

DAC-08 SERIES

Product Preview

8-Bit High-Speed Multiplying D/A Converter

The DAC-08 series of 8-bit monolithic multiplying Digital-to-Analog Converters provide very high-speed performance coupled with low cost and outstanding applications flexibility.

Advanced circuit design achieves 70 ns settling times with very low glitch and at low power consumption. Monotonic multiplying performance is attained over a wide 20-to-1 reference current range. Matching to within 1 LSB between reference and full-scale currents eliminates the need for full-scale trimming in most applications. Direct interface to all popular logic families with full noise immunity is provided by the high swing, adjustable threshold logic inputs.

Dual complementary outputs are provided, increasing versatility and enabling differential operation to effectively double the peak-to-peak output swing. True high voltage compliance outputs allow direct output voltage conversion and eliminate output op amps in many applications.

All DAC-08 series models guarantee full 8-bit monotonicity and linearities as tight as 0.1% over the entire operating temperature range. Device performance is essentially unchanged over the ± 4.5 V to ± 18 V power supply range, with 37 mW power consumption attainable at ± 5.0 V supplies.

The compact size and low power consumption make the DAC-08 attractive for portable and military aerospace applications.

Features

- Fast Settling Output Current – 70 ns
- Full-Scale Current Prematched to ± 1.0 LSB
- Direct Interface to TTL, CMOS, ECL, HTL, PMOS
- Relative Accuracy to 0.1% Maximum Overtemperature Range
- High Output Compliance –10 V to +18 V
- True and Complemented Outputs
- Wide Range Multiplying Capability
- Low FS Current Drift – ± 10 ppm/ $^{\circ}$ C
- Wide Power Supply Range – ± 4.5 V to ± 18 V
- Low Power Consumption – 37 mW at ± 5.0 V

Applications

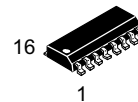
- 8-Bit, 1.0 μ s A-to-D Converters
- Servo-Motor and Pen Drivers
- Waveform Generators
- Audio Encoders and Attenuators
- Analog Meter Drivers
- Programmable Power Supplies
- CRT Display Drivers
- High-Speed Modems
- Other Applications where Low Cost, High Speed and Complete Input/Output Versatility are Required
- Programmable Gain and Attenuation
- Analog-Digital Multiplication

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.

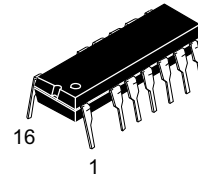


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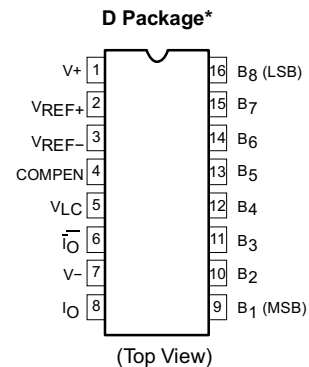
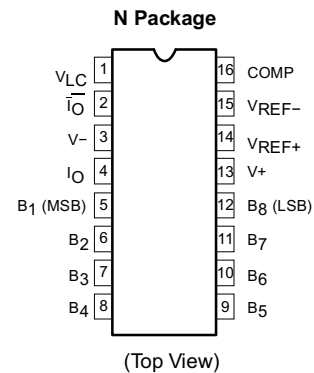


SOIC-16
D SUFFIX
CASE 751B



PDIP-16
N SUFFIX
CASE 648E

PIN CONNECTIONS



*SO and non-standard pinouts.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 13 of this data sheet.

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DC ELECTRICAL CHARACTERISTICS Pin 3 must be at least 3.0 V more negative than the potential to which R₁₅ is returned.
V_{CC} = ±15 V, I_{REF} = 2.0 mA. Output characteristics refer to both I_{OUT} and I_{OUT} unless otherwise noted. T_{amb} = 0°C to 70°C.

