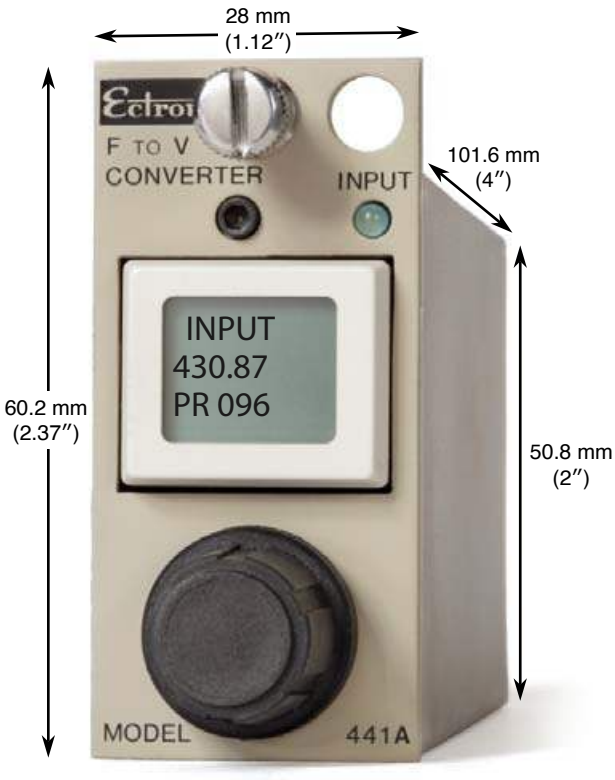
MODELS 441A AND 441AL
FREQUENCY-TO-VOLTAGE CONVERTERS

SENSOR COMPATIBILITY
- Anemometer
- Optical Sensor
- Variable-reluctance (VR) Speed Sensor
- Fifth-wheel Sensor
- Flow Meters

RUGGED APPLICATIONS
- Wind-turbine R&D
- Drive-train R&D
- Antilock-braking Systems (ABS) R&D
- Cruise-control Testing
- Gas-turbine Overspeed Monitor

ENVIRONMENTAL RATINGS
- 20 g Shock
- 10 g Continuous Vibration
- 0°C to 50°C
- 90% Relative Humidity
- Thermal-shock Resistant

PERFORMANCE HIGHLIGHTS
- 1 Hz to 50 kHz Frequency Range
- Fast Response
- Crystal-controlled Accuracy
- Digital Periodic Filter
- Adjustable Input Sensitivity and Filtering
- Front-panel Display of Frequency to 5 Digits
- Precise Control of Output Voltage vs. Input Frequency
- Automatically Accepts 10 mV to 100 V Input Signal Range
- Output Noise Independent of Frequency



With Exclusive Digital Periodic Filter

Model E408-1D Single-unit Mount, including DIN-rail adapter

Shown here containing Model 428.

Models 441A and 441AL Frequency-to-Voltage Converters

The Models 441A and 441AL produce an analog output that precisely represents the frequency of an applied input signal. Adjustable "input frequency to output voltage" set points allow the user to closely bracket the frequency of interest.

A unique crystal-controlled microcontroller design provides fast response, high conversion accuracy, and low output noise that is independent of frequency. The front-panel display shows the input frequency with up to five-digit resolution. All operating parameters are set using the display and one other front-panel control. The input signal conditioner automatically provides stable operation for a wide range of pulse-, square-, and sine-wave signals, or logic-level signals, up to 100 V in amplitude. Three selections each of input sensitivity and input bandwidth, plus a unique digital periodic filter that cancels unwanted output variation caused by an input signal whose frequency varies in a periodic manner, are provided.

FEATURES

The Models 441A and 441AL combine the latest electronic microcontroller technology with surface-mount construction to produce a true breakthrough in frequency-to-voltage products. Indeed, these instruments represent a worthy addition to the Ectron line of 400 Series products that have provided exceptional performance and reliability in rugged applications for more than 40 years.

Designed into the Models 441A and 441AL are rapid response to any change in frequency, low output noise that is independent of input frequency, and input-signal conditioning that automatically provides correct operation for a great variety of input signals, both in wave shape and amplitude. Included is a selectable digital filter which eliminates output noise due to the effects of an input signal whose frequency varies in a periodic manner. Setting the digital filter to the number of input pulses per revolution of a rotating device eliminates the periodic variation and provides a much more precise frequency conversion.

