

### FEATURES

LED Display with Latched Digital Outputs  
Small Size, Lightweight  
Automatic Zero Correction; Max Error: 0.05% ±1 Digit  
High Normal Mode Rejection: 40dB @ 50 or 60Hz  
Optional Ratiometric Operation  
Leading "0" Display Blanking  
5Vdc Powered

### APPLICATIONS

Medical/Scientific/Analytic Instruments Data  
Acquisition Systems  
Industrial Weighing Systems  
Readouts in Engineering Units  
Digital Thermometers



### GENERAL DESCRIPTION

The model AD2010 represents an advance in price/performance capabilities of 3½ digit digital panel meters. The AD2010 offers 0.05% ±1 digit maximum error with bipolar, single ended input, resolution of 100µV, and a commonmode rejection ratio of 60dB (CMRR) at ±200mV (CMV).

The AD2010 features a light-emitting-diode (LED) display with a full scale range of 0 to ±1999 millivolts, latched digital data outputs and control interface signals, and leading zero display blanking. Automatic zero correction circuitry measures and compensates for offset and offset drift errors, thereby providing virtually no error. Another useful feature of the AD2010 is its 5Vdc operation. The AD2010 can operate from the user's 5Vdc system supply, thereby eliminating the shielding and decoupling needed for line powered units when the ac line must be routed near signal leads.

To satisfy most application requirements, the conversion rate of the AD2010 is normally 4 readings per second. However, an external trigger may be applied to vary the sampling rates from a maximum of 24 readings per second down to an indefinite hold time. The AD2010 can also be connected for automatic conversion at its maximum conversion rate. During conversion, the previous reading is held by the latched logic. The numeric readout is available as BCD data. Application of the metering system in a computer or data logging system is made easy with the availability of the "overrange," "polarity," "overload," and "status" signals.

The AD2010/R option for ratiometric operation allows readings to be made of the ratio of two input voltages as well as the absolute value of the input. AD2010/R operation is described in a later section.

A simplified block diagram of the AD2010, illustrating the features described above is shown in Figure 1.

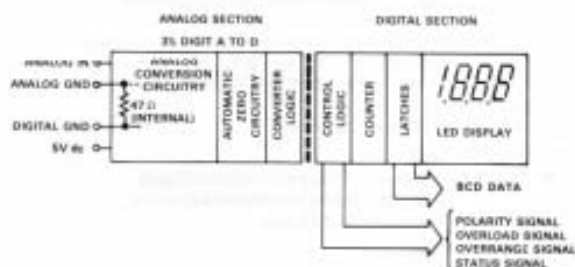


Figure 1. Simplified Block Diagram

### IMPROVED NOISE IMMUNITY, ACCURACY AND ZERO STABILITY

Dual-slope integration, as used in the AD2010 and as described in the theory of operation section, offers several design benefits.

- Conversion accuracy, for example, is independent of both the timing capacitor value and the clock frequency, since they affect both the up ramp and down ramp integration in the same ratio.
- Normal mode noise at line frequencies or its harmonics is rejected since the average value of this noise is zero over the integration period.



**Intronics  
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# Low Cost 3½ Digit Logic Powered DPM With LED Displays

## AD2021

### FEATURES

- "Second Generation" MOS-LSI Design
- Large 0.5" (13mm) LED Displays
- +5VDC Logic Powered
- ±1.999V or ±199.9mV Full Scale Ranges
- Limited Differential Input
- Low Power Consumption: 1.45 Watts
- Small Size

### APPLICATIONS

- General Purpose Logic Powered DPM Applications
- Portable Applications Requiring Low Power Consumption

### GENERAL DESCRIPTION

The AD2021 is a low cost, 3½ digit, +5VDC logic powered digital panel meter with large LED displays. While designed for general purpose DPM applications, the small size, light weight and low power consumption of the AD2021 make it an ideal digital readout for modern, compact instrument designs.

### THE BENEFITS OF "SECOND GENERATION" DESIGN

The AD2021 is designed around MOS-LSI (Metal-oxide semiconductor, large scale integration) integrated circuits, which greatly reduce the number of components, and thereby the size, and reduce power consumption to 1.45 watts. Both the lower power consumption and fewer interconnections between components promise greatly increased reliability, and the circuit design maintains the performance and features of earlier DPMs. Large 0.5 inch (13mm) LED displays offer the visual appeal of gas discharge displays with the ruggedness and lifetime of all solid state devices.

### EXCELLENT PERFORMANCE AND EASY APPLICATION

The AD2021 measures input voltage over a full scale range of ±1.999VDC or ±199.9mVDC ("S" option) with an accuracy of ±0.05% reading ±0.025% full scale ±1 digit. Using the "limited differential" input first used on Analog Devices' AD2010, the AD2021 prevents ground loop problems and provides 35 to 50dB of common mode rejection at common mode voltages up to ±200mV. Normal mode rejection is 40dB at 50 to 60Hz.

