

# DAC1408/1508 Series 8-Bit Multiplying D/A Converters

Linear Division Data Acquisition

### Description

The DAC1408/1508 Series are monolithic 8-bit multiplying digital-to-analog converters constructed using the Fairchild Planar Epitaxial process. It is designed for use where the output current is a linear product of an 8-bit digital word and an analog input voltage. The DAC1408/1508 Series are lead-for-lead replacements for the MC 1408 and SSS 1408 devices.

- **Relative Accuracy  $\pm 0.19\%$  Error Maximum DAC1408A**
- **7 And 6-Bit Accuracy Available DAC1408B, DAC1408C**
- **Fast Settling Time To 1/2 LSB — 85 ns**
- **Non-inverting Digital Inputs are TTL And CMOS Compatible**
- **Output Voltage Swing +0.5 V to -5.0 V**
- **High-speed Multiplying Input Slew Rate 4.0 mA/ $\mu$ s**
- **Standard Supply Voltages +5.0 V And -5.0 V To -15 V**
- **Low Full Scale Current Drift +10 ppm/ $^{\circ}$ C Typically**
- **Low Power Consumption 33 mW at  $\pm 5$  V**
- **Low Cost**

### Absolute Maximum Ratings

#### Storage Temperature Range

Ceramic DIP	-65°C to +175°C
Molded DIP	-65°C to +150°C

#### Operating Temperature Range

Extended (DAC1508M)	-55°C to +125°C
Commercial (DAC1408C)	0°C to +70°C

#### Lead Temperature

Ceramic DIP (soldering, 60 s)	300°C
Molded DIP (soldering, 10 s)	265°C

#### Internal Power Dissipation<sup>1, 2</sup>

16L-Ceramic DIP	1.50 W
16L-Molded DIP	1.04 W

#### V+

5.5 V

#### V-

-16.5 V

#### Digital Input Voltage (5 V to 12 V)

5.5 V

#### Applied Output Voltage

0.5 V to -5.2 V

#### Reference Current (I<sub>14</sub>)

5.0 mA

#### Reference Amplifier Inputs (V<sub>14</sub>, V<sub>15</sub>)

5.5 V, -16.5 V

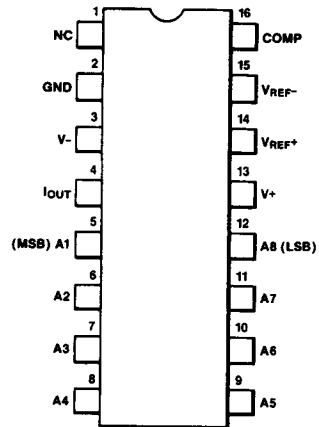
### Notes

1. T<sub>J Max</sub> = 150°C for the Molded DIP, and 175°C for the Ceramic DIP.

2. Ratings apply to ambient temperature at 25°C. Above this temperature, derate the 16L-Molded DIP at 8.3 mW/ $^{\circ}$ C, the 16L-Ceramic DIP at 10 mW/ $^{\circ}$ C.

### Connection Diagram

#### 16-Lead DIP (Top View)

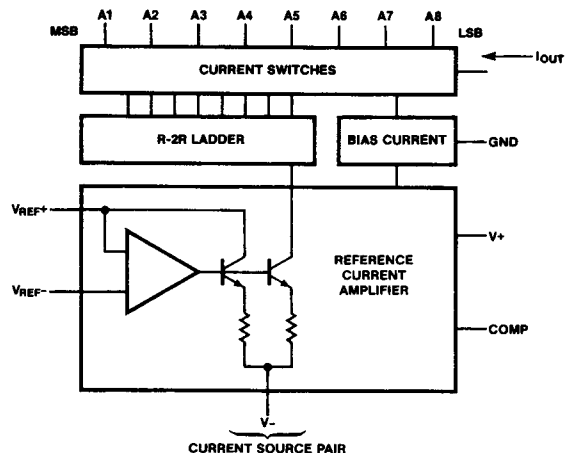


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### Order Information

Device Code	Package Code	Package Description
DAC1408ADC	7B	Ceramic DIP
DAC1408APC	9B	Molded DIP
DAC1408BDC	7B	Ceramic DIP
DAC1408BPC	9B	Molded DIP
DAC1408CDC	7B	Ceramic DIP
DAC1408CPC	9B	Molded DIP
DAC1508DM	7B	Ceramic DIP

