

August 1997

8-Bit, 125 MSPS, Flash A/D Converter

Features

- Differential Linearity Error ± 0.5 LSB (Typ) or Less
- Integral Linearity Error ± 0.5 LSB (Typ) or Less
- Built-In Integral Linearity Compensation Circuit
- Ultra High Speed Operation with Maximum Conversion Rate of 125 MSPS (Min)
- Low Input Capacitance (Typ)18pF
- Wide Analog Input Bandwidth (Min for Full Scale Input) 200MHz
- Single Power Supply-5.2V
- Low Power Consumption (Typ)870mW
- Low Error Rate
- Operable at 50% Clock Duty Cycle
- Capable of Driving 50 Ω Loads
- Direct Replacement for Sony CXA1396

Description

The HI1396 is an 8-bit, ultra high speed flash analog-to-digital converter IC capable of digitizing analog signals at the maximum rate of 125 MSPS. The digital I/O levels of the converter are compatible with ECL 100K/10KH/10K.

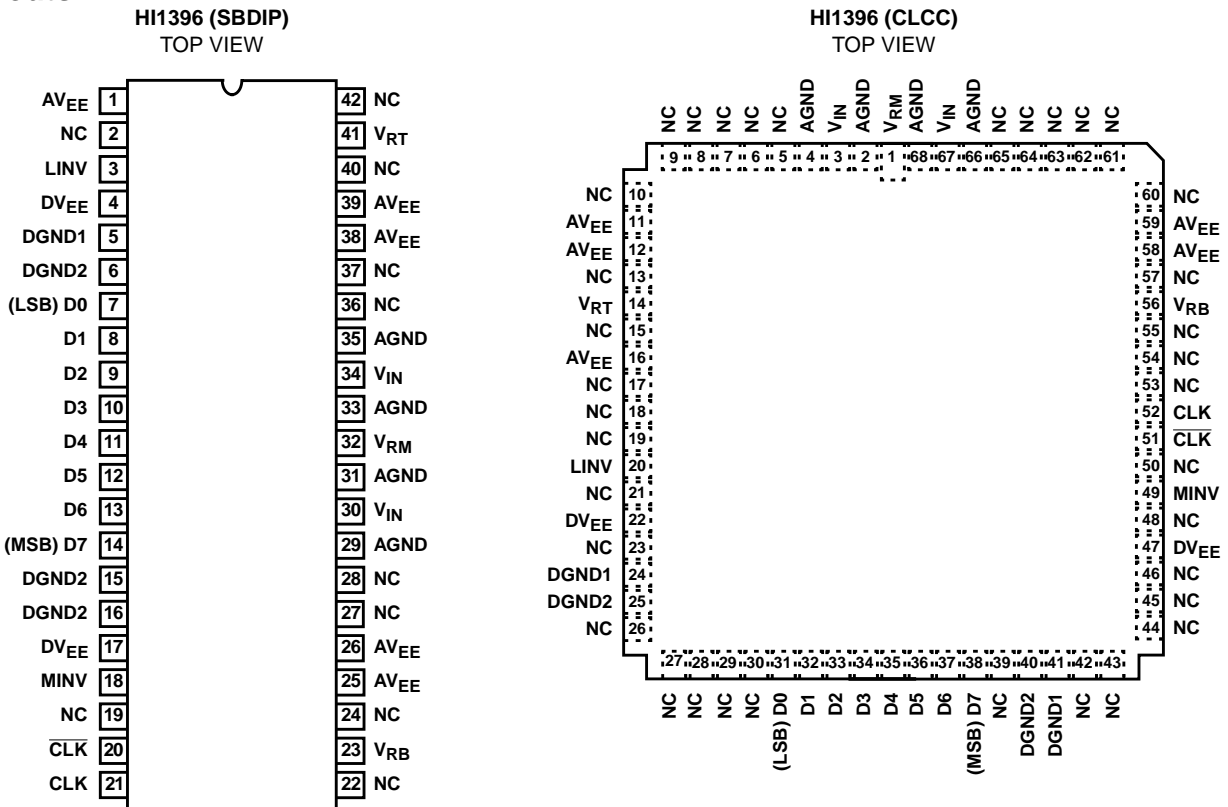
Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HI1396JCJ	-20 to 75	42 Ld SBDIP	D42.6
HI1396AIL	-20 to 100	68 Ld CLCC	J68.A

