FEATURES

- **Fast** ..... **3μs Settling Time Max**
- **Complete** ..... **Includes Reference, Ladder, Op Amp**
- **Low Power Consumption** ..... **250mW Max**
- **6-Bit Resolution** ..... **7-Bit Accuracy**
- **3 Output Options** ..... **+10V, ±5V, ±10V**
- **Standard Power Supplies** ..... **±12V to ±18V**
- **TTL — Compatible Logic Levels**
- **MIL-STD-883 Class B Processing Available From Stock**
- **Available in Die Form**

ORDERING INFORMATION†

	14-PIN HERMETIC DIP	
FULL TEMP. N.L. LSB	MILITARY TEMP.	COMMERCIAL TEMP.
±1/8	DAC01Y*	—
±1/4	DAC01BY*	DAC01CY
	DAC01FY**	DAC01HY**
±1/2	—	DAC01DY

* For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

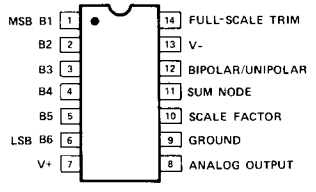
** Unipolar only — all others unipolar or bipolar.

† Burn-in is available on commercial and industrial temperature range parts in CerDIP, plastic DIP, and TO-can packages. For ordering information, see 1990/91 Data Book, Section 2.

GENERAL DESCRIPTION

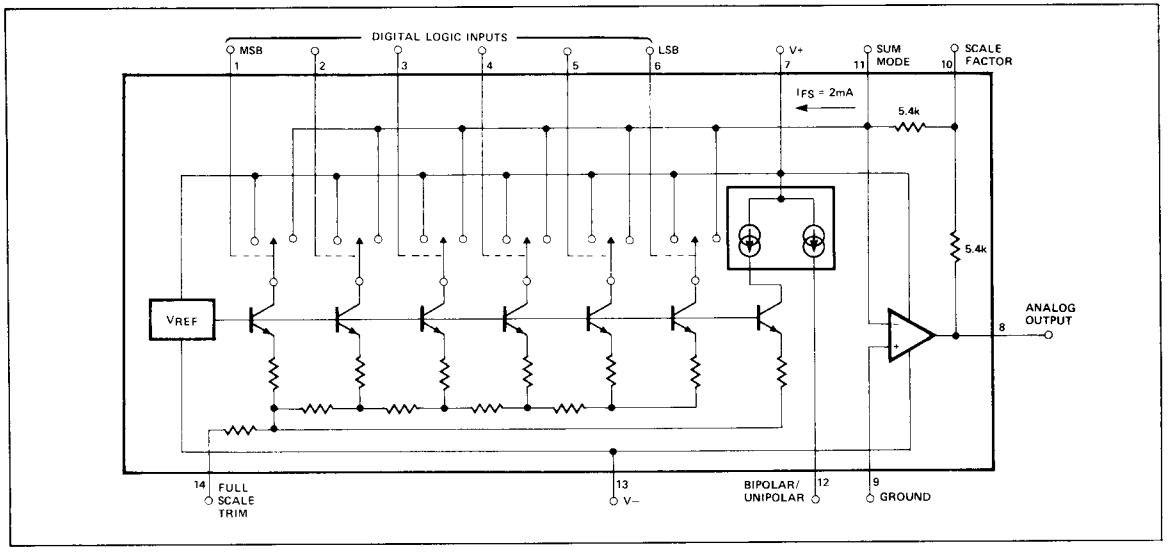
The DAC-01 is a complete monolithic 6-bit digital-to-analog converter. The device contains current steering logic, current sources, a diffused resistor ladder network, precision voltage reference and fast summing op amp on one chip. Monolithic construction provides low power consumption and high reliability. Wide power supply range, three output voltage options, and three input code options assure flexibility for a wide variety of applications. A seventh bit may also be added for greater resolution. Introduced in 1970, the DAC-01 is still the fastest, lowest power, most accurate 6-bit complete monolithic DAC available. The DAC-01 is ideal for CRT deflection circuits, servo positioning controls, digitally programmed power supplies and pulse generators, modem and telephone system digitizing and demodulation circuits, digital filters, and 6-bit A/D converters.