### Equivalent Circuit



FD00461F

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**Electrical Characteristics**  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  for the DAC1408,  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$  for the DAC1508;  
 $V_+ = +5.0\text{ V}$ ,  $V_- = -15\text{ V}$ ,  $V_{REF}/R14 = 2.0\text{ mA}$ . All digital inputs at HIGH logic level.

Symbol	Characteristic	Condition	Min	Typ	Max	Unit	
$E_r$	Relative Accuracy (Error Relative to Full Scale $I_O$ )	DAC1408A/DAC1508			$\pm 0.19$	%	
		DAC1408B <sup>1</sup>			$\pm 0.39$		
		DAC1408C <sup>1</sup>			$\pm 0.78$		
$t_S$	Settling Time to Within $\frac{1}{2}$ LSB (Includes $t_{PLH}$ )	$T_A = 25^\circ\text{C}$ <sup>2</sup>		85	135	ns	
$t_{PLH}$ , $t_{PHL}$	Propagation Delay	$T_A = 25^\circ\text{C}$		30	100	ns	
$TCI_O$	Output Full Scale Current Drift			$\pm 20$		ppm/ $^\circ\text{C}$	
$V_{IH}$	Logic Input Voltage HIGH		2.0			V	
$V_{IL}$	Logic Input Voltage LOW				0.8		
$I_{IH}$	Logic Input Current HIGH	$V_{IH} = 5.0\text{ V}$		0	0.04	mA	
$I_{IL}$	Logic Input Current LOW	$V_{IL} = 0.8\text{ V}$		-0.4	-0.8		
$I_{IS}$	Reference Input Bias Current			-1.0	-5.0	$\mu\text{A}$	
$I_{OR}$	Output Current Range	$V_- = -5.0\text{ V}$	0	2.0	2.1	mA	
		$V_- = -6.0$ to $-15\text{ V}$	0	2.0	4.2		
$I_O$	Output Current	$V_{REF} = 2.000\text{ V}$ , $R14 = 1.0\text{ k}\Omega$	1.9	1.99	2.1	mA	
$I_{O\text{ Min}}$	Output Current	All bits LOW		0	4.0	$\mu\text{A}$	
$V_{OC}$	Output Voltage Compliance	$E_r \leq 0.19\%$ at $T_A = 25^\circ\text{C}$	$V_- = -5.0\text{ V}$			-0.55, +0.4	V
			$V_-$ below $-10\text{ V}$			-5.0, +0.5	
$dI/dt$	Reference Current Slew Rate			4.0		$\text{mA}/\mu\text{s}$	
PSRR (-)	Output Current Supply Sensitivity			0.5	2.7	$\mu\text{A}/\text{V}$	
$I_+$	Supply Current	All bits LOW		+13.5	+22	mA	
$I_-$				-7.5	-13		
$V_{R+}$	Power Supply Voltage Range	$T_A = 25^\circ\text{C}$	+4.5	+5.0	+5.5	V	
$V_{R-}$			-4.5	-15	-16.5		
$P_c$	Power Consumption	All bits LOW, $V_- = -5.0\text{ V}$		105	170	mW	
		All bits LOW, $V_- = -15\text{ V}$		190	305		
		All bits HIGH, $V_- = -5.0\text{ V}$		90			
		All bits HIGH, $V_- = -15\text{ V}$		160			

**Notes**

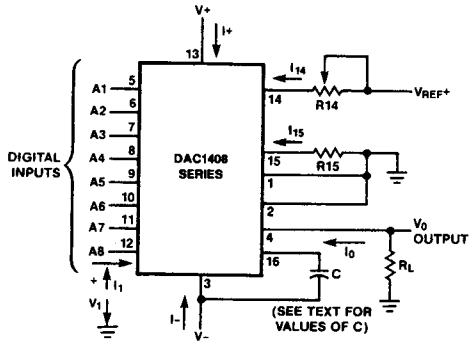
- All current switches are tested to guarantee at least 50% of rated output current.
- All bits switched.

