



# SPT1175

## 8-BIT, 20 MSPS CMOS A/D CONVERTER

### FEATURES

- 20 MSPS Maximum Conversion Rate
- Internal Sample-and-Hold Function
- 90 mW Power Dissipation
- Internal Voltage Reference
- Single +5.0 V Power Supply
- Three-State TTL-Outputs
- CMOS Compatible Clock

### APPLICATIONS

- Video Digitizing
- Image Scanners
- Personal Computer Video
- Medical Ultrasound
- Multimedia
- Digital Television

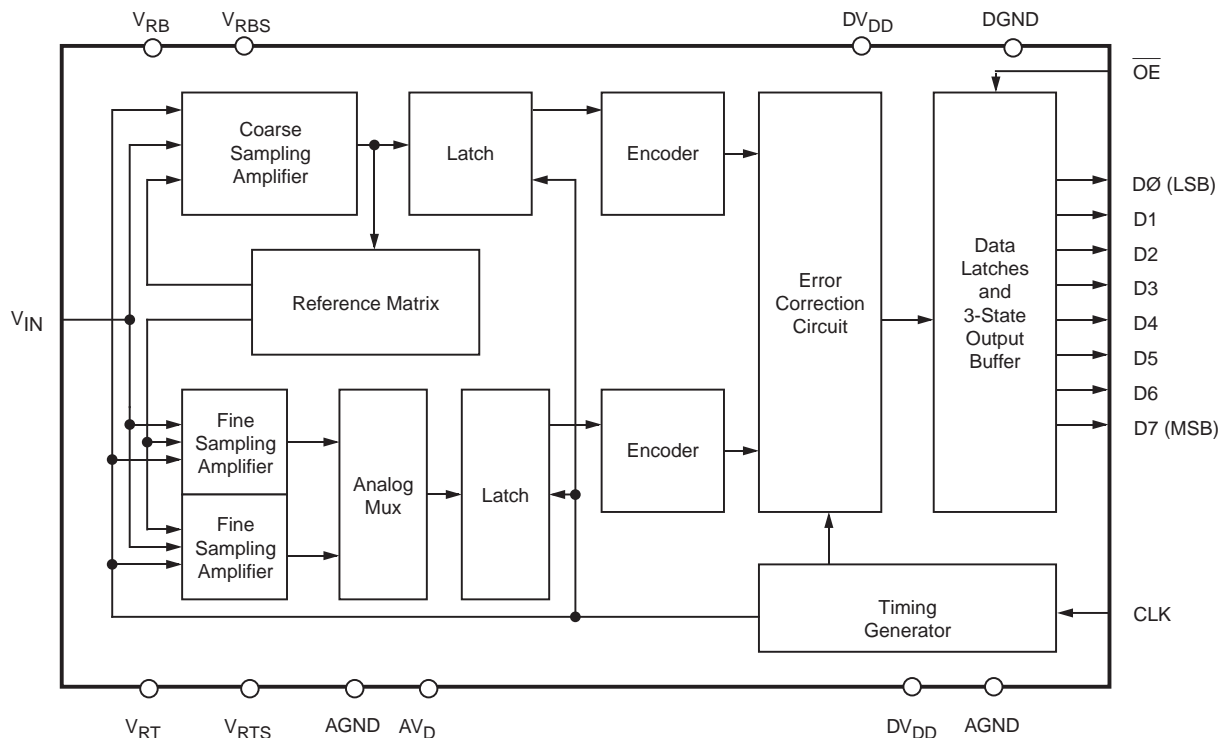
### GENERAL DESCRIPTION

The SPT1175 is a CMOS two-step A/D converter capable of digitizing full scale analog input signals into 8-bit digital words at a sample rate of 20 MSPS.

For most applications, no external sample-and-hold or video driving amplifiers are required due to the device's narrow aperture time, wide bandwidth, and low input capacitance.

The SPT1175 operates from a single +5.0 V power supply and has an internal voltage reference which eliminates the need for external reference circuitry. All digital inputs are CMOS compatible and the tri-state outputs are TTL-compatible. The SPT1175 is ideal for most video and image processing applications that require low power dissipation and low cost. The SPT1175 is available in 24-lead plastic SOIC, plastic DIP, and PLCC packages over the commercial temperature range (0 to +70 °C). It is also available in die form.