PIN CONNECTIONS



14-PIN HERMETIC DIP
(Y-Suffix)

SIMPLIFIED SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (Note 2)

Operating Temperature
DAC-01, DAC-01B, DAC-01F ..... −55°C to +125°C
DAC-01C, DAC-01H, DAC-01D ..... 0°C to +70°C
Junction Temperature (T_j) ..... −65°C to +150°C
V+ Supply Voltage to Ground ..... 0 to +18V
V− Supply Voltage to Ground ..... 0 to −18V
Logic Input to Ground ..... −0.7 to +6V
Storage Temperature ..... −65°C to +150°C
Lead Temperature (Soldering, 60 sec) ..... +300°C

Output Short-Circuit Duration (Note 2) ..... Indefinite

PACKAGE TYPE	Θ_{JA} (Note 3)	Θ_{JC}	UNITS
8-Pin Hermetic DIP (Y)	108	16	°C/W

NOTES:
1. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature.
2. Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
3. Θ_{JA} is specified for worst case mounting conditions, i.e., Θ_{JA} is specified for device in socket for CerDIP package.

ELECTRICAL CHARACTERISTICS at $V_S = \pm 15V$ and over the rated operating temperature range, unless otherwise noted.

PARAMETER	SYMBOL	DAC-01*	DAC-01B*	DAC-01F	DAC-01C	DAC-01H	DAC-01D	UNITS
Output Options		Unipolar Bipolar	Unipolar Bipolar	Unipolar	Unipolar Bipolar	Unipolar	Unipolar Bipolar	
Temperature Range	T_A	−55/+125	−55/+125	−55/+125	0/+70	0/+70	0/+70	°C
Nonlinearity 25°C/Maximum	NL	±0.40	±0.40	±0.40	±0.40	±0.40	±0.78	%FS
Nonlinearity Over Temperature — Maximum	NL	±0.45	±0.45	±0.45	±0.45	±0.45	±0.78	%FS
Full-Scale Tempco — Maximum	T_C	±80	±120	±80	±160	±160	±160	ppm/°C
Unipolar Zero-Scale Output Voltage — Maximum (Notes 1, 2)	V_{ZS}	25	25	40	25	40	50	mV

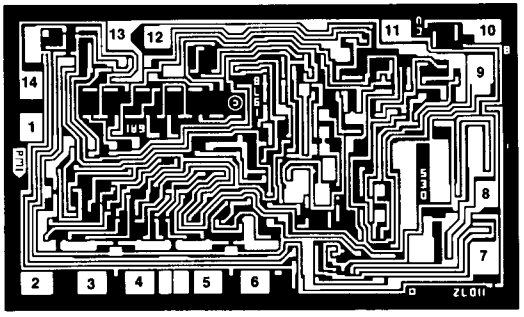
* Processed to MIL-STD-883 only.

ELECTRICAL CHARACTERISTICS for all DAC-01 grades, $V_S = \pm 15V$ and over the rated operating temperature range unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	DAC-01 MIN	DAC-01 TYP	DAC-01 MAX	UNITS
Unipolar Full Range Output Voltage (Note 3)	V_{FR}	2kΩ load, logic ≤ 0.8V, short pin 13 to pin 14. Short pin 12 to Ground and pin 10 to pin 11.	+10.0	—	+11.75	V
Bipolar Output Voltage (Note 3)		2kΩ load, short pin 11 to pin 12. Short pin 13 to pin 14, short pin 10 to pin 11.				
±5 Volt Range	V_{FR+}	Logic Inputs ≤ 0.8V	+4.93	—	+5.94	V
	V_{FR-}	Logic Inputs ≥ 2.0V	−5.94	—	−4.93	
±10 Volt Range		Open pin 10				
	V_{FR+}	Logic Inputs ≤ 0.8V	+9.86	—	+11.89	V
	V_{FR-}	Logic Inputs ≥ 2.0V	−11.89	—	−9.86	
Bipolar Offset Voltage (Note 1 ±1/2 ($\lvert V_{FR+} \rvert - \lvert V_{FS-} \rvert$)		±5 Volt Range	—	±40	±70	mV
		±10 Volt Range	—	±80	±140	
Resolution			6	—	—	Bits
Logic Input "0"	V_{INL}		—	—	0.8	V
Logic Input "1"	V_{INH}		2	—	—	V
Logic Input Current, Each Input	I_{IN}		—	±2	±8	μA
Power Supply Sensitivity	P_{SS}	$\pm 12V \le V_S \le \pm 18V$ $V_{FS} = 10.0V$	—	±0.01	±0.15	$\%V_{FS}/V$
Power Consumption	P_d	No Load	—	200	250	mW
Supply Current	I+	$V^+ = +15V$	—	—	7.3	mA
	I−	$V^- = -15V$ Logic Inputs ≤ 0.8V	—	—	9.3	
Setting Time to ±1/2 LSB (Note 4	t_S	2.0V ≤ Logic Level ≤ 0.8V $T_A = 25°C$	—	1.5	3	μs

