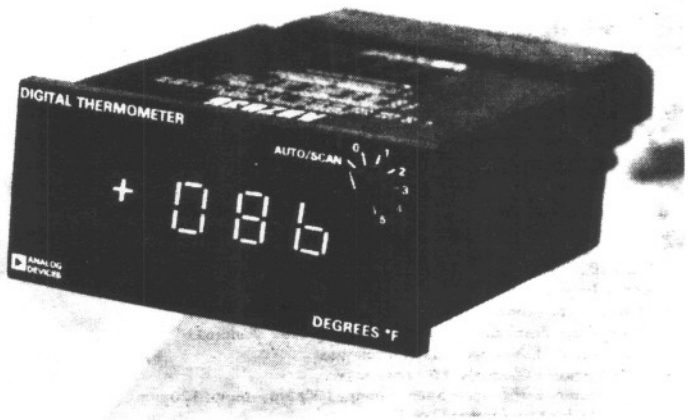
6 Channel Scanning Digital Thermometer

AD2036

FEATURES

- Automatic/Manual Scan of 6 Thermocouples (TCs)
- External Channel Selection by BCD Code
- J, K, or T Thermocouple
- °C or °F Readout
- Self-Contained Linearization
- Isolated Analog Input
- Parallel BCD Output
- 1° Resolution, 0.1° Optional
- AC Line or dc Powered
- +5V dc at 10mA for External Logic



APPLICATIONS

- Multi-Point Temperature Measurements for Remote Data Acquisition and Data Logging
- Temperature Monitoring in Design, Laboratory, Manufacturing and Quality Control

GENERAL DESCRIPTION

The AD2036 is a low cost 3½ digit, ac line or dc powered digital readout temperature meter. Inputs for six thermocouples of identical types, either J, K, or T and calibrated temperature ranges in °C or °F, make up a total of six available models.

Cycling on an internal clock, the AD2036 can continually scan 6 input channels. Individual channels can be manually selected via a small switch on the front. Channel selection can also be made via an external BCD input at the rear connector. A separate channel select output identifies the selected channel independent of selection mode. The channel select output together with the BCD Output provides complete information for automatic data collection. The Isolated Parallel BCD Output provides an easy interface to conventional recording and controlling instruments. For applications where there are high common mode voltages (CMV) present, the AD2036 has as a standard feature a floating opto isolated analog front end that will withstand CMV's up to 250V rms.

The AD2036 displays readings on large 0.5″ (13mm) high LED displays. Both (+) and (–) polarities are indicated. Controls are provided for blanking the display.

AUTO/SCAN

The AD2036, while in the Auto/Scan mode, will permit unattended scanning of all six input channels. The rate of the channel select is 3.2 seconds, 1.6 seconds or 0.8 seconds. The AD2036 can be used as a stand-alone instrument and with the Scan input held high will continually scan six channels. When the Scan input is brought low the AD2036 will continue to cycle and stop at channel 0. When used with a printer the channel select number in addition to the converted BCD value can be recorded.

MANUAL CHANNEL SELECTION

A switch on the front enables the user to manually select an individual thermocouple. As in the Auto/Scan mode, the BCD Output of the selected channel and the channel number are available. Selection of an individual TC channel automatically disables Scan and external channel selection is overridden. The Mode Output pin indicates when the switch is in this condition. On special order, meters can be supplied with card edge control for disabling the switch.

EXTERNAL CHANNEL SELECTION

For remote control of channel selection the AD2036 provides an input for an external BCD code selection. This feature enables external BCD switch, automatic microprocessor or computer control.

STANDARD PACKAGING

The AD2036 is packaged in Analog Devices' ac line powered DPM case which uses the same panel cutout as most other ac line powered DPM's from other manufacturers. In addition, the pin connections for the AD2036 converter board are the same as for the AD2022, AD2009, AD2016 and DPM's available from several other manufacturers.

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For detailed information, contact factory.