BCD data outputs are provided in a bit parallel, character serial format compatible to CMOS logic systems. For those applications requiring parallel BCD data, schemes for making the serial to parallel conversion are available. Controls to hold readings, select decimal points and blank the display are provided.



### INDUSTRY STANDARD PACKAGING

The AD2021 is packaged in Analog Devices' logic powered DPM case size, only 1.25 inches (32mm) deep. The small size of this DPM makes it easy to accommodate in any instrument design, and since several other manufacturers now use the same panel cutout for logic powered DPMs, this industry standardization allows mechanical second sourcing. In addition, the AD2021 uses the same pin connections as the AD2010 (except in BCD outputs, of course) as a convenience to allow updating designs to take advantage of the second generation design and larger display of the AD2021.

### DESIGNED AND BUILT FOR RELIABILITY

Even beyond the reliability advantages of the LSI-IC design and LED displays, the AD2021 has had extreme care taken in its design and manufacture to insure reliability. Manufacturing processes are monitored by continuous quality assurance inspections to insure proper workmanship and testing. Automatic test equipment is used to test each DPM thoroughly and without error. And each AD2021 receives a full one week failure free burn-in before shipment.

# SPECIFICATIONS

(typical at +25°C and nominal power supply voltage)

## DISPLAY OUTPUT

- Light emitting diode, planar seven segment display read-outs, 0.5" (13mm) high for three data digits, 100% over-range and negative polarity indication. Overload indicated by flashing display, polarity remains valid.
- Decimal points selectable at input connector.
- Display blanking on three data digits (does not affect overrange digit, polarity sign of decimal points).

## ANALOG INPUT

- Configuration: bipolar, limited differential
- Full Scale Range:  $\pm 1.999\text{V}$  or  $\pm 199.9\text{mV}$  ("S" option)
- Automatic Polarity
- Auto Zero
- Input Impedance:  $100\text{M}\Omega$
- Bias Current:  $50\text{pA}$
- Overvoltage Protection:  $\pm 50\text{VDC}$ , sustained

## ACCURACY

- $\pm 0.05\%$  reading  $\pm 0.025\%$  full scale  $\pm 1$  digit<sup>1</sup>
- Resolution:  $1\text{mV}$  or  $100\mu\text{V}$  ("S" option)
- Temperature Range<sup>2</sup>:  $0$  to  $+50^\circ\text{C}$  operating;  $-25^\circ\text{C}$  to  $+85^\circ\text{C}$  storage
- Temperature Coefficient: Gain:  $50\text{ppm}/^\circ\text{C}$   
Zero: auto zero
- Warm-Up Time to Rated Accuracy: less than one minute
- Settling Time to Rated Accuracy:  $0.4$  second

## NORMAL MODE REJECTION

- $40\text{dB}$  at  $50\text{--}60\text{Hz}$

## COMMON MODE REJECTION

- AD2021:  $35\text{dB}$  (DC  $-10\text{kHz}$ )
- AD2021/S:  $50\text{dB}$  (DC  $-10\text{kHz}$ )

## COMMON MODE VOLTAGE

- $\pm 200\text{mV}$

## CONVERSION RATE

- $5$  conversions per second
- Hold and read on command

## CONTROL INPUTS

- **Display Blanking:** (TTL, DTL compatible,  $2$  TTL loads). Logic "0" or grounding blanks the three data digits only, not the decimal points, overrange digit (if on) and polarity sign. Logic "1" or open circuit for normal operation. Display blanking has no effect on output data and the display reading is valid immediately upon removal of a blanking signal.
- **Hold:** (CMOS, DTL, TTL compatible,  $1\text{LP}$  TTL load). Logic "0" or grounding causes the DPM to cease conversions and display the data from the last conversion. Logic "1" or open circuit for normal operation. After the "Hold" input is removed, one to two conversions are needed before the reading is valid.
- **Decimal Points:** Grounding or Logic "0" will illuminate the desired decimal point. External drive circuitry must sink  $25\text{mA}$  peak at a  $25\%$  duty cycle when the decimal points are illuminated.

## DATA OUTPUTS (See Application Section for details on data outputs)

- BCD Data Outputs: (CMOS, LP TTL or LP Schottky compatible), bit parallel, character serial format.
- Digit Strobe Outputs: (CMOS, DTL, TTL compatible, one TTL load). Logic "1" on any of these lines indicates the output data is valid for that digit.
- Polarity Output: (CMOS, TTL, DTL compatible, one TTL load). Logic "1" indicates positive polarity input, logic "0" indicates negative polarity.
- Status: (CMOS or LP TTL compatible). When this signal is at Logic "1", the output data is valid.
- Clock: (CMOS, DTL, TTL compatible, one TTL load). The clock signal is brought out to facilitate conversion from character serial to parallel data.