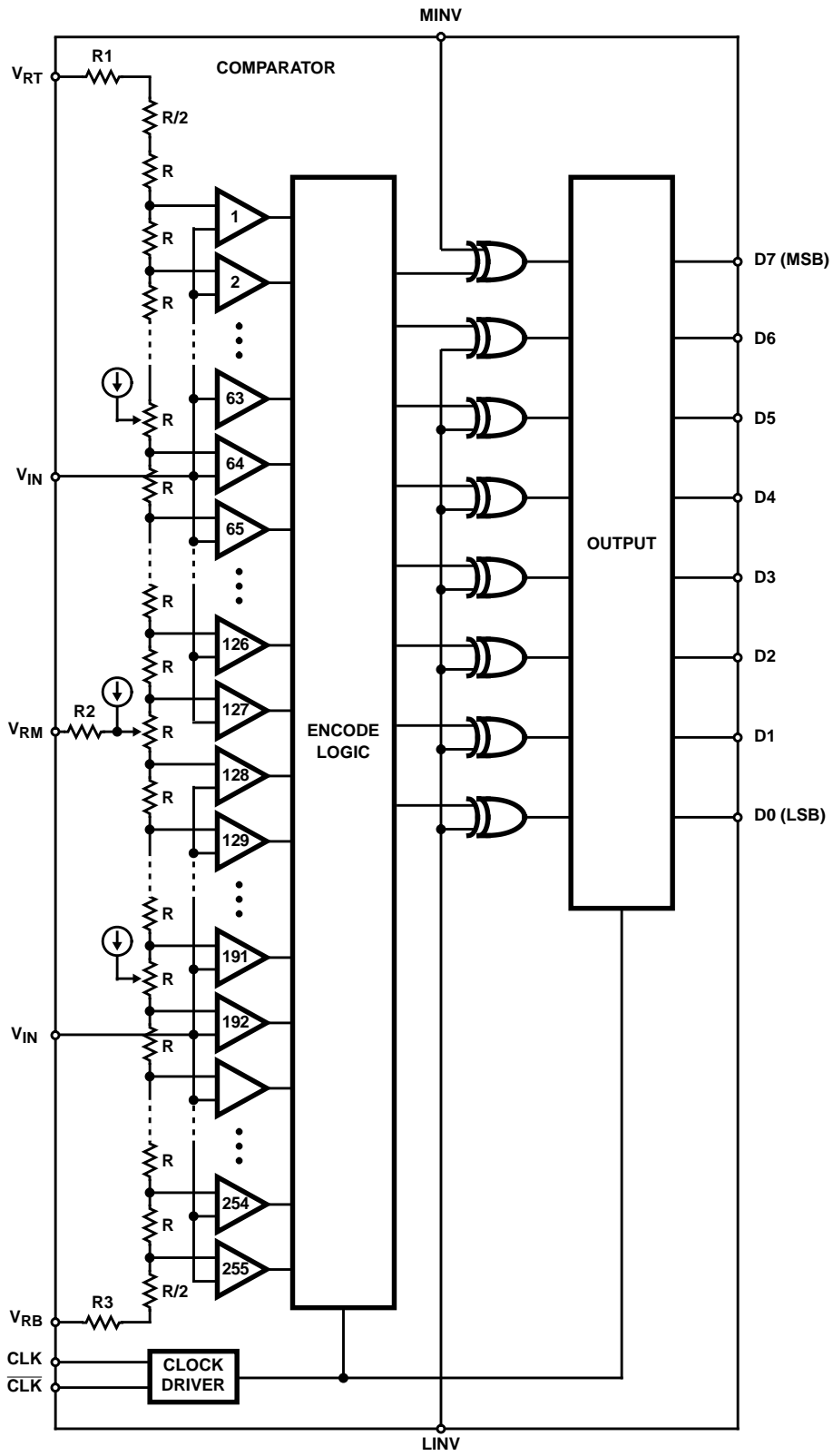
Applications

- Video Digitizing
- HDTV (High Definition TV)
- Direct RF Down-Conversion
- Communication Systems
- Radar Systems
- Digital Oscilloscopes