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

TYPES OF THERMOCOUPLE (TCs): J, K, or T

ACCURACY[1]

	°C	Error ±½LSB		°F	Error ±½LSB
J	−60 to 0	±1.4	J	−76 to 32	±2.5
	0 to 500	±1.4		32 to 932	±2.5
	500 to 760	±2.2		932 to 1400	±4.0
K	−60 to 0	±1.4	K	−76 to 32	±2.5
	0 to 150	±1.4		32 to 302	±2.5
	150 to 1350	±2.6		302 to 2000	±4.7
T	−100 to 0	±1.3	T	−148 to 32	±2.3
	0 to 250	±1.5		32 to 450	±2.7
	250 to 400	±2.0		450 to 752	±3.6

DISPLAY OUTPUT
- Light emitting diode (LED), seven segment display readouts, 0.5" (13mm) high for 3 data digits, 100% overrange and polarity indication. Overload >1999 indicated by flashing display, polarity remains valid. There is no overload indication for out of range readings.
- Decimal points (3) selectable at input connector.
- Display Blanking

SIGNAL INPUT
- Input Impedance: 100MΩ
- Bias Current: 10nA
- Overvoltage Protection Between Channels: ±18V peak max
- Common Mode Voltage: ±350V peak max
- CMV Between Channels: ±6V peak max
- Temperature Coefficient: Span: ±temp, 100ppm; −temp, 120ppm
  Zero: 0.05 degrees/degree C or F
- Settling Time to Rated Accuracy: 2.0 seconds (full span step input)
- Normal Mode Rejection: 60dB at 50 – 400Hz
- Common Mode Rejection: 120dB @ 250V rms max CMV (Between TC's and digital gnd); $dv_{cm}/dt < 10^6$ V/sec, 250Ω imbalance

CONVERSION RATE
- 5 conversions per second
- Hold and read on command

CONTROL INPUTS

Display Blanking (TTL Compatible, 3 LSTTL Load) - Logic "0" or grounding blanks entire display except for decimal points; Logic "1" or open circuit for normal operation. Display blanking has no effect on output data. Display is valid immediately upon removal of blanking input.

$\overline{\text{Converter Hold}}$ (CMOS, TTL Compatible, 1 LSTTL Load) - Logic "0" or grounding causes DPM to cease conversions and display data from last conversion; Logic "1" or open circuit for normal operation. After "Converter Hold" is removed, one or two conversions are needed before reading and BCD are valid.

Decimal Points (Not TTL Compatible) - Logic "0" or grounding illuminates desired decimal point. External drive circuitry must sink 35mA peak at a 25% duty cycle, when decimal point is illuminated.

$\overline{\text{Data Hold}}$ (TTL Compatible, 1 TTL Load) - Logic "0" or grounding inhibits updating of latched parallel output data of AD2036. Logic "1" or open circuit allows data to be updated after each DPM conversion. This input has no effect on the normal conversion of the DPM and its display.

Scanner Enable (CMOS/TTL Compatible 1 LSTTL Load) - Logic "1" will enable Scanner to control the channel selection. External channel input BCD lines can remain connected. A Logic "0" enables external channel selection.

Scan ($\overline{\text{Scan}}$) (CMOS/TTL Compatible, 1 LSTTL Load) - A Logic "1" ("0") for <4 seconds will initiate a scan of six channels. To use $\overline{\text{Scan}}$ input, the Scan input must be a Logic "0". Both inputs have debounce circuitry. A momentary scan pulse while in the switch or external selection mode will initiate a sequence of six readings of the channel that is addressed then stop.

Channel BCD Input (CMOS/TTL Compatible 1 LSTTL Load) - Logic "0" on Scanner Enable will allow use of external control. All other control inputs remain the same.

Channel Increment (CMOS/TTL Compatible 1 LSTTL Load) - Positive going edge will initiate sequence to the next channel.

Spare Inverter Input (CMOS, TTL Compatible 1 LSTTL Load) - Spare inverter supplied for customer convenience.

