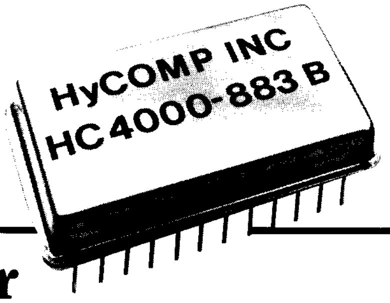
HyComp, Inc.



HC4000

12 Bit D/A Converter High-Speed ECL

FEATURES

- 35-nsec settling time
- Drop-in replacements for ADH-030 II ECL DAC
- MIL-STD-883C and industrial versions
- Extremely low glitch energy
- Internal reference
- 24-pin hermetic DIP

APPLICATIONS

- Video display
- X-Y deflection
- High-speed A/D converters
- Medical instrumentation
- Voltage-controlled oscillators

DESCRIPTION

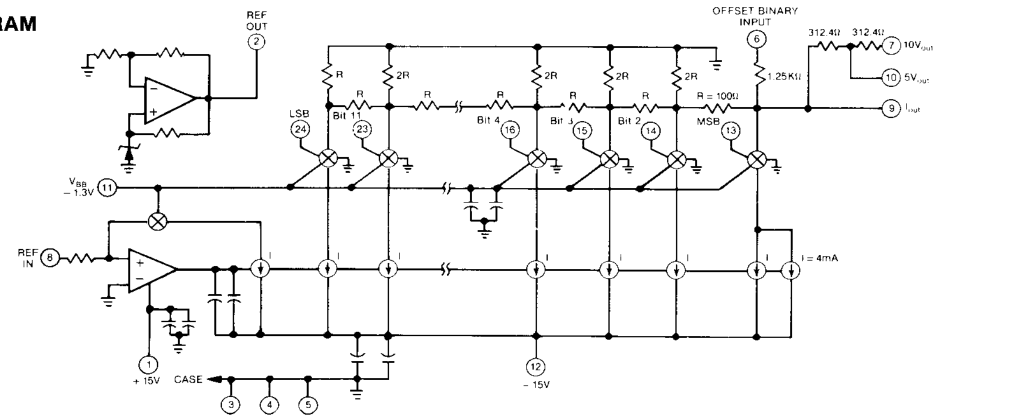
The HC4000 is a high-speed, low-glitch ECL-compatible 12-bit D/A converter. It contains twelve closely matched 4-mA ultra-fast switches driving an R/2R ladder network, to provide output-current ranges of 0 to − 15.996 mA unipolar or + 8 to − 7.994 mA bipolar. Containing a buffered + 10V, 15-mA reference, the HC4000 guarantees 12-bit monotonicity over the full operating-temperature range.

The HC4000's ladder-network and feedback resistors are carefully stabilized nickel-chromium thin films (no thick films used), functionally laser trimmed for optimum circuit performance. Moreover, functional trimming of the internal reference's Zener-diode feed current ensures the lowest possible gain drift.

The HC4000's internal reference allows the unit to operate without any external adjustments. For particular applications, however, provision exists for the use of an external + 10V ± 10% reference. In this range, the absolute output current is a direct, linear function of the reference voltage.

Both industrial (0 to + 70 °C) and MIL-STD (− 55 °C to + 125 °C) models are housed in hermetically sealed 24-pin Dual-In-Line packages. The full MIL-temperature model (suffix: -883) receives the complete series MIL-STD-883C screening, including preseal visual inspection, acceleration, stabilization bake, gross- and fine-leak tests and 160 hours operating burn-in. (Table 2)

FUNCTIONAL DIAGRAM



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HC4000 12-BIT ECL D/A CONVERTER

ABSOLUTE MAXIMUM RATINGS

Supply Voltages V_{CC}	+20V
V_{EE}	−20V
V_{BB}	−5V
Logic Inputs	−5V
Operating Temperature (3)	
HC4000	0°C to +70°C
HC4000-883	−55°C to +125°C
Storage Temperature	−65°C to +150°C
Lead Soldering Temperature (10 sec.)	300°C

ORDERING INFORMATION

PART NUMBER HC4000-883

Model Selection

Add "-883" for Screening to MIL-STD-883C, Method 5008

EXAMPLES

- Industrial Model; 0 to +70°C: HC4000
- MIL-STD Model; −55 to +125°C; MIL-STD-883C Screening: HC4000-883

SPECIFICATIONS (T_A = 25°C, Supply Voltages: ±15V and −1.3V unless otherwise specified)

