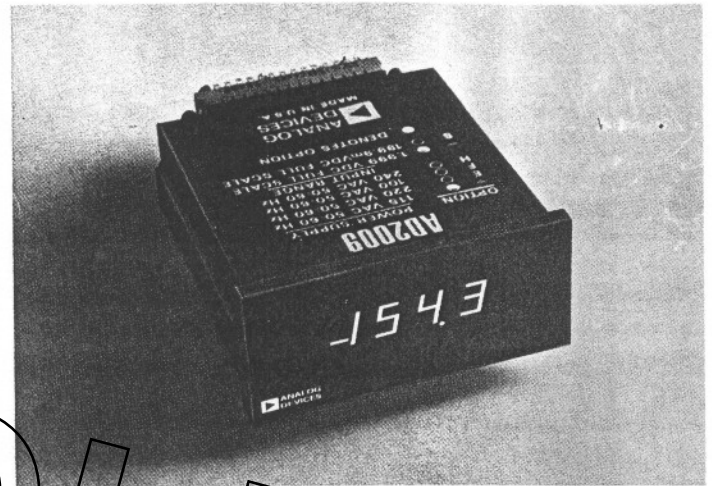


### FEATURES

- AC Line Powered
- Bright, Seven Segment Gas Discharge Display
- BCD Data Outputs Standard
- Hold and Trigger Control Signals
- Full Scale Ranges of  $\pm 1.999V$  or  $\pm 199.9mV$
- Display Blanking Control
- Industry Standard Panel Cutout

### APPLICATIONS

- General Purpose DPM Applications Requiring AC Power and a High Visibility Display
- Data Logging and Digital Feedback Control Systems



### GENERAL DESCRIPTION

The AD2009 is a low cost 3½ digit, AC line powered DPM designed for general purpose DPM applications. The AD2009 measures bipolar input voltages over full scale ranges of either  $\pm 1.999V$  or  $\pm 199.9mV$ , with an accuracy of  $\pm 0.1\%$  reading  $\pm 1$  digit and displays the readings on large, bright 0.55" (14mm) Beckman gas discharge displays.

### LARGE, BRIGHT DISPLAY

For display only applications, the Beckman display offers excellent appearance and visibility. The AD2009 display is easily read up to 50 feet (15m) away and over all ambient lighting conditions. The non-glare lens allows a choice of either red or amber display colors, and is easily silk-screened with company logo or measurement units. External control of decimal points and display blanking is provided.

### SIMPLE DATA INTERFACING

Since the AD2009 is designed around TTL logic circuits, parallel BCD data, TTL/DTL compatible, is a standard feature, allowing easy interfacing to a variety of data peripherals, such as digital comparators and line printers. Under internal control, the AD2009 converts at a nominal rate of six conversions per second. Using the Hold and Trigger controls, up to 100 conversions per second can be externally triggered.

### INDUSTRY STANDARD CASE DESIGN

In response to industry's urgent need for DPM standardization, Analog Devices has adopted the most popular AC powered DPM panel cutout size for the AD2009 and all future AC line powered DPM's. Since this 3.924" x 1.682" (99.67 x 42.72mm) panel cutout is used by so many AC powered panel meters, the potential DPM customers can be assured that second-sources

will be available and future new products will be usable without mechanical changes to their instruments or systems.

### DESIGNED AND BUILT FOR RELIABILITY

Design and manufacturing techniques are chosen to insure reliability in the AD2009. Conservative design techniques and thorough component evaluation are only the beginning. Manufacturing processes are monitored by continuous quality assurance inspections to insure proper workmanship and testing. Like every other Analog Devices' DPM, each AD2009 is fully tested for electrical specifications, calibrated, and given one full week of failure free burn-in before shipment.

### THEORY OF OPERATION

The AD2009 uses a dual slope conversion technique with an absolute value voltage to current converter input. The entire conversion cycle takes less than 10 milliseconds, allowing a complete conversion to be done during the negative half cycle of the AC line, and the resulting reading is displayed during the positive half cycle of the AC line. This scheme not only insures a flicker free display, but also allows externally triggered conversions at rates up to 100/second for data interfacing applications. In order to insure a bright display even during operation at low line voltages and to help insure the reliability of the Beckman displays, a separate power supply is provided to continually illuminate two "keep-alives" in the Beckman display.

