

8-Bit high-speed multiplying D/A converter

DAC08 Series

DESCRIPTION

The DAC08 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 70ns 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 DAC08 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 ±4.5V to ±18V power supply range, with 37mW power consumption attainable at ±5V supplies.

The compact size and low power consumption make the DAC08 attractive for portable and military aerospace applications.

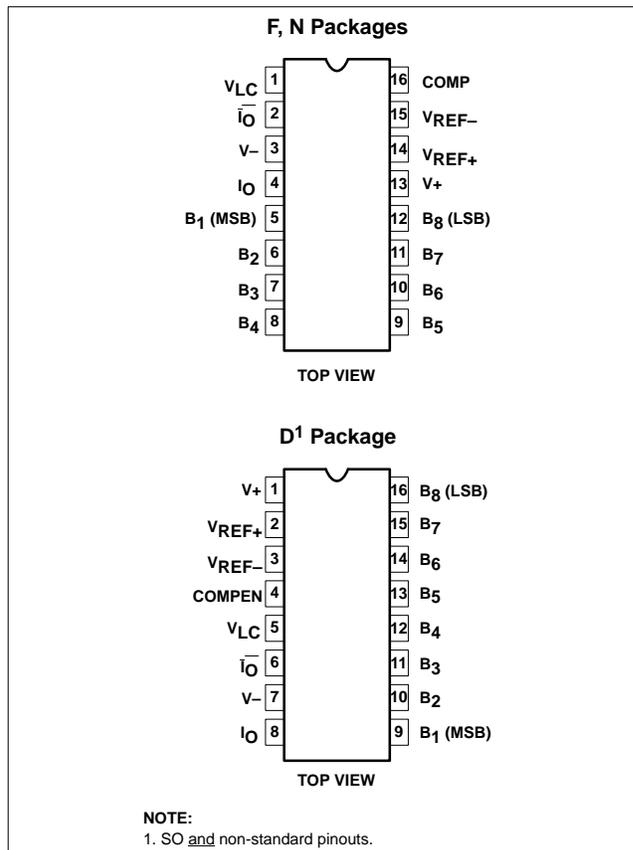
FEATURES

- Fast settling output current—70ns
- Full-scale current prematched to ±1 LSB
- Direct interface to TTL, CMOS, ECL, HTL, PMOS
- Relative accuracy to 0.1% maximum over temperature range
- High output compliance -10V to +18V
- True and complemented outputs
- Wide range multiplying capability
- Low FS current drift — ±10ppm/°C
- Wide power supply range—±4.5V to ±18V
- Low power consumption—37mW at ±5V

APPLICATIONS

- 8-bit, 1µs A-to-D converters
- Servo-motor and pen drivers

PIN CONFIGURATIONS



- 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

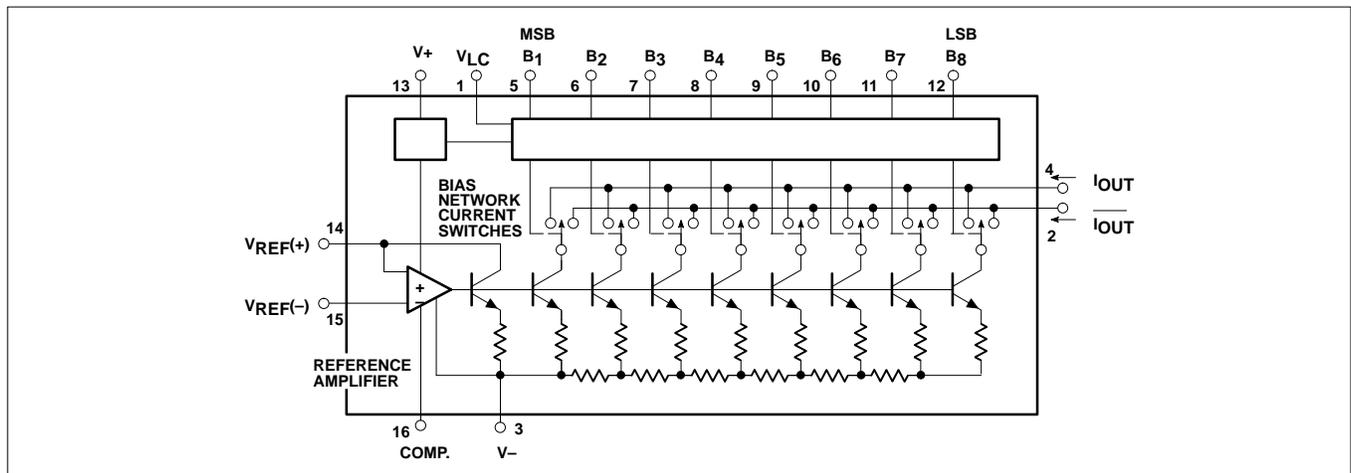
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ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
16-Pin Hermetic Ceramic Dual In-Line Package (Cerdip)	-55°C to +125°C	DAC08F	0582B
16-Pin Hermetic Ceramic Dual In-Line Package (Cerdip)	-55°C to +125°C	DAC08AF	0582B
16-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	DAC08CN	0406C
16-Pin Hermetic Ceramic Dual In-Line Package (Cerdip)	0 to +70°C	DAC08CF	0582B
16-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	DAC08EN	0406C
16-Pin Hermetic Ceramic Dual In-Line Package (Cerdip)	0 to +70°C	DAC08EF	0582B
16-Pin Plastic Small Outline (SO) Package	0 to +70°C	DAC08ED	0005D
16-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	DAC08HN	0406C

