4½ Digit AC Powered DPM With Beckman Displays

AD2008

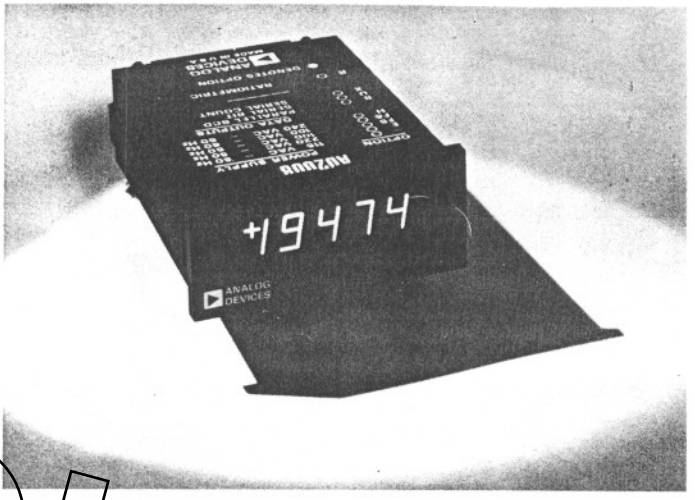
PRELIMINARY TECHNICAL DATA

FEATURES

- AC Line Powered
- Bright Seven-Segment Gas-Discharge Display
- Floating Input: >100dB CMRR, 300V RMS CMV
- NMR: >60dB @ 50 or 60Hz
- ±0.005%R ±50μV ±1 Digit Max Error
- Auto-Zero Correction
- Optional Ratiometric Operation
- Versatile Data Output Options — DTL/TTL/CMOS/PMOS Compatible

APPLICATIONS

- Accurate Measurements in Noisy Electrical Environments
- High Accuracy Readouts for Test Equipment, Process Control Instrumentation, and Analytical and Scientific Instruments



Analog Devices' AD2008 is a 4½ digit AC line powered DPM designed for making high accuracy measurements in adverse electrical environments. The AD2008 measures bipolar voltages with a full scale range of ±1.9999V and an accuracy of ±0.005% reading ±50μV ±1 digit. The full floating, opto-isolated input section provides >100dB of common mode noise rejection at common mode voltages up to 300V RMS even with control signals and optional data outputs connected. In addition, the dual slope integrating conversion technique allows >60dB of normal mode noise rejection at 50 or 60Hz without filtering.

LARGE, BRIGHT, EASILY READ DISPLAY

The AD2008 presents a visual readout on large 0.55 inch (14mm) Beckman seven-segment gas-discharge displays. These displays are easily read at distances up to 50 feet (15 meters) and over viewing angles of 130° in all ambient lighting conditions. Four decimal points are externally programmable. Controls are also available for display testing by illuminating all display segments, and independently blanking either the polarity sign or the entire display. The display lens is color matched to the gas discharge display. The lens has a non-glare, scratch-resistant finish and is easily marked with company logo or measurement units.

VERSATILE DATA OUTPUT OPTIONS

The AD2008 uses a MOS/LSI integrated circuit that provides 4½ decades of counters and latches with considerable savings in size and power consumption. The data from this chip is provided in a character serial format, one decade at a time, which is used to multiplex the display. Since this data is not easily interfaced to other data devices, two extra cost options are available for applications requiring BCD data interfacing. The AD2008/B provides full parallel latched BCD data for 4½ digits, overload and polarity. The AD2006/X provides a pulse train output and a polarity output, and the data must be counted external to the DPM. To extend application versatility, digital data output options are compatible to all DTL/TTL/CMOS/PMOS logic systems.

Full details on the data output options are given in the specifications and timing diagram (Figure 2). The AD2008 normally provides 2.5 conversions per second. Externally triggered rates up to 5 conversions per second or automatic recycling at 5–10 conversions per second are also possible.

OPTIONAL RATIOMETRIC OPERATION

The AD2008/R option allows the DPM to be used to measure the ratio of two input voltages. This is very useful when measuring with a transducer whose output is dependent on its excitation voltage. The DPM measures the ratio of the two voltages and thereby compensates for any variations caused by instability in the excitation voltage. Both the analog input and the external reference input are floating. For operation in the ratiometric mode, the AD2008/R is supplied without internal references; both positive and negative references must be supplied externally.