DATA OUTPUTS

Isolated Parallel BCD Outputs - 3 BCD digits, Overrange, $\overline{\text{Overload}}$ and Data Ready Outputs (TTL Compatible, 4 TTL Loads). BCD data outputs are latched positive true logic. Overrange Output is Logic "1" for data display greater than 999. $\overline{\text{Overload}}$ Output is Logic "0" for inputs greater than full scale range, Logic "1" when other data outputs are valid. Polarity Output (TTL Compatible, 4 TTL Loads latched) indicates positive polarity when high (Logic "1"). Digital outputs are fully isolated from input circuitry; all logic levels are referenced to digital ground.

Channel BCD Outputs (CMOS/TTL Compatible 2 TTL Loads) - BCD Channel number data outputs are positive true.

Mode Output (CMOS/TTL Compatible 2 TTL Loads) - Logic "1" indicates channel selection is by switch. Logic "0" indicates selection is by scanner or external control, useful in microcomputer interface.

Data Ready ($\overline{\text{Data Ready}}$) (CMOS/TTL Compatible 2 TTL Loads) - Logic "1" ("0") indicates data from Temperature Card is ready. Data remains valid until next clock pulse (198ms).

Spare Inverter Output (CMOS/TTL Compatible 2 TTL Loads) - Spare inverter supplied for customer convenience.

Clock OUT (CMOS, TTL Compatible, 2 TTL Loads) - Indicates E.O.C. When Clock pulse is high latches are being updated, data is invalid. Data is valid on negative going edge. Clock OUT pulse is disabled when $\overline{\text{DATA HOLD}}$ line is low.

Analog Output - Nonlinear Error ±0.5% ±1mV
V_{OUT}, °C = (1.784mV/°C) Temperature
V_{OUT}, °F = (0.991mV/°F)(T-32)

TEMPERATURE RANGE[2]
- 0 to +50°C Operating
- −25°C to +85°C Storage

POWER OUTPUT
- +5V dc @ 10mA

POWER INPUT
- AC line 50 – 400Hz, See Voltage Options below
- Power Consumption - 5.8W @ 50 – 400Hz
- 12V dc +20% – 10%, 4.8W
- 5V dc ± 5%, 4W

CALIBRATION ADJUSTMENTS
- Span
- Zero
- Recommended Recalibration Interval: six months

SIZE
- 3.92" x 1.67"H x 5.80"D (100 x 42 x 147mm)
- Panel cutout 3.930" x 1.682" (99.8 x 42.7mm)

WEIGHT
- 1.25 pounds (0.568 kg)

DISPLAY LENS[4]
Lens 22-1: Red, °C with ADI Logo
Lens 22-2: Red, °F with ADI Logo
Lens 23-1: Red, °C without ADI Logo
Lens 23-2: Red, °F without ADI Logo

CONNECTORS(2)
2 each, 30 pin, 0.156" spacing card edge connector
Viking 2VK15D/1-2 or equivalent.
Optional: Order AC1501.

ORDERING GUIDE

AD2036 □ – □ □ □ □

THERMOCOUPLE TYPE[3]
J, K, T – ENTER

POWER INPUT[3]
117V ac ±10%	1
220V ac ±10%	2
100V ac ±10%	3
240V ac ±10%	4
5V dc ±5%	5
12V dc +20%, −10%	6

– ENTER#

SCAN RATE[3]
3.2sec	1
1.6sec	2
0.8sec	3

– ENTER#

DEGREE READOUT[3]
°C	1
°F	2

– ENTER#

RESOLUTION[3]
1.0°	1
0.1°	2

– ENTER#

NOTES
[1] For 0.1° resolution accuracy remains the same. Range is limited to 200.0°
[2] Guaranteed
[3] Only one option may be specified.
[4] Lens 22 is supplied if no lens option is specified.

Specifications subject to change without notice.