Characteristic	Symbol	Test Conditions	DAC-08C			DAC-08E			Unit	
			Min	Typ	Max	Min	Typ	Max		
Resolution	-	-	8.0	8.0	8.0	8.0	8.0	8.0	Bits	
Monotonicity	-	-	8.0	8.0	8.0	8.0	8.0	8.0		
Relative Accuracy	-	Overtemperature Range	-	-	±0.39	-	-	±0.19	%FS	
Differential Non-Linearity	-	-	-	-	±0.78	-	-	±0.39		
Full-Scale Tempco	TCl _{FS}	-	-	±10	-	-	±10	-	ppm/°C	
Output Voltage Compliance	V _{OC}	Full-Scale Current Change < 1/2LSB	-10	-	+18	-10	-	+18	V	
Full-Scale Current	I _{FS4}	V _{REF} = 10.000 V; R ₁₄ , R ₁₅ = 5.000 kΩ	1.94	1.99	2.04	1.94	1.99	2.04	mA	
Full-Scale Symmetry	I _{FSS}	I _{FS4} -I _{FS2}	-	±2.0	±16	-	±1.0	±8.0	μA	
Zero-Scale Current	I _{ZS}	-	-	0.2	4.0	-	0.2	2.0	μA	
Full-Scale Output Current Range	I _{FSR}	R ₁₄ , R ₁₅ = 5.000 kΩ	-	-	-	-	-	-	-	
		V _{REF} = +15 V, V ₋ = -10 V	2.1	-	-	2.1	-	-	mA	
		V _{REF} = +25 V, V ₋ = -12 V	4.2	-	-	4.2	-	-	mA	
Logic Input Levels	V _{IL} V _{IH}	V _{LC} = 0 V	-	-	0.8	-	-	0.8	V	
			Low	2.0	-	-	2.0	-	-	
Logic Input Current	I _{IL} I _{IH}	V _{LC} = 0 V V _{IN} = -10 V to +0.8 V V _{IN} = 2.0 V to 18 V	-	-2.0	-10	-	-2.0	-10	μA	
			High	-	0.002	10	-	0.002	10	
Logic Input Swing	V _{IS}	V ₋ = -15 V	-10	-	+18	-10	-	+18	V	
Logic Threshold Range	V _{THR}	V _S = ±15 V	-10	-	+13.5	-10	-	+13.5	V	
Reference Bias Current	I ₁₅	-	-	-1.0	-3.0	-	-1.0	-3.0	μA	
Reference Input Slew Rate	dI/dt	-	4.0	8.0	-	4.0	8.0	-	mA/μs	
Power Supply Sensitivity	PSS _{I_{FS+}} PSI _{I_{FS-}}	I _{REF} = 1.0 mA V ₊ = 4.5 to 5.5 V, V ₋ = -15 V; V ₊ = 13.5 to 16.5 V, V ₋ = -15 V V ₋ = -4.5 to -5.5 V, V ₊ = +15 V; V ₋ = -13.5 to -16.5 V, V ₊ = +15 V	-	0.0003	0.01	-	0.0003	0.01	%FS/ %VS	
			Positive	-	0.002	0.01	-	0.002	0.01	%FS/ %VS
Power Supply Current	I ₊ I ₋	V _S = ±5.0 V, I _{REF} = 1.0 mA	-	3.1	3.8	-	3.1	3.8	mA	
			Negative	-	-4.3	-5.8	-	-4.3		-5.8
	I ₊ I ₋	V _S = +5.0 V, -15 V, I _{REF} = 2.0 mA	Positive	-	3.1	3.8	-	3.1		3.8
			Negative	-	-7.1	-7.8	-	-7.1		-7.8
I ₊ I ₋	V _S = ±15 V, I _{REF} = 2.0 mA	Positive	-	3.2	3.8	-	3.2	3.8		
		Negative	-	-7.2	-7.8	-	-7.2	-7.8		
Power Dissipation	P _D	±5.0 V, I _{REF} = 1.0 mA	-	37	48	-	37	48	mW	
		+5.0 V, -15 V, I _{REF} = 2.0 mA	-	122	136	-	122	136		
		±15 V, I _{REF} = 2.0 mA	-	156	174	-	156	174		

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DC ELECTRICAL CHARACTERISTICS (continued) Pin 3 must be at least 3.0 V more negative than the potential to which R₁₅ is returned. V_{CC} = +15 V, I_{REF} = 2.0 mA. Output characteristics refer to both I_{OUT} and I_{OUT} unless otherwise noted. T_{amb} = 0°C to 70°C.