(continued on page 3)

Route 1 Industrial Park; P.O. Box 280; Norwood, Mass. 02062
Tel: 617/329-4700 TWX: 710/394-6577
West Coast Tel: 213/595-1783
Mid-West Tel: 312/297-8710

PECIFICATIONS (typical @ +25°C and nominal line voltage unless otherwise specified)

SPLAY OUTPUT
- Beckman seven-segment gas discharge-displays, 0.55" (14mm) high, for four data digits, 100% overrange and polarity indications.
- Overload indicated by center segment dashes, polarity remains valid.
- Decimal points selectable at input connector.
- Polarity sign blanking
- Display blanking
- Display test

NALOG INPUT
- Full Scale Range – ±1.9999V
- Automatic Polarity
- Automatic Zero
- Input Impedance: $>10^9\,\Omega$, shunted with 10pF
- Bias Current: <1nA (<10nA over full operating temperature range)
- Overvoltage Protection: 115V RMS sustained

ATIOMETRIC INPUT
- Both positive and negative reference inputs must be provided. (Polarity and magnitude of the reference voltages are measured with respect to the analog low input since the DPM input section is floating.)
- Reference Input Range: $+600mV \leq +V_{REF} \leq +1.2V$, $-600mV \geq -V_{REF} \geq -1.2V$ for rated accuracy
- Reference Input Impedance: $>10^9\,\Omega$, shunted with 10pF
- Bias Current: <1nA (<10nA over full operating temperature range)
- Overvoltage Protection: 50V RMS sustained
- Reference Input Noise Rejection: 20dB/decade, beginning @ –3dB @ 5Hz

ACCURACY
- ±0.005% Reading ±50μV ±1 digit (internal reference) ±0.005% V_{IN}/V_{REF} ±50μV ±1 digit (Ratiometric)
- Resolution: 0.1mV
- Temperature Range: 0 to +60°C operating; –55°C to +85°C storage
- Temperature Coefficients: Gain: 15ppm/°C; Offset: <1μV/°C
- Stability (1000 hours): Gain: 100ppm; Zero: <±10μV
- Settling Time to Rated Accuracy: effectively zero for both analog input and reference input
- Warmup to Rated Accuracy: 15 minutes

ORMAL MODE REJECTION
- >60dB at 50 or 60Hz

OMMON MODE REJECTION
- >100dB with 10kΩ inbalance, $dV_{cm}/dt < 10^6$ V/sec (1.6×10^5 VHz) (i.e., 160V CMV @ 1kHz)

OMMON MODE VOLTAGE
- 300V RMS

DIGITAL CONTROL SIGNALS

Inputs
- Logic Levels: DTL/TTL Inputs: 0≤Logic "0" ≤+0.8V; +2.0 ≤Logic "1" ≤+5V
  Trigger/Hold Input: 0≤Logic "0" ≤+1.5V; +3.5V ≤Logic "1" ≤+5V
  (all inputs are 1TTL load)
- Display Segment Test. DTL/TTL Compatible. Logic "0" or grounding activates all display segments except decimal points. Logic "1" or open circuit for normal operation. After a display test has occurred, the display and output data will not be valid until a new conversion is completed.
- Display Blank. DTL/TTL Compatible. Logic "0" or grounding blanks the entire display including the decimal points. Logic "1" or open circuit for normal operation. Display blanking has no effect on output data and the display is valid immediately upon removal of a blanking signal.
- Polarity Sign Blank. DTL/TTL Compatible. Logic "0" or grounding blanks the polarity sign indication: logic "1" or open circuit for normal operation. Polarity sign blanking has no effect on output data and the polarity sign is valid immediately upon removal of the blanking signal.
- Decimal Points: Grounding the appropriate pin illuminates the desired decimal point. Open circuit turns the decimal point off. External drive circuitry must withstand 200V when decimal points are turned off.
- External Trigger/Hold. DTL/TTL/CMOS/PMOS Compatible. Open circuit on this line allows the DPM to convert at a rate of 2.5 conversions per second under control of its internal clock. Logic "0" on this line will inhibit any further conversions but allow completion of any conversion in process. A positive pulse on this line will trigger a new conversion provided no conversion is in process. The pulse width must be at least 10μsec, but not wider than one conversion period to prevent multiple conversions. The actual conversion begins approximately 10μs after the leading edge of the trigger pulse. Applying a constant logic "1" or connecting this input to the +5V output will cause the DPM to operate in a maximum rate automatic recycle mode, converting at a rate of 5–10 conversions per second, depending on input voltage.