## REFERENCE OUTPUT

- A  $6.4\text{V} \pm 5\%$  analog reference output is made available. This reference should be buffered and filtered if use in external circuitry is desired.

## POWER INPUT

- $+5\text{VDC} \pm 5\%$ ,  $1.45$  watts

## CALIBRATION ADJUSTMENTS (See Application Section for calibration instructions)

- Gain
- Zero
- Recommended recalibration interval: six months

## SIZE

- $3''\text{W} \times 1.8''\text{H} \times 1.25''\text{D}$  ( $76 \times 46 \times 32\text{mm}$ )
- $1.90''$  ( $48\text{mm}$ ) overall depth to rear of card edge connector.
- Panel cutout required:  $3.175'' \times 1.810''$  ( $80.65 \times 45.97\text{mm}$ ).

## WEIGHT

- $4$  ounces, ( $115$  grams)

## OPTIONS – ORDERING GUIDE

- Input Voltage Range: AD2021 –  $1.999\text{VDC}$  Full Scale  
AD2021/S –  $199.9\text{mVDC}$  Full Scale  
(Consult the factory or representative for other input ranges)
- Display Lens Option<sup>3</sup>: Lens 5 – Red with ADI logo  
Lens 6 – Red without ADI logo

## CONNECTOR

- $30$  pin,  $0.156''$  spacing card edge connector. Viking 2VK15D/1-2 or equivalent.
- Optional: Order AC1501

<sup>1</sup> Guaranteed at  $25^\circ\text{C}$  and nominal supply voltage

<sup>2</sup> Guaranteed

<sup>3</sup> If no lens is specified, Lens 5 will be supplied.

Specifications subject to change without notice.



## APPLYING THE AD2021

**WIRING CONNECTIONS.** Figure 1 is a wiring diagram for AD2021 applications. The "limited differential" input uses a 47 $\Omega$  resistor to isolate the analog input from digital and power supply sections to prevent ground loop problems. The analog ground must be connected to Pin 14 only, since there may be up to  $\pm 200\text{mV}$  difference in voltage between this input and the digital ground.

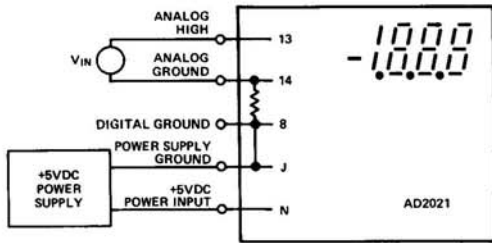


Figure 1. AD2021 Wiring Interconnections

- **DECIMAL POINTS.** Grounding, or Logic "0" applied to the appropriate pin will illuminate the desired decimal point. External drive circuitry, if used, must sink 25mA at a 25% duty cycle when a decimal point is turned on.
- **DISPLAY BLANKING.** Grounding, or Logic "0" blanks the three data digits, but does not affect the polarity sign, decimal points or overrange digit (if on). The display reading is valid upon removal of a blanking signal.
- **DISPLAY HOLD.** Grounding, or Logic "0" causes the DPM to cease conversions and display the data from the last conversion. After a "HOLD" input is removed, the auto zero conversion circuitry requires one to two conversions before the display is again valid.
- **REFERENCE VOLTAGE OUTPUT.** A stable +6.4V analog reference voltage is supplied as an output on Pin 10. It can be used as a reference for external circuitry, but it must be buffered by an operational amplifier and scaled external to the DPM, in order to not affect the accuracy of the DPM itself.
- **EXTENDED RANGE MEASUREMENTS.** Although the full scale range of the AD2021 is 2000 counts, and it flashes the display to indicate overrange beyond this point, it actually makes measurements up to approximately 3000 counts. Beyond this point, it will flash a constant number. Thus, one can use this extra measurement range as a guide to reducing the input to the normal range. Note that the display will flash only the three full digits, since it is impossible to flash a "2" on the overrange readout. Thus, a reading of 2.300 (or 230.0mV on an AD2021/S) will read as "300" and will be flashing.
- **INTERFACING DATA OUTPUTS.** The BCD data outputs are in a bit parallel, character serial format. There are four BCD bit outputs (1, 2, 4, 8) and four digit outputs ( $10^0$ ,  $10^1$ ,  $10^2$ ,  $10^3$ ). The BCD digits are gated onto the output lines sequentially, and the BCD bits are valid for the digit whose digit line is high. The data is valid except when being updated, which occurs within 2 milliseconds after the status line goes low.