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# SPECIFICATIONS (typical @ +25°C and nominal line voltage)

## DISPLAY OUTPUT

- Beckman Seven Segment Gas Discharge Display, 0.55" High (14mm) for Three Data Digits, 100% Overrange and Negative Polarity Indication. Overload indicated by blanking the three data digits and displaying the "1" overrange. The polarity remains valid.
- Decimal Points Selectable at Input.
- Display Blanking

## ANALOG INPUT

- Configuration: Bipolar, Single Ended
- Full Scale Range:  $\pm 1.999V$  or  $\pm 199.9mV$  (see S option)
- Automatic Polarity
- Input Impedance:  $100M\Omega DC$
- Bias Current, Both Ranges:  $3nA @ 2V FS$ ,  $20nA @ 200mV FS$
- Overvoltage Protection, Both Ranges:  $200VDC$  Sustained

## ACCURACY

- $\pm 0.1\% \pm 1 \text{ Digit}^1$
- Resolution:  $1mV$  or  $100\mu V$  (S option)
- Temperature Range<sup>2</sup>:  $0$  to  $+50^\circ C$  Operating,  $-25^\circ C$  to  $+85^\circ C$  Storage
- Temperature Coefficient:
  - Gain (both ranges)  $- +60ppm/^\circ C$
  - Zero Offset ( $2V$  Input)  $- +30\mu V/^\circ C$
  - ( $200mV$  Input)  $- \pm 10\mu V/^\circ C$
- Warm-Up Time to Rated Accuracy: 15 minutes
- Settling Time to Rated Accuracy: 0.3 sec

## NORMAL MODE REJECTION

- 18dB @ 60Hz

## COMMON MODE REJECTION ( $1k\Omega$ source imbalance @ 50-60Hz, with standard shielded transformer)

- 2V Input - 100dB
- 200mV Input - 80dB

## COMMON MODE VOLTAGE

- $\pm 300VDC$  ( $600VAC$  p/p) (floated on power supply transformer when BCD outputs and control signals are not used)

## CONVERSION TIME

- 10msec

## CONVERSION RATE

- Internal Trigger: 6 conversions per second
- External Trigger: 0-100 conversions per second

## DIGITAL CONTROL SIGNALS

- DTL/TTL Compatible

	In	Out
Logic "0"	$< 0.8V$	$< 0.4V$
	$> 2.0V$	$> 2.4V$

## CONTROL INPUTS<sup>3</sup>

- Display Blank (1TTL Load). Logic "0" or grounding blanks the entire display, not including the decimal points. 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 (1TTL Load). Logic "0" or grounding disables either the external or internal trigger and the last conversion is held and displayed.
- External Trigger (1TTL Load). Positive pulse (500 $\mu$ sec max width) will initiate conversion.

- Decimal Points (Not TTL Compatible). Grounding will illuminate the desired decimal point. External drive circuitry must be capable of withstanding 100V when the decimal points are turned off.

## DATA OUTPUTS<sup>3</sup>

- 3BCD Digits (Drives 6TTL Loads). Positive true, unlatched
- Overrange (Drives 6TTL Loads). Unlatched, Logic "0" indicates overrange ( $\geq 1000$ ).
- Overload (Drives 6TTL Loads). Unlatched, Logic "0" indicates overload ( $\geq 2000$ ).
- Polarity (Drives 6TTL Loads). Latched, Logic "1" indicates positive polarity.
- Status (Drives 10TTL Loads). All digital outputs are valid when status is at Logic "0". Logic "1" indicates conversion is in progress.
- Internal Trigger Output (Not TTL Compatible). When connected to External Trigger Input will cause the AD2009 to convert at 6 conversions per second. This output can only be used for triggering the AD2009.

## POWER INPUT

- AC line, 50-60Hz, 4.2 Watts at 60Hz; 4.7 Watts at 50Hz (at nominal line voltages).

## CALIBRATION ADJUSTMENTS

- Gain
- Zero
- Recommended recalibration interval - 6 months

## SIZE

- 4.18" W x 1.93" H x 4.17" L (106 x 49 x 112mm)
- 4.77" L (121mm) to rear of card edge connector
- Panel cutout required: 1.682 x 3.924" (42.72 x 99.67mm)

## WEIGHT

- 15 ounces (425 grams)

## OPTIONS<sup>4</sup> - ORDERING GUIDE

- AC Power Inputs (50-60Hz)
 

AD2009	- 117VAC	} $\pm 10\%$
AD2009/E	- 220VAC	
AD2009/F	- 100VAC	
AD2009/H	- 240VAC	
- AD2009 - 1.999VDC Full Scale
- AD2009/S - 199.9mVDC Full Scale
- Lens 7 - Red with ADI Logo
- Lens 8 - Red without ADI Logo
- Lens 13 - Amber with ADI Logo
- Lens 14 - Amber without ADI Logo