Characteristic	Symbol	Test Conditions	DAC-08H			Unit
			Min	Typ	Max	
Resolution	-	-	8.0	8.0	8.0	Bits
Monotonicity	-	-	8.0	8.0	8.0	
Relative Accuracy	-	Overtemperature Range	-	-	±0.1	%FS
Differential Non-Linearity	-	-	-	-	±0.19	%FS
Full-Scale Tempco	TCI _{FS}	-	-	±10	±50	ppm/°C
Output Voltage Compliance	V _{OC}	Full-Scale Current Change 1/2LSB	-10	-	+18	V
Full-Scale Current	I _{FS4}	V _{REF} = 10.000 V, R ₁₄ , R ₁₅ = 5.000 kΩ	1.984	1.992	2.000	mA
Full-Scale Symmetry	I _{FSS}	I _{FS4} - I _{FS2}	-	±1.0	±4.0	μA
Zero-Scale Current	I _{ZS}	-	-	0.2	1.0	μA
Full-Scale Output Current Range	I _{FSR}	R ₁₄ , R ₁₅ = 5.000 kΩ V _{REF} = +15 V, V ₋ = -10 V V _{REF} = +25 V, V ₋ = -12 V	- 2.1 4.2	- - -	- - -	mA mA
Logic Input Levels		V _{LC} = 0 V				V
Low	V _{IL}		-	-	0.8	
High	V _{IH}		2.0	-	-	
Logic Input Current		V _{LC} = 0 V				μA
Low	I _{IL}	V _{IN} = -10 V to +0.8 V	-	-2.0	-10	
High	I _{IH}	V _{IN} = 2.0 V to 18 V	-	0.002	10	
Logic Input Swing	V _{IS}	V ₋ = -15 V	-10	-	+18	V
Logic Threshold Range	V _{THR}	V _S = ±15 V	-10	-	+13.5	V
Reference Bias Current	I ₁₅	-	-	-1.0	-3.0	μA
Reference Input Slew Rate	dl/dt	-	4.0	8.0	-	mA/μs
Power Supply Sensitivity		I _{REF} = 1.0 mA				
Positive	PSSI _{FS+}	V ₊ = 4.5 to 5.5 V, V ₋ = -15 V; V ₊ = 13.5 to 16.5 V, V ₋ = -15 V	-	0.0003	0.01	%FS/%VS
Negative	PSI _{FS-}	V ₋ = -4.5 to -5.5 V, V ₊ = +15 V; V ₋ = -13.5 to -16.5 V, V ₊ = +15 V	-	0.002	0.01	%FS/%VS
Power Supply Current						mA
Positive	I ₊	V _S = ±5.0 V, I _{REF} = 1.0 mA	-	3.1	3.8	
Negative	I ₋		-	-4.3	-5.8	
Positive	I ₊	V _S = +5.0 V, -15 V, I _{REF} = 2.0 mA	-	3.1	3.8	
Negative	I ₋		-	-7.1	-7.8	
Positive	I ₊	V _S = ±15 V, I _{REF} = 2.0 mA	-	3.2	3.8	
Negative	I ₋		-	-7.2	-7.8	
Power Dissipation	P _D	±5.0 V, I _{REF} = 1.0 mA +5.0 V, -15 V, I _{REF} = 2.0 mA ±15 V, I _{REF} = 2.0 mA	- - -	37 122 156	48 136 174	mW

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AC ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	DAC-08C			DAC-08E			DAC-08H			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Settling Time	t_s	To $\pm 1/2$ LSB, All Bits Switched On or Off, $T_{amb} = 25^\circ\text{C}$	-	70	135	-	70	135	-	70	135	ns
Propagation Delay Low-to-High	t_{PLH}	$T_{amb} = 25^\circ\text{C}$, Each Bit	-	-	-	-	-	-	-	-	-	ns
High-to-Low	t_{PHL}	All Bits Switched	-	35	60	-	35	60	-	35	60	