The scheme shown in Figure 2 can be used to latch the bit parallel, character serial outputs of the AD2021 to provide parallel data for printers, comparators and other data interface devices. The "HOLD" input of the AD2021 can be used to prevent updating of the data outputs.

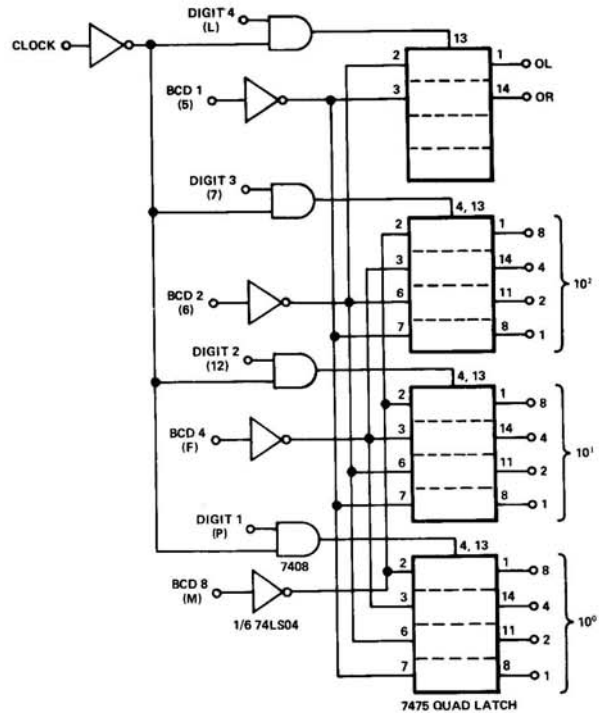


Figure 2. AD2021 Bit Parallel Character Serial to Full Parallel Data Conversion. AD2021 Pin Connections Are Shown in Parentheses.

- **CALIBRATION PROCEDURES.** A precision voltage reference is needed for the calibration of the AD2021. The location of the calibration potentiometers is shown in Figure 3. Always adjust the zero offset before the gain if zero adjustment is necessary.

**Zero Adjustment:** Short the signal inputs (Pins 13 and 14) and adjust the zero offset potentiometer until the meter reads 000.

**Gain Adjustment:** Apply an input of +1.800V (+180.0mV on AD2021/S models) and adjust the gain potentiometer until the meter reads 1800 exactly.

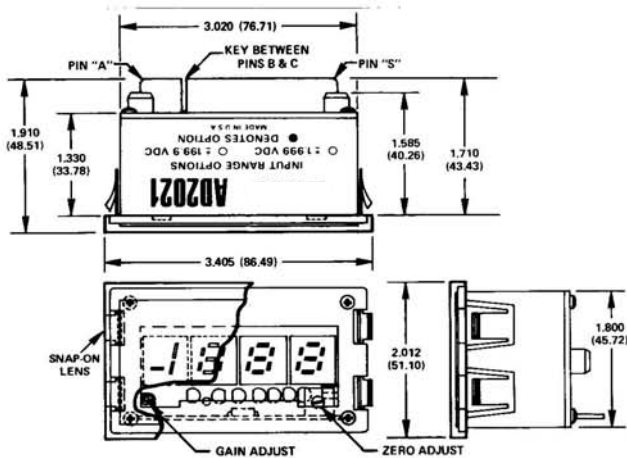


Figure 3. AD2021 Mechanical Outline  
(All Dimensions Are Given in Inches and (mm))