DATA OUTPUTS
- Logic Levels: 0V≤Logic "0" ≤0.4V; +4.0V≤Logic "1" ≤+5.0V (all outputs are capable of driving 6 standard TTL loads)
- Logic Compatibility: All data outputs are full compatible with all DTL/TTL/CMOS/PMOS logic
- Parallel Data Output (Option "B"):
  Data Ready Flag – Logic "1" when data is ready for transfer
  4½BCD Digits, Positive True
  Overload, Positive True
  Polarity Sign, Logic "0" for positive; Logic "1" for negative
- Count Data Output (Option "X"):
  Data Ready Flag – Logic "1" = true
  Polarity – Logic "0" = positive
  Count Output – positive transition

  The count output is a string of clock pulses at 200kHz (for 60Hz operation) or 166.66667kHz (for 50Hz), which can be counted by counters external to the DPM. The count output is "0" when not active until approximately 100ms after the ready flag falls. 5μs after the last count pulse, the ready flag comes up indicating the end of data transmission. External counters should count positive clock transitions. The delayed transition of the status after conversion allows using this signal to gate external ripple counters without timing problems.

CONVERSION TIME
- 200ms for full scale input, 320ms max for overload conversion (250ms for versions optimized for 50Hz operation, 400ms max for overload)

CONVERSION RATE
- Internal Trigger: 2.5 conversions per second
- External Trigger: 5 conversions per second maximum
- Auto Recycle Mode: 5–10 conversions per second, depending on input voltage
- Hold and Read on Command

EXTERNALLY AVAILABLE POWER OUTPUTS
- +5V @ 50mA maximum

POWER INPUT
- AC line, 47 to 440Hz, 4 watts max. Options for all common line voltages are available, see ordering guide.

SIZE
- 4.18"W x 1.93"H x 5.19"D (106 x 49 x 132mm)
  5.83" (148mm) max. to rear of connector

WEIGHT
- 2.3 oz., 65.2 gm.

CONNECTORS:
- P1 36 Pin, 0.156 inch spacing card edge connector, Viking No. 2Vk 18D/1-2 or equivalent
- P1 Optional – Order AC2610 @ $5.00 each
- P2 30 Pin, 0.156 inch spacing card edge connector, Viking No. 2Vk 15D/1-2 or equivalent
- P2 Optional – Order AC1501, $3.50 each

ORDERING GUIDE		PRICING 1–9	100
Power Supply Options[1]			
AD2008	115VAC ±10% @ 60Hz	$295	$195
AD2008/E	220VAC ±10% @ 50Hz		
AD2008/F5	100VAC ±10% @ 50Hz		
AD2008/F6	100VAC ±10% @ 60Hz		
AD2008/H	240VAC ±10% @ 50Hz		
Data Output Options[2]			
B (Parallel BCD)		$ 60[3]	$ 40[3]
X (Count)		$ 30[3]	$ 20[3]
Ratiometric Operation (R)		(No Cost)	
Display Lens Options[4]		(No Cost)	
Lens 7	Red with ADI Logo		
Lens 8	Red without ADI Logo		
Lens 13	Amber with ADI Logo		
Lens 14	Amber without ADI Logo		

[1] Only one power supply option may be specified on any single AD2008.
[2] Only one data output option may be specified. If data outputs are not needed, no option should be specified.
[3] Additional cost above base price of DPM.
[4] Lens 7 is supplied if no lens option is specified.

Specifications subject to change without notice.

