TELEDYNE PHILBRICK

8, 10, 12 Bit Ultra High Speed A/D Converters

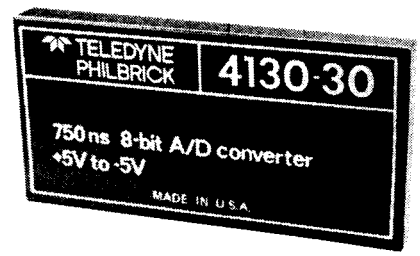
4130 Series

The 4130 Series Ultra High Speed A/D Converters were designed for applications demanding high linearity, excellent stability, fast conversion rates, and guaranteed operation over a wide temperature range. All models use the successive approximation technique for conversion and employ thin-film technology for ultra stable operation. Each converter has its own 10V internal reference and the capability for using an external reference. Digital outputs are fully buffered to eliminate any loading problems that could affect accuracy. Input voltage ranges and conversion times for the various models in the series are summarized below.

MODEL	FULL SCALE INPUT VOLTAGE	MAX CONVERSION TIME	RESOLUTION
4130-10 4130-20 4130-30 4130-40	0 V to -5 V 0 V to -10 V +5 V to -5 V +10 V to -10 V	750 nsec	8 Bits
4131-10 4131-20 4131-30 4131-40	0 V to - 5 V 0 V to -10 V +5 V to -5 V +10 V to -10 V	1 μsec	10 Bits
4132-22	0 to -10 V, ±5 V 0 to -20 V, ±10 V (user programmable)	3.5 μsec	12 Bits
4133-22		2.5 μsec	

Applications Information

The single conversion mode is achieved by applying an external pulse to the start convert input. The repetitive conversion mode is achieved by using a TTL inverter as shown in Figure 2. The delay time for the inverter must be added to the total conversion time. Data valid time is shown for both serial and parallel data in Figure 1. Serial output is in a non-return to zero format with the MSB occuring first. The circuit shown in Figure 3 is recommended for storing serial data. The three digital inverters provide approximately 36nsec delay. This delay assures that the information strobed into the shift register is correct because serial data does not become valid until a minimum of 10nsec after each falling clock edge.The circuits shown in Figure 4 are recommended for storing parallel data. The circuit in Figure 4A is recommended for storing data using edge-coupled registers such as an SN74174 or SN74S174. Transfer of information into the registers occurs on the rising edge of the clock pulse. The circuit in Figure 4B is recommended for storing data using DC-coupled registers such as SN7475. Parallel bit information remains valid for a minimum of 20nsec, typically 40nsec, after the rise of the next start convert pulse.



FEATURES

- Fast Conversion Times
  750nsec 8 Bits
  1μsec 10 Bits
  2.5μsec 12 Bits
- No Missing Codes Guaranteed Over Temperature
- Internal Clock and Reference
- Serial and Parallel Output
- Low Drift

APPLICATIONS

- High Speed Data Acquisition
- Fast Fourier Transforms
- Scanning Medical Instrumentation
- Transient Recorders
- Spectrum Analyzers

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SPECIFICATIONS At +25 °C, ±15 V and +5 V, unless otherwise indicated