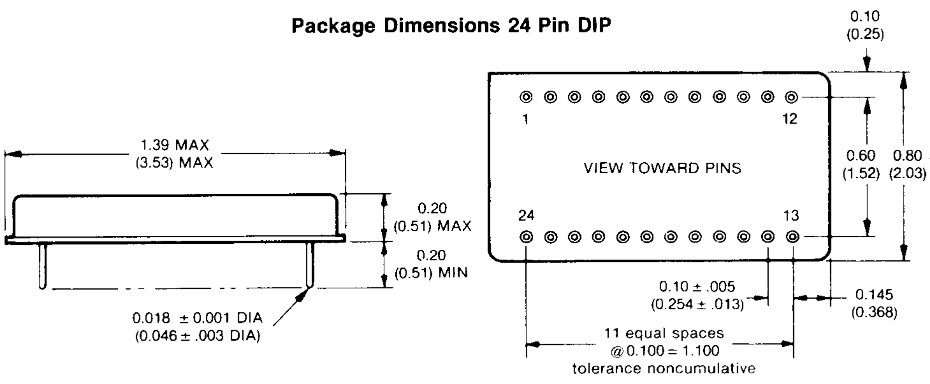
	MIN	TYP	MAX	UNITS
Output Current				
Unipolar Range		0 to −16		mA
Bipolar Range		±8		mA
Compliance	−0.5		+2.0	Volts
Impedance		200		Ω
Capacitance		20		pF
Transfer Characterisitics				
Integral Linearity			0.0125	%FS
Differential Linearity			0.0125	%FS
Gain Error		0.05		%FS
Unipolar Offset			1	μA
Bipolar Offset			4	μA
Monotonicity (Guaranteed Over Full Operating Temp. Range)	12			Bits
Temperature Drift (Guaranteed Over Full Operating Temp. Range)				
Integral Linearity		3	5	ppm/°C
Differential Linearity		3	5	ppm/°C
Gain		25		ppm/°C
Zero Offset		10		ppm/°C
Settling Time				
Full Scale Change				
to 1% FS		20	30	nsec
to 0.1% FS		30	40	nsec
to 0.0125% FS (1)		35	50	nsec
Update Rate	50			MHz
Switch Skew		400	800	psec
Output Time Constant (2)		1.3		nsec
Glitch (2)		25		mV–nsec

	MIN	TYP	MAX	UNITS
Logic Inputs				
"1"	−0.96		−0.81	Volts
"0"	−1.85		−1.65	Volts
Logic Current				
"1"			1	mA
"0"			0	mA
Coding				
Unipolar		CB		
Bipolar		COB		
Internal Reference				
Voltage		+10		Volts
Current			15	mA
External Reference				
Voltage	+9		+11	Volts
Current			15	mA
Power Supplies				
Operating Range	±13.5		±16.5	Volts
Supply Current				
V_{CC}			30	mA
V_{EE}			60	mA
PSRR			0.02	%/Volt
Operating Temperature				
HC4000	0		+70	°C
HC4000-883	−55		+125	°C
Thermal Resistance				
Junction/Air θ_{JA} (3)			20	°C/Watt
Junction/Case θ_{JC}			7	°C/Watt

SPECIFICATION NOTES:

1. For a 1-LSB change, settles to 0.0125% in 20 nsec (typ).
2. With a 100Ω load.
3. In free air.

Package Dimensions 24 Pin DIP



Dimensions are in inches (centimeters)

HC4000 Pin Connections

PIN	FUNCTION	PIN	FUNCTION
1	+15VDC	13	Bit 1 (MSB)
2	Ref. Output	14	Bit 2
3	Ground	15	Bit 3
4	Ground	16	Bit 4
5	Ground	17	Bit 5
6	Bipolar Offset	18	Bit 6
7	Feedback 2	19	Bit 7
8	Ref. Input	20	Bit 8
9	Output Current	21	Bit 9
10	Feedback 1	22	Bit 10
11	−1.3VDC	23	Bit 11
12	−15VDC	24	Bit 12 (LSB)

HC4000 ECL DAC APPLICATIONS INFORMATION

CURRENT-OUTPUT APPLICATIONS

Connect the HC4000 as shown in **Fig. 1.** It is recommended that Ground Pins 3, 4 and 5 be tied to a low-impedance ground plane on the pc board. Although the HC4000 features internal decoupling capacitors on all power-supply lines, it is nevertheless important to provide clean, noise-free, low-impedance supply buses to the converter.