(continued from page 1)

APPLICATION VERSATILITY

The high accuracy, good noise immunity, ratiometric option and versatile data output options make the AD2008 easy to integrate in many types of measurement systems. Some typical applications include:
- In-house test equipment for instruments and components where a bright, easily-read display, high accuracy and long term stability are needed.
- Digital weighing systems, using the ratiometric option for accurately reading the output of bridge-type transducers. The AD2008 can be calibrated easily to read out in the proper units. Long term stability is a plus here, too.
- Analytical and scientific instrumentation where high accuracy and wide dynamic range of measurement are necessary.
- Process control monitoring in an industrial environment, where E–M noise and high common mode voltages are commonplace.

DESIGNED AND BUILT FOR RELIABILITY

High reliability has been designed into the AD2008. In the AD2008, the latest IC technology is utilized to minimize parts count and lower heat dissipation for cooler operation. Manufacturing processes are controlled by continuous quality assurance inspections to insure proper workmanship and testing. Like every other Analog Devices' DPM, the AD2008 is fully tested for electronic specifications, vibration tested to 1% AQL and given one full week of failure-free burn-in before shipment. The design, manufacturing and testing procedures at Analog Devices are designed to insure reliable DPM's.

THEORY OF OPERATION

The block and timing diagrams for the AD2008 are shown in Figures 1 and 2. The analog section is fully isolated using transformer isolation of the power supplies and opto-isolation of all logic signals. Upon receipt of a conversion command, an auto-zero cycle removes residual zero offsets. The analog input voltage is then switched to the integrator which ramps "up" for a constant period equal to 3 AC line cycles. A stable reference voltage of opposite polarity is then switched to the integrator for the "ramp down" cycle. During the ramp down period, internal clock pulses are counted in a MOS/LSI counter. The number of clock pulses counted during the ramp down period is proportional to the input voltage. At the end of conversion, the data is transferred to the internal latches of the MOS chip and is ready for display. The display is multiplexed, one digit at a time, at a rate fast enough to prevent any visible display flicker. If the "B" output data option is specified, the logic circuitry also transfers the data into output registers at the end of each conversion, making the data available for interfacing to data output devices. The "X" data option provides a gated pulse train output during the ramp down period for counting external to the DPM.

APPLYING THE AD2008

Scaling Inputs

The AD2008 is designed to measure inputs over a full scale range of 0 to ±1.9999 volts. If inputs in other ranges need to be measured, scaling of inputs can easily be done by amplifying low level voltages or attenuating large voltage inputs. If a low level signal must be amplified to be measured by the AD2008, the amplifier chosen must be a high grade instrumentation