MODEL	4130 Typical	4130 Guaranteed	4131 Typical	4131 Guaranteed	4132 Typical	4132 Guaranteed	4133 Typical	4133 Guaranteed
RESOLUTION		8 Bit		10 Bit		12 Bit		12 Bit
INPUTS								
Analog								
Voltage Range/(R_{in})								
4130-10/4131-10	−5 V/0.5 KΩ ±3 Ω		−5 V/0.5 KΩ ±3 Ω		---	---	---	---
4130-20/4131-20	−10 V/1 KΩ ±5 Ω		−10 V/1 KΩ ±5 Ω		---	---	---	---
4130-30/4131-30	±5 V/1 KΩ ±5 Ω		±5 V/1 KΩ ± 5 Ω		---	---	---	---
4130-40/4131-40	±10 V/2 KΩ ±10 Ω		±10 V/2 KΩ ±10 Ω		---	---	---	---
4132-22/4133-22	---	---	---	---	±5 V/1 KΩ ± 0.5%		±5 V/1 KΩ ± 0.5%	
	---	---	---	---	−10 V/1 KΩ ± 0.5%		−10 V/1 KΩ ± 0.5%	
	---	---	---	---	±10 V/2 KΩ ± 0.5%		±10 V/2 KΩ ± 0.5%	
	---	---	---	---	−20 V/2 KΩ ± 0.5%		−20 V/2 KΩ ± 0.5%	
Offset Current	±0.4 V/R_{in}	---	±0.4 V/R_{in}	---	±0.4 V/R_{in}	---	±0.4 V/R_{in}	---
Reference								
Voltage	−10 V	---	−10 V	---	−10 V	---	−10 V	---
Resistance	---	8 KΩ ±0.5%	---	8 KΩ ±0.5%	---	8 KΩ ±0.5%	---	8 KΩ ±0.5%
Power	+15 V ±0.5 V @ 65 mA max.		+15 V ±0.5 V @ 65 mA max.		+15 V ±0.5 V @ 65 mA max.		+15 V ±0.5 V @ 65 mA max.	
	−15 V ±0.5 V @ 45 mA max.		−15 V ±0.5 V @ 45 mA max.		−15 V ±0.5 V @ 45 mA max.		−15 V ±0.5 V @ 45 mA max.	
	+5 V ±0.25 V @ 325 mA max.		+5 V ±0.25 V @ 325 mA max.		+5 V ±0.25 V @ 325 mA max.		+5 V ±0.25 V @ 325 mA max.	
Recommended Supply	Philbrick 2243		Philbrick 2243		Philbrick 2243		Philbrick 2243	
Digital								
Start Convert								
Logic	TTL Positive Pulse		TTL Positive Pulse		TTL Positive Pulse		TTL Positive Pulse	
Conversion Initiation	---	"0" to "1"	---	"0" to "1"	---	"0" to "1"	---	"0" to "1"
Pulse Width min./max.	---	50 to 105 nsec	---	50 to 130 nsec	---	50 to 200 nsec	---	50 to 200 nsec
Loading ①	---	1 TTL Load	---	1 TTL Load	---	1 TTL Load	---	1 TTL Load
TRANSFER CHARACTERISTICS								
Accuracy								
Nonlinearity	---	±½ LSB	---	±1 LSB	---	±1 LSB	---	±1 LSB
Differential Nonlinearity	---	±¼ LSB	±½ LSB	---	±½ LSB	---	±½ LSB	---
Quantizing Error	---	±½ LSB	---	±½ LSB	---	±½ LSB	---	±½ LSB
No Missing Codes	---	0 to 70 °C	---	0 to 70 °C	---	0 °C to 50 °C	---	0 °C to 50 °C
Monotonicity	---	0 to 70 °C	---	0 to 70 °C	---	0 ° to 70 °C	---	0 to 70 °C
Zero Offset Error, (Adj. to Zero)	---	±25 mV	---	±10 mV	---	−11 ±10 mV	---	−11 ±10 mV
Unipolar						−22 ±20 mV	---	−22 ±20 mV
Bipolar	---	±25 mV	---	±10 mV	---	−11 ±10 mV	---	−11 ±10 mV
						−22 ±20 mV	---	−22 ±20 mV
Gain Error (Adj. to Zero)	+0.2%	+0.3%	+0.06%	+0.1%	---	±0.1%	---	± 0.1%
Stability								
Nonlinearity vs. Temp.	---	±10 ppm/°C	---	±10 ppm/°C	---	±5 ppm/°C	---	±5 ppm/°C
Differential Nonlinearity vs. Temp	±5 ppm/°C	±10 ppm/°C	±5 ppm/°C	±10 ppm/°C	±3 ppm/°C	±5 ppm/°C	±3 ppm/°C	±5 ppm/°C
Zero Offset Error vs. Temp.								