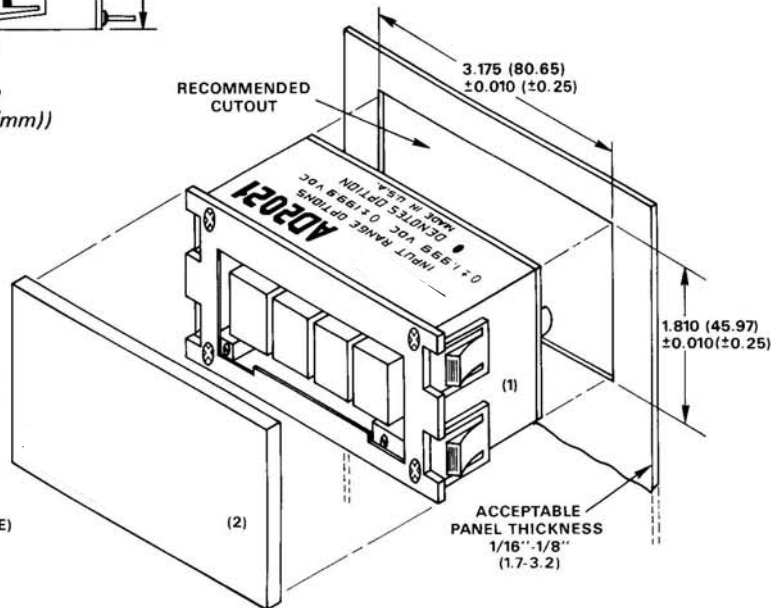


Figure 4. Snap In Case Assembly

- (1) DPM SNAPS INTO PANEL, IS HELD IN PLACE BY RETAINING FINGERS (DEPRESS TO REMOVE)  
(2) LENS ASSEMBLY SNAPS ONTO DPM

### AD2021 CONNECTOR PIN DESIGNATIONS

PIN REF	PIN FUNCTION
1	NC
2	KEY
3	
4	DP1XX.X
5	BCD 1
6	BCD 2
7	DIGIT 3 ( $10^2$ )
8	DIGITAL GND <sup>2</sup>
9	ANALOG HIGH <sup>1</sup>
10	REF OUT
11	NC
12	DIGIT 2 ( $10^1$ )
13	ANALOG HIGH <sup>1</sup>
14	ANALOG GND
15	DP2X.XX

PIN REF	PIN FUNCTION
A	NC
B	NC
C	NC
D	HOLD
E	POLARITY
F	BCD 4
H	BLANKING
J	DIGITAL GND <sup>2</sup>
K	STATUS
L	DIGIT 4 ( $10^3$ )
M	BCD 8
N	+5 SUPPLY
P	DIGIT 1 ( $10^0$ )
R	NC
S	DP1.XXX

NOTE 1. PIN 13 AND PIN 9 ARE BOTH ANALOG HIGH INPUTS.

NOTE 2. PIN 8 AND PIN J MAY BE USED INTERCHANGEABLY AS DIGITAL GROUND AND POWER SUPPLY RETURN.



**Intronics  
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# Low Cost 3 Digit AC Line or Logic Powered DPM

**AD2026**

## FEATURES

- Third Generation I<sup>2</sup>L LSI Design
- Either Line Powered or Logic Powered
- Large 0.56" Red Orange LED's
- Balanced Differential Input/Floating
- 1000V, CMV
- Terminal Block Interface (ac Version)
- High Reliability: > 250,000 Hour MTBF
- Small Size and Weight
- Low Cost

## GENERAL DESCRIPTION

The AD2026 is specifically designed to provide a digital alternative to analog panel meters. The AD2026 is available either logic powered (+5V dc) or ac line powered. Most of the analog and digital circuitry is implemented on a single I<sup>2</sup>L LSI chip, the AD2020. Only 13 additional components are required to complete the AD2026 +5V dc version. The entire dc version is mounted on a single 3" X 1 5/8" PCB. AC line power is achieved with the addition of a second PCB containing the ac power transformer and power supply circuitry.

The AD2026, on both the ac line and logic powered versions, offers as a standard feature, 0.56" high LED Displays. Brightness is enhanced on both versions due to the Red Orange lens. In addition to the Red Orange lens, the AD2026 is also available with a dark red lens for applications where maximum brightness is not required and minimum backlighting is desired.

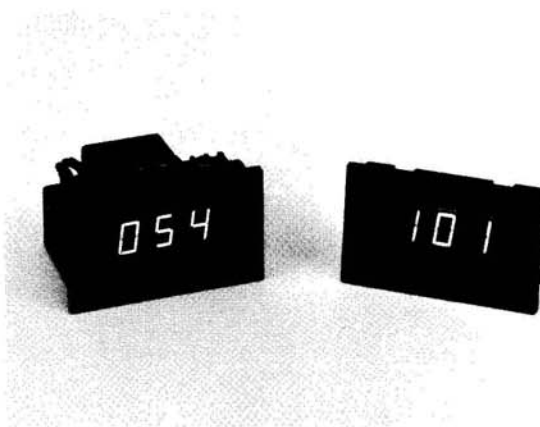
A unique patented case design utilizes molded-in fingers, both to capture the PCB in the case and to provide snap-in mounting of the DPM in a standard panel cutout. No mounting hardware of any kind is used. The dc version occupies less than 1" of space behind the panel. The line powered version offers the same mounting features but occupies 2 1/2" of behind-panel space.

## EXCELLENT PERFORMANCE

The AD2026 offers the instrument designer digital accuracy, resolution and use of readout while occupying less space than its analog counterpart. Other features of analog meters such as reliability and instantaneous response are retained in the AD2026.

The AD2026 measures and displays inputs from -99mV to +999mV, with an accuracy of 0.1% of reading  $\pm 1$  digit. Zero shift is less than one bit over the full operating temperature range, resulting in the same performance as a DPM with auto zero. The balanced differential input of the dc powered AD2026 rejects common mode voltages up to 200mV, enough to eliminate most ground loop problems. The floating differential input inherent in the ac line powered version offers 1000V of common mode voltage rejection.