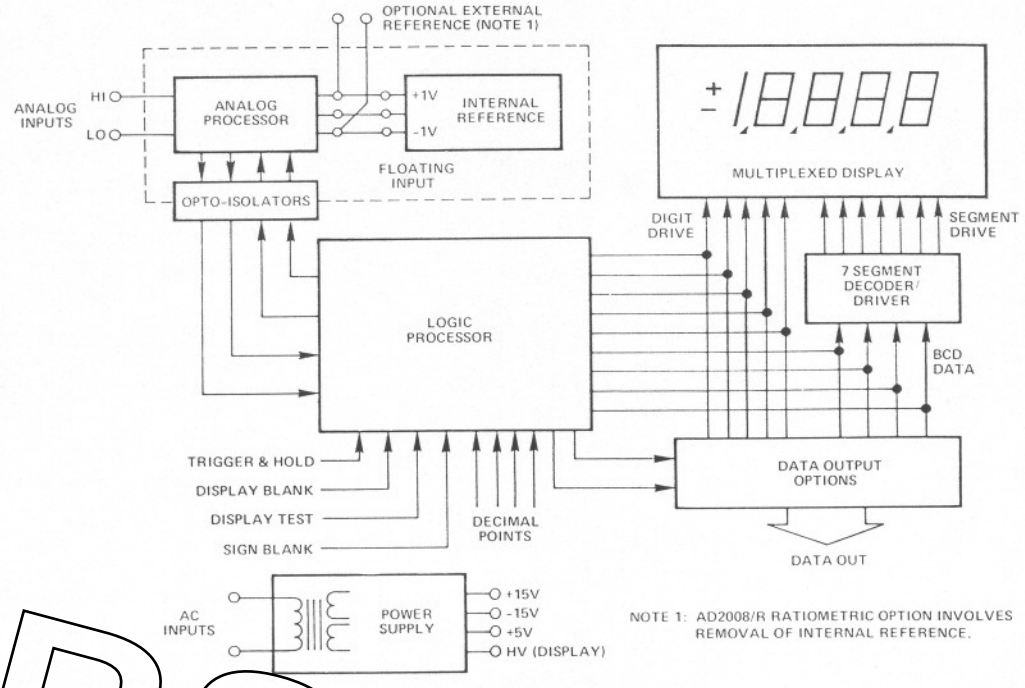


Figure 1. AD2008 Block Diagram

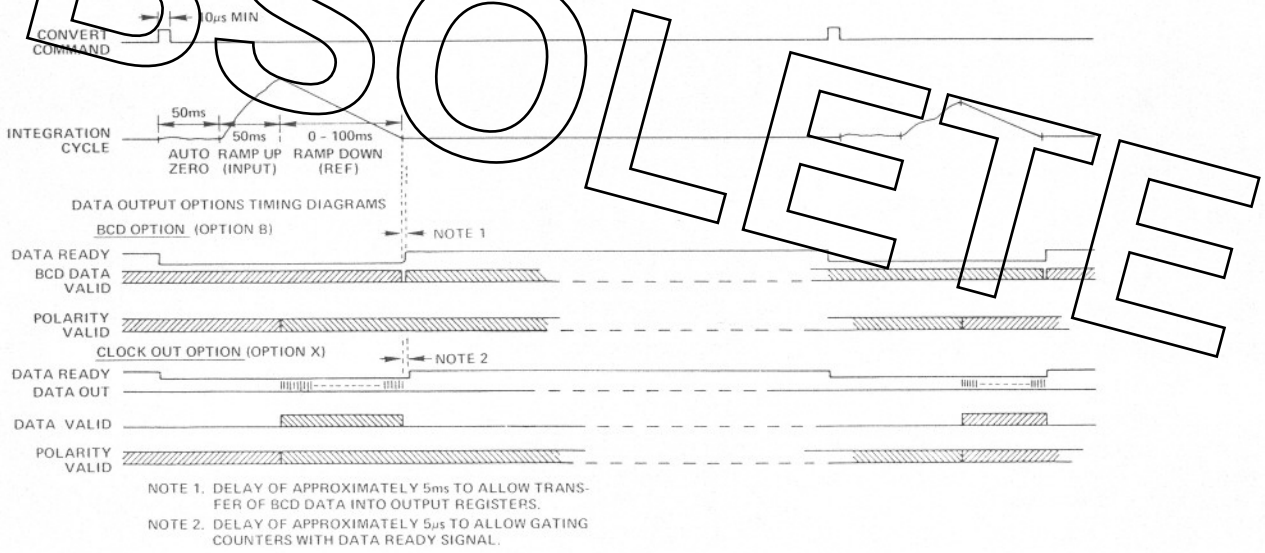


Figure 2. AD2008 Timing Diagram

amplifier or chopper amplifier with performance on a par with the DPM. Attenuators, likewise, must be chosen with the DPM in mind. Attenuator resistors should have tempcos of less than 15ppm and be selected for tracking characteristics. Since the bias current of the AD2008 will change with temperature, keeping the source impedance below 100kΩ will prevent a zero level shift with changes in temperature.

Whenever scaled inputs are necessary, remember to make the signal being transmitted to the DPM as large as possible. Amplification should be done close to the source, attenuation close to the DPM. This will minimize the effects of EMI in noisy environments.

The floating input of the AD2008 makes current measurements easy, by allowing measurements to be made at very high common mode voltages. Shunt resistors should be chosen with wattage ratings sufficient to prevent measurement degradation by heating. For very large currents, a four-terminal meter shunt can be used, but the tempco of the shunt should be carefully checked.