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# DAC1408/1508 Series

## Test Circuits

Figure 1 Notation Definitions



Typical values:  $R_{14} = R_{15} = 1 \text{ k}$   
 $V_{REF} = +20 \text{ V}$   
 $C = 15 \text{ pF}$

$V_1$  and  $I_1$  apply to inputs A1 thru A8

The resistor tied to lead 15 is to temperature compensate the bias current and may not be necessary for all applications.

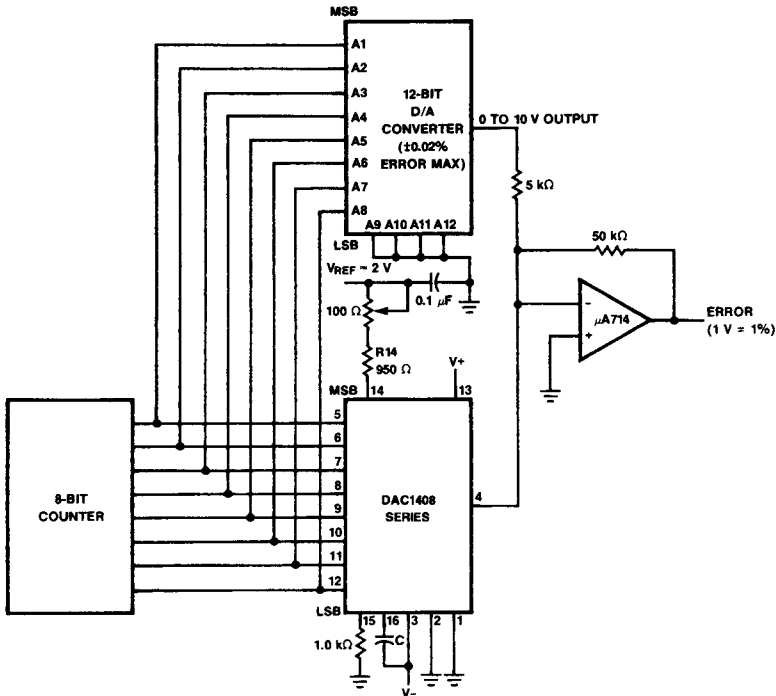
$$I_O = K \left[ \frac{A_1}{2} + \frac{A_2}{4} + \frac{A_3}{8} + \frac{A_4}{16} + \frac{A_5}{32} + \frac{A_6}{64} + \frac{A_7}{128} + \frac{A_8}{256} \right]$$

where  $K = \frac{V_{REF}}{R_{14}}$

and  $A_n = "1"$  if  $A_n$  is at HIGH level  
 $A_n = "0"$  if  $A_n$  is at LOW level

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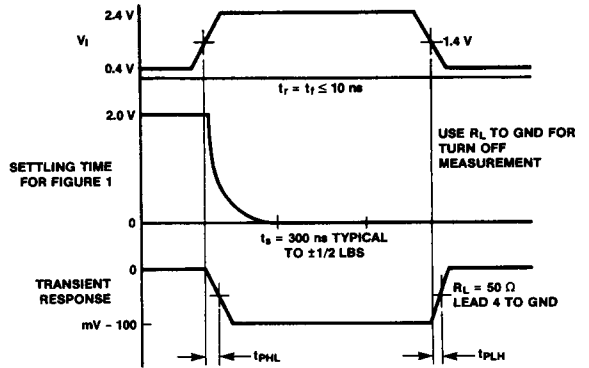
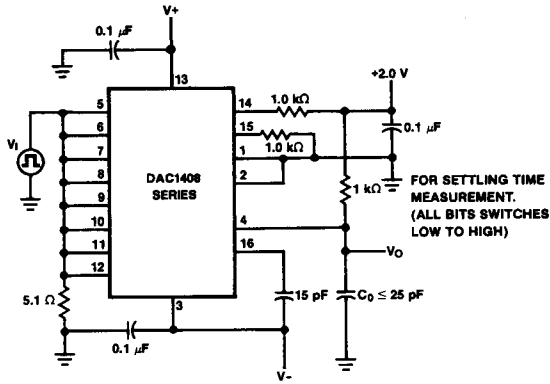
Figure 2 Relative Accuracy Test Circuit