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V ₊ to V ₋	Power supply voltage	36	V
V ₅ -V ₁₂	Digital input voltage	V ₋ to V ₋ plus 36V	
V _{LC}	Logic threshold control	V ₋ to V ₊	
V ₀	Applied output voltage	V ₋ to +18	V
I ₁₄	Reference current	5.0	mA
V ₁₄ , V ₁₅	Reference amplifier inputs	V _{EE} to V _{CC}	
P _D	Maximum power dissipation T _A =25°C (still-air) ¹		
	F package	1190	mW
	N package	1450	mW
	D package	1090	mW
T _{SOLD}	Lead soldering temperature (10sec max)	300	°C
T _A	Operating temperature range		
	DAC08, DAC08A	-55 to +125	°C
	DAC08C, E, H	0 to +70	°C
T _{STG}	Storage temperature range	-65 to +150	°C

NOTES:

- Derate above 25°C, at the following rates:
 F package at 9.5mW/°C
 N package at 11.6mW/°C
 D package at 8.7mW/°C

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DC ELECTRICAL CHARACTERISTICS

Pin 3 must be at least 3V more negative than the potential to which R₁₅ is returned. V_{CC}=±15V, I_{REF}=2.0mA. Output characteristics refer to both I_{OUT} and I_{OUT} unless otherwise noted. DAC08C, E, H: T_A=0°C to 70°C DAC08/08A: T_A=-55°C to 125°C

SYMBOL	PARAMETER	TEST CONDITIONS	DAC08C			DAC08E DAC08			UNIT
			Min	Typ	Max	Min	Typ	Max	
	Resolution		8	8	8	8	8	8	Bits
	Monotonicity		8	8	8	8	8	8	Bits
	Relative accuracy	Over temperature range			±0.39			±0.19	%FS
	Differential non-linearity				±0.78			±0.39	%FS
TCl _{FS}	Full-scale tempco			±10			±10		ppm/°C
V _{OC}	Output voltage compliance	Full-scale current change < 1/2LSB	-10		+18	-10		+18	V
I _{FS4}	Full-scale current	V _{REF} =10.000V, R ₁₄ , R ₁₅ =5.000kΩ	1.94	1.99	2.04	1.94	1.99	2.04	mA
I _{FSS}	Full-scale symmetry	I _{FS4} -I _{FS2}		±2.0	±16		±1.0	±8.0	μA
I _{ZS}	Zero-scale current			0.2	4.0		0.2	2.0	μA
I _{FSR}	Full-scale output current range	R ₁₄ , R ₁₅ =5.000kΩ V _{REF} =+15.0V, V ₋ =-10V V _{REF} =+25.0V, V ₋ =-12V	2.1 4.2			2.1 4.2			mA
V _{IL} V _{IH}	Logic input levels Low High	V _{LC} =0V	2.0		0.8	2.0		0.8	V
I _{IL} I _{IH}	Logic input current Low High	V _{LC} =0V V _{IN} =-10V to +0.8V V _{IN} =2.0V to 18V		-2.0 0.002	-10 10		-2.0 0.002	-10 10	μA
V _{IS}	Logic input swing	V ₋ =-15V	-10		+18	-10		+18	V
V _{THR}	Logic threshold range	V _S =±15V	-10		+13.5	-10		+13.5	V
I ₁₅	Reference bias current			-1.0	-3.0		-1.0	-3.0	μA
dl/dt	Reference input slew rate		4.0	8.0		4.0	8.0		mA/μs
PSSI _{FS+} PSI _{FS-}	Power supply sensitivity Positive Negative	I _{REF} =1mA V ₊ =4.5 to 5.5V, V ₋ =-15V; V ₊ =13.5 to 16.5V, V ₋ =-15V V ₋ =-4.5 to -5.5V, V ₊ =+15V; V ₋ =-13.5 to -16.5, V ₊ =+15V		0.0003 0.002	0.01 0.01		0.0003 0.002	0.01 0.01	%FS/%VS
I ₊ I ₋	Power supply current Positive Negative	V _S =±5V, I _{REF} =1.0mA		3.1 -4.3	3.8 -5.8		3.1 -4.3	3.8 -5.8	mA
I ₊ I ₋	Positive Negative	V _S =+5V, -15V, I _{REF} =2.0mA		3.1 -7.1	3.8 -7.8		3.1 -7.1	3.8 -7.8	
I ₊ I ₋	Positive Negative	V _S =±15V, I _{REF} =2.0mA		3.2 -7.2	3.8 -7.8		3.2 -7.2	3.8 -7.8	
P _D	Power dissipation	±5V, I _{REF} =1.0mA +5V, -15V, I _{REF} =2.0mA ±15V, I _{REF} =2.0mA		37 122 156	48 136 174		37 122 156	48 136 174	mW

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DC ELECTRICAL CHARACTERISTICS (Continued)

Pin 3 must be at least 3V more negative than the potential to which R15 is returned. $V_{CC} = +15V$, $I_{REF} = 2.0mA$. Output characteristics refer to both I_{OUT} and $\overline{I_{OUT}}$, unless otherwise noted. DAC08C, E, H: $T_A = 0^\circ C$ to $70^\circ C$. DAC08/08A: $T_A = -55^\circ C$ to $125^\circ C$.