RATIOMETRIC OPERATION

The optional AD2008/R measures the ratio of the analog input voltage and an external reference voltage. Since the DPM ramps "up" on the analog input and "down" on the reference input, it is essential that both these voltages be stable during the conversion period to assure accurate ratiometric measurements. In the ratiometric mode, the DPM displays $10^4 \times V_{in}/V_{ref}$. Reference voltages in the range of 600mV to 1.3V can be used. Reference voltages of both polarities are needed for proper operation of the AD2008 auto-zero circuit. However, if unipolar measurements only are necessary, only the reference voltage of the opposite polarity of the input needs to be stable; a 1V reference that is not noisy is acceptable for the reference voltage of the same polarity as the input. Since the input of the AD2008 is fully floating, both the input and references are measured with respect to the analog low input.

INTERFACING DIGITAL SIGNALS

Conversion Rate Control

The External Trigger/Hold input is a tri-state logic circuit allowing full control of the DPM conversion rate. Leaving this input open will allow the DPM to convert at the internally clocked 2.5 conversions per second rate. A logic "1" or +5V applied to this input will cause the DPM to begin a new conversion immediately (~20μs) after completing the previous conversion. Since the conversion time depends on the input voltage, the DPM will convert at rates between 5 and 10 per second. If it is desirable to use the DPM in the auto recycle mode and have data outputs, one must use the pulse train output (Option X), since insuffieient time exists between conversions to allow loading the BCD parallel data registers (Option B).

If the Trigger/Hold input is held at logic "0" or grounded, the DPM will complete any conversion in process and hold the reading until this line is released. A positive pulse on this line (logic "0" to logic "1" and return) will initiate a new conversion within 10μs of the leading edge of the pulse, provided no conversion is in process. When a conversion is in process, the pulse will be ignored. Pulse width must be at least 10μs, but less than one conversion period to prevent multiple conversions.

Parallel Data Output Option

The parallel data outputs (Option B) can be interfaced to any data processing device in a conventional manner. Note on the timing diagram (Figure 2) that while the BCD data is updated at the end of each conversion, the polarity bit is updated after the "ramp up" period. Therefore, the data is valid after the "Data Ready" signal goes high, but data transfer to external devices must be completed before the polarity bit is updated (approximately 100ms after the status goes low again).

Pulse Train Output Option

The pulse train output (Option X) is a series of pulses designed to be counted external to the DPM. The timing diagram (Figure 2) shows that the pulse train output is available during the ramp down period, which begins ~100ms after the status line goes low. The frequency of these pulses is 200kHz on units optimized for 60Hz operation, 166.67kHz on units for 50Hz operation. External counters should count on the positive transition. Since the "Data Ready" line does not go high until approximately 5μs after the last pulse, the status signal can be used to gate ripple counters without timing problems. As with the BCD data, the polarity bit is updated at the end of the ramp up period, just preceding the pulse train output.

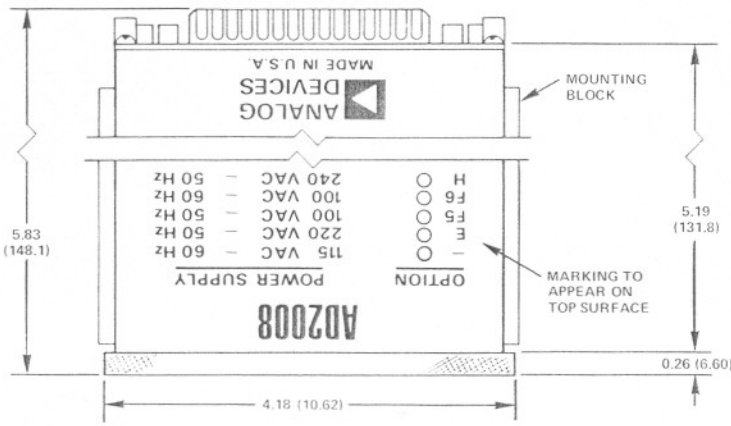
AD2008 CALIBRATION PROCEDURES

Warning: for the safety of personnel and interconnected equipment, all calibration adjustments should be made using a plastic trimming tool only.