Unipolar	---	±15 ppm/°C	---	±15 ppm/°C	---	±5 ppm/°C	---	±5 ppm/°C
Bipolar	---	±15 ppm/°C	---	±15 ppm/°C	---	±10 ppm/°C	---	±10 ppm/°C
Gain Error vs. Temp.	---	±20 ppm/°C	---	±20 ppm/°C	---	±20 ppm/°C	---	±20 ppm/°C
Conversion Time vs. Temp.	±0.5 nsec/°C	---	±1 nsec/°C	---	---	±2.8 nsec/°C	---	±2.8 nsec/°C
V_{Ref} Out vs. Temp.	±3 ppm/°C	±10 ppm/°C	±3 ppm/°C	±10 ppm/°C	±3 ppm/°C	±10 ppm/°C	±3 ppm/°C	±10 ppm/°C
PSRR	±2.4 mV/V	---	±2.4 mV/V	---	±2.4 mV/V	---	±2.4 mV/V	---
Long Term Stability	0.02%/month	---	0.01%/month	---	0.007%/month	---	0.007%/month	---
Dynamic Characteristics								
Conversion Time	0.735 µsec	0.750 µsec	0.980 µsec	1 µsec	3.4 µsec	3.5 µsec	2.4 µsec	2.5 µsec
Conversion Rate	---	1.333 MHz	---	1 MHz	---	0.285 MHz	---	0.4 MHz
OUTPUTS								
Reference								
Voltage	−10 V±1.0%	---	−10 V±1.0%	---	−10 V±0.1%	---	---	−10 V ±0.1%
Current	−5 mA	---	−5 mA	---	−5 mA	---	−5 mA	---
Digital								
Logic Codes								
Parallel, Unipolar	BIN		BIN		BIN		BIN	
Parallel, Bipolar	OBIN, 2SC		OBIN, 2SC		OBIN, 2SC		OBIN, 2SC	
Output Drive ①	---	10 TTL Loads	---	10 TTL Loads	---	10 TTL Loads	---	10 TTL Loads
Serial, Unipolar	BIN		BIN		BIN		BIN	
Serial, Bipolar	OBIN		OBIN		OBIN		OBIN	
Format	NRZ		NRZ		NRZ		NRZ	
Output Drive ①	---	8 TTL Loads	---	8 TTL Loads	---	8 TTL Loads	---	8 TTL Loads
Switching Levels, all digital outputs								
"0" State	---	⩽ 0.5 V	---	⩽ 0.5 V	---	⩽ 0.5 V	---	⩽ 0.5 V
"1" State	---	⩾ 2.4 V	---	⩾ 2.4 V	---	⩾ 2.4 V	---	⩾ 2.4 V
Data Valid Delay ②	3 nsec	10 nsec	3 nsec	10 nsec	3 nsec	10 nsec	3 nsec	10 nsec
Data Valid Margin ③	40 nsec	20 nsec	40 nsec	20 nsec	40 nsec	20 nsec	40 nsec	20 nsec
Status								
"1" State	During Conversion		During Conversion		During Conversion		During Conversion	
Output Drive ①	---	4 TTL Loads	---	5 TTL Loads	---	4 TTL Loads	---	4 TTL Loads
Clock Out								
Logic	TTL Positive Pulse		TTL Positive Pulse		TTL Positive Pulse		TTL Positive Pulse	
Pulse Width	35 nsec	---	40 nsec	---	35 nsec	---	35 nsec	---
Rate	13.3 MHz	---	12.5 MHz	---	3.8 MHz	---	5.4 MHz	---
Output Drive ①	---	8 TTL Loads	---	8 TTL Loads	---	8 TTL Loads	---	8 TTL Loads
ENVIRONMENTAL SPECIFICATIONS								
Operating Temp. Range	---	0 to +70 °C	---	0 to +70 °C	---	0 to +70 °C	---	0 to +70 °C
Storage Temp. Range	---	−55 to +125 °C	---	−55 to +125 °C	---	−55 to +125 °C	---	−55 to +125 °C
ABSOLUTE MAXIMUM RATINGS								
Supply Voltages to Ground								
±15 V	---	±18 V	---	±18 V	---	±18 V	---	±18 V
+5 V	---	+6 V	---	+6 V	---	+6 V	---	+6 V
Digital Input Voltage	---	+5 V	---	+5 V	---	+5 V	---	+5 V
Analog Input Voltage								
R_{in} = 500 Ω	---	±11 V	---	±11 V	---	±11 V	---	±11 V
R_{in} = 1000 Ω	---	±16 V	---	±16 V	---	±16 V	---	±16 V
R_{in} = 2000 Ω	---	±22 V	---	±22 V	---	±22 V	---	±22 V