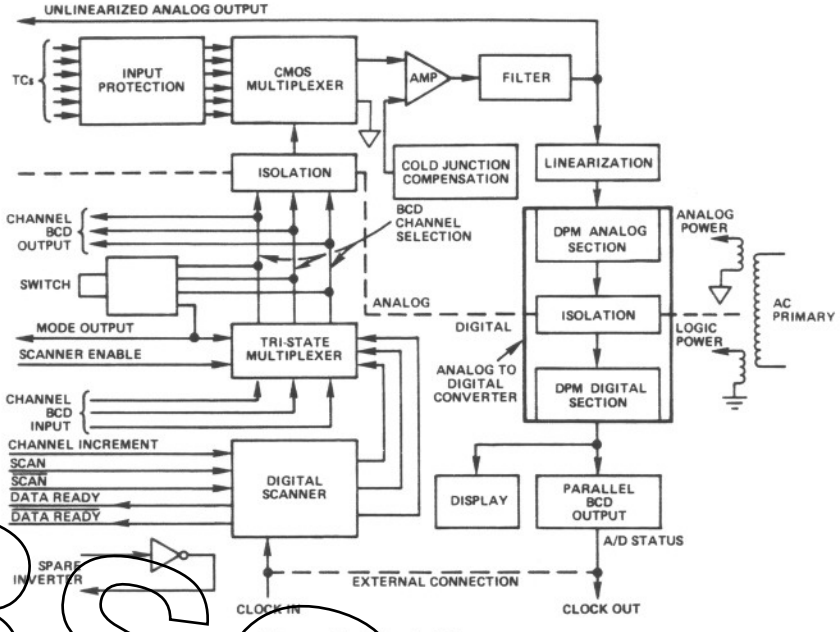

Figure 1. Block Diagram

DESIGNED AND BUILT FOR RELIABILITY

Even beyond the inherent advantages of the LSI IC design and LED displays, the AD2036 has had extreme care taken in its design and manufacture to insure reliability. Manufacturing processes are monitored by continual quality assurance inspections to insure proper workmanship and testing. Automatic equipment is used to test each DPM, both at the board level and at final assembly, to assure fault free performance. And, prior to shipment, each AD2036 must pass one full week of failure-free +50°C cycled power burn-in.

APPLYING THE AD2036

Description of Operation

The AD2036 Block Diagram is shown in Figure 1. Thermocouple selection is made by the CMOS Multiplexer which is comprised of two sets of six switches. The output of the Multiplexer is on two lines. One is connected to Analog Ground. The other is fed into an Amplifier that provides for Cold-Junction Compensation. The signal is then filtered and linearized and processed by the Analog to Digital Converter. The converter drives the Display and the Parallel BCD Output circuitry.

BCD Channel Selection is obtained from the Switch or the output of the Tri-State Multiplexer. In standard units, switch selection of individual TC Channels always takes precedence over the Tri-State Multiplexer. On special order, units can be wired for card edge enable/disable of the Switch. Under control of the Scanner Enable input, the Tri-State Multiplexer switches between channel selection from the Digital Scanner and the external Channel BCD Input. A logic low enables external selection. A logic high enables input from the Scanner.

As shown in the Timing Diagram of Figure 2, a Channel Scan is initiated by a logic high on the Scan input (pin S). The conclusion of the previous scan cycle will have resulted in Channel "0" already being selected. Conversions take place 5 times per second but 3.2 seconds are allowed to elapse before the Data Ready output indicates the data is valid. A minimum of 2 seconds is required for worst case settling