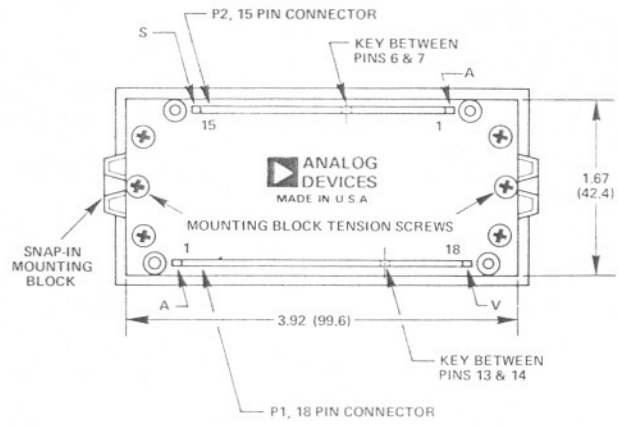
Zero and gain adjustments are provided for both (+) and (–) inputs. Although the AD2008 has an automatic zero correction circuitry, the zero adjustment is provided to compensate for non-linearities at very low input signal levels. This zero adjustment is fully calibrated in final testing and it normally will not need adjustment.

Zero Adjustment: Using a calibrated reference source, apply an input of +100μV ±15μV, and adjust the (+) zero pot until the meter reads +0001. Repeat the procedure for –100μV ±15μV, adjusting the (–) zero pot.

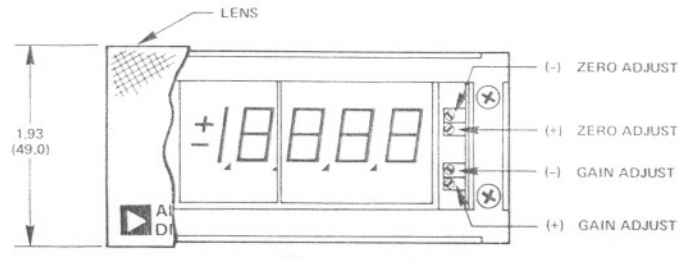
Gain: Apply an input of +1.9V ±15μV. Adjust the (+) gain pot so that the DPM reads +1900. Turning the pot clockwise increases the reading. Repeat for an input of –1.9V ±15μV, adjusting the (–) gain pot.



TOP VIEW



REAR VIEW



FRONT VIEW

Figure 3. AD2008 Mechanical Outline (Dimensions shown in inches and (mm))

P1

PIN	FUNCTION
1*	2×10^3
2*	2×10^2
3*	2×10^1
4*	2×10^0
5*	4×10^3
6*	4×10^2
7*	4×10^1
8*	4×10^0
9*	8×10^3
10*	8×10^2
11*	8×10^1
12*	8×10^0
13*	1×10^4
14*	AC LINE COMMON
15	N.C.
16	AC LINE (LO)
17	N.C.
18	AC LINE (HI)

KEY

PIN	FUNCTION
A	ANALOG HI
B	ANALOG LO
C	(-) REF
D	(+) REF
E	N.C.
F	GUARD
H*	DATA READY
J*	1×10^3
K*	1×10^2
L*	1×10^1
M*	1×10^0
N*	POLARITY
P*	OVERLOAD
R	AC LINE COMMON
S	N.C.
T	AC LINE (LO)
U	N.C.
V	AC LINE (HI)

*DENOTES PARALLEL BCD DATA (OPTION "B")

P2

PIN	FUNCTION
1	N.C.
2	N.C.
3	N.C.
4	N.C.
5	N.C.
6	$+V_E$ (+5V)
7	N.C.
8	N.C.
9	N.C.
10	N.C.
11	N.C.
12	N.C.
13	N.C.
14	DIGITAL COMMON
15	DISPLAY BLANK