Gone is the clutter of switches, knobs, pots, etc. associated with other frequency-to-voltage converters. All have been replaced with two easy-to-use, front-panel controls: the display and the encoder.

The backlit digital display/push button has the dual function of display and screen selection. Seven easy-to-use setup screens, six less frequently used screens, and the operate screen are accessible at the touch of the display.

The encoder, a rotary/push-button control, has the dual function of character selection and change. The user can easily configure the Model 441A or 441AL to any specific application desired.

With an input frequency range of 1 Hz to 50 kHz and an output voltage range of –10 V to +10 V, the Models 441A and 441AL offer precise frequency-to-voltage conversion for almost any application.

Because the Models 441A and 441AL operate from any dc power from 10.5 V to 32 V, use the same connector, and have the same pin assignments for signal input, output, and power as all other Ectron 400 Series products, they can be used—even intermixed—with Models 352 and 428 conditioner-amplifiers and Model 451 LVDT signal conditioners in all standard Ectron enclosures designed for these products.

DIFFERENCES BETWEEN THE MODELS 441A AND 441AL

The only difference between these models is in their input signal sensitivity and the ability of the instrument to start the conversion process when the input signal starts or changes rapidly.

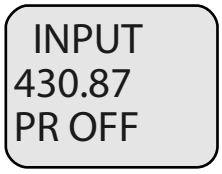
Using the Model 441AL, the start-up characteristics of turbomachinery and high acceleration or deceleration equipment can be analyzed. Similar to the Model 441A, the Model 441AL incorporates an input amplifier optimized for logic-level signals. While the Model 441A can reliably condition frequency signals down to 10 mV or less, the Model 441AL provides almost instantaneous start-up characteristics for those applications where capturing data during the first few milliseconds is critical.

The Model 441A has sensitivity down to 10 mV peak (for square- and sine-wave signals) and can handle signals as large as 100 V peak. The Model 441AL is designed to accept logic level signals from 0 V to either 5 V, 25 V, or 100 V peak.

FRONT PANEL

Display: The front-panel backlit LCD display shows the input frequency and status of the periodic filter when in the operate position shown. Five digits of resolution are indicated even at lower frequencies. When pressed, the display cycles through the following setup screens:

(1) Upper- and lower-frequency set points
(2) Upper- and lower-voltage set points
(3) Periodic filter
(4) Input sensitivity
(5) Input bandwidth
(6) Output filter
(7) Calibration frequency
(8)* LCD view angle
(9)* Alignment, –10 V
(10)* Alignment, +10 V
(11) Memory error
(12) Alignment required
(13)* Reset



Operate position displays the current input frequency using floating-point display and status of digital periodic filter.

* Screens (8), (9), and (10) are secondary setup screens accessed by pressing the display button for more than one second. When in screen (10), pressing the rotary switch for over one second displays screen (13). When a memory error occurs, screen (11) is displayed. Pressing any control when viewing screen (11) produces screen (12). Unless the –10 V and +10 V alignment settings have been reset following a memory error, screen (12) is displayed whenever the unit is powered up. Screen (13) allows the operator to reset all user-controlled parameters to their default values.

Controls: The display/push button allows the operator to sequence through the various setup screens. The second switch has both push-button and rotary action. The push button moves the cursor to the digit to be changed and the rotary switch is used to change the selected digit. All operating parameters are set using these controls in conjunction with the display.

Input LED: The green LED on the front panel indicates that a valid input signal is present and that the output represents the input frequency.

SPECIFICATIONS

INPUT

Configuration: Differential with a common-mode-voltage rating of up to 100 V dc or peak ac.

Impedance: 200 kΩ in parallel with 300 pF nominal.

Frequency Range: 1 Hz to 50 kHz.

Sensitivity and Filtering: Three steps of input sensitivity and three steps of input filtering are provided to optimize input signal-to-noise ratio.

Model 441A Input:

Sensitivity Steps: MIN 200 mV; MID 25 mV; MAX <10 mV (all values nominal).

Square- and Sine-wave Amplitude Range: 10 mV to 100 V peak.

Pulse Amplitude Range: 40 mV to 100 V peak (2.5% to 97.5% duty cycle, 5 µs minimum pulse width).

