

August 1997

## 8-Bit, 500 MSPS, Flash A/D Converter

### Features

- Differential Linearity Error .....  $\pm 0.5$  LSB
- Integral Linearity Error .....  $\pm 0.7$  LSB
- Built-In Integral Linearity Compensation Circuit
- Ultra High Speed Operation with Maximum Conversion Rate (Min)..... 500 MSPS
- Low Input Capacitance (Typ) ..... 20pF
- Wide Analog Input Bandwidth (Min for Full Scale Input)..... 300MHz
- Single Power Supply ..... -5.2V
- Low Power Consumption (Typ) ..... 2.8W
- Low Error Rate
- Capable of Driving 50 $\Omega$  Loads
- Direct Replacement for Sony CXA1276K

### Description

The HI1276 is an 8-bit, ultra-high-speed, flash Analog-to-Digital converter IC capable of digitizing analog signals at a maximum rate of 500 MSPS. The digital I/O levels of this A/D converter are compatible with ECL 100K/10KH/10K.

The HI1276 is available in the Industrial temperature range and is supplied in a 68 lead ceramic LCC package.

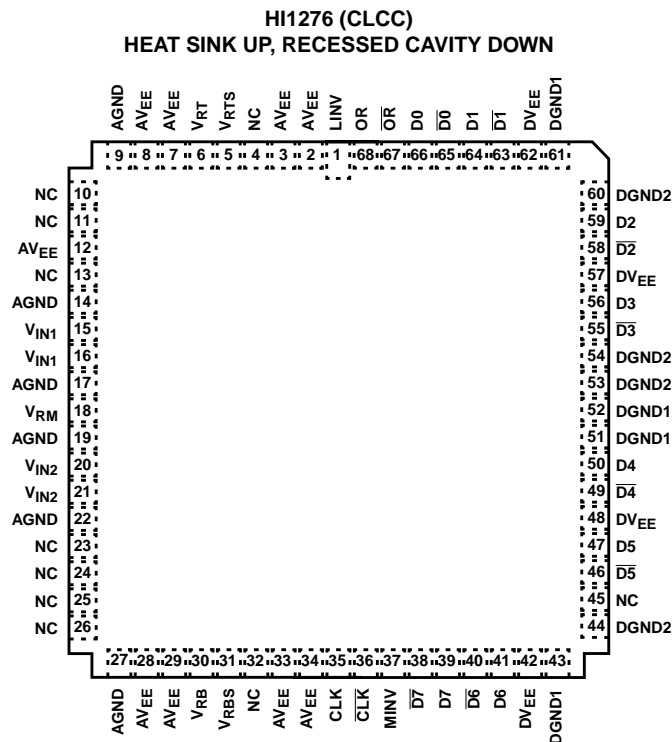
### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HI1276AIL	-20 to 100	68 Ld CLCC	J68.B
HI1276-EV	25	Evaluation Board	