① A Standard TTL unit load is −1.6 mA at +0.4 V (LO) and +40 µA max. at +2.4 V (HI).
② Delay from fall of Status Signal before LSB becomes valid.
③ Minimum time data from previous conversion is valid after rise of next start convert pulse.

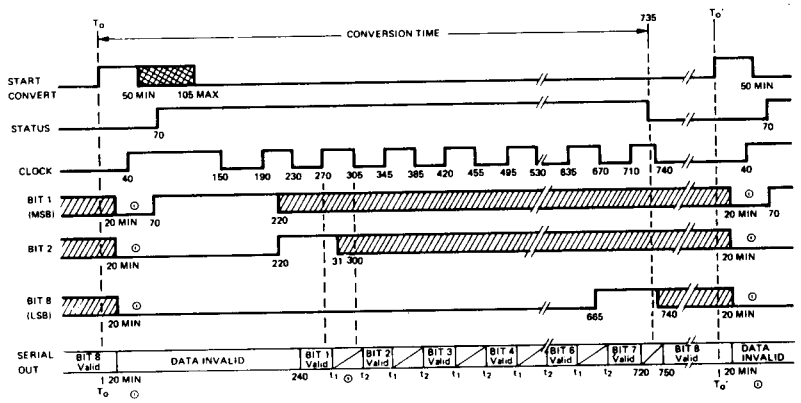


Figure 1A. Model 4130 Timing Diagram

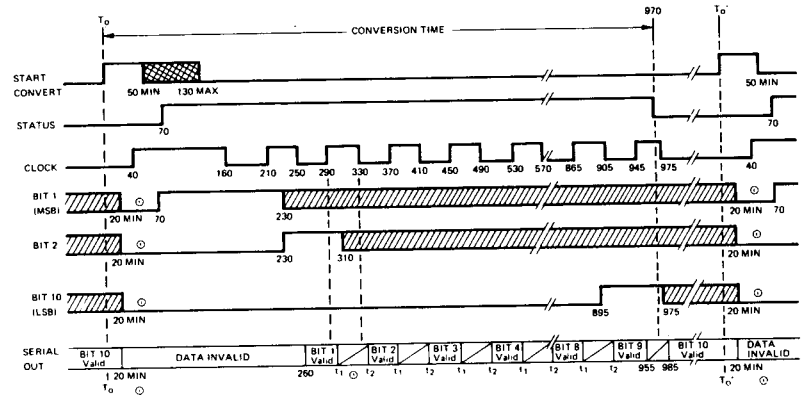


Figure 1B. Model 4131 Timing Diagram

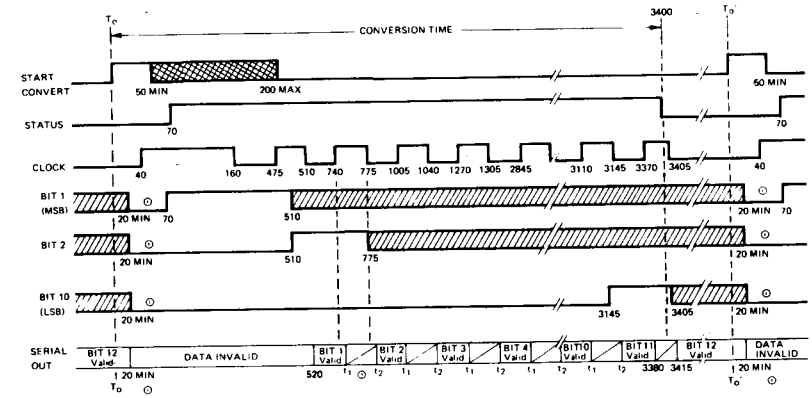
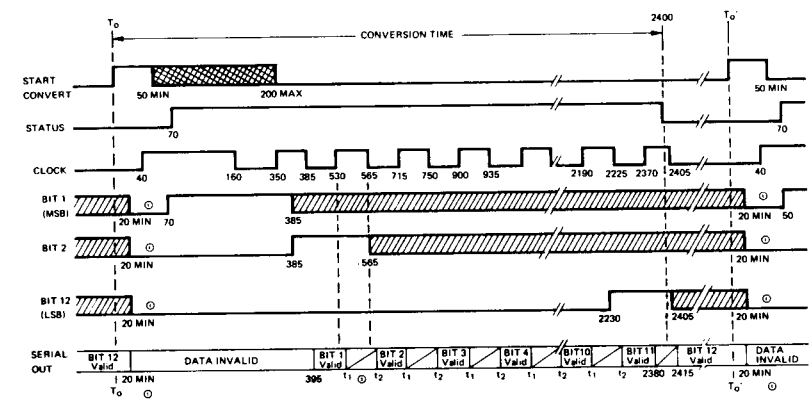


Figure 1C. Model 4132 Timing Diagram