Pinouts



Functional Block Diagram



HI1396

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

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

Operating Conditions (Note 1)

Temperature Ranges (Note 4)	
SBDIP Package, T_A	-20°C to 75°C
CLCC Package, T_C	-20°C to 100°C
Supply Voltage Ranges	
V_{EE} , DV_{EE}	-5.5V to -4.95V
$V_{EE} - DV_{EE}$	-0.05V to 0.05V
AGND - DGND	-0.05V to 0.05V
Reference Input Voltage	
V_{RT}	-0.1V to 0.1V
V_{RB}	-2.2V to -1.8V

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} °C/W	θ_{JC} °C/W
SBDIP Package	45	7
CLCC Package	45	8
Maximum Junction Temperature		
Ceramic Packages		175°C
Maximum Storage Temperature Range (T_{STG})		-65°C to 150°C
Maximum Lead Temperature (Soldering 10s)		300°C

Analog Input Voltage, V_{IN}	V_{RB} to V_{RT}
Pulse Width of Clock	
t_{PW1}	4.0ns (Min)
t_{PW0}	4.0ns (Min)

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.

NOTE:

- θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SYSTEM PERFORMANCE					
Resolution		-	8	-	Bits
Integral Linearity Error, INL HI1396JCJ, HI1396AIL	$f_C = 125$ MSPS	-	± 0.3	± 0.5	LSB
Differential Linearity Error, DNL HI1396JCJ, HI1396AIL	$f_C = 125$ MSPS	-	-	± 0.5	LSB
ANALOG INPUT					
Input Bandwidth	$V_{IN} = 2V_{P-P}$	200	-	-	MHz
Analog Input Capacitance, C_{IN}	$V_{IN} = 1\text{V} + 0.07V_{RMS}$	-	17	-	pF
Analog Input Resistance, R_{IN}		50	190	-	k Ω
Input Bias Current, I_{IN}	$V_{IN} = -1\text{V}$	20	130	400	μA
REFERENCE INPUTS					
Reference Resistance, R_{REF}		75	110	155	Ω
Offset Voltage					
E_{OT}	V_{RT}	8	19	32	mV
E_{OB}	V_{RB}	0	15	24	mV
DIGITAL INPUTS					
Logic H Level, V_{IH}		-1.13	-	-	V
Logic L Level, V_{IL}		-	-	-1.50	V
Logic H Current, I_{IH}	Input Connected to -0.8V	0	-	50	μA
Logic L Current, I_{IL}	Input Connected to -1.6V	0	-	50	μA
Input Capacitance		-	7	-	pF
DIGITAL OUTPUTS					
Logic H Level, V_{OH}	$R_L = 50\Omega$ to -2V	-1.10	-	-	V
Logic L Level, V_{OL}	$R_L = 50\Omega$ to -2V	-	-	-1.62	V

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
TIMING CHARACTERISTICS					
Output Rise Time, t_r	$R_L = 50\Omega$ to -2V , 20% to 80%	0.5	0.9	1.2	ns
Output Fall Time, t_f	$R_L = 50\Omega$ to -2V , 20% to 80%	0.5	1.0	1.3	ns
Output Delay, t_{OD}		3.0	3.6	4.2	ns
H Pulse Width of Clock, t_{PW1}		4.0	-	-	ns
L Pulse Width of Clock, t_{PW0}		4.0	-	-	ns
DYNAMIC CHARACTERISTICS					
Maximum Conversion Rate, f_C	Error Rate 10^{-9} TPS (Note 2)	125	-	-	MSPS
Aperture Jitter, t_{AJ}		-	10	-	ps
Sampling Delay, t_{DS}		-	1.5	-	ns
Signal to Noise Ratio (SINAD) = $\frac{\text{RMS Signal}}{\text{RMS Noise} + \text{Distortion}}$	Input = 1MHz, Full Scale $f_C = 125$ MSPS	-	46	-	dB
	Input = 31.5MHz, Full Scale $f_C = 125$ MSPS	-	40	-	dB
Error Rate	Input = 31.249MHz, Full Scale Error > 16 LSB, $f_C = 125$ MSPS	-	-	10^{-9}	TPS (Note 2)
Differential Gain Error, DG	NTSC 40 IRE Mod.	-	1.0	-	%
Differential Phase Error, DP	Ramp, $f_C = 125$ MSPS	-	0.5	-	Degree
POWER SUPPLY CHARACTERISTICS					
Supply Current, I_{EE}		-230	-160	-	mA
Power Consumption	Note 3	-	870	-	mW