NOTES:
1. Zero-scale or bipolar offset voltage can be trimmed to zero volts or to the exact one's or two's complement condition with an external resistor network to pin 11.
2. Logic input voltage ≥ 2.0V.
3. Full-scale is adjustable to precisely 10V for unipolar operation and 10V or 20V peak-to-peak bipolar operation with an external 500Ω potentiometer from pin 14 to V−.
4. Guaranteed by design.

DICE CHARACTERISTICS



DIE SIZE 0.093 × 0.055 inch, 5115 sq. mils (2.36 × 1.40 mm, 3.30 sq. mm)

For additional DICE ordering information, refer to 1990/91 Data Book, Section 2.

1. B1 (MSB)
2. B2
3. B3
4. B4
5. B5
6. B6 (LSB)
7. V+
8. ANALOG OUTPUT
9. GROUND
10. SCALE FACTOR
11. SUM NODE
12. BIPOLAR/UNIPOLAR
13. V−
14. FULL-SCALE TRIM

WAFER TEST LIMITS at $T_A = 25°C$.

PARAMETER	SYMBOL	CONDITIONS	DAC-01N BIPOLAR AND UNIPOLAR LIMIT	DAC-01G BIPOLAR AND UNIPOLAR LIMIT	UNITS
Nonlinearity	NL	$V_S = \pm 15V$	1/4	1/2	L.S.B. MAX
Zero-Scale Voltage	V_{ZS}	$V_S = \pm 15V$	25	35	mV MAX

WAFER TEST LIMITS at $V_S = \pm 15V$, $T_A = 25°C$, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	DAC-01 LIMIT	UNITS
Unipolar Full-Scale Output Voltage (All Models)	V_{FR}	2kΩ Load, Logic ≤ 0.8V, Short V− to Full-Scale Trim, Unipolar/ Bipolar to Ground, and Scale Factor to Sum Node	10.00 11.75	V MIN V MAX
Bipolar Output Voltage ±5 Volt Range ±10 Volt Range	V_{FR+} V_{FR-} V_{FR+} V_{FR-}	2kΩ Load, Short Sum Node to Unipolar/Bipolar. Short V− to Full-Scale Trim and Scale Factor to Sum Node. Logic Inputs ≤ 0.8V Logic Inputs ≥ 2.0V Open-Scale Factor Logic Inputs ≤ 0.8V Logic Inputs ≥ 2.0V	+4.93 −5.94 +9.78 −11.89	V MIN V MAX V MIN V MAX
Bipolar Offset Voltage ±1/2 ($\lvert V_{FR+} \rvert - \lvert V_{FR-} \rvert$)		±5 Volt Range ±10 Volt Range	±1/2	LSB MAX
Resolution			6	Bits MAX
Logic Input "0"	V_{INL}		0.8	V MAX
Logic Input "1"	V_{INH}		2	V MIN
Logic Input Current, Each Input	V_{OV}		±8	μA MAX
Power Supply Rejection	PSR	$\pm 12V \le V_S \le \pm 18V$, $V_S = 10.0V$	0.15	%FS/V MAX
Power Consumption	P_d	No Load	250	mW MAX

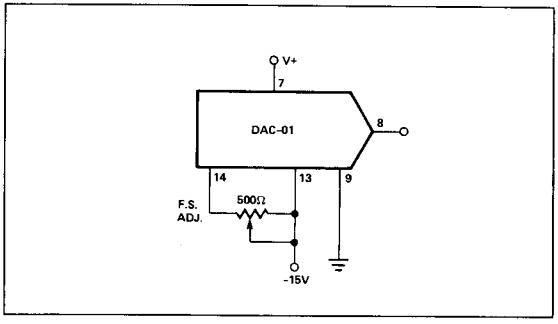
NOTE:
Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

TYPICAL ELECTRICAL CHARACTERISTICS at 25° C.

