

## 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.
- $\pm 10$ -V amplifier output.
- $\pm 40$ -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  $\Omega$  in any unbalance over the temperature range of  $-25^{\circ}\text{C}$  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- $\Omega$  unbalance:  $\geq 140 \text{ dB}$ .

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

Ac, 60 Hz, 100- $\Omega$

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

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

Ac, 400 Hz, 100- $\Omega$

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 ( $20^{\circ}\text{C}$  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  $\mu\text{F}$ .

### LINEAR RANGE

#### Voltage

Standard:

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

Option B: From 0 V to  $+5.0 \text{ V}$  ( $-0.8 \text{ V}$  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  $\mu\text{F}$ .

### 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:**  $\geq 10.5$  to  $\leq 32 \text{ V}$  dc.

### OVERVOLTAGE PROTECTION

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

$-50 \text{ V}$ : 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- $\Omega$  resistor in a 1-MHz bandwidth.

**Maximum fault current:** 230 mA.

## PHYSICAL PROPERTIES

### STORAGE TEMPERATURE

$-60^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

### OPERATING TEMPERATURE

$-25^{\circ}\text{C}$  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.

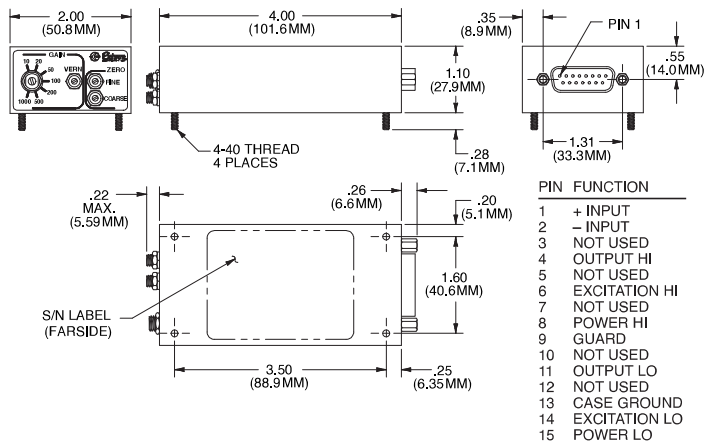
### MOUNTING FORCE

**(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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