NOTES:

1. Electrical Specifications guaranteed within stated operating conditions.
2. TPS: Times Per Sample.

$$3. P_D = I_{EE} \cdot V_{EE} + \frac{(V_{RT} - V_{RB})^2}{R_{REF}}$$

4. T_A specified in still air and without heat sink. To extend temperature range, appropriate heat management techniques must be employed.

Timing Diagram

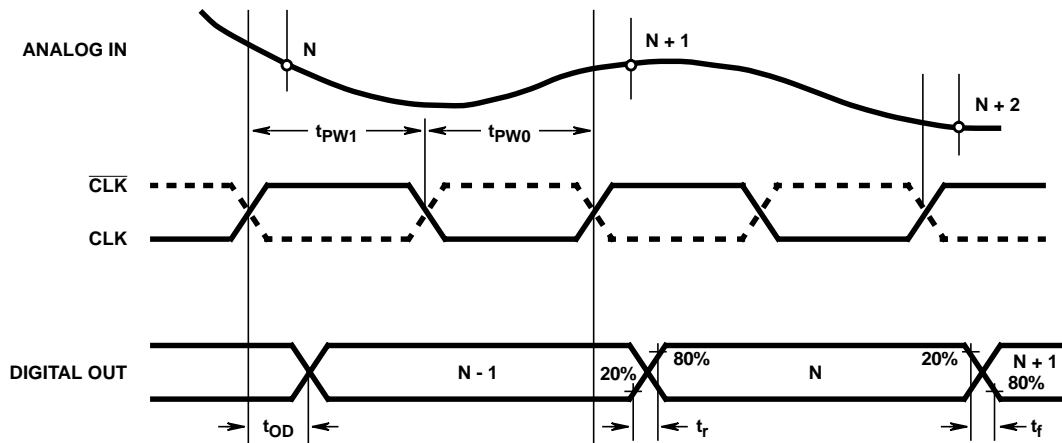


FIGURE 1.

Pin Descriptions and I/O Pin Equivalent Circuits

PIN NUMBER		SYMBOL	I/O	STANDARD VOLTAGE LEVEL	EQUIVALENT CIRCUIT	DESCRIPTION
DIP	LCC					
29, 31, 33, 35	49, 51, 53, 55	AGND	-	0V		Analog GND. Used as GND for input buffers and latches of comparators. Isolated from DGND1, DGND2.
1, 25, 26, 38, 39	41, 42, 62, 63, 67	AV _{EE}	-	-5.2V		Analog V _{EE} -5.2V (Typ). Internally connected to DV _{EE} (Resistance: 4Ω to 6Ω). Bypass with 0.1μF to AGND.
21	35	CLK	I	ECL		CLK Input.
20	34	CLK				Input complementary to CLK. When left open pulled down to -1.3V. Device is operable without CLK input, but use of complementary inputs of CLK and CLK is recommended to obtain stable high speed operation.
5, 16	7, 24	DGND1	-	0V		Digital GND for internal circuits.
6, 15	8, 23	DGND2	-	0V		Digital GND for output transistors.
4, 17	5, 30	DV _{EE}	-	-5.2V		Digital V _{EE} . Internally connected to AV _{EE} (resistance: 4Ω to 6Ω). Bypass with 0.1μF to DGND
7	14	D0	O	ECL		LSB of data outputs. External pull-down resistor is required.
8	15	D1				Data outputs. External pull-down resistors are required.
9	16	D2				
10	17	D3				
11	18	D4				
12	19	D5				
13	20	D6				
14	21	D7		MSB of data outputs. External pull-down resistor is required.		