### BLOCK DIAGRAM



## Signal Processing Technologies, Inc.

4755 Forge Road, Colorado Springs, Colorado 80907, USA

Phone: (719) 528-2300 FAX: (719) 528-2370

**ABSOLUTE MAXIMUM RATINGS (Beyond which damage may occur)<sup>(1)</sup> 25 °C****Supply Voltages**V<sub>DD</sub> ..... -0.5 to +7.0 V**Input Voltages**Analog Input ..... AGND to V<sub>DD</sub>Reference Input Voltage ..... AGND to V<sub>DD</sub>

ESD Susceptibility(2) ..... ±1,500 V

**Temperature**

Operating Temperature ..... 0 to +70 °C

Junction Temperature ..... 175 °C

Lead Temperature, (soldering 10 seconds) ..... 300 °C

Storage Temperature ..... -55 to +125 °C

- Notes:** 1. Operation at any Absolute Maximum Rating is not implied. See Electrical Specifications for proper nominal applied conditions in typical applications.  
2. 100 pF discharged through a 1.5 kΩ resistor (human body model).

**ELECTRICAL SPECIFICATIONS**T<sub>A</sub>= +25 °C, AV<sub>DD</sub>=DV<sub>DD</sub>=+5.0 V, AGND=DGND=0.0 V, V<sub>RB</sub>=+0.6 V and V<sub>RT</sub>=+2.6 V, unless otherwise specified.

PARAMETERS	TEST CONDITIONS	TEST LEVEL	SPT1175			UNITS
			MIN	TYP	MAX	
Resolution			8			Bits
DC Accuracy (+25 °C)						
Integral Nonlinearity		I		±0.8	±1.2	LSB
Differential Nonlinearity		I		±0.6	±1.0	LSB
No Missing Codes		I		Guaranteed		
Analog Input						
Input Voltage Range		I	V <sub>RB</sub>		V <sub>RT</sub>	V
Input Bias Current		I			±5.0	μA
Input Resistance		VI	100	200		kΩ
Input Capacitance		V		15		pF
Input Bandwidth		V	12			MHz
Reference Input						
Reference Ladder Resistance		I	200	300	400	Ω
Reference Current		I	5.0	6.7	10.0	mA
Reference Input Voltage	V <sub>RB</sub>	IV	0	0.6	-	V
	V <sub>RT</sub>	IV	-	2.6	2.8	V
Internal Bias	V <sub>RB</sub>	I	0.55	0.60	0.65	V
	V <sub>RT</sub> -V <sub>RB</sub>	I	1.9	2.0	2.1	V
	Short V <sub>RT</sub> and V <sub>RTS</sub>					
	Short V <sub>RB</sub> and V <sub>RBS</sub>					
Offset Voltage Error						
Top		I	-18	-25	-68	mV
Bottom		I	0	10	40	mV
Timing Characteristics						
Maximum Conversion Rate	1 MHz Input Sine Wave	I	20	30		MSPS
Output Data Delay (td)		IV		18	30	ns
Output Data Delay (Tdish, Tdisl)	(High Z)	IV			100	ns
Data Valid Time (Teneh, Tenel)	Tri-State Circuit	IV			100	ns
Sampling Time Offset		IV		5	10	ns

NOTE: It is strongly recommended that all of the supply pins (AV<sub>DD</sub>, DV<sub>DD</sub>) be powered from the same source.

**ELECTRICAL SPECIFICATIONS**

$T_A = +25\text{ }^\circ\text{C}$ ,  $AV_{DD} = DV_{DD} = +5.0\text{ V}$ ,  $AGND = DGND = 0.0\text{ V}$ ,  $V_{RB} = +0.6\text{ V}$  and  $V_{RT} = +2.6\text{ V}$ , unless otherwise specified.