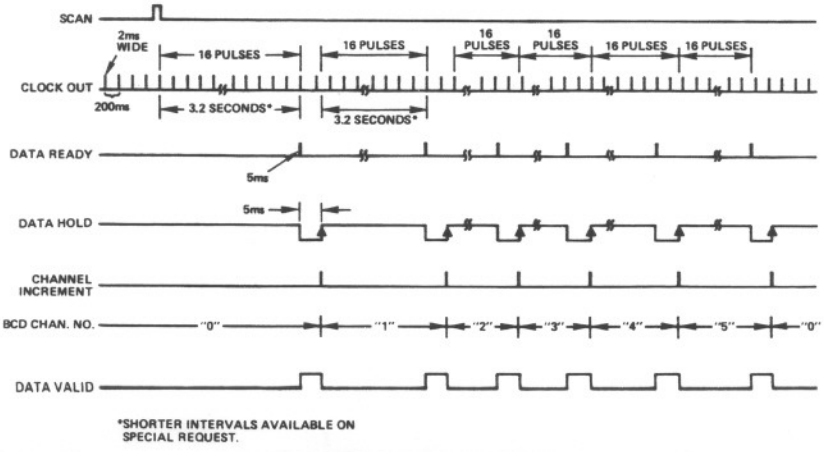

Figure 2. SCAN Timing Diagram

a full span step change as could take place in switch-nnel selection. On special order, where conditions do rrant the 3.2 second delay, units can be provided with teady occurring after 1.6 seconds or 0.8 seconds. Data tually be taken up to the maximum 5 per second con- rate (contact factory for further information).

standard unit, the Data Ready line switches high 16 pulses after Scan initiation (approximately 3.2 seconds). Data Hold input can then be switched low if it is de- to retain the data unchanged for more than the mini- interval of 200ms. Upon releasing the Hold, it is neces- to produce a positive going pulse change on the Channel ement input in order to step the Channel Selection. In y cases the Data Hold and Channel Increment inputs can ied together so that release of the Hold will automati- y step the Channel Selection.

his fashion (and as shown in Figure 2) a complete cycle he six channels can be obtained with the AD2036 stopping Channel "0" and awaiting another Scan input pulse to al the start of another cycle.

eration with Printer

put and output connections for operating with a printer shown in Figure 3. A scan of the channels is initiated via ish button or other pulse source. When Data Ready goes gh, Busy from the printer goes low. This "holds" the Data nd Channel Number Outputs until the printer raises the usy. When Busy goes high the "hold" is released and the hannel counter is incremented. After 3.2 seconds (in the tandard unit), the Data Ready again goes high and the inter- ocking of signals repeat 5 times until data has been printed for all six channels. Each automatic or manual initiation of the scan causes the sequence to repeat.

To continuously scan all six channels with a printer, set up as in Figure 3 except $\overline{\text{Scan}}$ must be held at Logic "0". .

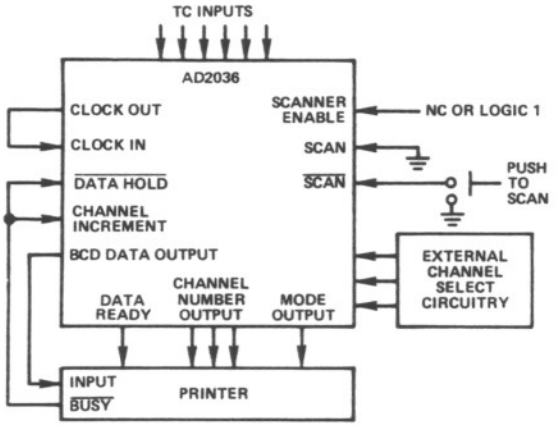

Figure 3. AD2036 with Printer

For continuous printing of a single channel set up as in Figure 3 except fix $\overline{\text{Scan}}$ at Logic "0". Channel can be selected by switch or externally.

For external Channel Selection, the Scanner Enable line should be held low. Under external BCD control, Channel Selection occurs immediately. If the Scan line is pulsed to a logic low, the printer will print the selected channel data 6 times and stop. If held low, a continuous printout of the selected channel will result. +5V power is provided at the rear connector to power external control logic.

Stand-Alone Operation

The AD2036 can at any time under switch control be operated so as to allow examination of individual channels. When used as a stand-alone instrument, it may also be desirable to be able to initiate a single scan of all six inputs. Figure 4 shows the necessary interconnections to obtain this operation. As before, the cycle is initiated via a pulse from a push button or other source. In this case, however, the Data Hold and Channel Increment inputs are controlled by the Data Ready. Each time Data Ready goes from low to high, the channel is incremented and conversions are made on the newly selected channel. The process continues until the meter is back on channel "0". The meter then waits for another scan initiation. During a scan each channel is displayed for 3.2 seconds (the whole scan takes approximately 20 seconds). Simultaneous display of channel number and converted value requires implementation of a separate display for channel number.