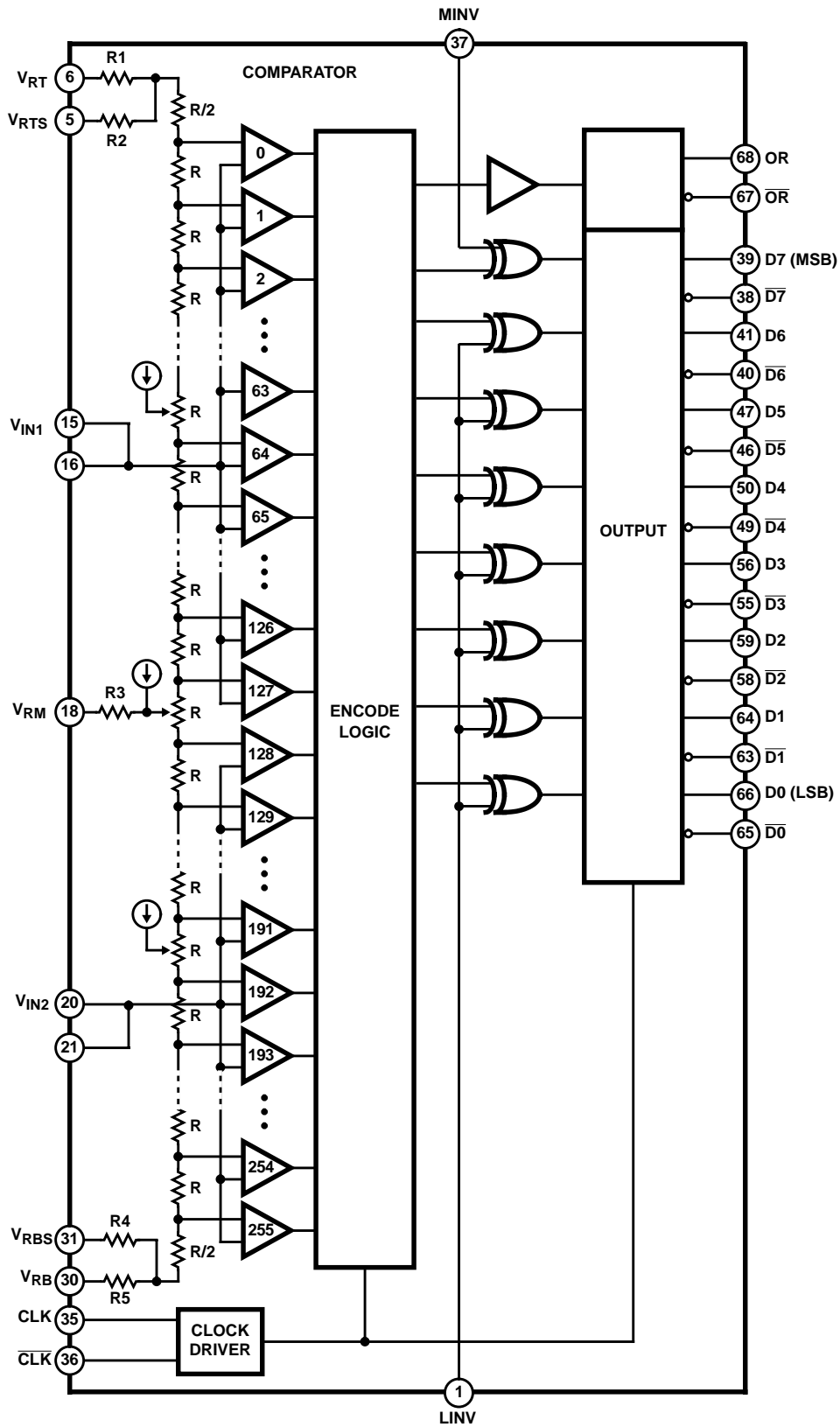
### Applications

- Radar Systems
- Communication Systems
- Digital Oscilloscopes
- Direct RF Down-Conversion

### Pinout



Functional Block Diagram



# HI1276

## Absolute Maximum Ratings $T_A = 25^\circ\text{C}$

Supply Voltage ( $V_{EE}$ , $DV_{EE}$ )	-7V to +0.5V
Analog Input Voltage ( $V_{IN}$ )	-2.7 to +0.5V
Reference Input Voltage	
$V_{RT}$ , $V_{RB}$ , $V_{RM}$	$V_{EE}$ to +0.5V
$ V_{RT} - V_{RB} $	2.5V
Digital Input Voltage	
$\overline{MINV}$ , $LINV$	-4V to +0.5V
$CLK$ , $\overline{CLK}$	$DV_{EE}$ to +0.5V
$ CLK - \overline{CLK} $	2.7V
$V_{RM}$ Pin Input Current ( $I_{VRM}$ )	-3mA to +3mA
Digital Output Current	
( $ID0$ to $ID7$ , $IOR$ , $\overline{ID0}$ to $\overline{ID7}$ , $\overline{IOR}$ )	-30mA to 0mA

## Thermal Information

Thermal Resistance (Typical)	$\theta_{JA}^\circ\text{C/W}$	$\theta_{JC}^\circ\text{C/W}$
CLCC Package	18	4
Maximum Junction Temperature	175°C	
Maximum Storage Temperature Range ( $T_{STG}$ )	-65°C to 150°C	
Maximum Lead Temperature (Soldering 10s)	300°C	

## Operating Conditions (Note 1)

Supply Voltage	MIN	TYP	MAX	Reference Input Voltage	MIN	TYP	MAX
$V_{EE}$ , $DV_{EE}$	-5.5V	-5.2V	-4.95V	$V_{RT}$	-0.1V	-2	0.1V
$V_{EE} - DV_{EE}$	-0.05V	0V	0.05V	$V_{RB}$	-2.2V	-2	-1.8V
$AGND - DGND$	-0.05V	0V	0.05V	Analog Input Voltage, $V_{IN}$	$V_{RB}$	-	$V_{RT}$
Temperature Range (Note 5)							
$T_C$	-20°C	-	100°C				