SYMBOL	PARAMETER	TEST CONDITIONS	DAC08H DAC08A			UNIT
			Min	Typ	Max	
	Resolution		8	8	8	Bits
	Monotonicity		8	8	8	Bits
	Relative accuracy	Over temperature range			± 0.1	%FS
	Differential non-linearity				± 0.19	%FS
TCI_{FS}	Full-scale tempco			± 10	± 50	ppm/ $^\circ C$
V_{OC}	Output voltage compliance	Full-scale current change 1/2LSB	-10		+18	V
I_{FS4}	Full-scale current	$V_{REF}=10.000V$, R_{14} , $R_{15}=5.000k\Omega$	1.984	1.992	2.000	mA
I_{FSS}	Full-scale symmetry	$I_{FS4}-I_{FS2}$		± 1.0	± 4.0	μA
I_{ZS}	Zero-scale current			0.2	1.0	μA
I_{FSR}	Full-scale output current range	R_{14} , $R_{15}=5.000k\Omega$ $V_{REF}=+15.0V$, $V=-10V$ $V_{REF}=+25.0V$, $V=-12V$	2.1 4.2			mA
V_{IL} V_{IH}	Logic input levels Low High	$V_{LC}=0V$	2.0		0.8	V
I_{IL} I_{IH}	Logic input current Low High	$V_{LC}=0V$ $V_{IN}=-10V$ to $+0.8V$ $V_{IN}=2.0V$ to $18V$		-2.0 0.002	-10 10	μA
V_{IS}	Logic input swing	$V=-15V$	-10		+18	V
V_{THR}	Logic threshold range	$V_S=\pm 15V$	-10		+13.5	V
I_{15}	Reference bias current			-1.0	-3.0	μA
dl/dt	Reference input slew rate		4.0	8.0		mA/ μs
$PSS _{FS+}$ PSI_{FS-}	Power supply sensitivity Positive Negative	$I_{REF}=1mA$ $V+=4.5$ to $5.5V$, $V=-15V$; $V+=13.5$ to $16.5V$, $V=-15V$ $V=-4.5$ to $-5.5V$, $V+=+15V$; $V=-13.5$ to -16.5 , $V+=+15V$		0.0003 0.002	0.01 0.01	%FS/%VS
$I+$ $I-$	Power supply current Positive Negative	$V_S=\pm 5V$, $I_{REF}=1.0mA$		3.1 -4.3	3.8 -5.8	mA
$I+$ $I-$	Positive Negative	$V_S=+5V$, $-15V$, $I_{REF}=2.0mA$		3.1 -7.1	3.8 -7.8	
$I+$ $I-$	Positive Negative	$V_S=\pm 15V$, $I_{REF}=2.0mA$		3.2 -7.2	3.8 -7.8	
P_D	Power dissipation	$\pm 5V$, $I_{REF}=1.0mA$ $+5V$, $-15V$, $I_{REF}=2.0mA$ $\pm 15V$, $I_{REF}=2.0mA$		37 122 156	48 136 174	mW

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AC ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	TEST CONDITIONS	DAC08C			DAC08E DAC08			DAC08H DAC08A			UNIT
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
t_s	Settling time	To $\pm 1/2$ LSB, all bits switched on or off, $T_A=25^\circ\text{C}$		70	135		70	135		70	135	ns
t_{PLH} t_{PHL}	Propagation delay Low-to-High High-to-Low	$T_A=25^\circ\text{C}$, each bit. All bits switched		35	60		35	60		35	60	ns