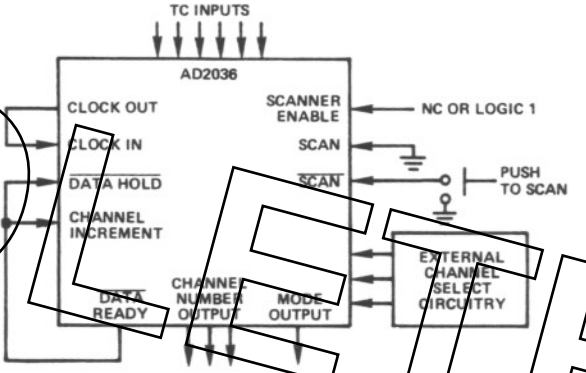

Figure 4. Stand-Alone Operation

To continuously scan, set up as per Figure 4 except fix the $\overline{\text{Scan}}$ input at Logic "0".

Opto Isolation

The AD2036 has as a standard feature Opto Isolation. This prevents external digital load currents from entering the analog circuitry via common ground paths and also enables safe temperature monitoring of equipment where there is no isolation from ac. As shown in the block diagram, Figure 1, digital and analog circuitry as well as the ac are isolated.

Wiring Connections

Power connections, thermocouple connections and control and digital connections are accessible at the rear. All but the thermocouple connections are via card edge (see Figures 6 and 7). Thermocouple wires are connected to a barrier strip on the top board (see Figure 5).

To install thermocouple wires, remove shroud from rear of unit by removing the screw. Feed thermocouple wires through slots in the shroud (see Figure 9). Thermocouple inpu wires are attached directly to the barrier strip. For easy acces turn AD2036 upside down. (+) and (–) polarities are designate on the P.C.B. Care must be taken when connecting input wir to insure correct polarity. Figure 5 shows proper polarity an channel designations. Replace shroud after connecting TC's.

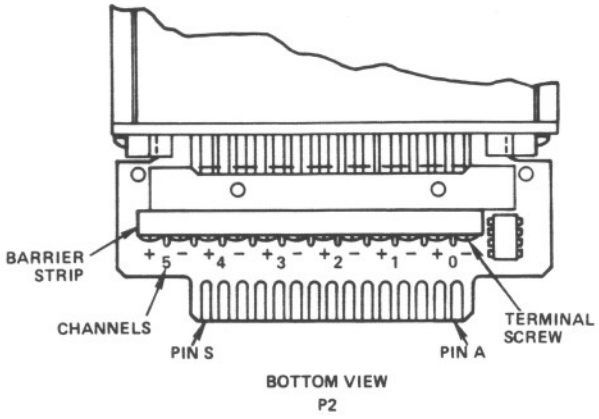

Figure 5. Thermocouple Connections

Power connections, control inputs and digital connections are contained in the pin out diagrams in Figures 6 and 7.

PIN REF	PIN FUNCTION
1	DATA HOLD
2	NC
3	CLOCK OUT
4	POLARITY
5	BCD 8
6	BCD 2
7	BCD 80
8	BCD 20
9	BCD 800
10	ANALOG GROUND
11	BCD 400
12	BCD 200
13	DISPLAY BLANK
14	OVERRANGE
15	AC LINE HIGH

KEY

PIN REF	PIN FUNCTION
A	NC (HOLE Y4)
B	NC (HOLE Y5)
C	OVERLOAD
D	CONVERTER 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 LOW

Figure 6. Converter Card Pin Designations, P1

Calibration Procedure

A precision voltage source and pure water Ice Bath are required. Location of the calibration adjusts are shown in Figure 8.