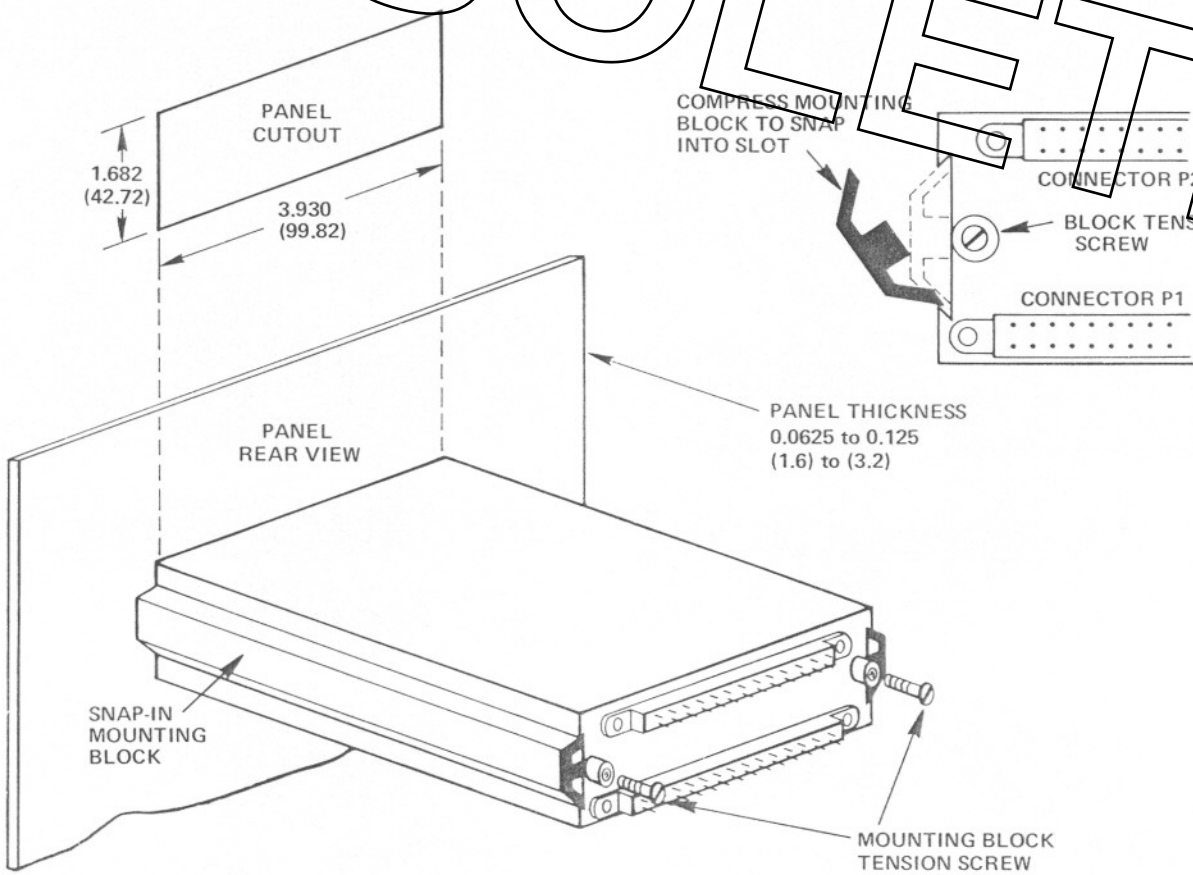
KEY

PIN	FUNCTION
A	DP1X.XXX
B	DP1XX.XX
C	DP1XXX.X
D	DP1.XXXX
E	SIGN BLANK
F	N.C.
H	N.C.
J	N.C.
K	N.C.
L	N.C.
M	N.C.
N	N.C.
P	N.C.
R	LAMP TEST
S	EXT. TRIGGER/HOLD

COUNT DATA OUTPUT
(OPTION X)

PIN	FUNCTION
P1-J	COUNT OUT
P1-H	DATA READY
P1-N	POLARITY
P2-14	DIGITAL COMMON

Figure 4. AD2008 Signal & Pin Designations



MOUNTING INSTRUCTIONS:
1. SLIDE DPM THROUGH PANEL CUTOUT FROM FRONT OF PANEL.
2. SNAP MOUNTING BLOCK INTO SLOT ON DPM SIDES.
3. TIGHTEN MOUNTING BLOCK TENSION SCREWS SNUGLY TO SECURE DPM TO PANEL (DO NOT OVERTIGHTEN!)
4. SNAP LENS ONTO FRONT OF DPM.

Figure 5. AD2008 Mounting Instructions (Dimensions shown in inches and (mm)).

C212-10-8/74

PRINTED IN U.S.A.