① DATA VALID MINIMUM OF 20 NSEC AFTER RISE ON START CONVERT PULSE
② ALL TIMES ARE EXPRESSED IN NSEC AND ARE RELATIVE T_O TO OR T_O'
////////////// PARALLEL DATA VALID
③ SERIAL DATA IS INVALID BETWEEN TIMES t_1 AND t_2 WHERE t_1 OCCURS 10 NSEC MAX AFTER THE RISE ON THE CLOCK PULSE AND t_2 OCCURS 10 NSEC MIN AFTER THE FALL ON THE CLOCK PULSE.

Figure 1D. Model 4133 Timing Diagram

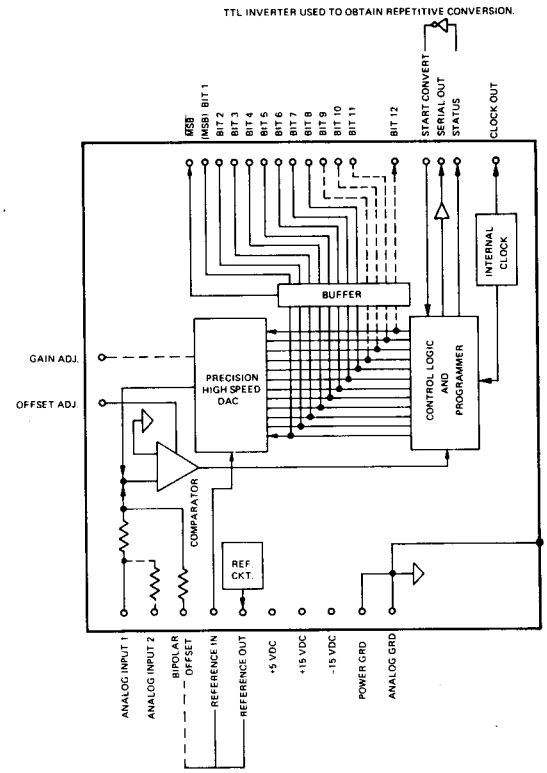
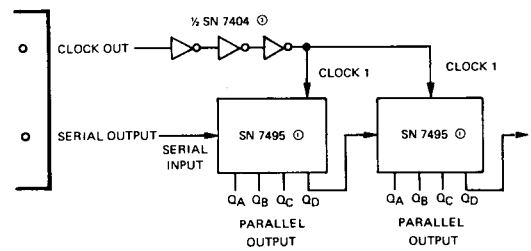
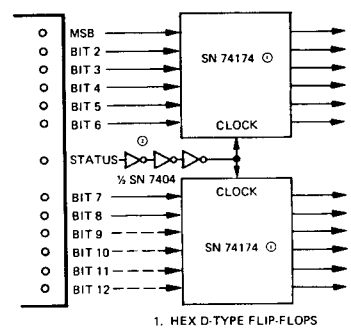