Response to Rapid Change in Amplitude: The Model 441A will recover and provide the proper output within 0.2 s + $\frac{1}{f_{in}}$ following a 10:1 change in amplitude of the input signal, where f_{in} is the frequency of the input signal.

Model 441AL Input:

Amplitude Ranges (Sensitivity Steps): 0 V to either 5 V (MAX), 25 V (MID), or 100 V (MIN) nominal logic levels, either polarity.

Minimum Pulse Width: 5 µs with input bandwidth set to MAX.

Maximum Risetime: No limit. However, output noise may increase.

Trigger Polarity: Falling edge.

Trigger Point: 30% of nominal logic level, typical.

Hysteresis: 30% of nominal logic level, typical.

Screens

Operate position displays the current input frequency using floating-point display and status of digital periodic filter.

INPUT
430.87
PR OFF

(1) Allows setting of upper- and lower-frequency set points. Frequencies between zero and 50 kHz can be set in 1 Hz increments.

FREQ
U50000
L15000

(2) Allows setting of upper- and lower-voltage set points. Voltages between –10.0 V and +10.0 V can be set in 0.1 V increments.

VOLTS
U+07.5
L+04.0

(3) Allows selection of the digital periodic filter and number of periodic pulses, 1 to 999, per revolution.

PULSES
/ REV
ON 096

(4) Allows one of three input sensitivities, MIN, MID, or MAX, to be selected. (See above.)

INPUT
SENS
MAX

(5) Allows one of three input bandwidths, MIN, MID, or MAX, to be selected.
MIN 10 Hz NOM.
MID 500 Hz NOM.
MAX >50 kHz.

INPUT
B/W
MID

(6) Allows selection of output filter cutoff frequency of 1 Hz, 10 Hz, or 100 Hz. Wideband (approximately 1.5 kHz) is also available.

OUTPUT
FILTER
100

(7) Allows setting of calibration frequency between zero and 50 kHz in 1 Hz increments. Calibration can be turned on and off.

CAL
ON
29500

(8) Allows setting of the optimum display viewing angle.

VIEW
ANGLE

(9) Allows alignment of the analog section at –10 V using a voltmeter connected to the output.

ADJUST
-10V
+000

(10) Allows alignment of the analog section at +10 V using a voltmeter connected to the output.

ADJUST
+10V
+000

(11) This screen is displayed if the data in the internal nonvolatile memory is corrupt. Pressing any front-panel control will clear this screen and reset the internal memory to default values.

MEMORY
ERROR

(12) After resetting internal memory to default values (either through a memory error or through the RESET screen) and until both the minus and plus ten-volt alignment points have been adjusted, this screen is displayed each time the unit is turned on.

ALIGN
REQ'D

(13) Allows resetting the internal nonvolatile memory to default values.

RESET?
PUSH
Y KNOB

OUTPUT

Voltage: The linear range of the analog output is from –10 V to +10 V with up to 10 mA current. The output limits are approximately ±10.5 V. Output voltage versus frequency is determined by voltage and frequency set points.

Uncertainty: Within

$$\pm 0.0022\ \text{V} + \left(\frac{f_{in}}{2 \times 10^4} \times \frac{V_U - V_L}{f_U - f_L} \right),$$

where f_{in} is the input frequency and V_U and V_L and f_U and f_L are the upper and lower voltage and frequency settings of the instrument, respectively.

Resolution: For input frequencies above 1 kHz, resolution in volts at the output is:

$$0.0012\ \text{V or } \left(\frac{f_{in}^2}{1500F} \times \frac{V_U - V_L}{f_U - f_L} \right),$$

whichever is greater, where f_{in} is the input frequency, F is $f_{in}/1000$ rounded down to the nearest integer, V_U and V_L are the voltage settings, and f_U and f_L are the frequency settings.

For input frequencies at or below 1 kHz, the resolution at the output is:

$$0.0012\ \text{V or } \left(\frac{f_{in}^2}{1.5 \times 10^6} \times \frac{V_U - V_L}{f_U - f_L} \right),$$

whichever is greater, where f_{in} is the input frequency, V_U and V_L are the voltage settings, and f_U and f_L are the frequency settings.

Impedance: Less than 1 Ω at dc.