PARAMETERS	TEST CONDITIONS	TEST LEVEL	SPT1175			UNITS	
			MIN	TYP	MAX		
<b>Dynamic Performance</b>							
Signal-To-Noise Ratio	$f_S = 20\text{ MSPS}$						
$f_{IN} = 1.0\text{ MHz}$			I	44	46		dB
$f_{IN} = 3.58\text{ MHz}$			I	43	45		dB
$f_{IN} = 10\text{ MHz}$		V		39	dB		
<b>Spurious Free Dynamic Range</b>							
	$f_S = 20\text{ MSPS}$						
$f_{IN} = 1.0\text{ MHz}$			I	44	47		dB
$f_{IN} = 3.58\text{ MHz}$			I	41	44		dB
$f_{IN} = 10\text{ MHz}$		V		33	dB		
Differential Phase	NTSC 20 IRE Mod Ramp	V		0.7	Degrees		
Differential Gain	$f_S = 14.3\text{ MSPS}$	V		1.0	%		
<b>Digital Inputs</b>							
Input Current, Logic High	$V_{DD} = 5.25\text{ V}$ , $V_{IH} = V_{DD}$					1.0	
Input Current, Logic Low			$V_{DD} = 5.25\text{ V}$ , $V_{IL} = DGND$	I			
Pulse Width High (CLK)		IV	15		ns		
Pulse Width Low (CLK)		IV	15		ns		
Voltage, Logic High		I	4.0		V		
Voltage, Logic Low		I			1.0	V	
<b>Digital Outputs</b>							
Output Current, High	$V_{DD} = 4.75\text{ V}$	IV	-1.1			mA	
Output Current, Low	$V_{DD} = 4.75\text{ V}$	IV	3.5			mA	
Output Current, High Z	$V_{DD} = 5.25\text{ V}$ , $\overline{OE} = V_{DD}$	IV			16	$\mu\text{A}$	
Voltage High		I	4.0			V	
Voltage Low		I			0.4	V	
<b>Power Supply Requirements</b>							
Analog Supply Voltage ( $AV_{DD}$ )		IV	+4.75	+5.0	+5.25	V	
Digital Supply Voltage ( $DV_{DD}$ )		IV	+4.75	+5.0	+5.25	V	
Supply Voltage Difference ( $AV_{DD} - DV_{DD}$ )		IV	-0.1	0.0	0.1	V	
Supply Current	$f_S = 20\text{ MSPS}$	I		18	27	mA	
Power Dissipation		I		90	135	mW	

**TEST LEVEL CODES**

All electrical characteristics are subject to the following conditions:

All parameters having min/max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality Assurance inspection. Any blank section in the data column indicates that the specification is not tested at the specified condition.