TEST CIRCUITS

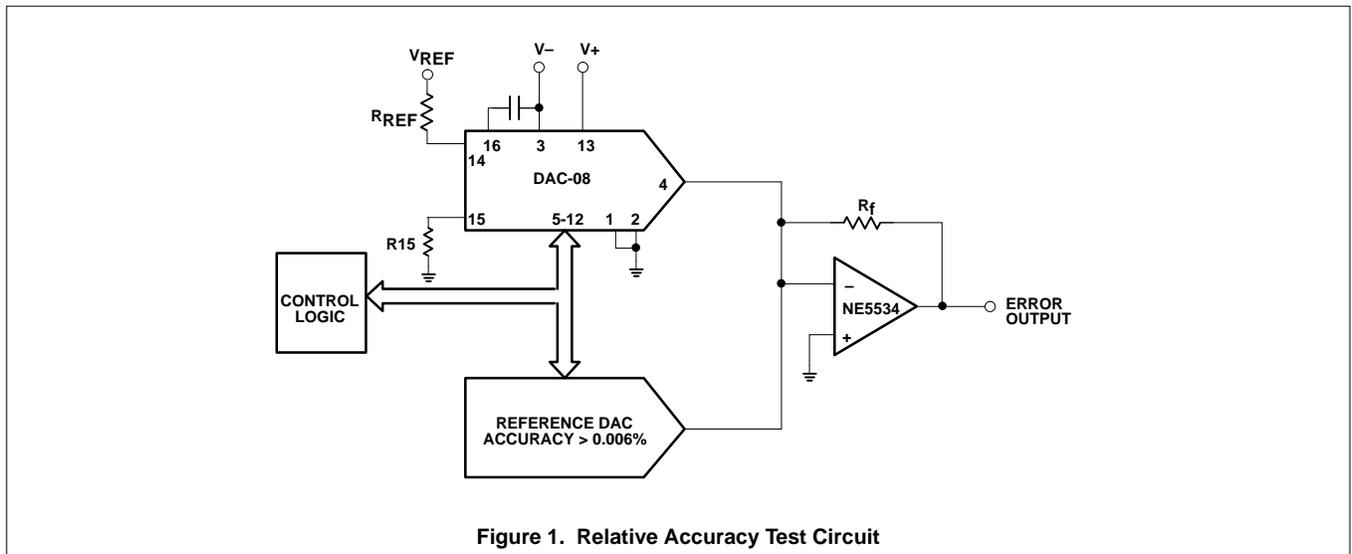


Figure 1. Relative Accuracy Test Circuit

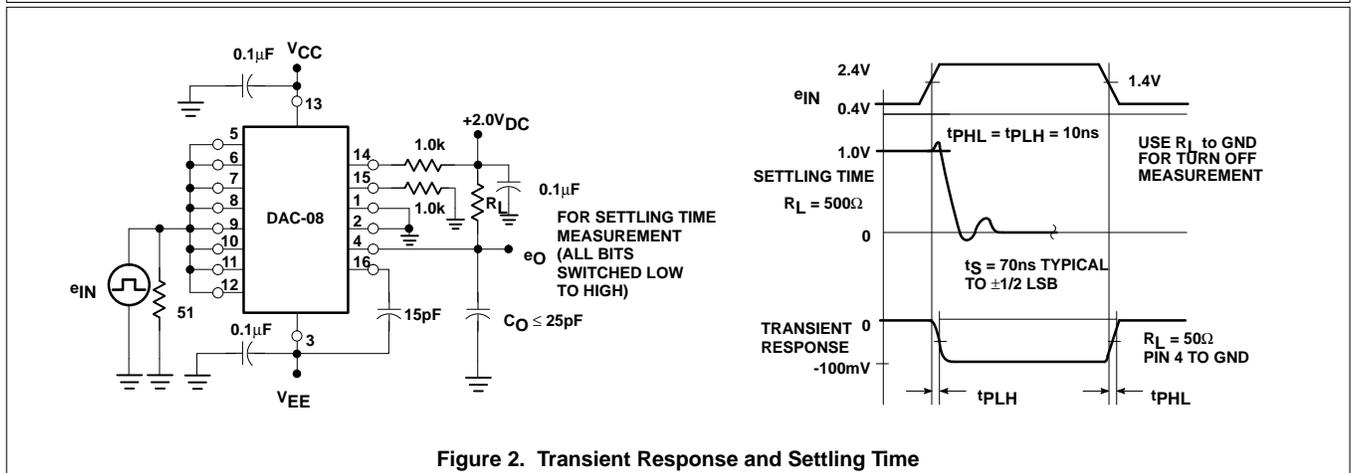


Figure 2. Transient Response and Settling Time

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TEST CIRCUITS (Continued)