TEST CIRCUITS

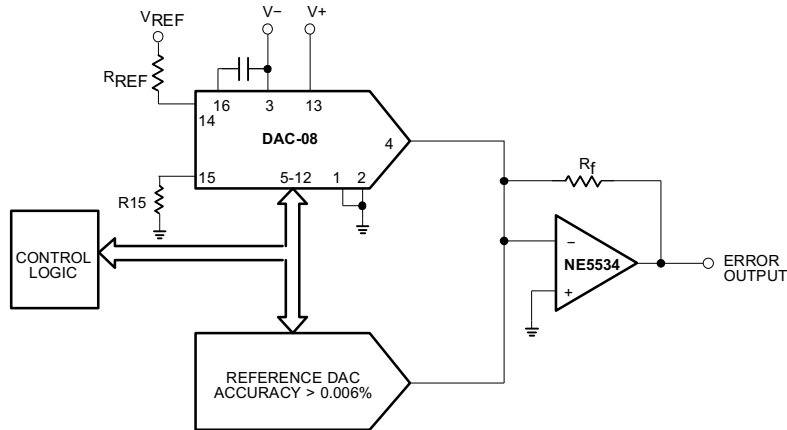


Figure 2. Relative Accuracy Test Circuit

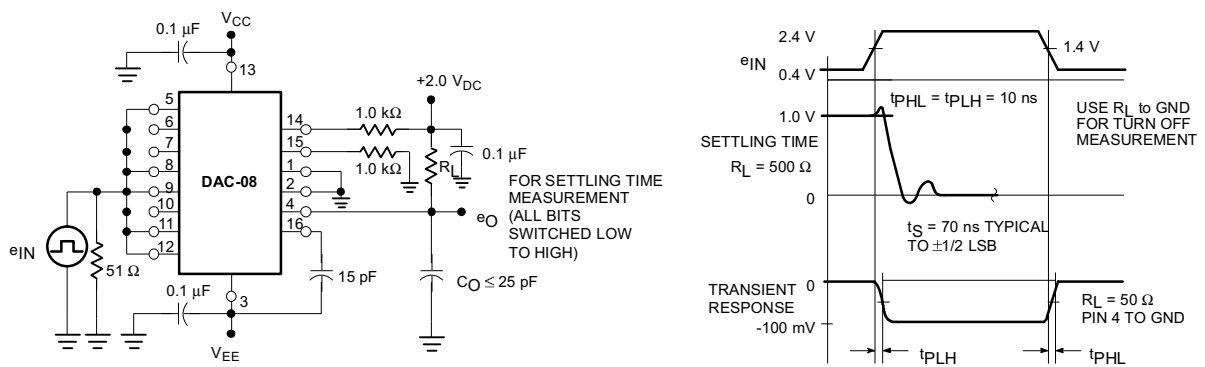


Figure 3. Transient Response and Settling Time

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TEST CIRCUITS

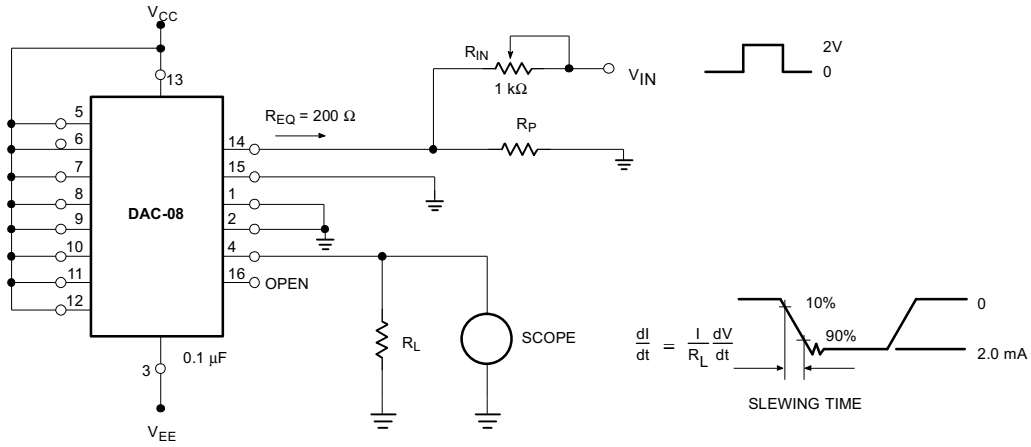
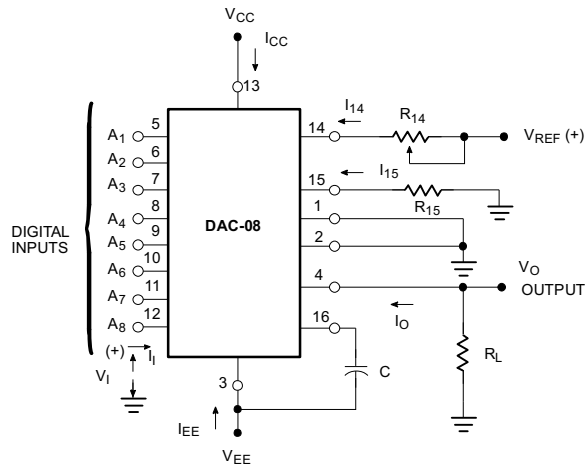


Figure 4. Reference Current Slew Rate Measurement



NOTES:

(See text for values of C.)

Typical values of $R_{14} = R_{15} = 1 \text{ k}\Omega$

$V_{REF} = +2.0 \text{ V}$

$C = 15 \text{ pF}$

V_1 and I_1 apply to inputs A_1 through A_8

The resistor tied to Pin 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 $K \approx \frac{V_{REF}}{R_{14}}$

and $A_N = '1'$ if A_N is at High Level

$A_N = '0'$ if A_N is at Low Level

Figure 5. Notation Definitions

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TYPICAL PERFORMANCE CHARACTERISTICS