\*Covered by patent numbers: 4,092,698; 29,992; 3,872,466; and 3,887,863.



Optional 10.0V full scale (F.S.) range is available on the ac line version that will accept inputs from -0.99V to 9.99V.

## WIRING CONNECTIONS

For Balanced Differential operation with the AD2026 dc version, connect input as shown in Figure 1. The common mode loop must provide a return path for the bias currents internal to the AD2026. The resistance of this path must be less than 100k $\Omega$  and total common mode voltages must not exceed 200mV.

For applications where attenuation is required, scaling resistors can be connected between pins 6 and 7 and between pins F and H. Pin 5 must be used as the High Analog Input when scaling resistors are used and pin 4 when they are not. Pin E is the Analog Low Input.

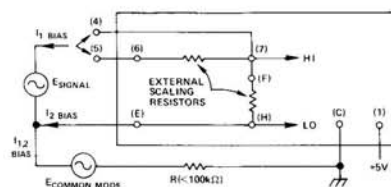


Figure 1.

Connection to the ac line powered AD2026 is via the terminal strip on the rear. AC line power is connected to terminals 4 and 5 and the signal input is connected to terminal 1 (Analog HI) and 2 (Analog Ground).



# SPECIFICATIONS

(typical at +25°C and nominal supply voltage unless otherwise noted)

## DISPLAY OUTPUT

- Light emitting diode, planar seven segment display readouts, 0.56" (14.6mm) high (orange)
- Overload Indication: EEE
- Negative Indication: -XX
- Negative Overload Indication: —
- Decimal Points: three (3) selectable at input connector (dc version); internally on ac version

## ANALOG INPUT

- Configuration: balanced differential input (dc version) single ended isolated (ac version)
- Full Scale Range: -99mV to +999mV  
-0.99V to +9.99V (10V option on ac version)
- Automatic Polarity
- Input Impedance: 100MΩ; 100kΩ (10V option)
- Bias Current: 100nA
- Overvoltage Production: ±15V dc, sustained

## ACCURACY

- ±0.1% ±1 digit<sup>1</sup>
- Resolution: 1mV or 10mV
- Temperature Range<sup>2</sup>: -10°C to +60°C operating; -25°C to +80°C storage
- Temperature Coefficient: Gain: 50ppm/°C  
Zero: 10μV/°C (essentially auto zero)
- Warm-Up Time to Rated Accuracy: Instantaneous
- Settling Time to Rated Accuracy: 0.3 second for full input voltage swing (dc version); 0.75 second for full input voltage swing (ac version)

## COMMON MODE REJECTION (1kΩ source imbalance, dc to 1kHz)

- 50dB, ±200mV common mode voltage (dc version)
- 116dB (96dB on 10V range); 1000V rms max CMV (ac version)

## NORMAL MODE REJECTION

- 30dB at 50-60Hz (ac version)

## CONVERSION RATE

- 4 conversions per second
- Hold and read on command (dc version only)

## CONTROL INPUTS

**Display Blanking/Display Power Input, (dc version only):** The display of the AD2026 can be blanked by removal of power to the display power input, with no effect on conversion circuitry. If external logic switching is used, the display requires 110mA peak (85mA average) when illuminated.

**Hold (dc version only):** When the Hold input is at Logic "0", grounded or open circuit, the AD2026 will convert at 4 conversions per second. If a voltage of 0.6V to 2.4V is applied to this input, the DPM will stop converting and hold the last reading. A 12kΩ resistor in series with this input to +5V will provide the proper voltage input. (Consult factory for "HOLD" on ac version.)

## DECIMAL POINT

- To illuminate decimal points on dc version, ground appropriate pin (A, B or 3).
- To illuminate decimal points on ac version, remove shroud and bridge appropriate solder pad (A, B or 3).

## POWER INPUT LOGIC POWER<sup>3</sup>

- Converter: +5V ±5%, 0.2 watts typ; 0.33 watts max
- Display: +5V ±40%, 0.45 watts typ; 0.75 watts max

## POWER INPUT AC LINE POWER

- AC line, 50-60Hz, 1.5 watts

## CALIBRATION ADJUSTMENTS

- Gain
- Zero
- Recommended recalibration interval: six months

## SIZE<sup>4</sup>

- 3.43"W X 2.0"H X 0.85"D (87 X 52 X 22mm)
- 0.88" (22mm) overall depth to rear of connector
- Panel cutout required: 3.175 ±0.015" X 1.810 ±0.015" (80.65 ±0.38 X 45.97 ±0.38mm)

## WEIGHT

- 1.8 ounces (53 grams) (dc version)
- 7 ounces (198 grams) (ac version)

## CONNECTIONS

A 10 pin T&B/Ansley 609-1000M with two feet of 10 conductor ribbon cable is available.