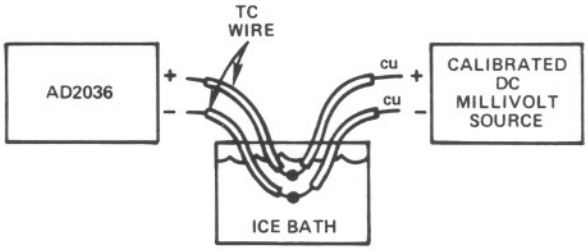

Figure 8. Calibration Diagram

With the voltage source set to zero, adjust the Zero control (top left) for a reading of 000 for Celsius or 032 for Fahrenheit units.

Using Table 1 for the proper thermocouple, set the calibrated voltage source to the appropriate number of millivolts and set span adjust (outer bottom right) for a correct reading.

PIN REF	PIN FUNCTION
1	ANALOG GND
2	DATA READY
3	SPARE INVERTER OUTPUT
4	RESERVED FOR FUTURE FUNCTION
5	FACTORY USE
6	MODE OUTPUT
7	CHANNEL INPUT BCD 1
8	NC
9	NC
10	NC
11	NC
12	CLOCK IN
13	CHANNEL OUTPUT BCD 4
14	DIGITAL GND
15	FACTORY USE

KEY

PIN REF	PIN FUNCTION
A	ANALOG OUTPUT
B	DATA READY
C	CHANNEL INCREMENT
D	CHANNEL OUTPUT BCD 1
E	FACTORY USE
F	SPARE INVERTER INPUT
H	CHANNEL INPUT BCD 2
J	RESERVED FOR FUTURE FUNCTION
K	CHANNEL OUTPUT BCD 2
L	SCANNER ENABLE
M	RESERVED FOR FUTURE FUNCTION
N	CHANNEL INPUT BCD 4
P	SCAN
R	+5V dc (REF. TO DIG. GRD)
S	SCAN

Figure 7. Temperature Card Pin Designations, P2

				Zero Adjust		Span Adjust	
TC	Sensor Type	Color Code	Polarity	Input	Reading	Input/mV	Reading
J	Iron	White	+	0.0mV	0°C	41.013	730°C
	Constantan	Red	−	0.0mV	32°F	41.013	1346°F
K	Chromel	Yellow	+	0.0mV	0°C	52.049	1290°C
	Alumel	Red	−	0.0mV	32°F	42.303	1880°F
T	Copper	Blue	+	0.0mV	0°C	19.516	373°C
	Constantan	Red	−	0.0mV	32°F	19.536	713°F