Model 441A Noise: Less than or equal to 10 mV p-p independent of input frequency. (Measured with a bandwidth of 0.1 Hz to 1 MHz.) For slower rise-time signals such as sine waves, output noise depends on input-signal noise and amplitude since accurate timing is hampered by noise.

Response Time: Response to an abrupt frequency change is 0.005 s + $\frac{1}{f_{in}}$, where f_{in} is the frequency of the input, with the filter set to wideband. For other frequencies add $\frac{5}{f_{co}}$, where f_{co} is the filter cutoff frequency.

Update Rate: 1 ms or $\frac{1}{f_{in}}$, where f_{in} is the frequency of the input, whichever is a longer period of time.

Filter: Selectable output filter frequencies of 1 Hz, 10 Hz, and 100 Hz plus wideband (approximately 1.5 kHz). The filter has a two-pole Bessel characteristic.

FREQUENCY-TO-VOLTAGE CONVERSION

Conversion Circuit: Following the input conditioner-agc circuit, a microcontroller converts the input frequency to equivalent analog using a unique algorithm. The output is then scaled to a 14-bit DAC based on the user-controlled frequency and voltage set points.

Continued on back page.

SPECIFICATIONS (Continued from previous page)

Upper- and Lower-Frequency Set Points: These set points determine the input frequency at which the upper- and lower-voltage set points are reached. The frequency set points can be any two frequencies between 0 Hz and 50 kHz with a resolution of 1 Hz. (The upper- and lower-frequency set points can be within 10 Hz of each other.)

Upper- and Lower-Voltage Set Points: These set points determine the output voltages corresponding to the upper- and lower-frequency set points, respectively. The voltage set points may be any voltage from –10 V to +10 V with a resolution of 0.1 V. (The upper- and lower-voltage set points can be within 0.1 V of each other.)

Digital Periodic Filter: Selectable, from 1 to 999 pulses per revolution, this periodic filter eliminates output noise and periodic wander caused by irregularly spaced wheel cogs, unequally spaced pick-ups, run-out problems and periodic amplitude/frequency modulation for input frequencies up to 1 kHz.

CALIBRATION

When in the CAL mode of operation, an internally generated calibration signal can be set to any frequency between 0 Hz and 50 kHz in 1 Hz increments. When enabled, the analog output assumes a value according to the frequency and voltage set points. The calibration signal can be activated only when in the CAL mode. It can be used for system linearity check.

ALIGNMENT

Alignment of the Model 441A or 441AL is performed using the –10 V and +10 V alignment modes. This calibration feature allows field alignment and calibration of the instrument using only a digital voltmeter.

INPUT POWER

Range: 10.5 V dc to 32 V dc unregulated.
Overvoltage Protection: Up to +60 V for 15 seconds, +32 V and –50 V continuous.
Current (nominal): 150 mA.

ENVIRONMENT

Relative Humidity: 90% noncondensing.
Operating Temperature: 0°C to +50°C.
Storage Temperature: –40°C to +80°C.
Altitude: No limit with adequate heat dissipation.
EMI/RFI: Internal RFI filters are provided on all connector leads.
Static Acceleration Resistance: 200 m/s^2 (approximately 20 g) in any plane.
Shock Resistance: 200 m/s^2 (approximately 20 g), 11 ms in any plane.
Vibration Resistance: 100 m/s^2 (approximately 10 g) in any plane.

DIMENSIONS

Height (panel)	Height (case)	Width	Depth
60.2 mm (2.37″)	50.8 mm (2″)	28 mm (1.12″)	101.6 mm (4″)

Weight: 255 g (9 oz.) nominal.
Connector: DA-15P (mate DA-15S).

RETENTION OF SETTINGS

All settings of the Models 441A and 441AL are retained in nonvolatile memory unless they are reset to default values by a memory error or the user commands a master reset.

ENCLOSURES

COMPATIBILITY

The Models 441A and 441AL will operate in all standard Ectron enclosures designed for Models 352 and 428 Conditioner-Amplifiers and Model 451 LVDT Signal Conditioners. These include Models E408-1, E408-6, and R408-14 enclosures.

Model E408-6 Six-channel Portable Enclosure

Model R408-14 Fourteen-channel Rack-mount Enclosure

Model 441A Rear View with Connector

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

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