AC Powered 3½ Digit DPM with Sperry Display

AD2006

FEATURES
AC Line Powered (+5V dc Powered Optional)
0.55" Sperry Display
Differential Input
Maximum Error: ±0.05%±1 Digit
AC Terminal Strip for Safety
Ratiometric Operation
Power Outputs for External Circuitry

APPLICATIONS
Analytical, Medical and Scientific Instrumentation
Industrial Test Equipment
Process Control Instrumentation

GENERAL DESCRIPTION

Analog Devices' model AD2006 is an ac line-powered, 3½ digit panel meter with Sperry displays for high visibility. The design of the AD2006 includes ratiometric operation and external power outputs to increase its application versatility.

The AD2006 provides high accuracy measurements of bipolar, differential input signals over a full scale range of ±1.999V, with a maximum error of ±0.05% (reading) ±1 digit. For most applications, the differential input section provides greater than 70dB of common mode rejection (CMRR) at common mode voltages (CMV) up to ±5V. In addition, the AD2006 can be floated on the ac power supply in the single-ended mode, allowing common mode voltages up to ±300V to be accommodated with common mode rejection exceeding 100dB. To insure the safety of operational personnel and interconnected equipment, especially at high CMV, a terminal strip is provided for connection of ac power.

For best visual readout, the AD2006 is internally programmed to make 5 readings per second. For data acquisition applications, up to 90 conversions per second can be externally triggered. DTL/TTL compatible parallel BCD data outputs and control signals are provided for interfacing to other digital data systems. To extend its versatility, external power outputs suitable for powering op amps and IC circuits are available to facilitate scaling or buffering inputs and driving external logic. Standard ratiometric operation allows normalizing inputs to an external reference voltage for making compensated measurements with bridge and potentiometric transducers.

In addition to ac line powered versions, the AD2006/D is available for operation from +5V dc power supplies commonly used for digital logic circuitry. The AD2006/D has identical performance specifications to all other AD2006 versions, except that it cannot be floated on the power supply for measurements at high common mode voltages and, of course, the +5V dc output is not available.

LARGE CLEAR DISPLAY ENHANCES READABILITY

The AD2006 uses large (0.55") Sperry, seven-segment, planar gas-discharge displays which appear as continuous solid digits. The display size, brightness and contrast ratio makes the AD2006 readable at distances up to 40 feet or more and in any ambient lighting condition including bright sunlight. The display is filtered to provide bright red digits and is readable without distortion over a 130° viewing angle. Overload conditions are indicated by displaying all dashes with the polarity sign remaining valid. The polarity sign can be blanked for display in engineering units where polarity indication is unnecessary.

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For detailed information, contact factory.

SPECIFICATIONS (typical @ +25°C unless otherwise noted)

DISPLAY OUTPUT
- Sperry Gas Discharge displays (seven segment, 0.55" (1.4cm)H), for 3 data digits, 100% overrange and polarity indication.
- Overload: Center segment dashes, polarity remains valid.
- Decimal Points: Selectable at input connector (contact closure).
- Polarity Sign may be blanked for display in engineering units.

INPUT
- Full Scale Range: 0 – ±1.999V
- Automatic Polarity
- Differential
- Bias Current: High Input – 3nA typ. (7nA maximum)
  Low Input – 200nA typ. (500nA maximum)
- Impedance: >100MΩ
- Overvoltage Protection: Analog Hi = ±50V sustained
  Analog Low = ±30V sustained

EXTERNAL REFERENCE INPUT
- Range: +5.8 to +6.8 Volts
- Input Impedance: >0.5MΩ
- Not protected against overvoltage
- Absolute Value Measurements: Internal +6.4V reference must be externally connected to the reference input.

ACCURACY
- Maximum Error: 0.05% of reading ±1 digit
- Resolution: 1mV
- Temperature Range: 0 to +50°C operating, -55°C to +85°C storage.
- Temperature Coefficient: Gain: <50ppm/°C
  Zero: <±50μV/°C

COMMON MODE REJECTION
- Differential Mode: 70dB, dc to 1kHz, with 1kΩ unbalance
- Floated on power supply transformer: >100dB[1]

COMMON MODE VOLTAGE
- Differential Mode: ±5V
- Floating Mode: ±300V dc (600V p-p ac)[1]

SPEED
- External Trigger: Up to 90 conversions per second (without display)
- Internal Trigger: 5 conversions per second
- Hold and Read on Command

CONVERSION TIME
- Normal Conversion: 9ms maximum
- Overload Conversion: 11ms maximum