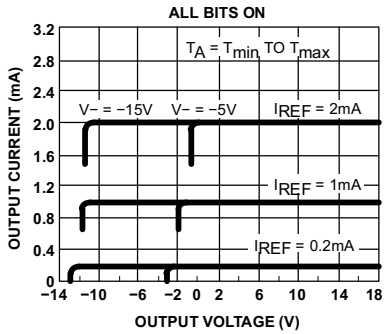


Figure 6. Output Current vs. Output Voltage (Output Voltage Compliance)

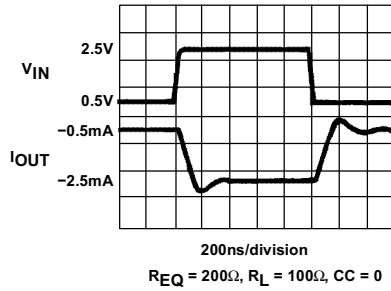


Figure 7. Fast Pulsed Reference Operation

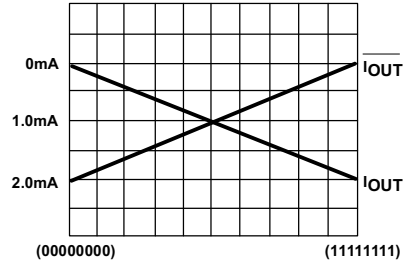


Figure 8. True and Complementary Output Operation

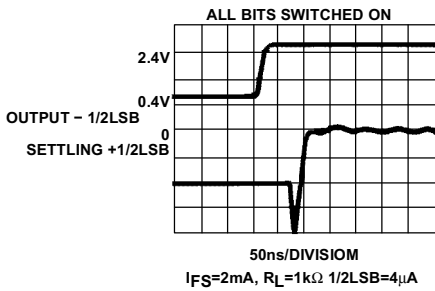


Figure 9. Full-Scale Settling Time

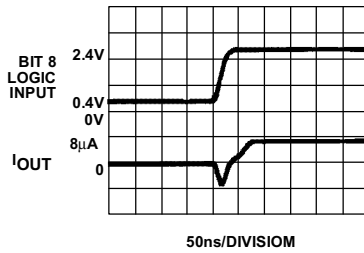


Figure 10. LSB Switching

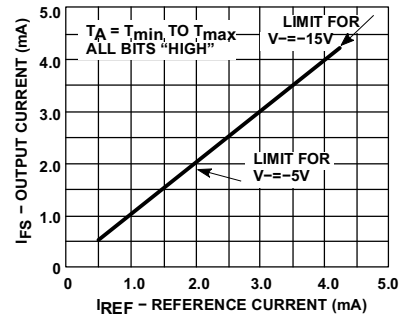


Figure 11. Full-Scale Current vs. Reference Current

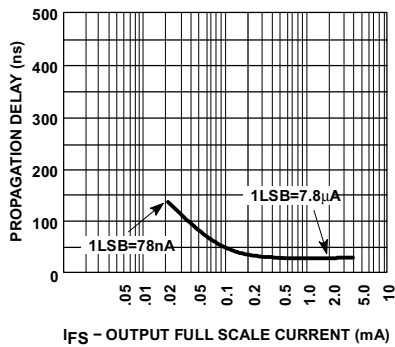


Figure 12. LSB Propagation Delay vs. IFS

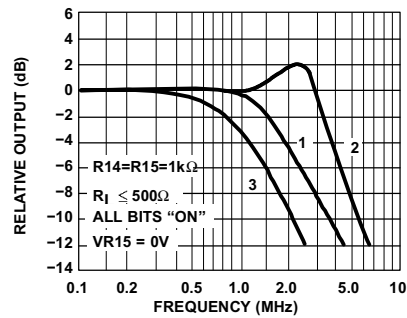


Figure 13. Reference Input Frequency Response

NOTES:

- Curve 1: $CC = 15pF$, $V_{IN} = 2.0V_{p-p}$ centered at $+1.0V$
- Curve 1: $CC = 15pF$, $V_{IN} = 5m0V_{p-p}$ centered at $+200mV$
- Curve 1: $CC = 15pF$, $V_{IN} = 100m0V_{p-p}$ centered at $0V$ and applied through 50Ω connected to Pin 14. $+2.0V$ applied to R_{14} .