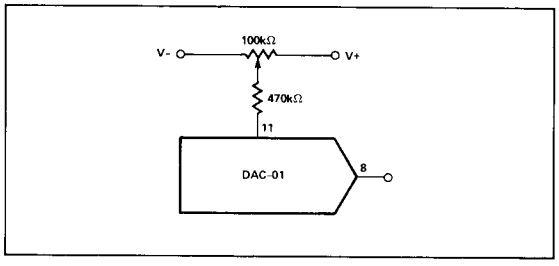
PARAMETER	SYMBOL	CONDITIONS	DAC-01N TYPICAL	DAC-01G TYPICAL	UNITS
Settling Time	t_S	To ±1/2 LSB	1.5	1.5	μs
Full-Scale Tempco	TCV_{FS}	$V_S = \pm 15V$	60	90	ppm/°C

BASIC CIRCUIT CONNECTIONS

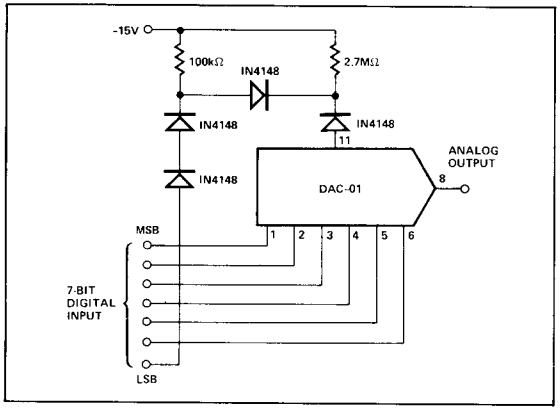
FULL-SCALE ADJUSTMENT TECHNIQUE



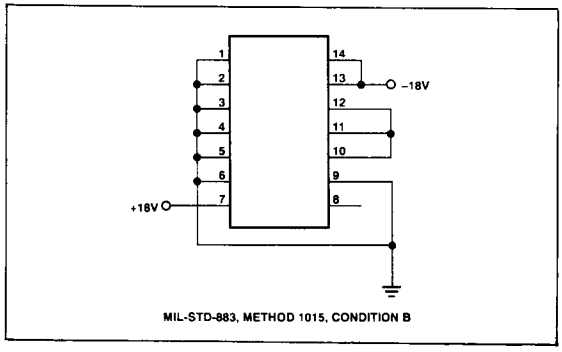
OPTIONAL ZERO-SCALE OR BIPOLAR OFFSET ADJUSTMENT



ADDITION OF 7th BIT



BURN-IN CIRCUIT



MIL-STD-883, METHOD 1015, CONDITION B

APPLICATIONS INFORMATION

INPUT CODES

The DAC-01 uses standard complementary binary coding for unipolar operation (all inputs logic high produces zero output voltage). One's complement coding may be implemented by shorting pin 11 to pin 12 and inverting the MSB (all other bits are not inverted). Complementary offset binary coding may be implemented by shorting pin 11 to pin 12, and injecting approximately 5μA into pin 11 (which is at ground potential) by using the "optional Zero-Scale or bipolar offset adjustment" circuit. Two's complement code is achieved when the MSB for complementary offset binary is inverted.

FULL-SCALE ADJUST

A 500Ω pot from pin 14 to V− can be used to adjust the Full-Scale output voltage to exactly 10 volts in unipolar mode or 10 to 20 volts peak-to-peak in bipolar mode. If no pot is used, connect pin 14 to V−.

SCALE FACTOR

For +10 volts or ±5 volt outputs, short pin 10 to pin 11 (adjusts the feedback resistor around the output amplifier). For ±10 volt output, leave pin 10 open. Intermediate output voltages may be obtained by placing a pot between pin 10 and pin 11. This will, however, seriously degrade the Full-Scale temperature coefficient due to the mismatch between the +1150ppm/°C tempco of the diffused resistors and the pot tempco.

CAPACITIVE LOADS

When driving capacitive loads greater than 50pF in Unipolar mode or 30pF in Bipolar mode a 100pF capacitor may be placed from pin 11 to ground for added stability.

LOWER RESOLUTION APPLICATIONS

When less than 6 bits of resolution is required, connect unused bits to a voltage level greater than +2.0 volts. The +5 volt logic supply is adequate.