INTERFACE SIGNALS
- DTL/TTL Compatible

	IN	OUT
logic "0"	<0.8V	<0.4V
logic "1"	>2.0V	>2.4V

- Inputs
  Polarity Sign Blanking: Logic "0" or grounding blanks the polarity sign being displayed.
  External Hold: Logic "0" or grounding this input disables the internal trigger, and the last conversion is held and displayed. External triggering can only be done when the AD2006 is in "HOLD".
  External Trigger: A negative trigger pulse applied to the external trigger input will initiate conversion.
- Outputs
  Status: All digital outputs are valid when status is low (logic "0"), logic "1" indicates conversion is in process.
  3BCD Digits (8421 positive true), unlatched, 6TTL loads.
  Overrange: Logic "1", unlatched, 6TTL loads, indicates overrange (>1.000V).
  Overload: Logic "1" unlatched, 6TTL loads, indicates overload (>1.999V), logic "0" indicates data is valid.
  Polarity: Logic "1", latched, 6TTL loads, indicates postive polarity.
  Polarity: Logic "1", latched, 6TTL loads indicates negative polarity.[2]

POWER
- AC line power (see option table), 7 Watts at nominal line voltage.
- AD2006/D: +5V dc @ 850mA

WARMUP
- 20 minutes to specified accuracy.

ADJUSTMENTS
(recommended calibration period: 6 months)
- Gain
- Zero Offset

EXTERNALLY AVAILABLE POWER OUTPUTS
- +5V ±5% @ 50mA (continuous short circuit protection)[1]
- ±15V ±10% @ 10mA (No short circuit protection; may require filtering for power supply-sensitive components)

SIZE
- 3"W x 1.8"H x 4"D (7.62 x 4.57 x 10.16cm) (4.95" (12.57cm) max to rear of mating connector, 4.80(12.19cm) max on AD2006/C)

WEIGHT
- 19 oz. (540gm) with ac power
- 10½ oz. (300gm) on AD2006/D

OPTIONAL FEATURES & ORDERING GUIDE
(All options on any AD2006 are listed on the label affixed to the bottom of the unit.)
- Power Supply Inputs (only one may be specified)

AD2006	115V ac ±10%	(50 – 60Hz)
AD2006/E	220V ac ±10%	(50 – 60Hz)
AD2006/H	240V ac ±10%	(50 – 60Hz)
AD2006/F	100V ac ±10%	(50 – 60Hz)
AD2006/D	+5V dc ±5%	

- Card Edge Connector: AD2006/C
- Any combination of the above options – excluding power inputs – can be specified. When ordering, specify power supply option first, then the other option desired. For example, an AD2006/E/C operates on 220V ac, and has the connector card edge.
- Display Lenses (only one may be specified):
  Lens-5 will be supplied if none is specified)
  Lens-5 Red w/ADI Logo
  Lens-6 Red no ADI Logo
  Lens-9 Amber w/ADI Logo
  Lens-10 Amber no ADI Logo

CONNECTOR
- 3M connector #3414, (optional) AC1600–34 pin connector and 6 ft. (1.83m) of color-coded, 34 way, 28 AWG flat woven cable.
- AC1601-connector only.
- AD2006/C requires 30 pin, 0.156 spacing, Viking No. 2VK 15D/1-2 or Cinch type 251 No. 5030A30.
- AD2006/C optional – Order AC1501.
- AC Power Line Cords are not supplied by ADI.

NOTES
[1] Not applicable to AD2006/D.
[2] Not applicable to AD2006/C.
Specifications subject to change without notice.

RATIOMETRIC OPERATION EXTENDS APPLICATIONS

The AD2006 has provision for making measurements normalized to an external reference voltage. This feature allows compensation for transducer outputs sensitive to excitation voltage variations, by making all measurements with reference to the excitation voltage. Figure 1 shows the AD2006 used with a bridge transducer which may be measuring temperature, pressure or any other physical parameter. The excitation voltage of the transducer is used as the reference input of the DPM. When used in the ratiometric mode, reference inputs in the range of +5.8 to 6.8 volts must be presented to the REFERENCE INPUT. The reference input must be relatively stable since the

DPM measures $\frac{\int_t E_{in}dt}{\int_t E_{ref}dt}$ not $\int_t \frac{E_{in}}{E_{ref}}dt$, and any variations

in the reference voltage during conversion may produce erroneous readings.