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

## Electrical Specifications $T_A = 25^\circ\text{C}$ , $V_{EE} = DV_{EE} = -5.2V$ , $V_{RT}$ , $V_{RTS} = 0V$ , $V_{RB}$ , $V_{RBS} = -2V$ (Note 1)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>SYSTEM PERFORMANCE</b>					
Resolution		-	8	-	Bits
Integral Linearity Error, INL	$f_C = 500$ MSPS	-	$\pm 0.3$	$\pm 0.7$	LSB
Differential Linearity Error, DNL	$f_C = 500$ MSPS	-	$\pm 0.3$	$\pm 0.5$	LSB
<b>DYNAMIC CHARACTERISTICS</b>					
Signal to Noise and Distortion Ratio, SINAD = $\frac{\text{RMS Signal}}{\text{RMS Noise} + \text{Distortion}}$	Input = 1kHz, Full Scale $f_C = 500$ MSPS	-	46	-	dB
	Input = 100MHz, Full Scale $f_C = 500$ MSPS	-	37	-	dB
Error Rate	Input = 100MHz, Full Scale Error > 16 LSB, $f_C = 400$ MSPS	-	$10^{-11}$	$10^{-9}$	TPS (Note 3)
	Input = 125MHz, Full Scale Error > 16 LSB, $f_C = 500$ MSPS	-	$10^{-8}$	$10^{-6}$	TPS (Note 3)
Differential Gain Error, DG	NTSC 40 IRE Mod.	-	1.0	-	%
Differential Phase Error, DP	Ramp, $f_C = 500$ MSPS	-	0.5	-	Degree
Overrange Recovery Time		-	1.0	-	ns
Maximum Conversion Rate, $f_C$		500	-	-	MSPS
Aperture Jitter, $t_{AJ}$	Input = 150MHz	-	11	-	ps
Sampling Delay, $t_{DS}$	Input = 150MHz	0.2	0.8	1.5	ns
<b>ANALOG INPUT</b>					
Analog Input Capacitance, $C_{IN}$	$V_{IN} = 1V + 0.07V_{RMS}$	-	20	-	pF
Analog Input Resistance, $R_{IN}$		30	70	-	k $\Omega$
Input Bias Current, $I_{IN}$	$V_{IN} = -1V$	-	-	850	$\mu\text{A}$
Full Scale Input Bandwidth	$V_{IN} = 2V_{P-P}$	300	-	-	MSPS
<b>REFERENCE INPUTS</b>					
Reference Resistance, $R_{REF}$		70	110	160	$\Omega$