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TYPICAL PERFORMANCE CHARACTERISTICS

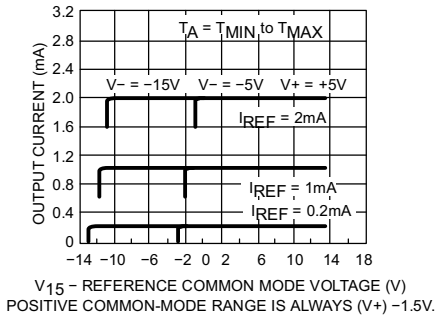


Figure 14. Reference AMP Common-Mode Range All Bits On

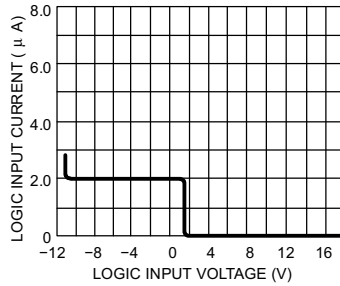


Figure 15. Logic Input Current vs. Input Voltage

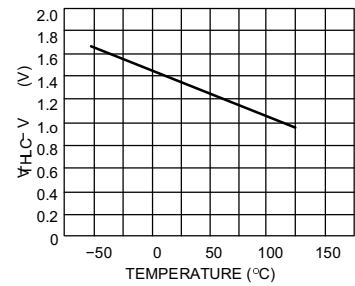


Figure 16. $V_{TH}-V_{LC}$ vs. Temperature

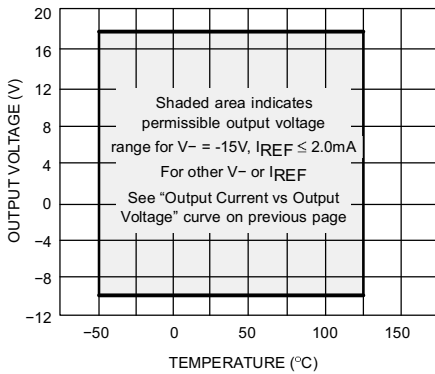


Figure 17. Output Voltage Compliance vs. Temperature

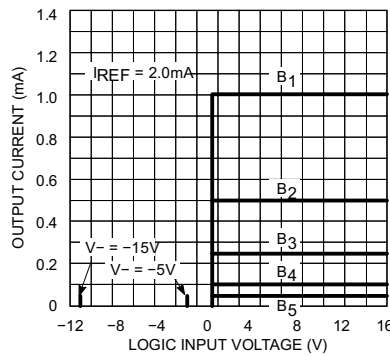


Figure 18. Bit Transfer Characteristics

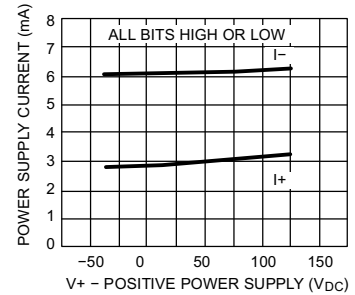


Figure 19. Power Supply Current vs. V_+

NOTES:

B1 through B8 have identical transfer characteristics. Bits are fully switched, with less than 1/2LSB error, at less than $\pm 100\text{mV}$ from actual threshold. These switching points are guaranteed to lie between 0.8 and 2.0V over the operating temperature range ($V_{LC} = 0.0\text{V}$).