**TEST LEVEL**

I  
II  
III  
IV  
V  
VI

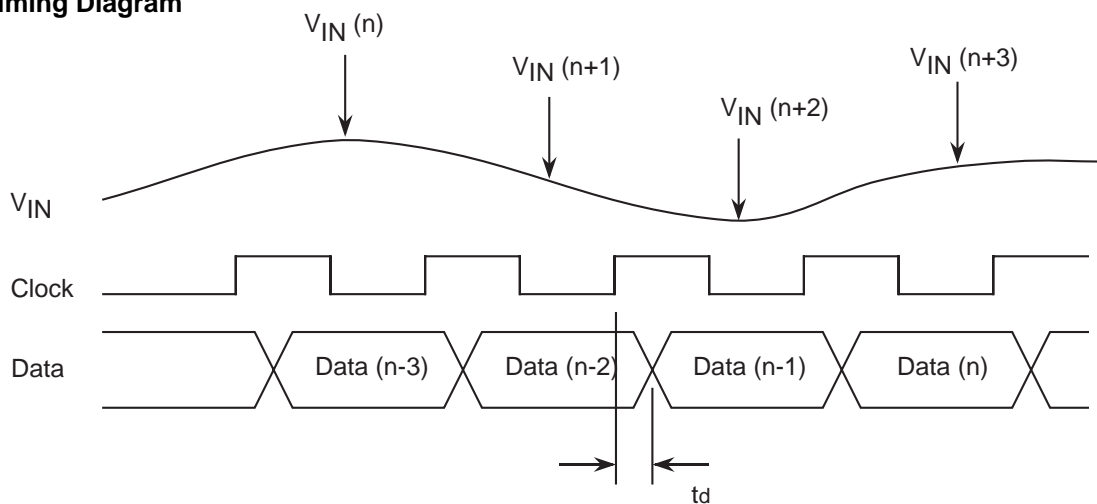
**TEST PROCEDURE**

100% production tested at the specified temperature.  
100% production tested at  $T_A = +25\text{ }^\circ\text{C}$ , and sample tested at the specified temperatures.  
QA sample tested only at the specified temperatures.  
Parameter is guaranteed (but not tested) by design and characterization data.  
Parameter is a typical value for information purposes only.  
100% production tested at  $T_A = +25\text{ }^\circ\text{C}$ . Parameter is guaranteed over specified temperature range.

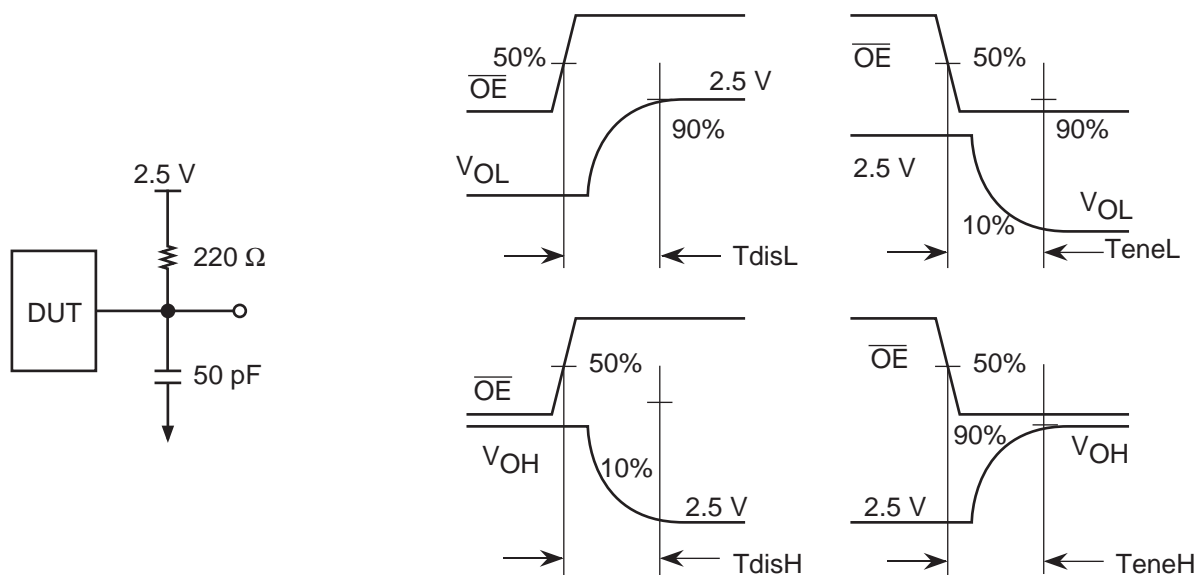
**Table I - Output Coding**

INDEX	ANALOG INPUT (V)	DIGITAL OUTPUT
0	0.6078125	00000000
1	0.6078125 ~ 0.6156260	00000001
2	0.6156250 ~ 0.6234375	00000010
....	....	....
123	1.5921875 ~ 1.6000000	01111111
124	1.6000000 ~ 1.6078125	10000000
125	1.6078125 ~ 1.6156250	10000001
....	....	....
254	2.5843750 ~ 2.5921875	11111110
255	2.5921875 ~	11111111

**Figure 1A: Timing Diagram**



**Figure 1B: Tri-State Output Timing Diagram**



## TYPICAL INTERFACE CIRCUIT

The SPT1175 is an 8-bit analog-to-digital converter which uses a two-step, ping-pong architecture to perform conversions up to 20 MSPS. Figure 2 shows the typical interface requirements when using the SPT1175 in normal operation. The following sections describe the function and operation of the device.