Conductor to pin A is color coded. Sequence of ribbon connections is A, 1, B, 2, C, 3, etc.

The AD2026 ac version is complete with terminal strip for easy interface.

## ORDERING GUIDE

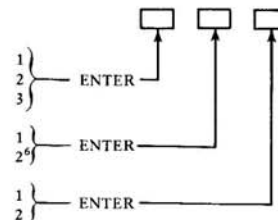
### AD2026

#### Power Input

- +5V dc
- 90-129V ac
- 198-264V ac
- Full Scale Input<sup>5</sup>
- 1V dc Full Scale
- 10V dc Full Scale

#### Lens<sup>5</sup>

- Red Lens
- Red Orange Lens



## NOTES:

<sup>1</sup> Guaranteed at +25°C and nominal supply voltage.

<sup>2</sup> Guaranteed.

<sup>3</sup> When the same power supply is used to power both display and converter, +5V, ±5%, 0.65 watts typical, 0.9 watts max is required.

<sup>4</sup> Dimensions for ac line powered version: 3.43"W X 2.0"H X 2.44"D (87mm X 52mm X 63mm)

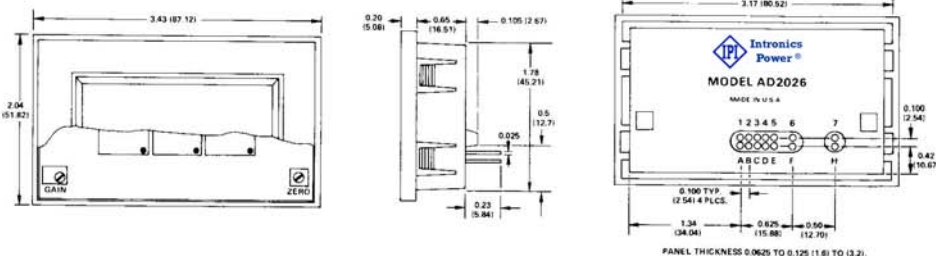
<sup>5</sup> No Charge Options

<sup>6</sup> 10V dc full scale option is available on ac power only

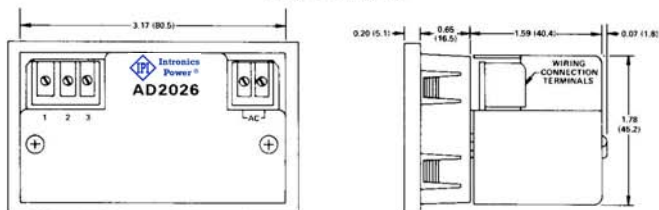
Specifications subject to change without notice.

## OUTLINE DIMENSIONS

Dimensions shown in inches and (mm)



## AC VERSION



## PIN CONNECTIONS

### AC VERSION

PIN	FUNCTION
1	Input
2	Analog Ground
3	NC
4	AC HI
5	AC LO

### DC VERSION

PIN	FUNCTION
1	+5V Power
2	+5V Display Power
3	Decimal Point XX.X
4	Input (When Scaling Resistors Not Used)
5*	Input (When Scaling Resistors Are Used)
6*	Series Arm of Scaling Resistor Divider
7*	Series Arm of Scaling Resistor Divider
A	Decimal Point XX.X
B	Decimal Point XXX.
C	Power Ground
D	Hold
E	Analog Ground
F*	Shunt Arm of Scaling Resistor Divider
H*	Shunt Arm of Scaling Resistor Divider

\*NOT NORMALLY USED. ALLOWS CONVENIENT MOUNTING OF SCALING RESISTORS.

# R101/401 GENERAL-PURPOSE LOW-COST TRUE-RMS COMPUTING SUB-SYSTEMS

- Lowest Cost — save 75% to 95% over other circuit techniques or devices having comparable performance.
- Accuracies to  $\pm 0.1\%$   $\pm 5\text{mV}$
- 50kHz and 500kHz bandwidths

Model R101 and Model R401 True-RMS Computing Subsystems are complete plug-in modules for computing the true-RMS value of virtually any input signal from DC to 500kHz (Model R101) or 50kHz (Model R401), including AC/DC combinations, to an accuracy of  $\pm 0.1\%$ . They require only a power supply ( $\pm 14.7$  to  $\pm 15.3\text{VDC}$ , 12mA), a scale-factor potentiometer, and an offset-trimming potentiometer to be completely operational at full rated accuracy, with a 0-10VDC, 0-5mA output range (short-circuit protected). Both models perform a measurement in a small fraction of the time required by thermocouple-type instruments, and at a small fraction of the cost.

