ω resistor in a 1-MHz bandwidth.

Maximum fault current: 230 mA.

PHYSICAL PROPERTIES

STORAGE TEMPERATURE

-60°C to $+125^{\circ}\text{C}$.

OPERATING TEMPERATURE

-25°C to $+85^{\circ}\text{C}$.

RELATIVE HUMIDITY

$< 90\%$ noncondensing.

ALTITUDE

No limit with adequate heat dissipation.

STATIC ACCELERATION

100 g.

SHOCK (6-ms sawtooth):

100 g.

VIBRATION

0.12" DA (5 to 55 Hz).

20 g (55 Hz to 2 kHz).

EMI/RFI PROTECTION

Filters are provided in all connector leads.

DIMENSIONS

Height	Width	Depth
50.8 mm (2")	28 mm (1.1")	101.6 mm (4")

WEIGHT

Conditioner-amplifier

255 g (9 oz) nominal.

Mating connector and hardware

16 g (0.6 oz) nominal.

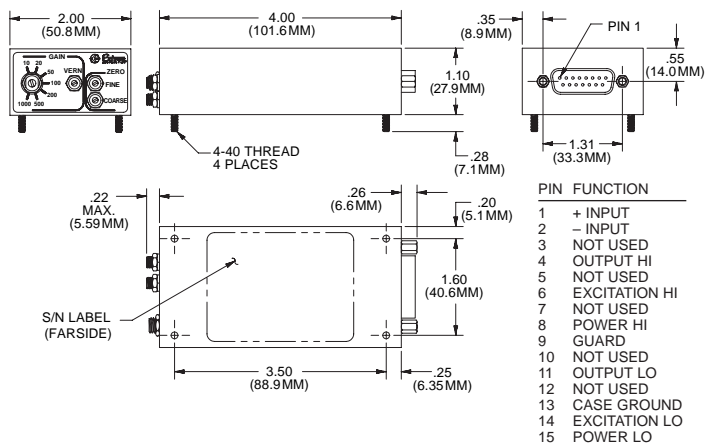
MOUNTING FORCE

(Four 4-40 studs):

6 inch-pounds maximum.

CONNECTOR

DAM-15P (Mate, DAM-15S with hood, cable clamp, and captive screws included).



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