## POWER SUPPLIES AND GROUNDING

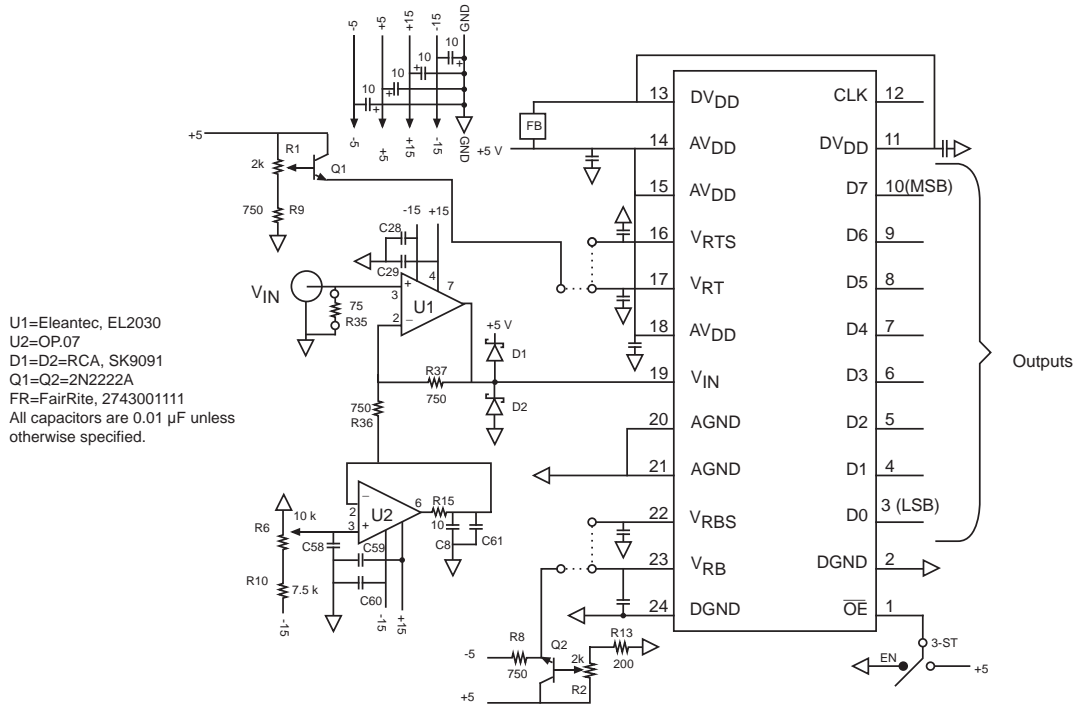
The SPT1175 operates from a single +5 V power supply.  $AV_{DD}$  and  $DV_{DD}$  must be supplied from the same source (analog +5 V) to prevent a latch-up condition due to power supply sequencing. Each power supply pin should be bypassed as closely as possible to the device. For optimal performance, both the AGND and DGND should be connected to the system's analog ground plane.

## ANALOG INPUT AND VOLTAGE REFERENCE

The SPT1175 input voltage range is  $V_{RT} > V_{IN} > V_{RB}$ . Two reference voltages ( $V_{RT}$  and  $V_{RB}$ ) are required for device operation. These voltages may be generated externally or the SPT1175's internal reference may be used.

Inside the SPT1175, reference resistors are placed between  $AV_{DD}$  and  $V_{RTS}$  and between AGND and  $V_{RBS}$  so that  $V_{RTS}$  and  $V_{RBS}$  generate the 2.6 V and 0.6 V references respectively. (See figure 3.) In order to utilize the internal self-bias reference voltage,  $V_{RTS}$  is to be shorted with  $V_{RT}$  and the

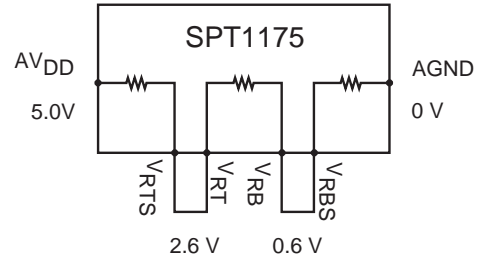
Figure 2 - Typical Interface Circuit



NOTE:  $AV_{DD}$  and  $DV_{DD}$  must be supplied from the same source (Analog +5 V) to prevent a latch-up condition due to power supply sequencing.