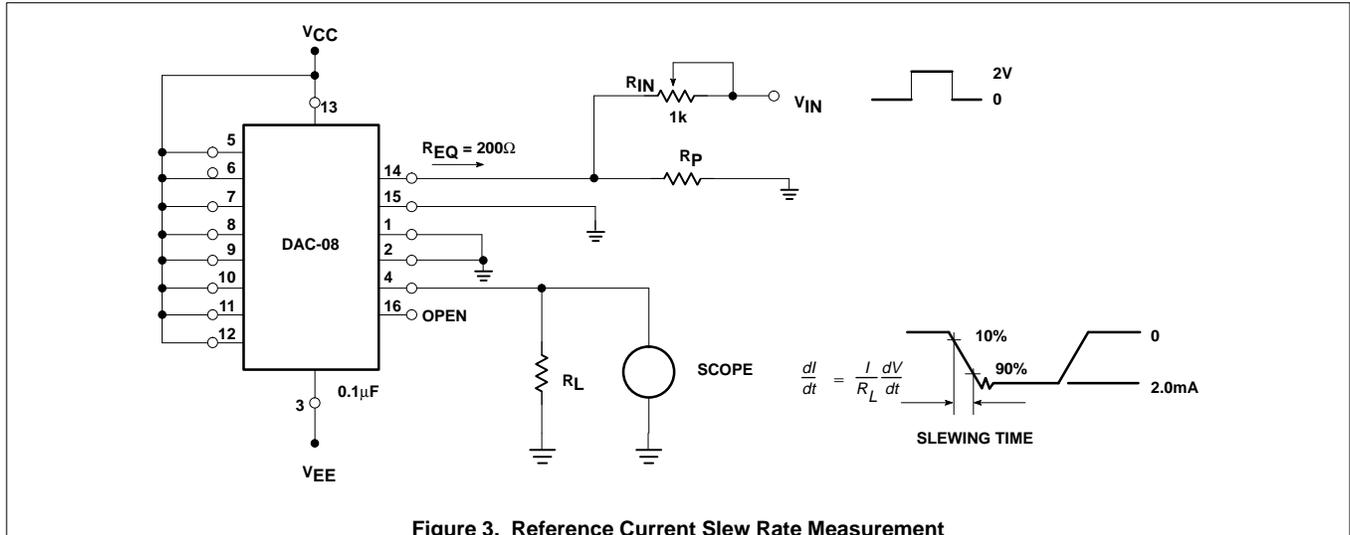


Figure 3. Reference Current Slew Rate Measurement

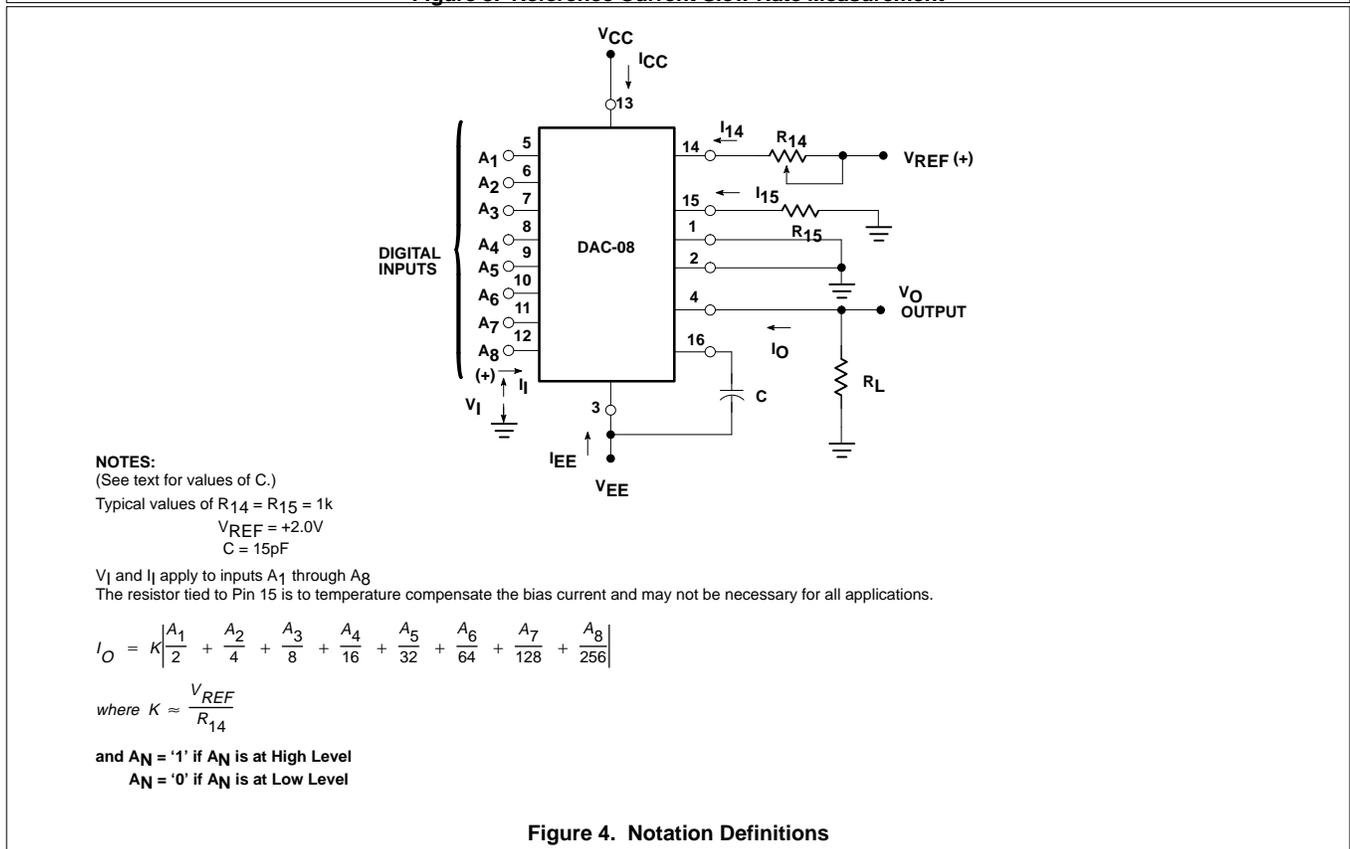


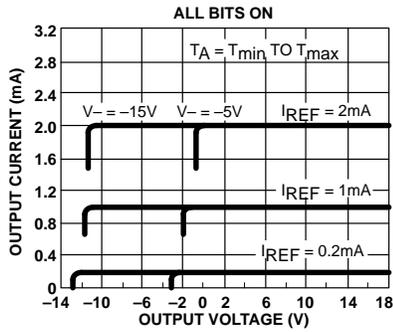
Figure 4. Notation Definitions

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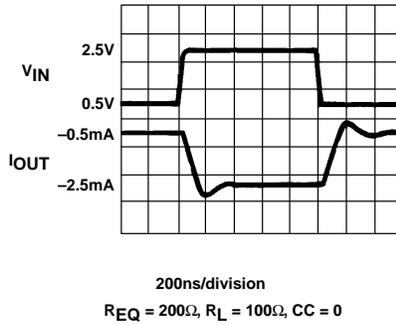
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TYPICAL PERFORMANCE CHARACTERISTICS

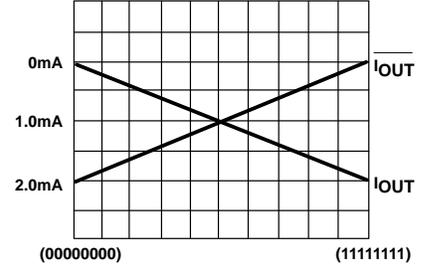
Output Current vs Output Voltage (Output Voltage Compliance)