Table 1. Calibration Chart

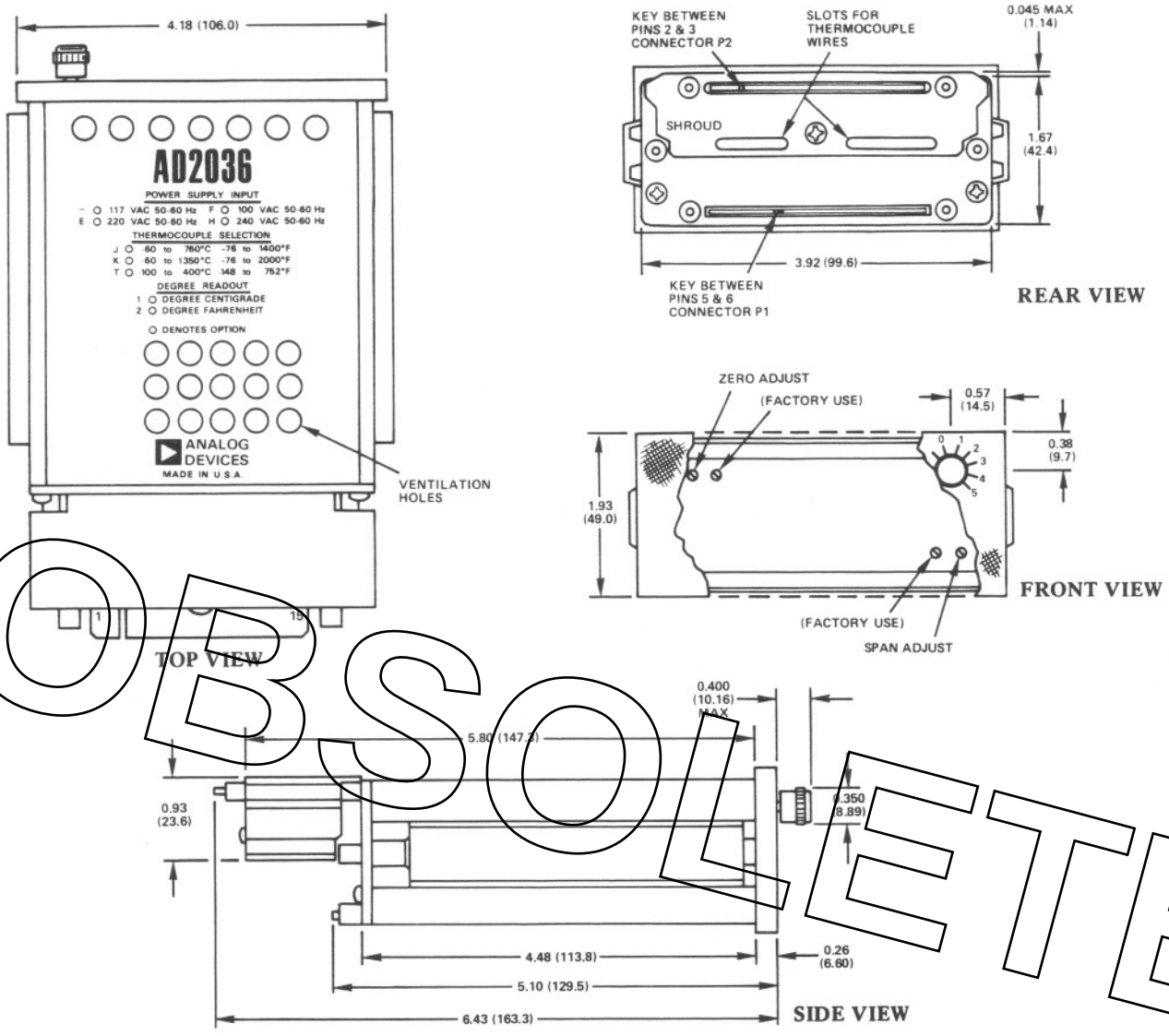

Figure 9. AD2036 Mechanical Outline
(Dimensions shown in inches and (mm))

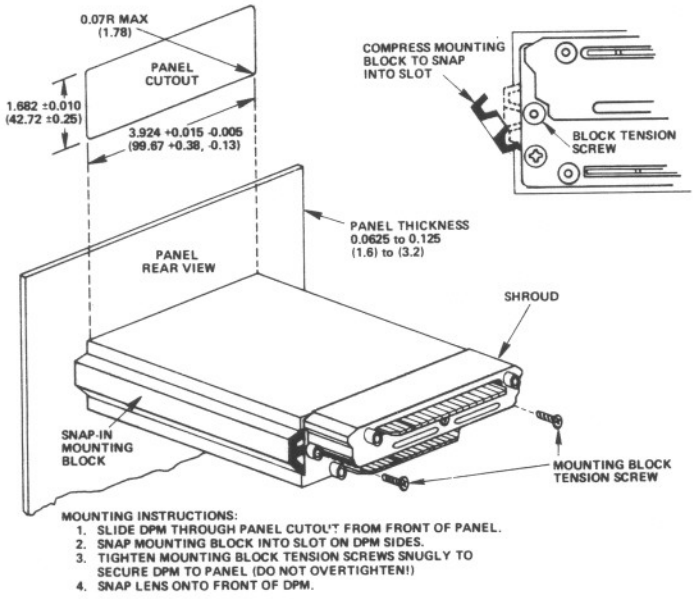

Figure 10. AD2036 Mounting Instructions
(Dimensions shown in inches and (mm))