$V_{RBS}$  pin is to be shorted to the  $V_{RB}$  pin. The self-bias internal reference is not as stable over temperature and supply variations as externally generated reference voltages but will perform well in many commercial video applications.

Figure 3 - Reference Circuit Diagram



## DIGITAL INPUTS AND OUTPUTS

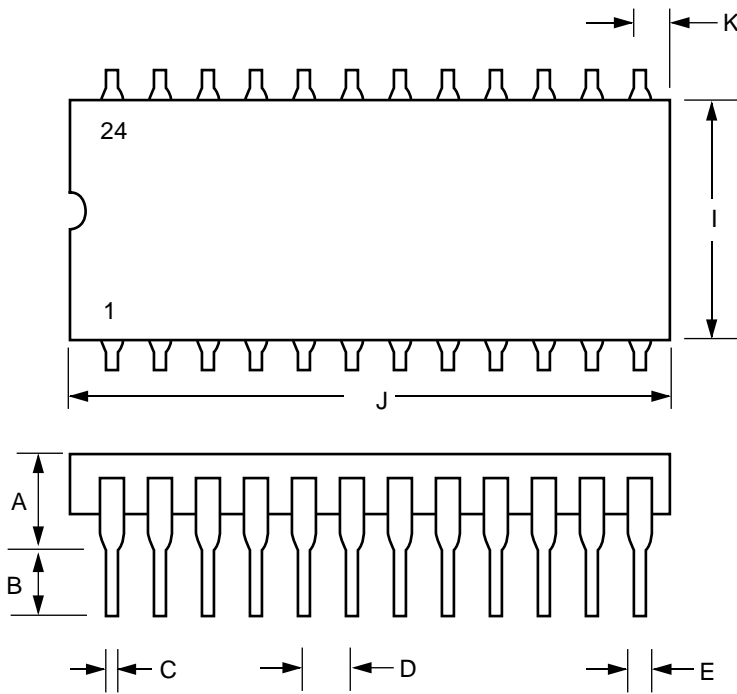
The analog input is sampled and tracked on the first 'H' cycle of the external clock and is held from the falling edge of CLK. The output remains valid (output hold time), and the new data becomes valid (output delay time) after the rising edge of CLK, delayed by 2.5 clock cycles. The clock input and output enable input must be driven at CMOS-compatible levels.

## EVALUATION BOARD

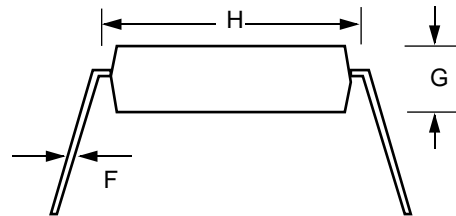
The EB1175 evaluation board is available to aid designers in demonstrating the full performance of the SPT1175. This board includes a reference circuit, clock driver circuit, output data latches, and an on-board reconstruction DAC. An application note describing the operation of the board is available. Contact the factory for price and delivery.