## APPLICATIONS

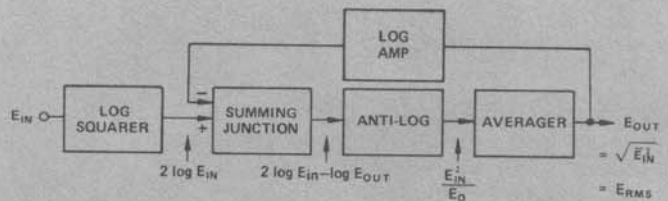
- Low-Cost True-RMS AC Interface for digital panel meters (DPM's), digital voltmeters (DVM's), and digital multimeters (DMM's).
- True-RMS Sensor for constant-RMS voltage or current regulators.
- True-RMS Converter for vibration and distortion energy measurements.
- True-RMS Converter for sub-audio to low-RF noise energy measurements.

## APPLICATION NOTES

**Power.** Model R101 requires only 10mA, Model R401 only 12mA, at 14.7 to 15.3VDC. Power supply sensitivities are only 2mV/% and 1mV/%, respectively.

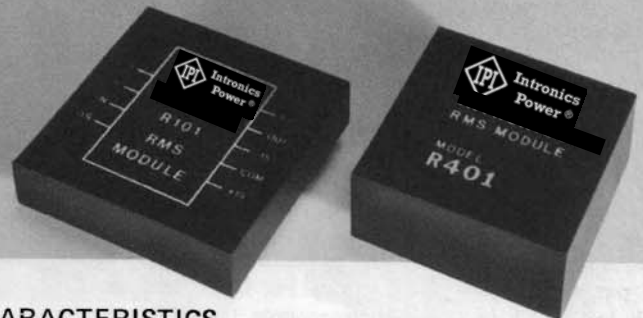
**Trimming.** Terminals are provided for connection of external trimming potentiometers for scale-factor adjustment (500 Ohms) and offset-voltage zeroing (20 kilohms), to attain full rated measurement accuracy.

**Averaging.** The internal averaging capacitor can be paralleled at external terminals, to increase the averaging time constant for meaningful measurement of low-frequency inputs.



The Models R101 and R401 combine log-function techniques with an explicit computation of  $E_{\text{rms}}$ : squaring the absolute value of the input, averaging the squarer output, then taking the square root of that average.

$$(DC) E_{\text{out}} = \sqrt{E_{\text{in}}^2} = E_{\text{in}} \text{ (RMS)}$$



## CHARACTERISTICS

(typical @ +25°C and $\pm 15\text{VDC}$ supply unless otherwise noted)	General Purpose R101	Low Cost R401
<b>ACCURACY</b> Error, Max. no adj.* (Offset + % Reading) Error, max., with adj. (Offset + % Reading)	$\pm 10\text{mV} \pm 0.4\%$ $\pm 10\text{mV} \pm 0.1\%$	$\pm 10\text{mV} \pm 0.2\%$ $\pm 5\text{mV} \pm 0.1\%$
<b>CREST FACTOR</b> For .25% Reading Error For 1.0% Reading Error	1.5/1 2/1	1.5/1 2/1
<b>INPUT/OUTPUT</b> Input Voltage Range, max.** Input Impedance Output Voltage Range, max. Output Current (S.C. protected) Output Impedance, DC	$\pm 10\text{V}$ 1M $\Omega$ 0 to +10V 5mA 0.1 $\Omega$	$\pm 10\text{V}$ 2k $\Omega$ 0 to +10V 5mA 0.1 $\Omega$
<b>DYNAMIC RESPONSE</b> Freq. for 1% Error, 20V PP Input Sine Freq. for 1% Error, 2V PP Input Sine Output Filter Time Constant	500kHz 50kHz 2msec. + 20ms/ $\mu\text{F}$	25kHz 50kHz 20msec + 20ms/ $\mu\text{F}$
<b>TEMPERATURE &amp; SUPPLY STABILITY</b> Output Offset Drift, max. Scale Factor Drift, max. Supply Sensitivity	500 $\mu\text{V}/^\circ\text{C}$ 0.02%/°C 2mV/%	100 $\mu\text{V}/^\circ\text{C}$ 0.02%/°C 1mV/%
<b>POWER SUPPLY</b> Voltage (Rated Performance) Current, Quiescent	$\pm 14.7$ to $\pm 15.3\text{VDC}$ 10mA	$\pm 14.7$ to $\pm 15.3\text{VDC}$ 12mA
<b>TEMPERATURE RANGE†</b> Operating (Rated Performance) Storage	0°C to +85°C -55°C to +100°C	0°C to +70°C -55°C to +100°C
<b>DIMEN. &amp; PINOUTS</b> , (page 72) Approximate Weight Socket	Figure A 1 ounce S112	Figure B 1 ounce S108

\*R101 requires offset adjustment.

\*\*Note:  $\pm 10\text{V}$  sinewave input = 7.07V RMS

†Available in extended temperature ranges. Consult Factory for price and delivery.