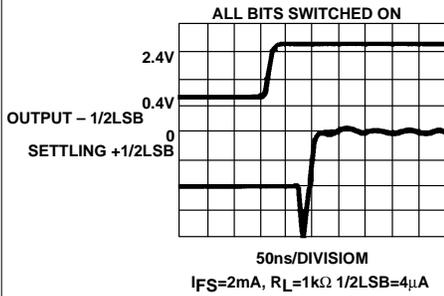
Fast Pulsed Reference Operation



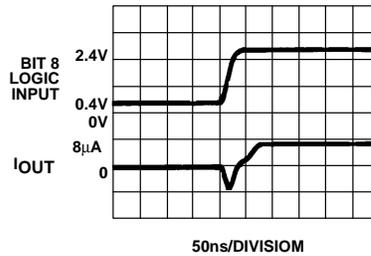
True and Complementary Output Operation



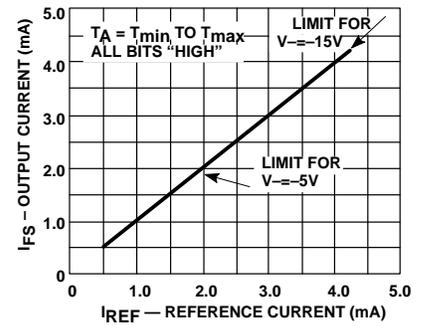
Full-Scale Settling Time



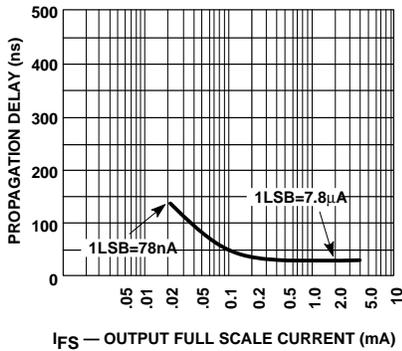
LSB Switching



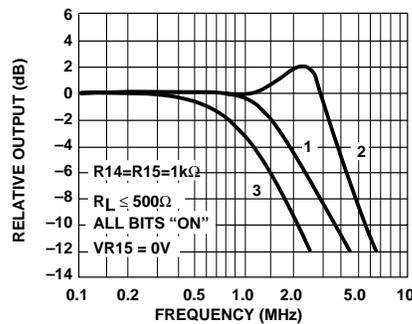
Full-Scale Current vs Reference Current



LSB Propagation Delay vs IFS



Reference Input Frequency Response



NOTES:

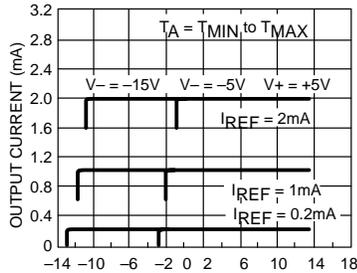
- Curve 1: $CC = 15\text{pF}$, $V_{IN} = 2.0\text{Vp-p}$ centered at +1.0V
- Curve 1: $CC = 15\text{pF}$, $V_{IN} = 5\text{mVp-p}$ centered at +200mV
- Curve 1: $CC = 15\text{pF}$, $V_{IN} = 100\text{mVp-p}$ centered at 0V and applied through 50Ω connected to Pin 14. +2.0V applied to R_{14} .

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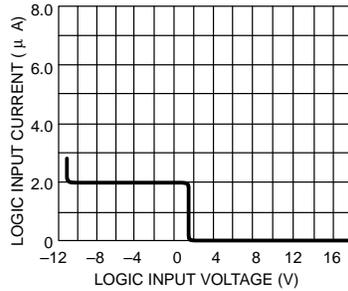
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

**Reference AMP Common-Mode Range
All Bits On**

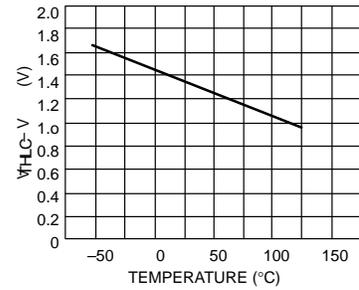


V₁₅ — REFERENCE COMMON MODE VOLTAGE (V)
POSITIVE COMMON-MODE RANGE IS ALWAYS (V+) -1.5V.

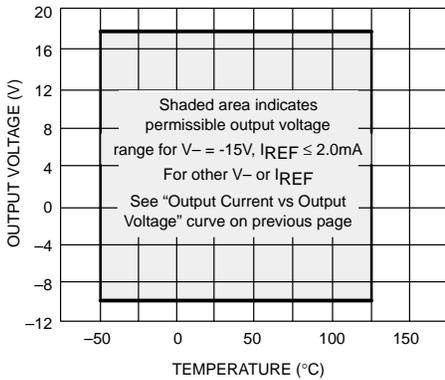
Logic Input Current vs Input Voltage



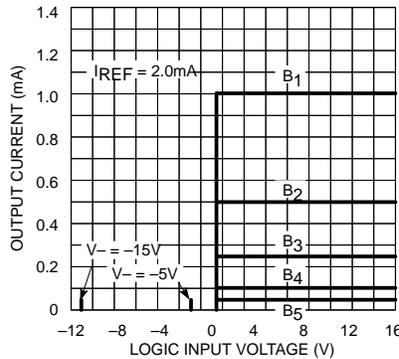
V_{TH} - V_{LC} vs Temperature



**Output Voltage Compliance
vs Temperature**



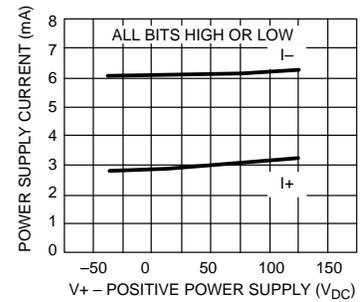
Bit Transfer Characteristics



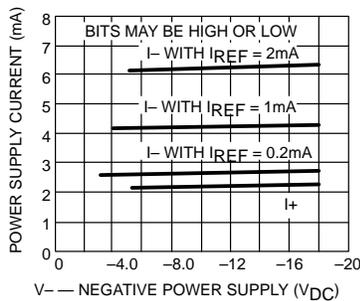
NOTES:

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

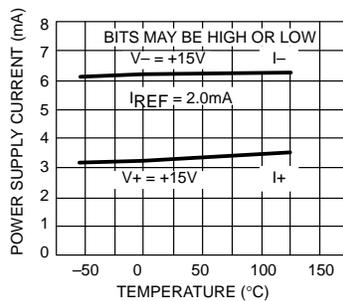
Power Supply Current vs V+



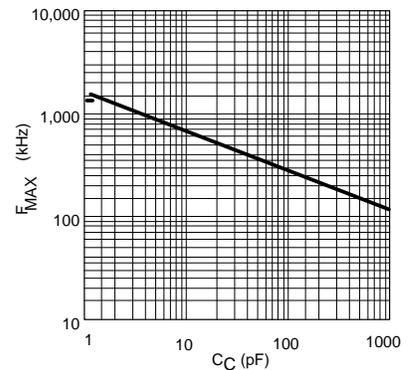
Power Supply Current vs V-



Power Supply Current vs Temperature



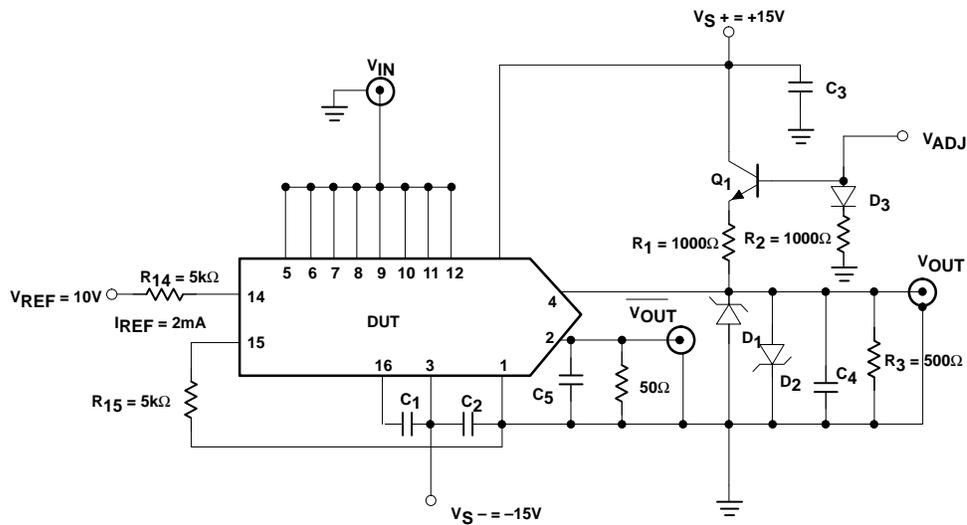
**Maximum Reference Input Frequency
vs Compensation Capacitor Value**



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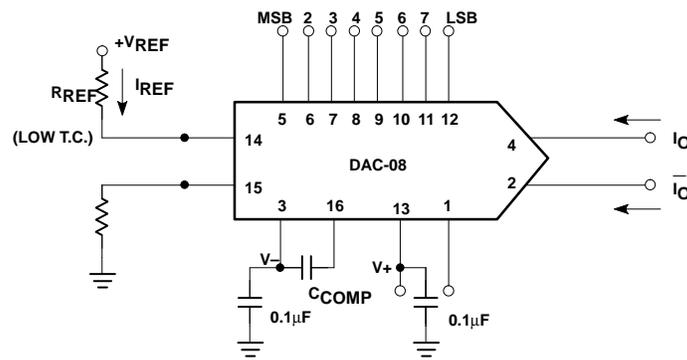
DAC08 Series

SETTLING TIME AND PROPAGATION DELAY



- NOTES:**
 D₁, D₂ = IN6263 or equivalent
 D₃ = IN914 or equivalent
 C₁ = 0.01μF
 C₂, C₃ = 0.1μF
 Q₁ = 2N3904
 C₄, C₅ = 15pF and includes all probe and fixturing capacitance.

BASIC DAC08 CONFIGURATION

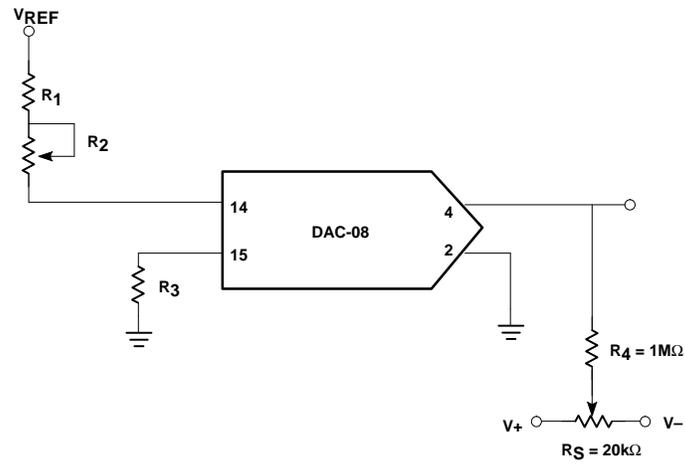


- NOTES:**
 $I_{FS} \approx \frac{+V_{REF}}{R_{REF}} \times \frac{255}{256}$; $I_O + \bar{I}_O = I_{FS}$ for all logic states