## PACKAGE OUTLINES

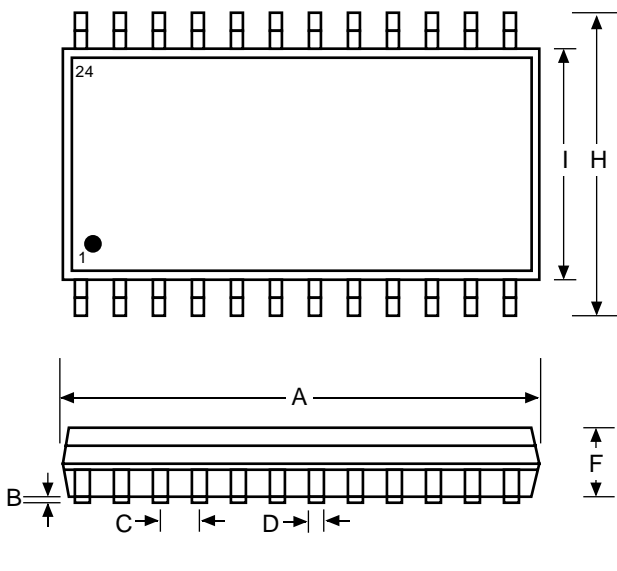
### 24-Lead Plastic DIP



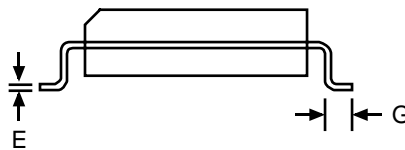
SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.130	0.230	3.30	5.84
B	0.115	0.200	2.92	5.08
C	0.014	0.023	0.36	0.58
D	0.045	0.070	1.14	1.78
E	.100 typ		2.54	0.00
F	0.008	0.015	0.20	0.38
G	0.115	0.195	2.92	4.95
H	.30 typ		7.62	0.00
I	0.240	0.310	6.10	7.87
J	1.180	1.285	29.97	32.64
K	.005 typ		0.13	



### 24-Lead SOIC



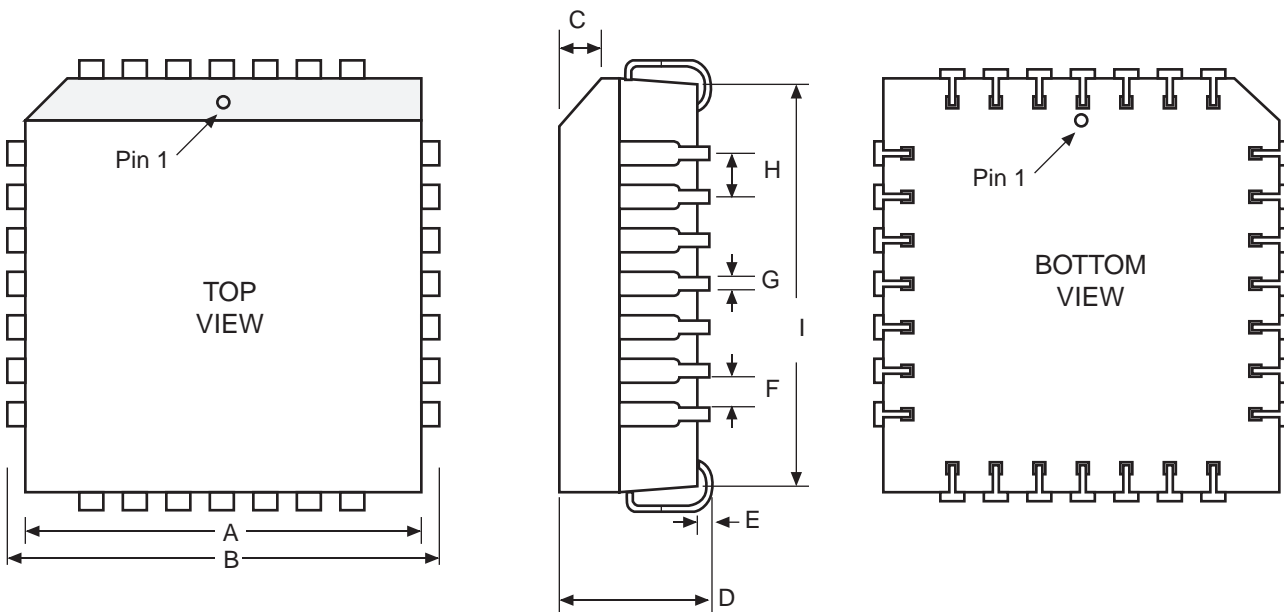
SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.587	0.606	14.90	15.40
B				
C	.050 typ		1.27 typ	
D	0.014	0.022	0.35	0.55
E	0.006	0.012	0.15	0.30
F	0.067	0.089	1.70	2.25
G	0.012	0.028	0.30	0.70
H	0.295	0.327	7.50	8.30
I	0.205	0.220	5.20	5.60