**Electrical Specifications**  $T_A = 25^{\circ}\text{C}$ ,  $AV_{EE} = DV_{EE} = -5.2\text{V}$ ,  $V_{RT}$ ,  $V_{RTS} = 0\text{V}$ ,  $V_{RB}$ ,  $V_{RBS} = -2\text{V}$  (Note 1) (Continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Residual Resistance	R1	Note 2	0.1	0.5	2.0	$\Omega$
	R2		0.5	5.2	10	$\Omega$
	R3		0.5	1.6	5.0	$\Omega$
	R4		0.5	8.7	20	$\Omega$
	R5		0.1	0.5	2.0	$\Omega$
<b>DIGITAL INPUTS</b>						
Logic H Level, $V_{IH}$			-1.10	-	-	V
Logic L Level, $V_{IL}$			-	-	-1.55	V
Logic H Current, $I_{IH}$		Input Connected to -0.8V	0	-	70	$\mu\text{A}$
Logic L Current, $I_{IL}$		Input Connected to -1.6V	-50	-	60	$\mu\text{A}$
Input Capacitance			-	6	-	pF
<b>DIGITAL OUTPUTS</b>						
Logic H Level, $V_{OH}$		$R_L = 50\Omega$	-1.03	-	-	V
Logic L Level, $V_{OL}$		$R_L = 50\Omega$	-	-	-1.58	V
<b>TIMING CHARACTERISTICS</b>						
Clock Duty Cycle			45	50	55	%
Output Rise Time, $t_r$		$R_L = 50\Omega$ , 20% to 80%	0.5	0.7	1.0	ns
Output Fall Time, $t_f$		$R_L = 50\Omega$ , 80% to 20%	0.5	0.7	1.0	ns
Output Delay, $t_{OD}$			1.5	1.9	2.3	ns
<b>POWER SUPPLY CHARACTERISTICS</b>						
Supply Current, $I_{EE}$			-680	-520	-	mA
Power Consumption, $P_D$		Note 4	-	2.8	3.6	W

NOTES:

1. Electrical Specifications guaranteed within stated operating conditions.
2. See Functional Block Diagram.
3. TPS: Times Per Sample.
4.  $P_D = I_{EEA} \cdot AV_{EE} + I_{EED} \cdot DV_{EE} + \frac{(V_{RT} - V_{RB})^2}{R_{REF}}$ .
5.  $T_A$  is specified in still air and without heatsink. To extend temperature range, appropriate heat management techniques must be employed (See Figure 2).

**Timing Diagram**

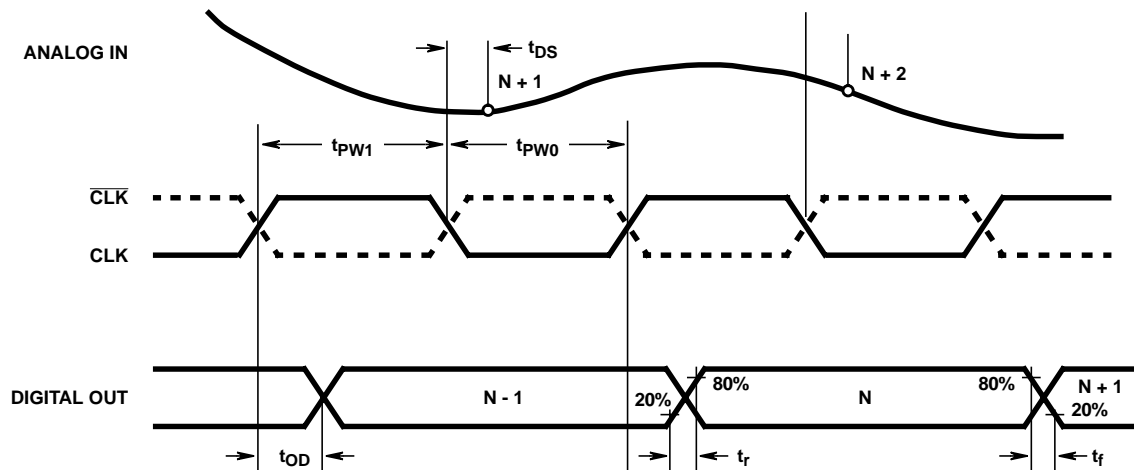


FIGURE 1.