Pin Descriptions and I/O Pin Equivalent Circuits (Continued)

PIN NUMBER		SYMBOL	I/O	STANDARD VOLTAGE LEVEL	EQUIVALENT CIRCUIT	DESCRIPTION
DIP	LCC					
3	3	LINV	I	ECL		Input pin for D0 (LSB) to D6 output polarity inversion (see A/D Output Code Table). Pulled low when left open.
18	32	MINV	I	ECL		Input pin for D7 (MSB) output polarity inversion (see A/D Output Code Table). Pulled low when left open.
30, 34	50, 54	V _{IN}	I	V _{RT} to V _{RB}		Analog input pins. These two pins must be connected externally, since they are not internally connected.
23	39	V _{RB}	I	-2V		Reference voltage (bottom). Typically -2V. Bypass with a 0.1μF and 10μF to AGND.
32	52	V _{RM}	I	V _{RB} /2		Reference voltage mid point. Can be used as a pin for integral linearity compensation.
41	65	V _{RT}	I	0V		Reference voltage (top) typically 0V. When a voltage different from AGND is applied to this pin, bypass with a 0.1μF and 10μF to AGND.

Pin Descriptions and I/O Pin Equivalent Circuits (Continued)

PIN NUMBER		SYMBOL	I/O	STANDARD VOLTAGE LEVEL	EQUIVALENT CIRCUIT	DESCRIPTION
DIP	LCC					
2, 19, 22, 24, 27, 28, 36, 37, 40, 42	1, 2, 4, 6, 9-13, 25-29, 31, 33, 36-38, 40, 43-48, 56-61, 64, 66, 68	NC	-	-		Unused pins. No internal connections have been made to these pins. Connecting them to AGND or DGND on PC board is recommended.

A/D OUTPUT CODE TABLE

V _{IN} (Note 5)	STEP	MINV 1, LINV 1		0, 1		1, 0		0, 0	
		D7	D0	D7	D0	D7	D0	D7	D0
0V	0	000 ••••• 00	100 ••••• 00	011 ••••• 11	111 ••••• 11	011 ••••• 11	111 ••••• 11	011 ••••• 11	111 ••••• 11
		000 ••••• 00	100 ••••• 00	011 ••••• 11	111 ••••• 11	011 ••••• 11	111 ••••• 11	011 ••••• 11	111 ••••• 11
		000 ••••• 01	100 ••••• 01	011 ••••• 10	111 ••••• 10	011 ••••• 10	111 ••••• 10	011 ••••• 10	111 ••••• 10
-1V	127	•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
-1V	128	011 ••••• 11	111 ••••• 11	000 ••••• 00	100 ••••• 00	111 ••••• 11	011 ••••• 11	000 ••••• 00	100 ••••• 00
	128	100 ••••• 00	000 ••••• 00	111 ••••• 11	011 ••••• 11	000 ••••• 00	100 ••••• 00	111 ••••• 11	011 ••••• 11
-2V	254	•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
-2V	255	111 ••••• 10	011 ••••• 10	100 ••••• 01	000 ••••• 01	111 ••••• 11	011 ••••• 11	100 ••••• 01	000 ••••• 01
	255	111 ••••• 11	011 ••••• 11	100 ••••• 00	000 ••••• 00	111 ••••• 11	011 ••••• 11	100 ••••• 00	000 ••••• 00
-2V		111 ••••• 11	011 ••••• 11	100 ••••• 00	000 ••••• 00	111 ••••• 11	011 ••••• 11	100 ••••• 00	000 ••••• 00

NOTE:

5. V_{RT} = 0V, V_{RB} = -2V.

Test Circuits

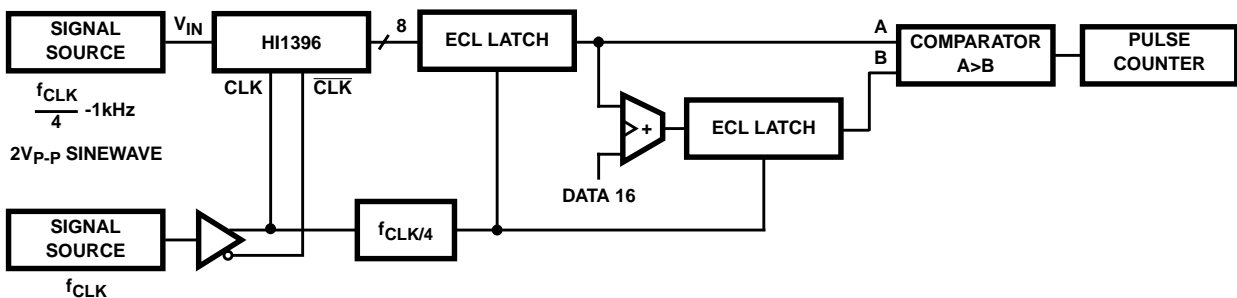


FIGURE 2. MAXIMUM CONVERSION RATE TEST CIRCUIT

Test Circuits (Continued)

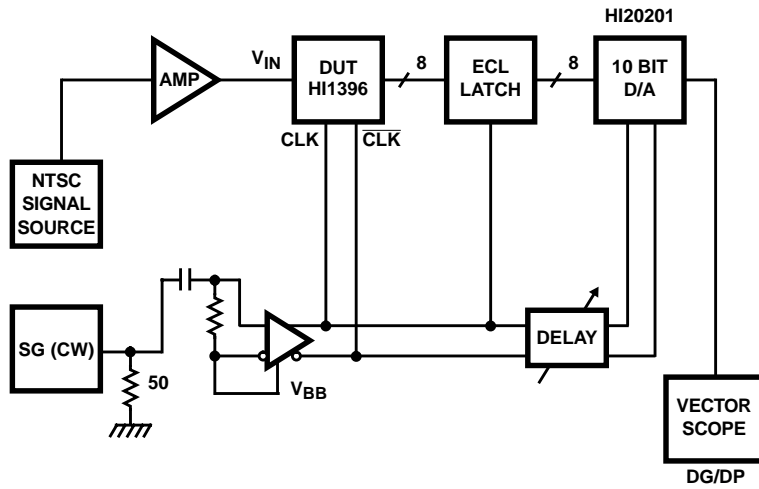


FIGURE 3. DIFFERENTIAL GAIN AND PHASE ERROR TEST CIRCUIT

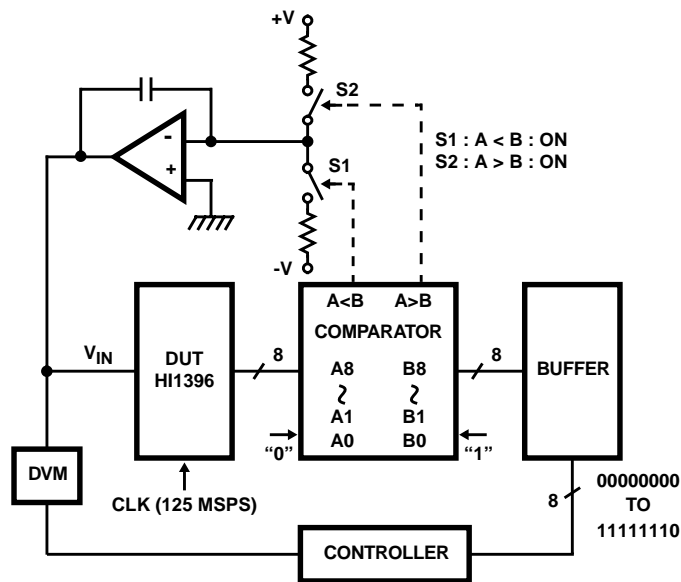


FIGURE 4. INTEGRAL AND DIFFERENTIAL LINEARITY ERROR TEST CIRCUIT

Test Circuits (Continued)