The HC4000 can be configured for 0 to − 16 mA unipolar or ± 8 mA bipolar outputs. **Table 1** gives the pin connections and the digital-input coding for both ranges, using the converter's internal reference. To use an external reference (+ 10V ± 10%), leave Pin 2 open and connect the reference to Pin 8.

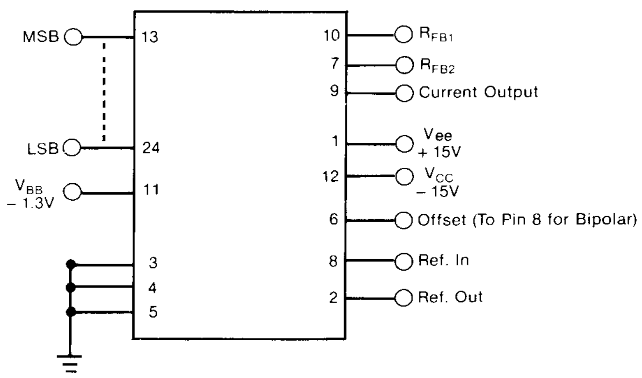


Fig. 1 Current-Output DAC

VOLTAGE-OUTPUT APPLICATIONS

You can use the HC4000's current output with a suitable load resistor to yield a voltage output. The − 0.5V max compliance is the load resistor's limiting factor. Given the fact that the HC4000's output is a 200Ω impedance 0 to − 16 mA or ± 8 mA current source, the load resistor's maximum value (for − 0.5V max negative output voltage) is 37Ω for the unipolar connection (yielding 0 to − 0.5V output) and 90Ω for the bipolar connection (yielding ± 0.5V output).

To obtain larger voltage-output ranges, use a fast-settling amplifier such as the HC1437. **Fig. 2** gives the connections for unipolar outputs of 0 to + 5V and 0 to + 10V and bipolar outputs of ± 2.5V and ± 5V. By paralleling the internal 312.5Ω feedback resistors (connect Pin 7 to Pin 10; Pin 9 to the op amp's summing junction), you can also obtain 0 to + 2.5V or ± 1.25V outputs. The use of the HC4000's internal feedback resistors ensures the lowest possible temperature drift.

To trim **Fig. 2's** circuit in unipolar mode, first apply all ONEs to the digital inputs and adjust the Offset-Trim potentiometer for 0V output. In bipolar mode, apply code 011111111111 and trim for 0V output. Next, trim the 6.8- to 18-pf compensating capacitor for optimum settling time (using **Fig. 3's** Test Circuit) by switching the digital inputs from all ZEROs to all ONEs for a full-scale excursion.

CURRENT OUTPUT (mA)		DIGITAL INPUTS
Unipolar Pin 2 to Pin 8	**Bipolar Pin 2 to Pin 8 Pin 6 to Pin 8**	**MSB LSB**
0	− 8.0000	111111111111
− 0.0039	− 7.9961	111111111110
− 4.0000	− 4.0000	101111111111
− 9.7761	− 0.0039	100000000000
− 8.0000	0	011111111111
− 8.0039	+ 0.0039	011111111110
− 15.9961	+ 7.9961	000000000000

Table 1 Digital Coding

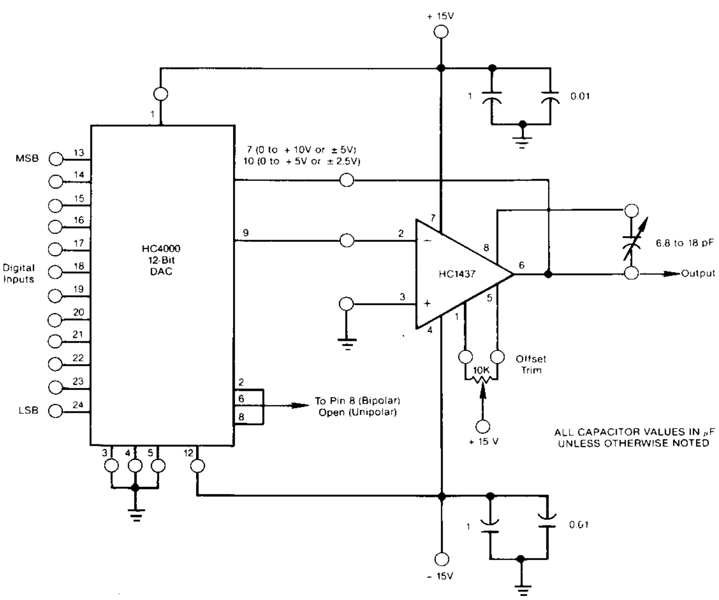


Fig. 2 Voltage Output DAC

The circuit in Fig. 3 can be used to test the voltage-output DAC's settling time. The potentiometer's rotor represents a "virtual summing junction". Because the input waveform and the amplifier's output are mirror images, this point's voltage is zero—except during transitions, in which the DAC and amplifier take a finite time to settle. The Schottky diodes clamp the junction's excursions to prevent scope overloading.