**Typical Performance Curves**

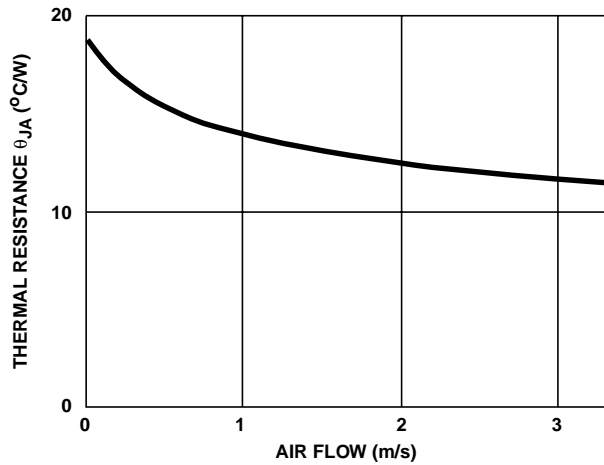


FIGURE 2. THERMAL RESISTANCE MOUNTED ON-BOARD

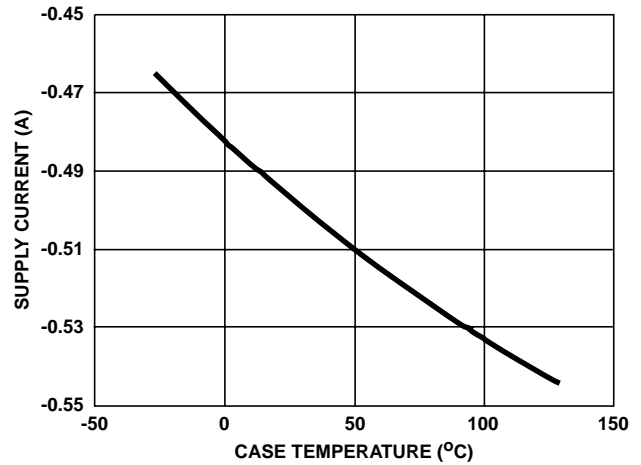


FIGURE 3. SUPPLY CURRENT vs TEMPERATURE CHARACTERISTICS

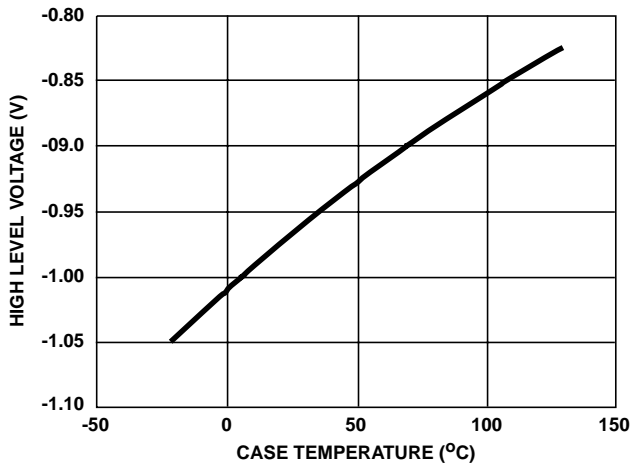


FIGURE 4. D0 PIN HIGH LEVEL VOLTAGE vs TEMPERATURE CHARACTERISTICS

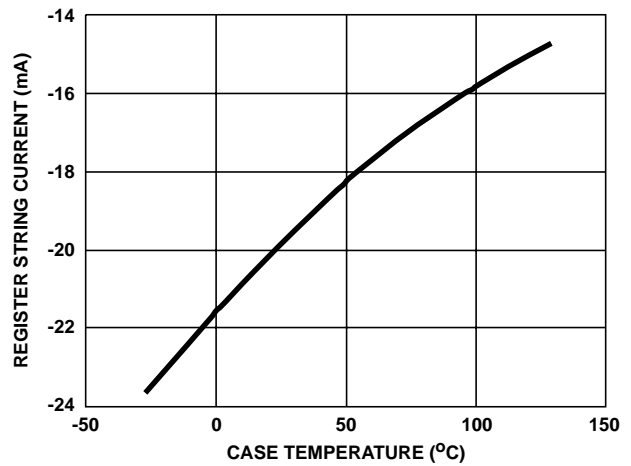


FIGURE 5. REGISTER STRING CURRENT vs TEMPERATURE CHARACTERISTICS

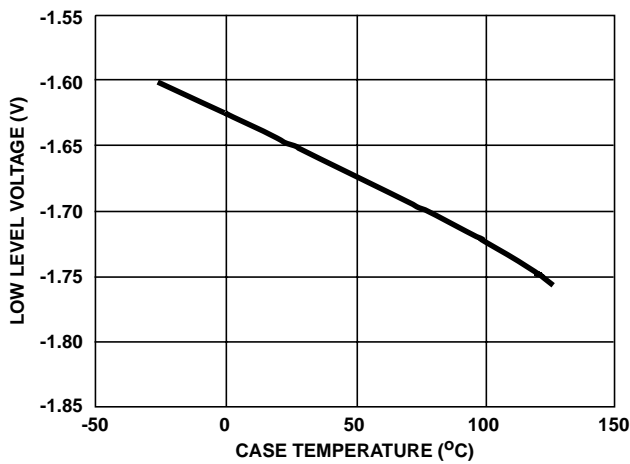


FIGURE 6. D0 PIN LEVEL VOLTAGE vs TEMPERATURE CHARACTERISTICS

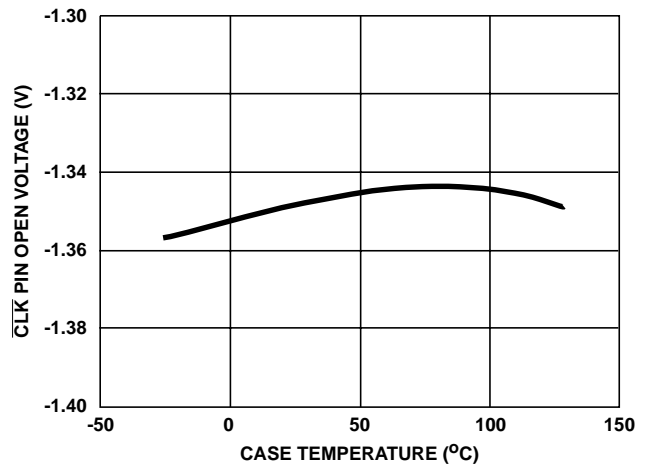


FIGURE 7. CLK PIN OPEN VOLTAGE vs TEMPERATURE CHARACTERISTICS

Typical Performance Curves (Continued)