Figure 2. Functional Block Diagram



NOTES: 1. 4 BIT PARALLEL-ACCESS SHIFT REGISTERS
2. HEX INVERTER

Figure 3. Storing Serial Data



1. HEX D-TYPE FLIP-FLOPS
2. HEX INVERTER

Figure 4A. Edge Coupled Registers

OFFSET TRIMMING

1.Unipolar Mode

Apply –1/2 LSB of voltage to the Analog Input and adjust the Offset Trim potentiometer, see Figure 5, for a digital output which is exactly on the threshold of changing from all 0's to 000...001.

2. Bipolar Mode

Apply +F.S. –1/2 LSB of voltage to the Analog Input and adjust the Offset Trim potentiometer, see Figure 5, for an output which is exactly on the threshold of changing from all 0's to 000...001.

GAIN TRIMMING

Apply –F.S. +3/2 LSB of voltage to Analog Input and adjust the Gain Trim potentiometer, see Figure 5, for a digital output which is exactly on the threshold of changing from 111...110 to 111...111.

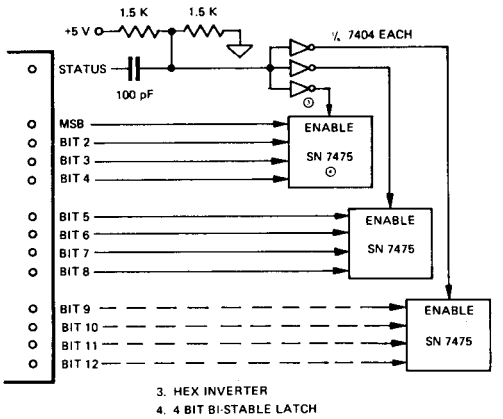
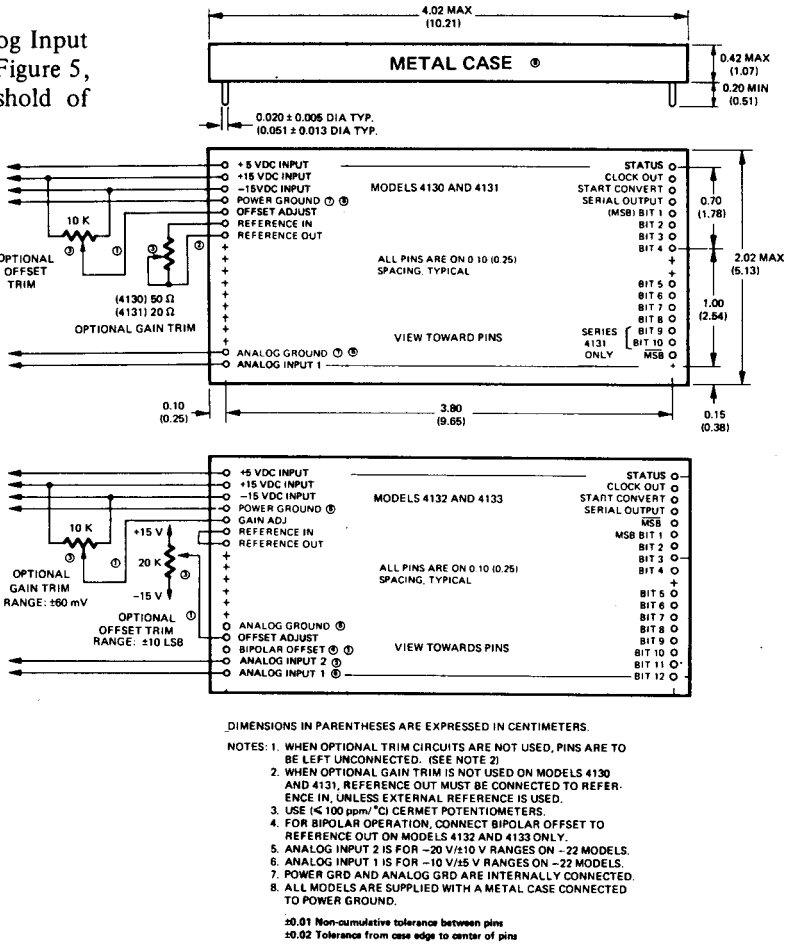