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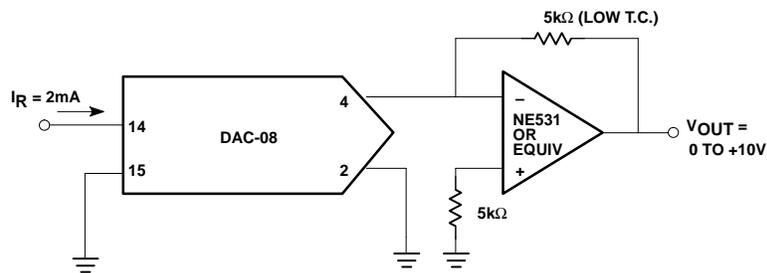
RECOMMENDED FULL-SCALE AND ZERO-SCALE ADJUST



NOTES:

- R₁ = low T.C.
- R₃ = R₁ + R₂
- R₂ = 0.1 R₁ to minimize pot. contribution to full-scale drift

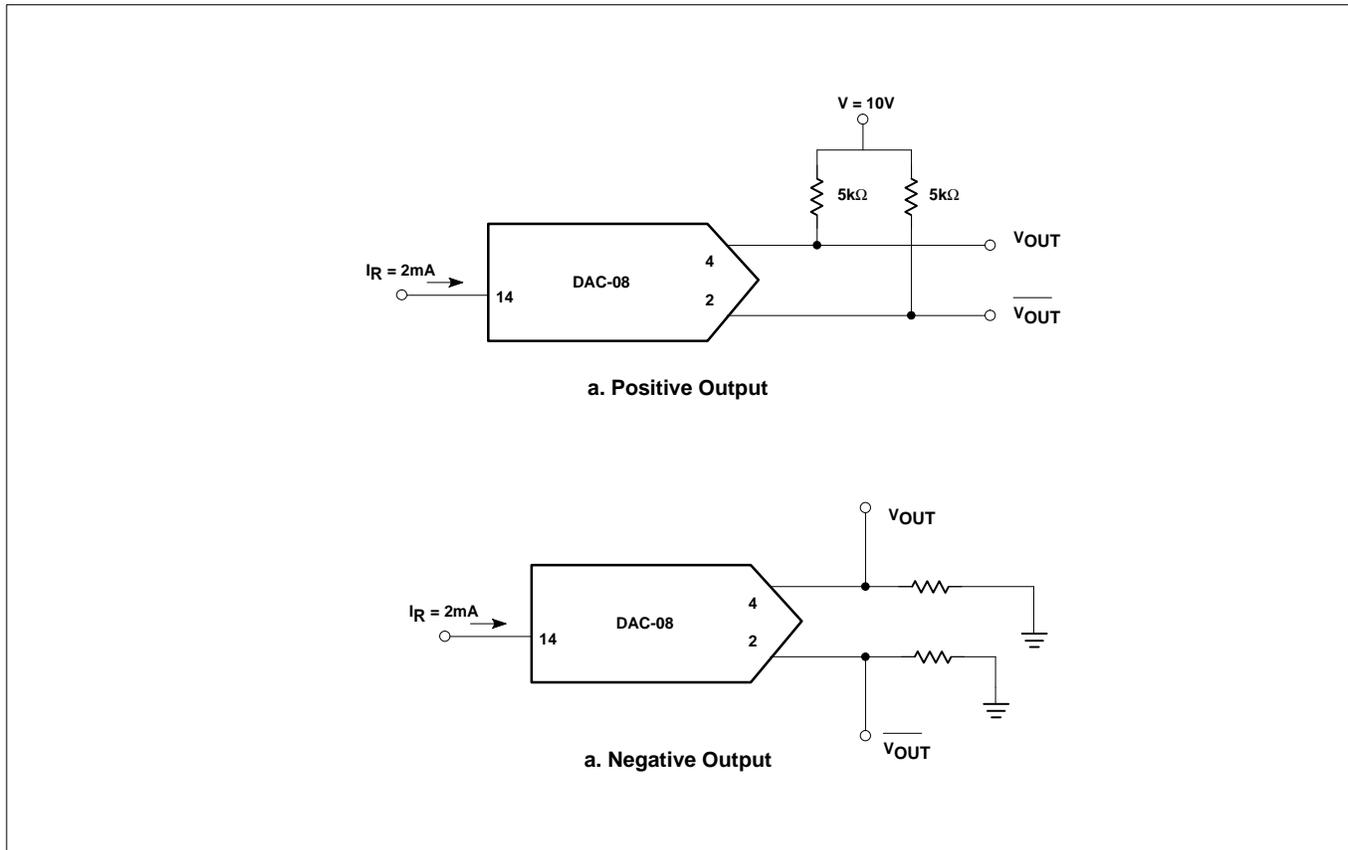
UNIPOLAR VOLTAGE OUTPUT FOR LOW IMPEDANCE OUTPUT



8-Bit high-speed multiplying D/A converter

DAC08 Series

UNIPOLAR VOLTAGE OUTPUT FOR HIGH IMPEDANCE OUTPUT



BASIC BIPOLAR OUTPUT OPERATION (OFFSET BINARY)