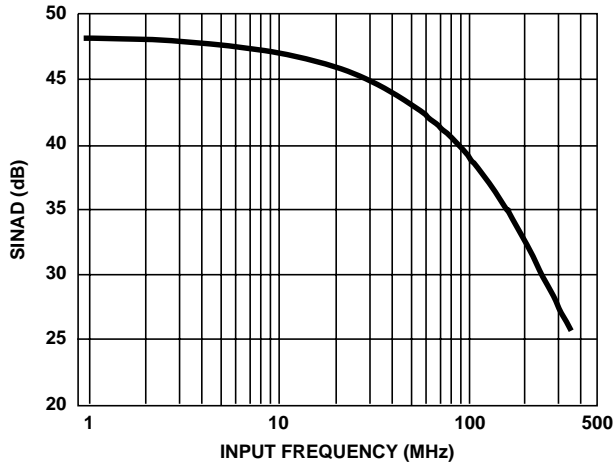


FIGURE 8. SINAD vs INPUT FREQUENCY CHARACTERISTICS

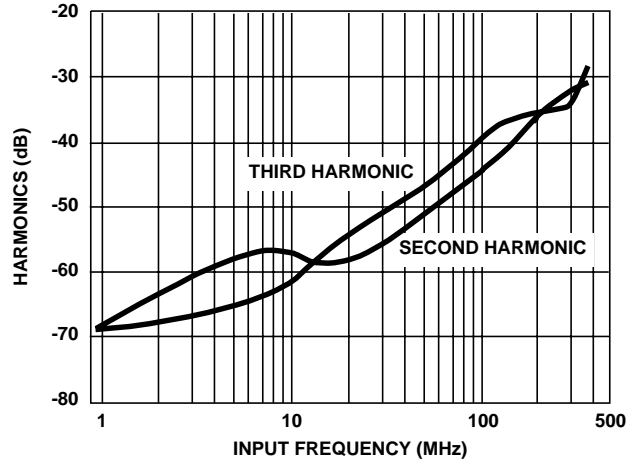


FIGURE 9. HARMONIC DISTORTION vs INPUT FREQUENCY CHARACTERISTICS

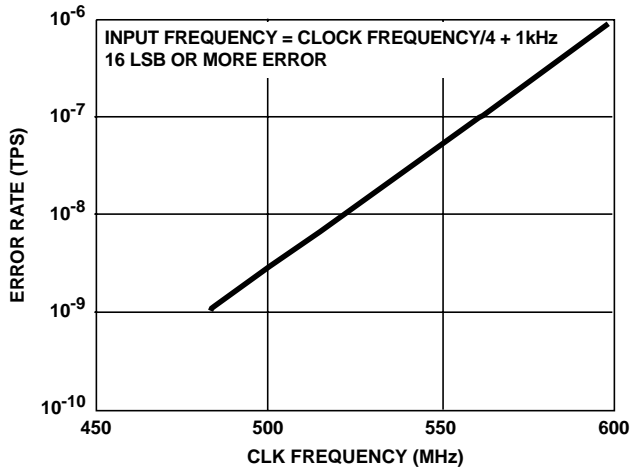


FIGURE 10. ERROR RATE vs CONVERSION FREQUENCY CHARACTERISTICS

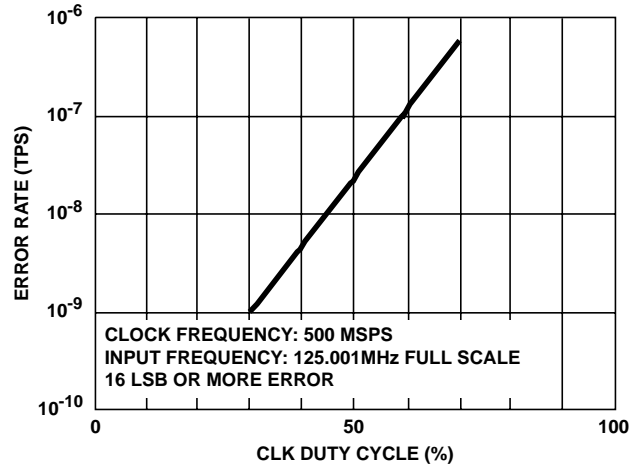


FIGURE 11. ERROR RATE vs CLOCK DUTY CYCLE CHARACTERISTICS

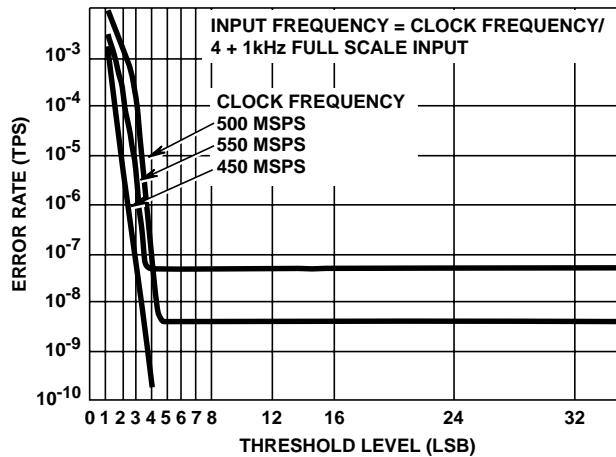


FIGURE 12. ERROR RATE vs THRESHOLD LEVEL CHARACTERISTICS

Pin Descriptions

PIN NUMBER	SYMBOL	I/O	STANDARD VOLTAGE LEVEL	EQUIVALENT CIRCUIT	DESCRIPTION
1	LINV	I	ECL		<p>Polarity Selection for LSBs (refer to the A/D Output Code Table.) Pulled low when left open.</p> <p>Polarity Selection for MSB (refer to the A/D Output Code Table.) Pulled low when left open.</p>
37	MINV				
6	V <sub>RT</sub>	I	0V		<p>Analog Reference Voltage (Top) (0V Typ).</p> <p>Reference Voltage Sense (Top).</p> <p>Reference Voltage Mid Point. Can be used for linearity compensation.</p> <p>Reference Voltage Sense (Bottom).</p> <p>Analog Reference Voltage (Bottom).</p>
5	V <sub>RTS</sub>	O	0V		
18	V <sub>RM</sub>	I	V <sub>RB</sub> /2		
31	V <sub>RBS</sub>	O	-2V		
30	V <sub>RB</sub>	I	-2V		
15, 16	V <sub>IN1</sub>	I	V <sub>RTS</sub> to V <sub>RBS</sub>		<p>Analog Input. All of the pins must be wired externally.</p>
20, 21	V <sub>IN2</sub>				

Pin Descriptions (Continued)