## CONNECTOR

- 30 Pin, 0.156" Spacing Card Edge Connector, Amphenol 225-215 24-601 (117) or Equivalent
- Optional: Order AC2611 @ \$4.50

## PRICING

- \$140 (unit quantity)
- Consult Factory for OEM quantity pricing

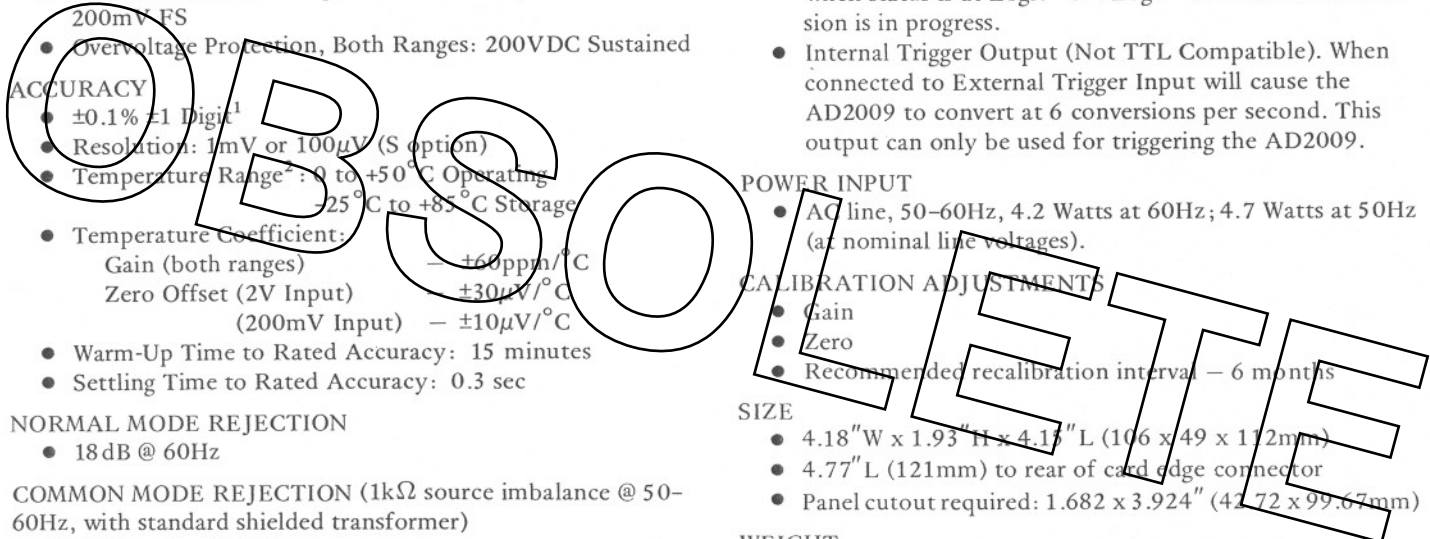
<sup>1</sup> Guaranteed @ +25°C.

<sup>2</sup> Guaranteed.

<sup>3</sup> Not to be used when the AD2009 is floating on common mode voltages.

<sup>4</sup> Only one input range and AC power input may be specified.

<sup>5</sup> Lens 7 is supplied if no lens option is specified. Specifications subject to change without notice.



# Applying the AD2009

## INTERFACING THE AD2009

### Input Connections

The AD2009 has a single ended input with common analog and digital grounds. When digital control lines and BCD data outputs are not used, the entire DPM can be floated on the power supply transformer at up to 300VDC common mode voltages. If these signals are used, care should be taken to insure against ground loops within the system causing erratic and/or erroneous readings.

### Decimal Points

Grounding the proper pin will illuminate the desired decimal point. If external logic drives are used to control the decimal points, drive circuitry must be able to withstand 100V when the decimal points are turned off.

### Display Blanking

The entire display (excluding decimal points) may be blanked by applying logic "0" or grounding the proper control input (pin 13). Blanking the display has no effect on the output data or the conversion process. The data remains valid during blanking and the DPM reading is correct immediately upon removal of the blanking signal.

### Interfacing Digital Data Outputs

The digital data outputs of the AD2009 are unlatched, positive true, parallel BCD, at DTL/TTL logic levels. As shown in the timing diagram (Figure 1), all data outputs are valid when the STATUS line is low. The STATUS line is high during conversion when erroneous data will be present on the outputs.