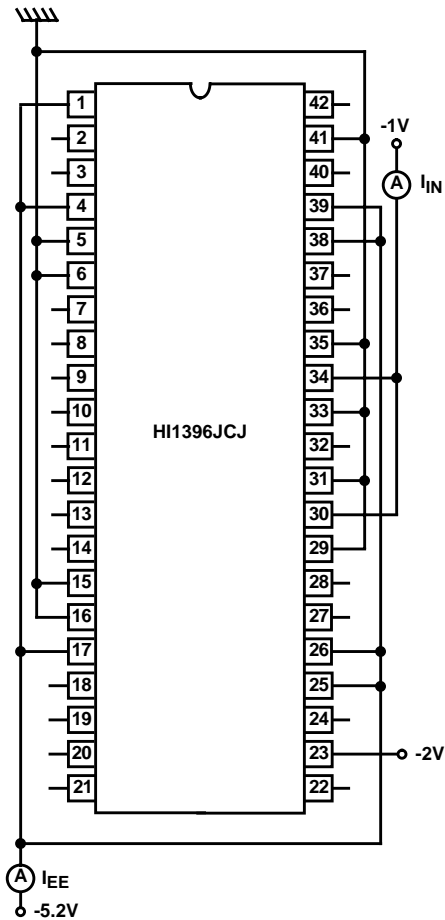


FIGURE 5A.

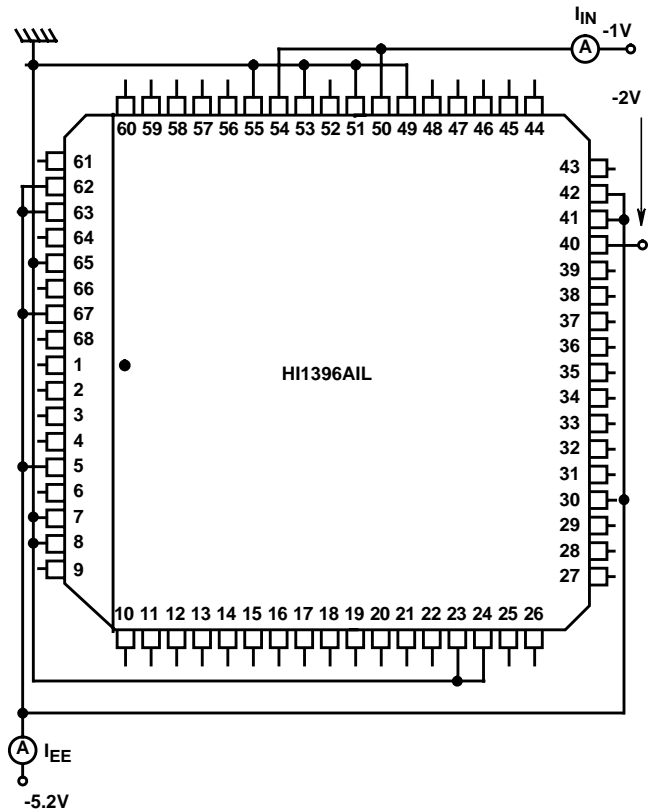


FIGURE 5B.

FIGURE 5. ANALOG INPUT BIAS AND POWER SUPPLY CURRENT TEST CIRCUITS

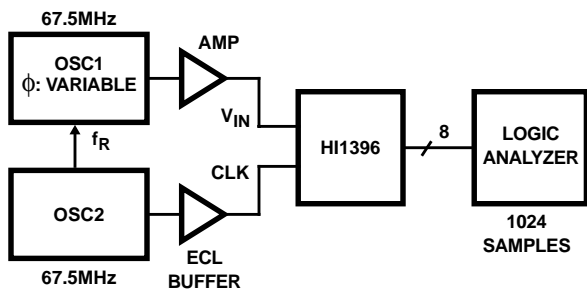
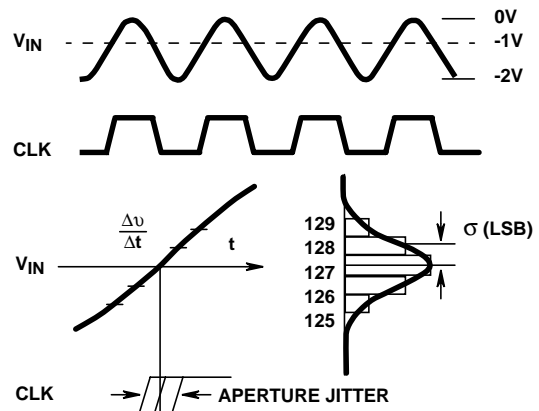


FIGURE 6A.

FIGURE 6. SAMPLING DELAY AND APERTURE JITTER TEST CIRCUIT



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 σ (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 6B. APERTURE JITTER TEST METHOD

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