PIN NUMBER	SYMBOL	I/O	STANDARD VOLTAGE LEVEL	EQUIVALENT CIRCUIT	DESCRIPTION
35	CLK	I	ECL		CLK Input.
36	$\overline{\text{CLK}}$				Complementary CLK Input. Pulled down to -1.3V when left open.
38, 39	$\overline{\text{D7}}, \text{D7}$	O	ECL		MSB and Complementary Msb Data Output.
40, 41	$\overline{\text{D6}}, \text{D6}$				D1 to D6: Data output D1 to D6: Complementary data output
46, 47	$\overline{\text{D5}}, \text{D5}$				LSB Data Complementary Output LSB Data Output.
49, 50	$\overline{\text{D4}}, \text{D4}$				Overrange and Complementary Overrange Output.
55, 56	$\overline{\text{D3}}, \text{D3}$				
58, 59	$\overline{\text{D2}}, \text{D2}$				
63, 64	$\overline{\text{D1}}, \text{D1}$				
65, 66	$\overline{\text{D0}}, \text{D0}$				
67, 68	$\overline{\text{OR}}, \text{OR}$				
2, 3, 7, 8, 12, 28, 29, 33, 34	$\text{AV}_{\text{EE}}$	-	-5.2V		Analog Supply. Internally connected to $\text{DV}_{\text{EE}}$ (resistance: 4Ω to 6Ω).
9, 14, 17, 19, 22, 27	AGND		0V		Analog Ground.
42, 48, 57, 62	$\text{DV}_{\text{EE}}$		-5.2V		Digital Supply. Internally connected to $\text{AV}_{\text{EE}}$ (resistance: 4Ω to 6Ω).
43, 51, 52, 61	DGND1		0V		Digital Ground.
44, 53, 54, 60	DGND2 (Note 6)		0V		Digital Ground for Output Drive.
4, 10, 11, 13, 23, 24, 25, 26, 32	NC				No-Connect pins. It is recommended to wire these pins to AGND.
45	NC			No-Connect pin. It is recommended to wire these pins to DGND.	

NOTE:

6.  $V_{\text{RT}} = V_{\text{RTS}} = 0\text{V}$ ,  $V_{\text{RM}} = -1\text{V}$  or open,  $V_{\text{RB}} = V_{\text{RBS}} = -2\text{V}$



A/D OUTPUT CODE TABLE

(NOTE 1) $V_{IN}$	STEP	MINV 1, LINV 1			0, 1			1, 0			0, 0		
		OR	D7	D0	OR	D7	D0	OR	D7	D0	OR	D0	D7
0V		1	000	000	1	100	000	1	011	000	1	111	000
	0	0	000	000	0	100	000	0	011	000	0	111	000
-1V	1	0	000	000	0	100	000	0	011	000	0	111	000
-2V	254	0	111	000	0	011	000	0	100	000	0	000	000
	255	0	111	000	0	011	000	0	100	000	0	000	000
		0	111	000	0	011	000	0	100	000	0	000	000

Test Circuits

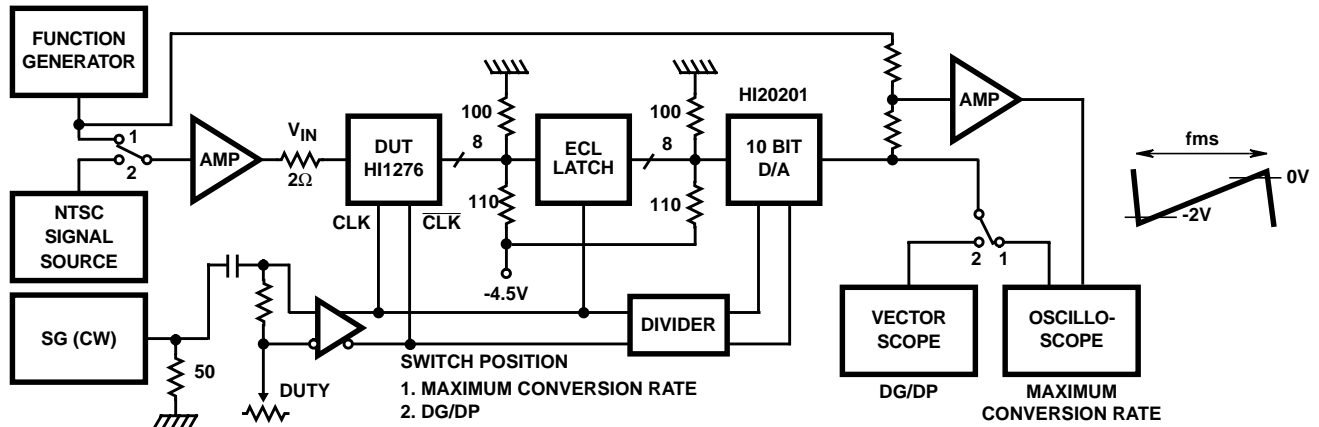


FIGURE 13. MAXIMUM CONVERSION RATE AND DIFFERENTIAL GAIN/PHASE ERROR TEST CIRCUIT

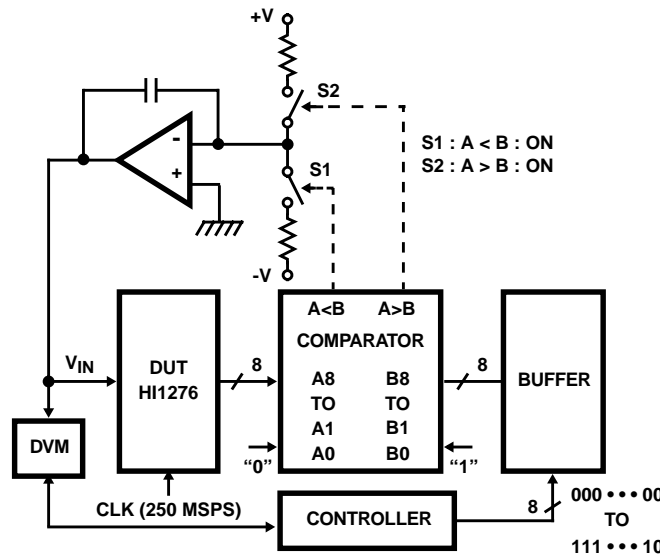


FIGURE 14. INTEGRAL AND DIFFERENTIAL LINEARITY ERROR TEST CIRCUIT

Test Circuits (Continued)