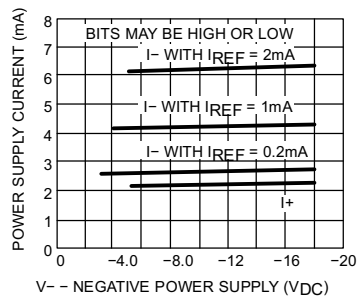


Figure 20. Power Supply Current vs. V_-

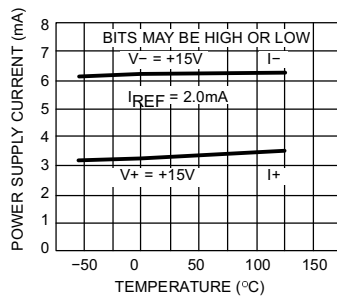


Figure 21. Power Supply Current vs. Temperature

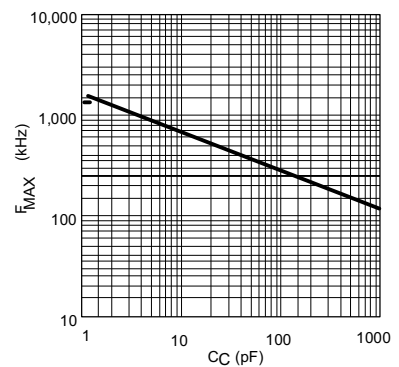


Figure 22. Maximum Reference Input Frequency vs. Compensation Capacitor Value

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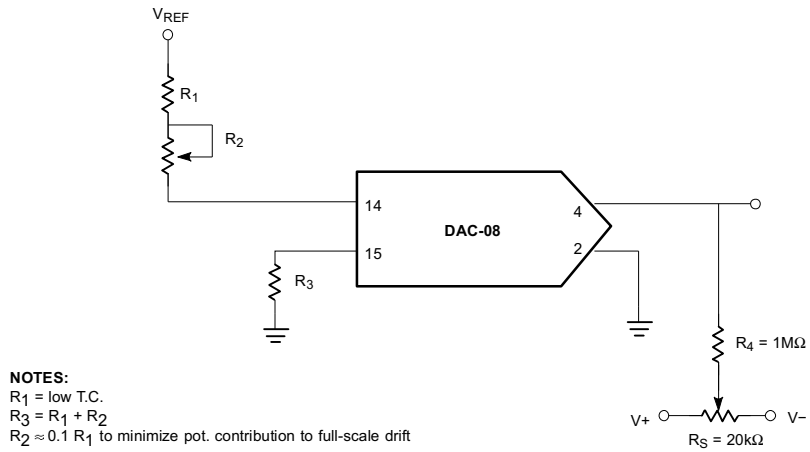


Figure 26. Recommended Full-Scale and Zero-Scale Adjust

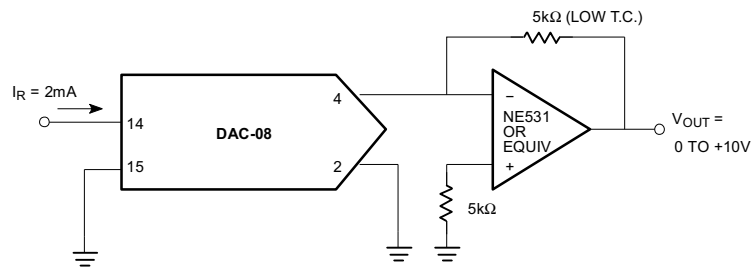
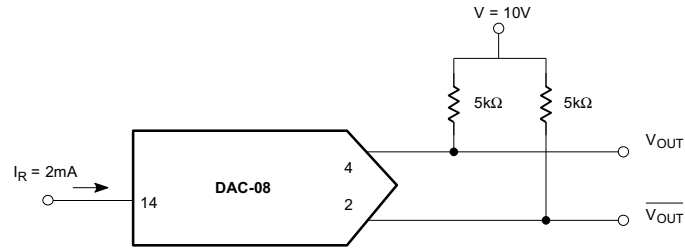
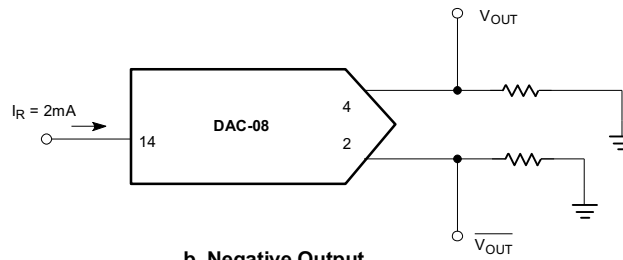


Figure 27. Unipolar Voltage Output for Low Impedance Output

DAC-08 SERIES

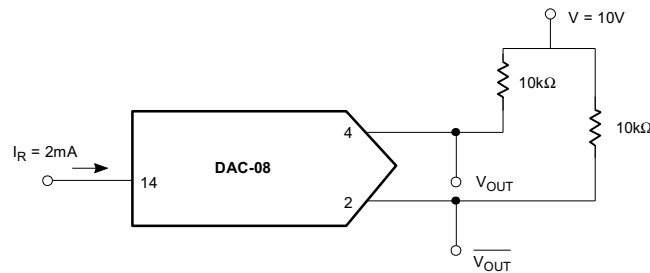


a. Positive Output



b. Negative Output

Figure 28. Unipolar Voltage Output for High Impedance Output



	B1	B2	B3	B4	B5	B6	B7	B8	V _{OUT}	$\overline{V_{OUT}}$
Positive full-scale	1	1	1	1	1	1	1	1	-9.920V	+10.000
Positive FS - 1LSB	1	1	1	1	1	1	1	0	-9.840V	+9.920
+ Zero-scale + 1LSB	1	0	0	0	0	0	0	1	-0.080V	+0.160
Zero-scale	1	0	0	0	0	0	0	0	0.000	+0.080
Zero-scale - 1LSB	0	1	1	1	1	1	1	1	0.080	0.000
Negative full scale - 1LSB	0	0	0	0	0	0	0	1	+9.920	-9.840
Negative full scale	0	0	0	0	0	0	0	0	+10.000	-9.920

Figure 29. Basic Bipolar Output Operation (Offset Binary)