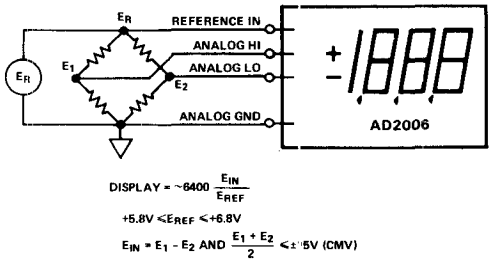

Figure 1. Bridge Transducer Measurements Using the AD2006's Ratiometric Input

The REFERENCE OUTPUT can be used for driving transducers if it is properly buffered using an external op amp. Figure 2 shows a thermistor temperature measuring circuit using the AD2006 to power the entire measurement system. The REFERENCE INPUT is a high impedence input which will not load any reference source, but this input is not protected from overload damage. If normal operation of a AD2006 is required, connection of the Reference Output to the Reference Input will allow operation using the internal +6.4V reference source.

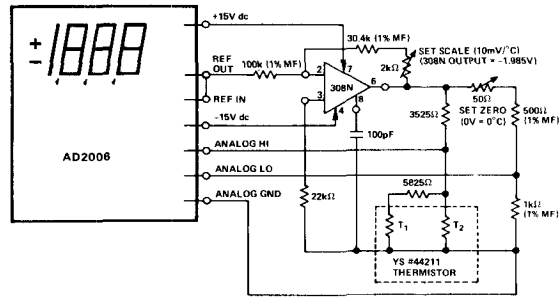

Figure 2. AD2006 Thermistor Temperature Measurement System

DC OUTPUTS CAN POWER EXTERNAL CIRCUITRY

Since the circuitry of the AD2006 requires ±15V and +5V to be generated internally, these voltages are made available to allow operation of external circuitry used in conjunction with the DPM. Sufficient power is available to drive op amps to scale inputs or even buffer the reference output to drive transducers such as in the thermistor application shown in Figure 2. The +5V output (not available on AD2006/D models) can be used for external logic. In many measurement systems, these power outputs will be sufficient to power all the circuitry external to the DPM. Although the regulation and ripple are adequate for the sensitive analog and digital circuitry of the AD2006, further filtering may be necessary for components that are extremely power supply sensitive.

AD2006 THEORY OF OPERATION

Figures 3 and 4 are the block diagram and timing diagram for the AD2006. The AD2006 uses a standard dual slope conversion technique with an absolute value voltage to current converter on the input. The absolute value of the analog input voltage produces a proportional current. When the convert command pulse initiates conversion, this current is integrated "up" for a fixed time period (1000 clock periods). The con-

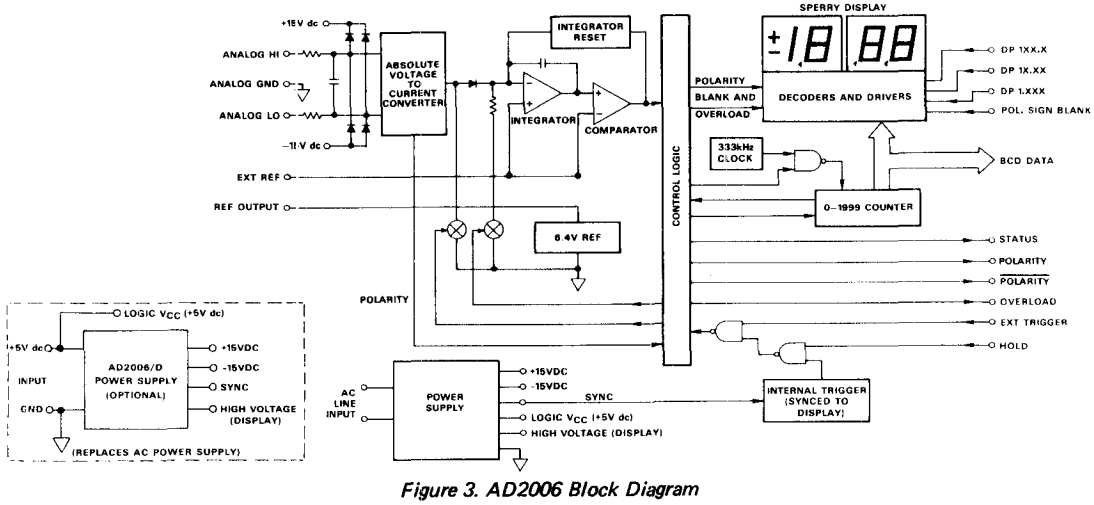

Figure 3. AD2006 Block Diagram

verter then integrates "down" using a reference current of opposite polarity until the comparator senses that the integrator output voltage has returned to the original baseline. During the ramp-down period, the counters count clock pulses, and the number stored at the end of ramp-down is proportional to the analog input voltage.