### TRIGGERING CONVERSIONS

The AD2009 may be triggered internally at six conversions per second, or externally at rates of up to 100 conversions per second. For internal triggering, the Internal Trigger Output (Pin 1) should be connected to the Trigger Input (Pin B). For external triggering, a positive trigger pulse ( $<500\mu\text{s}$  width) should be applied to the Trigger Input (Pin B). Whether in-

ternal or external triggering is used, the last reading can be held and displayed by grounding or applying logic "0" to the Hold Input. At high conversion rates, the display may flicker unless synchronized to the AC line input, but data outputs will remain valid.

### CALIBRATION PROCEDURE

**"WARNING: For the safety of personnel and interconnected equipment, all calibration should be done using a plastic trimming tool only."**

A precision voltage reference is needed for calibration of the AD2009. The location of calibration potentiometers is shown in Figure 2. Before calibrating the AD2009, allow the unit to warmup to normal operating temperature. Always adjust the zero offset first then the gain.

**Zero adjustment:** Short the signal input (Pin 2) to the signal ground (Pin 10) and adjust the zero adjustment pot until the meter reads 000.

**Gain adjustment:** Apply an input of +1.900V (+190.0mV on AD2009/S) and adjust the gain pot until the meter reads 1900 exactly.

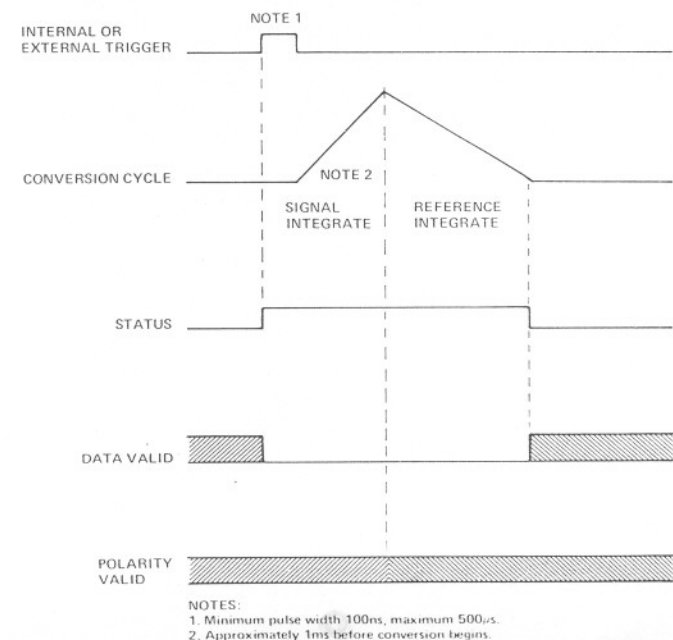


Figure 1. AD2009 Timing Diagram

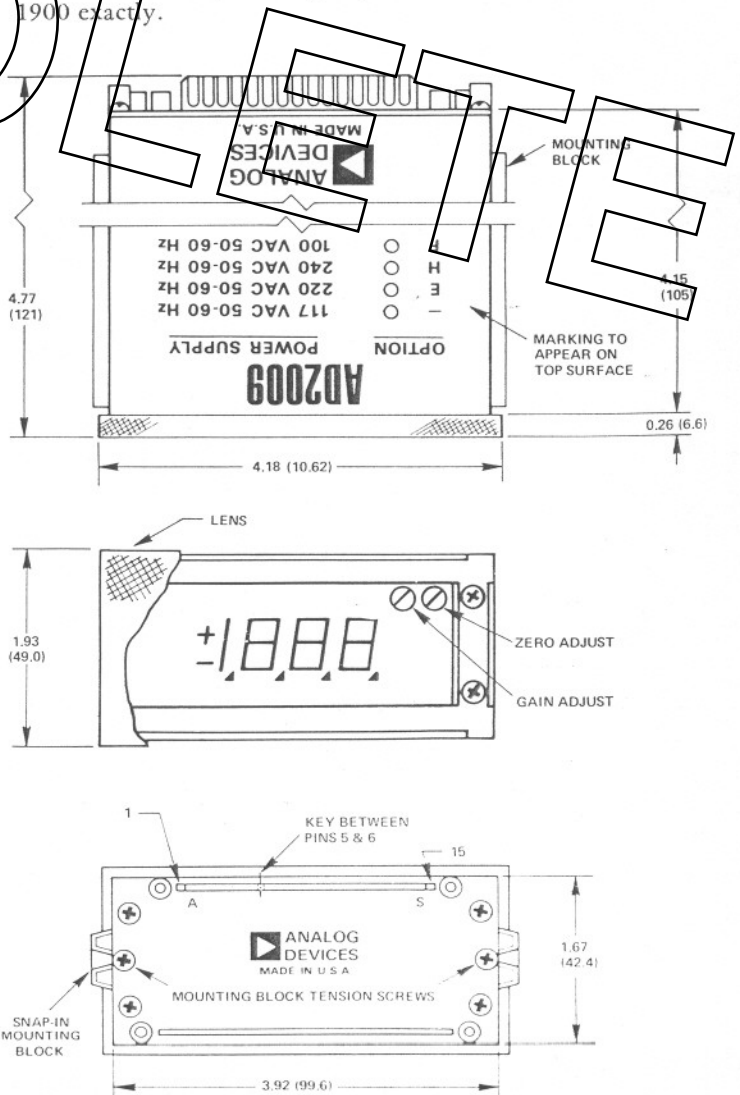


Figure 2. AD2009 Mechanical Outline (Dimensions shown in inches and (mm))

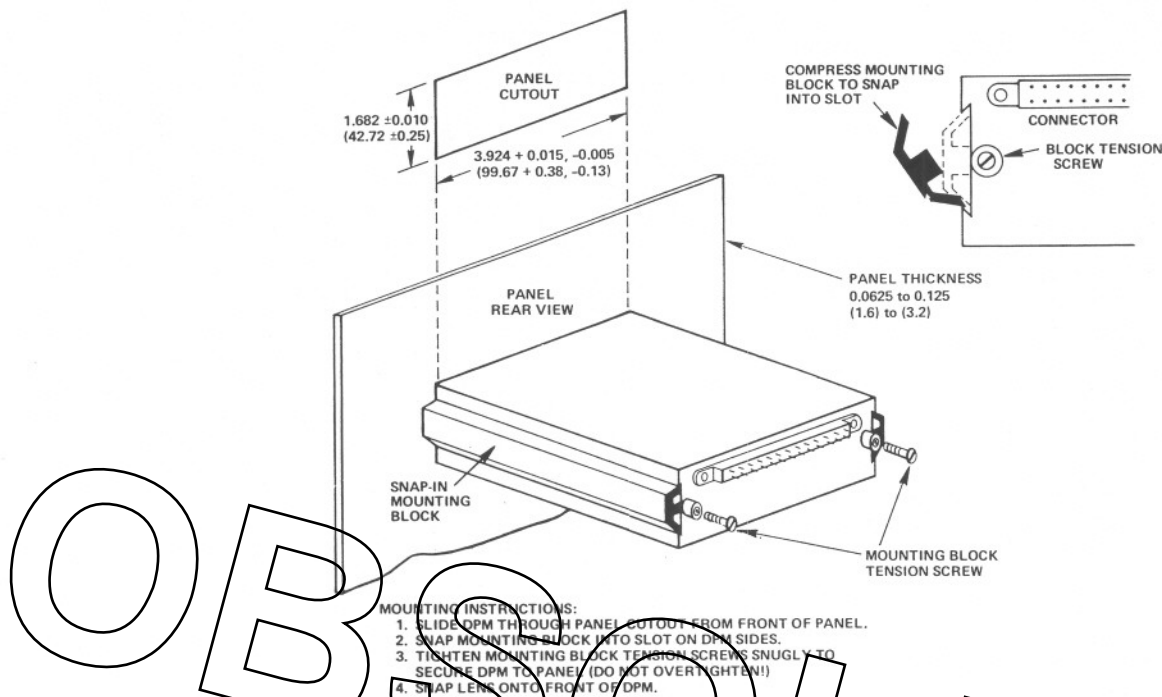


Figure 3. AD2009 Mounting Instructions  
(Dimensions shown in inches and (mm))

PIN REF	PIN FUNCTION
1	INTERNAL TRIGGER OUT <sup>1</sup>
2	SIGNAL INPUT
3	STATUS (PRINT)
4	POLARITY
5	BCD 8
6	BCD 2
7	BCD 80
8	BCD 20
9	BCD 800
10	SIGNAL GROUND
11	BCD 400
12	BCD 200
13	DISPLAY BLANK
14	OVERRANGE
15	AC LINE HI

KEY

PIN REF	PIN FUNCTION
A	NO CONNECTION
B	EXTERNAL TRIGGER IN <sup>1</sup>
C	OVERLOAD
D	HOLD
E	BCD 1
F	BCD 4
H	BCD 10
J	BCD 40
K	BCD 100
L	DP3/XX.X
M	DP2/X.XX
N	DIGITAL GROUND
P	DP1/.XXX
R	SHIELD (EARTH GROUND)
S	AC LINE LO

<sup>1</sup> Pin 1 and Pin B must be connected for operation with internal trigger.

Figure 4. AD2009 Signal and Pin Designations