DAC-08 SERIES

ORDERING INFORMATION

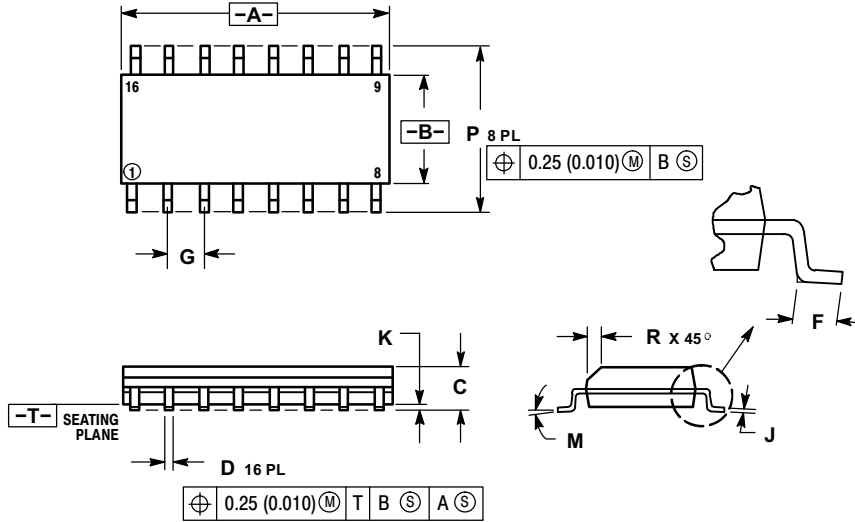
Device	Description	Temperature Range	Shipping†
DAC-08ED	16-Pin Plastic Small Outline Package	0 to +70°C	48 Units/Rail
DAC-08EDR2	16-Pin Plastic Small Outline Package	0 to +70°C	2500 Tape & Reel
DAC-08CN	16-Pin Plastic Dual In-Line Package	0 to +70°C	25 Units/Rail
DAC-08EN	16-Pin Plastic Dual In-Line Package	0 to +70°C	25 Units/Rail
DAC-08HN	16-Pin Plastic Dual In-Line Package	0 to +70°C	25 Units/Rail

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

DAC-08 SERIES

PACKAGE DIMENSIONS

SOIC-16
D SUFFIX
CASE 751B-05
ISSUE J



NOTES:

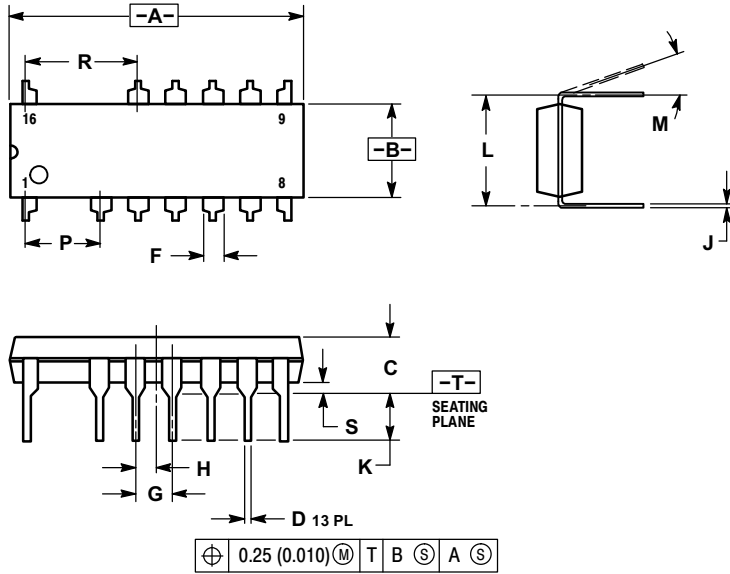
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 [°]	7 [°]	0 [°]	7 [°]
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

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PACKAGE DIMENSIONS

PDIP-16
N SUFFIX
CASE 648E-01
ISSUE O




NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION A AND B DOES NOT INCLUDE MOLD PROTRUSION.
5. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.25 (0.010).
6. ROUNDED CORNER OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.740	0.760	18.80	19.30
B	0.245	0.260	6.23	6.60
C	0.145	0.175	3.69	4.44
D	0.015	0.021	0.39	0.53
F	0.050	0.070	1.27	1.77
G	0.100 BSC		2.54 BSC	
H	0.050 BSC		1.27 BSC	
J	0.008	0.015	0.21	0.38
K	0.120	0.140	3.05	3.55
L	0.295	0.305	7.50	7.74
M	0°	10°	0°	10°
P	0.200 BSC		5.08 BSC	
R	0.300 BSC		7.62 BSC	
S	0.015	0.035	0.39	0.88

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