GAIN AND OFFSET TRIMMING

Fig. 4 shows a method to adjust the HC4000's gain and offset errors to zero. First, apply all ONEs to the digital inputs, then adjust the Offset-Trim potentiometer for the correct output (0 mA in unipolar mode; 8 mA in bipolar mode). Next, apply all ZEROs to the inputs and trim the Gain-Trim potentiometer for the correct full-scale output (– 15.9961 mA in unipolar mode; – 7.9961 mA in bipolar mode). Note that this trim provides for a reduction of gain only. To increase gain in voltage-output applications, insert low-value resistors in the feedback-resistor lines from Pin 7 or 10. Use low-temperature-coefficient trimpots and metal-film fixed resistors to obtain lowest possible added temperature drift.

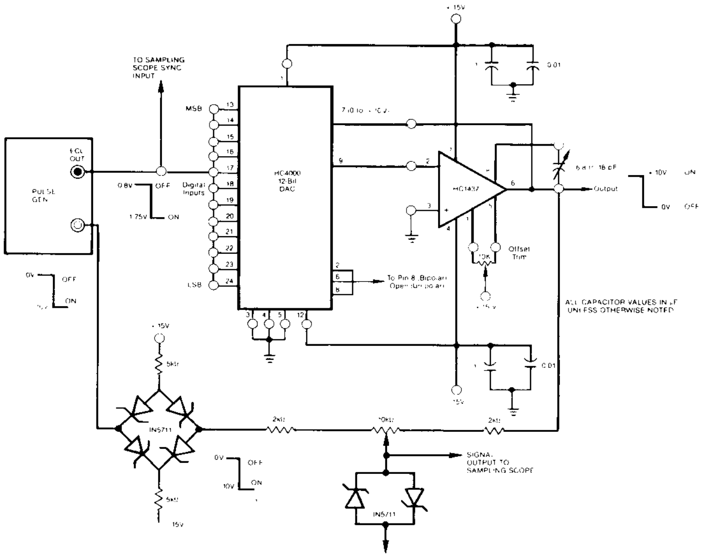


Fig. 3 Settling Time Test Circuit

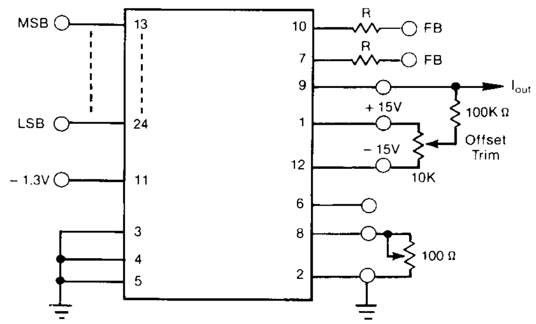


Fig. 4 Gain and Offset Trim

Table 2

100% Screening According to MIL-STD-883, Method 5008, Class B

Test	Methods and Conditions	Purpose
*Internal Visual	Method 2017	Removes visually defective units and reduces failures due to materials, construction, and workmanship.
*Stabilization Bake	Method 1008, Condition C 24 hours at 150 °C	Stabilizes circuit components prior to conducting further screening and testing.
Temperature Cycling	Method 1010, Condition C 10 cycles from $-65\,°C^{+0\,°C}_{-5\,°C}$ to $+150\,°C^{+3\,°C}_{-0\,°C}$	Removes potential failures due to poor workmanship.
Constant Acceleration	Method 2001, Condition A Y_1 Axis, 5,000 g	Removes potential failures due to poor workmanship.
*Seal, Fine and Gross	Method 1014, Fine Leak condition A, Bomb time 2 hours at 60 psi; Leak Rate $< 2 \times 10^{-7}$ cc/sec: Gross Leak, Condition C, no bubbles	Ensures hermeticity.
Burn In	Method 1015, Condition B, 160 hours at 125 °C	Removes devices subject to infant mortality.
*Electrical Test	Per Data Sheet (page 2)	Ensures electrical performance.
*External Visual	Method 2009	Removes visually defective units and reduces failures due to materials, construction, and workmanship.

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