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Test Circuits (Cont.)

Figure 3 Transient Response and Settling Time



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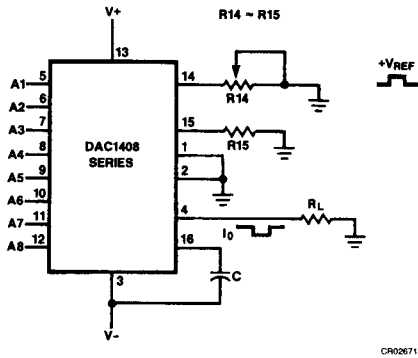
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Applications

- Tracking a/d Converters
- Successive Approximation a/d Converters
- 2 1/2 Digit Panel Meters and DVMs
- Waveform Synthesis
- Sample and Hold
- Peak Detector
- Programmable Gain and Attenuation
- CRT Character Generation
- Audio Digitizing and Decoding
- Programmable Power Supplies
- Analog-Digital Multiplication
- Digital-Digital Multiplication
- Analog-Digital Division
- Digital Addition and Subtraction
- Speech Compression and Expansion
- Stepping Motor Drive

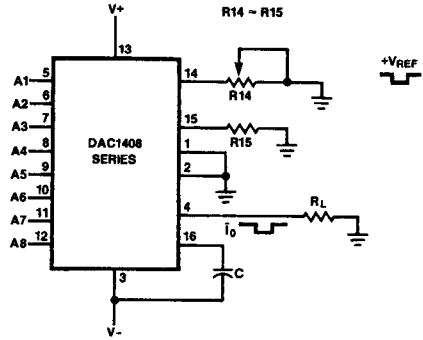
## Applications (Cont.)

Figure 4 Positive V<sub>REF</sub>



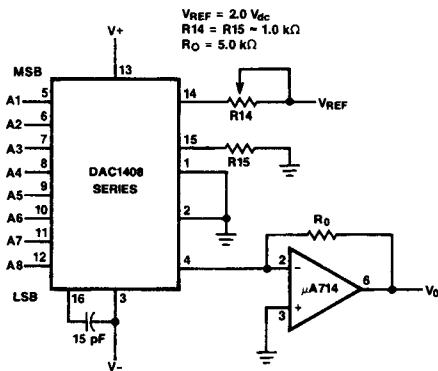
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Figure 5 Negative V<sub>REF</sub>



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Figure 6 Use with Current-to-Voltage Converting OP AMP



### Theoretical V<sub>O</sub>

$$V_O = \frac{V_{REF}}{R_{14}} (R_O) \left[ \frac{A_1}{2} + \frac{A_2}{4} + \frac{A_3}{8} + \frac{A_4}{16} + \frac{A_5}{32} + \frac{A_6}{64} + \frac{A_7}{128} + \frac{A_8}{256} \right]$$

Adjust V<sub>REF</sub> R<sub>14</sub> or R<sub>O</sub> so that V<sub>O</sub> with all digital inputs at HIGH level is equal to 9.961 Volts.

$$V_O = \frac{2V}{1k} (5k) \left[ \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{64} + \frac{1}{128} + \frac{1}{256} \right]$$

$$= 10 V \frac{255}{256} = 9.961 V$$

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