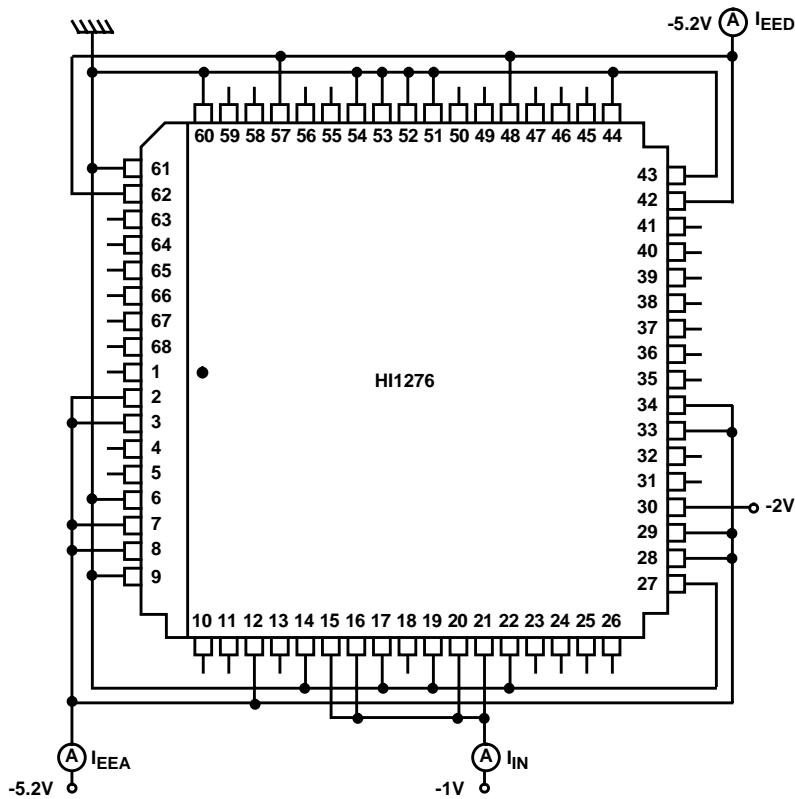


FIGURE 15. POWER SUPPLY AND ANALOG INPUT BIAS CURRENT TEST CIRCUIT

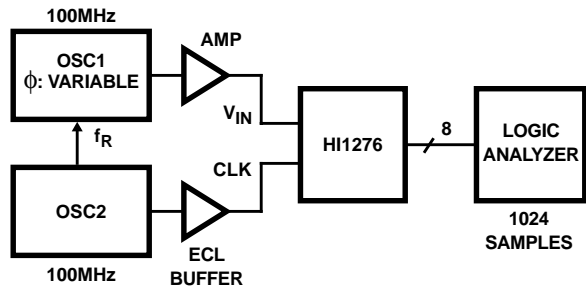
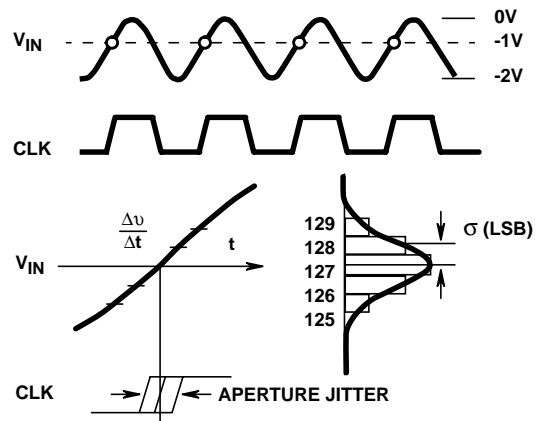


FIGURE 16A.



Aperture jitter is defined as follows:

$$t_{AJ} = \sigma / \frac{\Delta v}{\Delta t} = \sigma / \left( \frac{256}{2} \times 2\pi f \right)$$

Where  $\sigma$  (unit: LSB) is the deviation of the output codes when the input frequency is exactly the same as the clock and is sampled at the largest slew rate point.

FIGURE 16B. APERTURE JITTER TEST METHOD

FIGURE 16. SAMPLING DELAY AND APERTURE JITTER TEST CIRCUIT

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#### **EUROPE**

Intersil SA  
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100, Rue de la Fusee  
1130 Brussels, Belgium  
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#### **ASIA**

Intersil (Taiwan) Ltd.  
Taiwan Limited  
7F-6, No. 101 Fu Hsing North Road  
Taipei, Taiwan  
Republic of China  
TEL: (886) 2 2716 9310  
FAX: (886) 2 2715 3029