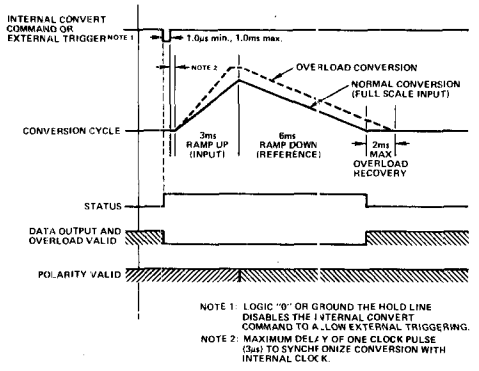

Figure 4. AD2006 Timing Diagram

INTERFACING THE AD2006

AC POWER CONNECTIONS: Connect ac power lines to the terminal strip on the rear of the AD2006. The ground line is internally connected to the case of the DPM. To assure safe operation, always use three-wire ac only, and cover the terminal strip with the protective cover provided. AD2006/D versions use the +5V dc Output and the Digital Ground as power supply INPUTS.

INPUT CONNECTIONS: Differential input signals should be connected between the ANALOG HI and the ANALOG LOW. The ANALOG GROUND must be connected to the system ground. For single-ended operation, connect the ANALOG LOW to the ANALOG GROUND. To allow operation at high common mode voltage, the AD2006 may be floated on the ac power supply transformer in the single-ended mode, without the digital interface signals connected. (See note on decimal points. AD2006/D versions can only be operated in the differential mode.) For absolute value measurements, the REFERENCE OUTPUT must be connected to the REFERENCE INPUT.

DECIMAL POINTS: Grounding the appropriate pin will illuminate the desired decimal point. (Note: Decimal points can be used in the "floating" mode if and only if the appropriate pin is grounded only to the AD2006 digital ground.

DIGITAL DATA OUTPUTS: The digital data outputs are unlatched, positive true, parallel BCD, at DTL/TTL logic levels. All data outputs are valid when the STATUS line is low (logic "0"). Erroneous data will be present when the conversion is in process and the STATUS line is high.

EXTERNAL CONTROL SIGNALS:

EXTERNAL HOLD: Logic "0" or grounding the HOLD input disables the internal trigger, and the last conversion is held and displayed. If a HOLD input is applied during conversion, the conversion will be completed and displayed. No further conversions will be made unless the HOLD input is removed or an EXTERNAL TRIGGER pulse is applied.

EXTERNAL TRIGGER: Operating in the EXTERNAL TRIGGER mode requires that the HOLD line be held at logic "0" or grounded. A negative going trigger pulse (logic "1" to logic "0" and return) of 1μs minimum and 1ms maximum width applied to the trigger input will initiate a conversion. The external trigger input must be a pulse since the STATUS is set on the negative-going edge of the pulse and the conversion is initiated on the positive-going edge of the pulse. Triggering at high rates asynchronously with line frequency may cause modulation of the display brightness, since the display is blanked both during conversion and during the negative half of the line cycle. *Care should be taken to insure that triggering does not occur during conversion, as this will cause an erroneous conversion.*

POLARITY SIGN: A logic "0" or ground blanks the polarity sign being displayed.

CALIBRATION PROCEDURES

WARNING: For the safety of personnel and interconnected equipment, all calibration should be done using a PLASTIC TRIMMING TOOL ONLY.

The accuracy of the AD2006 should be checked approximately every six months. A precision voltage reference or a calibrated DVM or DMM and a stable voltage source are required. The location of the adjustment potentiometers are shown on the mechanical layout drawings. Under most circumstances, only the gain will need adjustment. Should zero adjustment be necessary, adjust the zero before adjusting the gain.

ZERO OFFSET: Apply an input of 0V or short the analog inputs. If the meter does not read zero, adjust the zero offset pot until the meter reads zero and the polarity sign periodically changes. (Turning the pot clockwise, viewed from the back, makes the reading more negative.)

GAIN: Set the input of the panel meter to 1.900V. The input can be from a precision reference source, or from a stable voltage source set using a calibrated DVM or DMM. If the meter does not read 1900, adjust the gain pot to set the proper reading. (Turning the pot clockwise will increase the reading.) This is a bipolar adjustment, when correctly adjusted, the meter will read correctly for both polarities.