Figure 4B. DC Coupled Registers

	UNIPOLAR	BIPOLAR	
Analog Input	Binary	Offset Binary	2's Complement
+ FS		000 . . . 000	100 . . . 000
+ FS – 1 LSB		000 . . . 001	100 . . . 001
+3/4 Scale		001 . . . 000	101 . . . 000
+ 1/2 Scale		010 . . . 000	110 . . . 000
0 + 1 LSB		011 . . . 111	111 . . . 111
0	000 . . . 000	100 . . . 000	000 . . . 000
0 – 1 LSB	000 . . . 001	100 . . . 001	000 . . . 001
– 1/2 Scale	100 . . . 000	110 . . . 000	010 . . . 000
– 3/4 Scale	110 . . . 000	111 . . . 000	011 . . . 000
– FS + 1 LSB	111 . . . 111	111 . . . 111	011 . . . 111

Figure 6. Digital Code Table



DIMENSIONS IN PARENTHESES ARE EXPRESSED IN CENTIMETERS.

NOTES:
1. WHEN OPTIONAL TRIM CIRCUITS ARE NOT USED, PINS ARE TO BE LEFT UNCONNECTED. (SEE NOTE 2)
2. WHEN OPTIONAL GAIN TRIM IS NOT USED ON MODELS 4130 AND 4131, REFERENCE OUT MUST BE CONNECTED TO REFERENCE IN, UNLESS EXTERNAL REFERENCE IS USED.
3. USE (< 100 ppm/°C) CERMET POTENTIOMETERS.
4. FOR BIPOLAR OPERATION, CONNECT BIPOLAR OFFSET TO REFERENCE OUT ON MODELS 4132 AND 4133 ONLY.
5. ANALOG INPUT 2 IS FOR –20 V/±10 V RANGES ON –22 MODELS.
6. ANALOG INPUT 1 IS FOR –10 V/±5 V RANGES ON –22 MODELS.
7. POWER GRD AND ANALOG GRD ARE INTERNALLY CONNECTED.
8. ALL MODELS ARE SUPPLIED WITH A METAL CASE CONNECTED TO POWER GROUND.

±0.01 Non-cumulative tolerance between pins
±0.02 Tolerance from case edge to center of pins

Figure 5. Mechanical Dimensions and Optional Trim Circuits

POWER AND GROUNDING CONSIDERATIONS

High speed systems require added care in power distribution for maximum accuracy and speed. Although power supply inputs on all models are internally bypassed, it is recommended that a 1 μF tantalum capacitor and a 0.01 μF disc capacitor be added externally to each supply input for optimum performance.

The Analog Ground and Power Ground are internally connected on Models 4130 and 4131. Therefore, the system power ground must be very low impedance to ensure that there are no ground loop errors. All models are housed in a metal case which is internally connected to Power Ground.

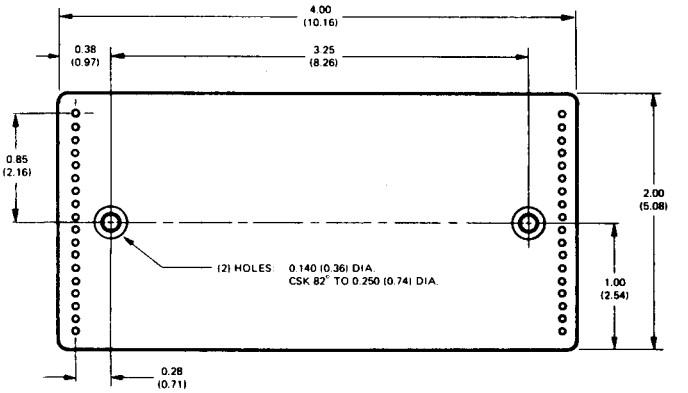


Figure 7. Optional Socket Model 6132

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