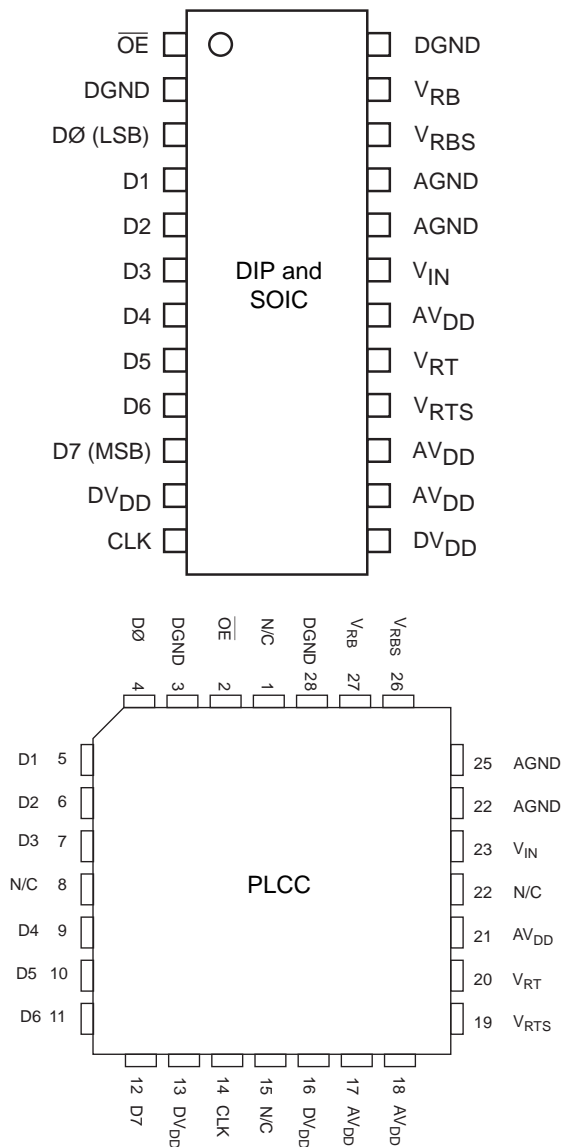
## PACKAGE OUTLINES

### 28-Lead PLCC

SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.450	0.456	11.43	11.58
B	0.485	0.495	12.32	12.57
C	45°		45°	
D	0.165	0.175	4.19	4.45
E		0.010		0.25
F	0.022 typ		.56 typ	0.00
G	0.18 typ		4.57 typ	0.00
H	0.05 typ		1.27 typ	0.00
I	0.039	0.430	0.99	10.92



## PIN ASSIGNMENTS



## PIN FUNCTIONS

Name	Function
OE	Tri-State Output Enable Tri-State When OE = DV <sub>DD</sub> , Enable When OE = DGND
DGND	Digital Ground
D0	Digital Output Data (LSB)
D1-6	Digital Output Data
D7	Digital Output Data (MSB)
DV <sub>DD</sub>	Digital Supply
CLK	CMOS Digital Clock Input
AV <sub>DD</sub>	Analog Supply
V <sub>RTS</sub>	Internal Self-Biased Reference Top Shorted with V <sub>RT</sub> (pin 17). Generates 2.6 V.
V <sub>RT</sub>	Reference Resistor Top Side
V <sub>IN</sub>	Analog Input
AGND	Analog Ground
V <sub>RBS</sub>	Internal Self-Biased Reference Bottom Shorted with V <sub>RB</sub> (pin 23). Generates 0.6 V.
V <sub>RB</sub>	Reference Resistor Bottom Side

## ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE TYPE
SPT1175ACN	0 to +70 °C	24L Plastic Dip
SPT1175ACP	0 to +70 °C	28L PLCC
SPT1175ACS	0 to +70 °C	24L SOIC
SPT1175ACU	+25 °C	Die*

\*See the die specification for guaranteed electrical performance.

Signal Processing Technologies, Inc. reserves the right to change products and specifications without notice. Permission is hereby expressly granted to copy this literature for informational purposes only. Copying this material for any other use is strictly prohibited.

**WARNING - LIFE SUPPORT APPLICATIONS POLICY -** SPT products should not be used within Life Support Systems without the specific written consent of SPT. A Life Support System is a product or system intended to support or sustain life which, if it fails, can be reasonably expected to result in significant personal injury or death.

Signal Processing Technologies believes that ultrasonic cleaning of its products may damage the wire bonding, leading to device failure. It is therefore not recommended, and exposure of a device to such a process will void the product warranty.