

16-Bit, Dual Voltage Output DIGITAL-TO-ANALOG CONVERTER

FEATURES

- **LOW POWER: 4mW**
- **UNIPOLAR OR BIPOLAR OPERATION**
- **SETTLING TIME: 10 μ s to 0.003% FSR**
- **15-BIT LINEARITY AND MONOTONICITY: -40°C to +85°C**
- **RESET TO MID-SCALE (DAC7642) OR ZERO-SCALE (DAC7643)**
- **DATA READBACK**
- **DOUBLE-BUFFERED DATA INPUTS**

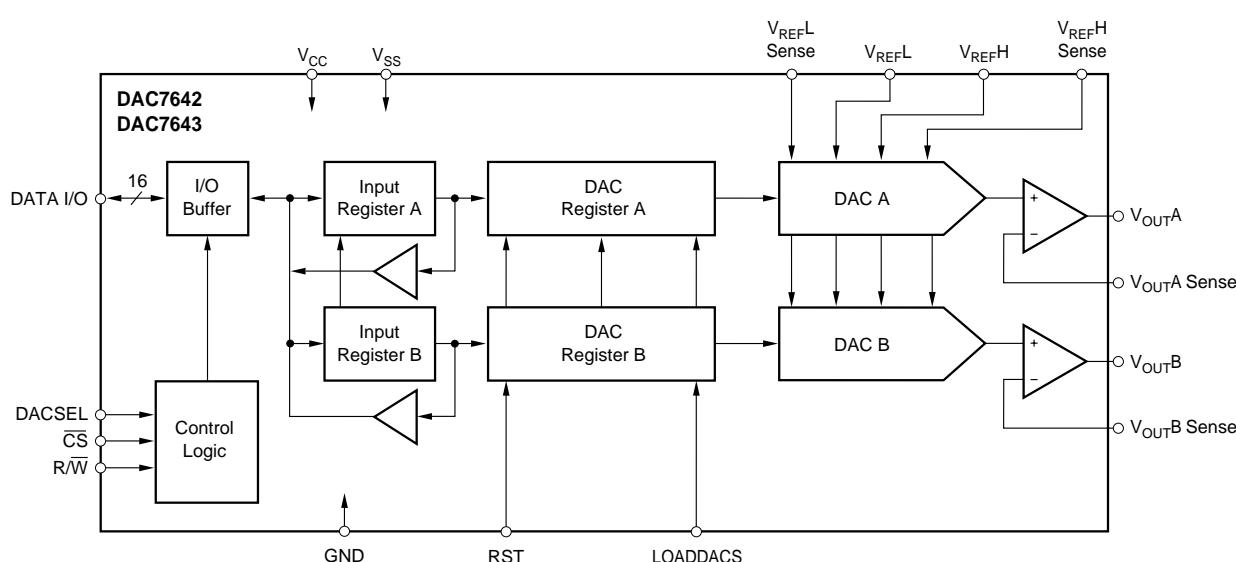
APPLICATIONS

- **PROCESS CONTROL**
- **CLOSED-LOOP SERVO-CONTROL**
- **MOTOR CONTROL**
- **DATA ACQUISITION SYSTEMS**
- **DAC-PER-PIN PROGRAMMERS**

DESCRIPTION

The DAC7642 and DAC7643 are dual channel, 16-bit, voltage output Digital-to-Analog Converters (DACs) which provide 15-bit monotonic performance over the specified temperature range. They accept 16-bit parallel input data, have double-buffered DAC input logic (allowing simultaneous update of all DACs), and provide a readback mode of the internal input registers. Programmable asynchronous reset clears all registers to a mid-scale code of 8000_H (DAC7642) or to a zero-scale code of 0000_H (DAC7643). These DACs can operate from a single +5V supply or from +5V and -5V supplies, providing an output range of 0 to +2.5V or -2.5V to +2.5V, respectively.

Low power and small size per DAC make the DAC7642 and DAC7643 ideal for automatic test equipment, DAC-per-pin programmers, data acquisition systems, and closed-loop servo-control. The DAC7642 and DAC7643 are available in a LQFP-32 package and specified over a -40°C to +85°C temperature range.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

V_{CC} to V_{SS}	-0.3V to 11V
V_{CC} to GND	-0.3V to 5.5V
V_{REFL} to V_{SS}	-0.3V to (V_{CC} - V_{SS})
V_{CC} to V_{REFH}	-0.3V to (V_{CC} - V_{SS})
V_{REFH} to V_{REFL}	-0.3V to (V_{CC} - V_{SS})
Digital Input Voltage to GND	-0.3V to V_{CC} + 0.3V
Digital Output Voltage to GND	-0.3V to V_{CC} + 0.3V
Maximum Junction Temperature	+150°C
Operating Temperature Range	-40°C to +85°C
Storage Temperature Range	-65°C to +125°C
Lead Temperature (soldering, 10s)	+300°C

NOTE: (1) Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum conditions for extended periods may affect device reliability.



ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGE/ORDERING INFORMATION

PRODUCT	MONOTONICITY	PACKAGE-LEAD	PACKAGE DESIGNATOR ⁽¹⁾	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
DAC7642VF "	14 Bits "	LQFP-32 "	VF "	-40°C to +85°C "	DAC7642 "	DAC7642VFT DAC7642VFR	Tape and Reel, 250 Tape and Reel, 1000
DAC7642VFB "	15 Bits "	LQFP-32 "	VF "	-40°C to +85°C "	DAC7642B "	DAC7642VFBT DAC7642VFR	Tape and Reel, 250 Tape and Reel, 1000
DAC7643VF "	14 Bits "	LQFP-32 "	VF "	-40°C to +85°C "	DAC7643 "	DAC7643VFT DAC7643VFR	Tape and Reel, 250 Tape and Reel, 1000
DAC7643VFB "	15 Bits "	LQFP-32 "	VF "	-40°C to +85°C "	DAC7643B "	DAC7643VFBT DAC7643VFR	Tape and Reel, 250 Tape and Reel, 1000

NOTE: (1) For the most current specifications and package information, refer to our web site at www.ti.com.

ELECTRICAL CHARACTERISTICS (Dual Supply)

At $T_A = T_{MIN}$ to T_{MAX} , $V_{CC} = +5V$, $V_{SS} = -5V$, $V_{REFH} = +2.5V$, and $V_{REFL} = -2.5V$, unless otherwise noted.

PARAMETER	CONDITIONS	DAC7642VF DAC7643VF			DAC7642VFB DAC7643VFB			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
ACCURACY	Channel-to-Channel Matching Channel-to-Channel Matching At Full-Scale	14	± 3	± 4	15	± 2	± 3	LSB LSB LSB Bits mV ppm/ $^{\circ}$ C mV ppm/ $^{\circ}$ C mV mV ppm/V
			± 4	± 2		± 2	± 2	
			± 2	± 3		± 1	± 2	
			± 1	± 3		*	*	
			5	10		*	*	
			± 1	± 3		*	*	
			5	10		*	*	
			± 1	± 3		± 1	± 3	
			± 1	± 3		± 1	± 3	
			10	100		*	*	
ANALOG OUTPUT	$R_L = 10k\Omega$ Output Current Maximum Load Capacitance Short-Circuit Current Short-Circuit Duration	$V_{REFL} = -1.25$ No Oscillation GND, V_{CC} or V_{SS}	500 -10, +30 Indefinite	$V_{REFH} = +1.25$ * *	*	*	*	V mA pF mA
REFERENCE INPUT	Ref High Input Voltage Range Ref Low Input Voltage Range Ref High Input Current Ref Low Input Current	$V_{REFL} = +1.25$ -2.5	500 -500	$V_{REFH} = +2.5$ $V_{REFH} = -1.25$	*	*	*	V V μ A μ A
DYNAMIC PERFORMANCE	Settling Time Channel-to-Channel Crosstalk Digital Feedthrough Output Noise Voltage DAC Glitch	To $\pm 0.003\%$, 5V Output Step See Figure 5 $f = 10\text{kHz}$ $7FFF_H$ to 8000_H or 8000_H to $7FFF_H$	8 0.5 2 60 40	10	*	*	*	μ s LSB $nV\text{-s}$ nV/Hz $nV\text{-s}$
DIGITAL INPUT	V_{IH} V_{IL} I_{IH} I_{IL}	$0.7 \cdot V_{CC}$	$0.3 \cdot V_{CC}$ ± 10 ± 10	*	*	*	*	V V μ A μ A
DIGITAL OUTPUT	V_{OH} V_{OL}	$I_{OH} = -0.8\text{mA}$ $I_{OL} = 1.2\text{mA}$	3.6 0.3	4.5 0.4	*	*	*	V V
POWER SUPPLY	V_{CC} V_{SS} I_{CC} I_{SS} Power		+4.75 -5.25 -1.2	+5.0 -5.0 0.7 -0.8 7.5	+5.25 -4.75 1.1 11.5	*	*	V V mA mA mW
TEMPERATURE RANGE	Specified Performance		-40		+85	*	*	°C

* Specifications same as DAC7642VF and DAC7643VF.

ELECTRICAL CHARACTERISTICS (Single Supply)

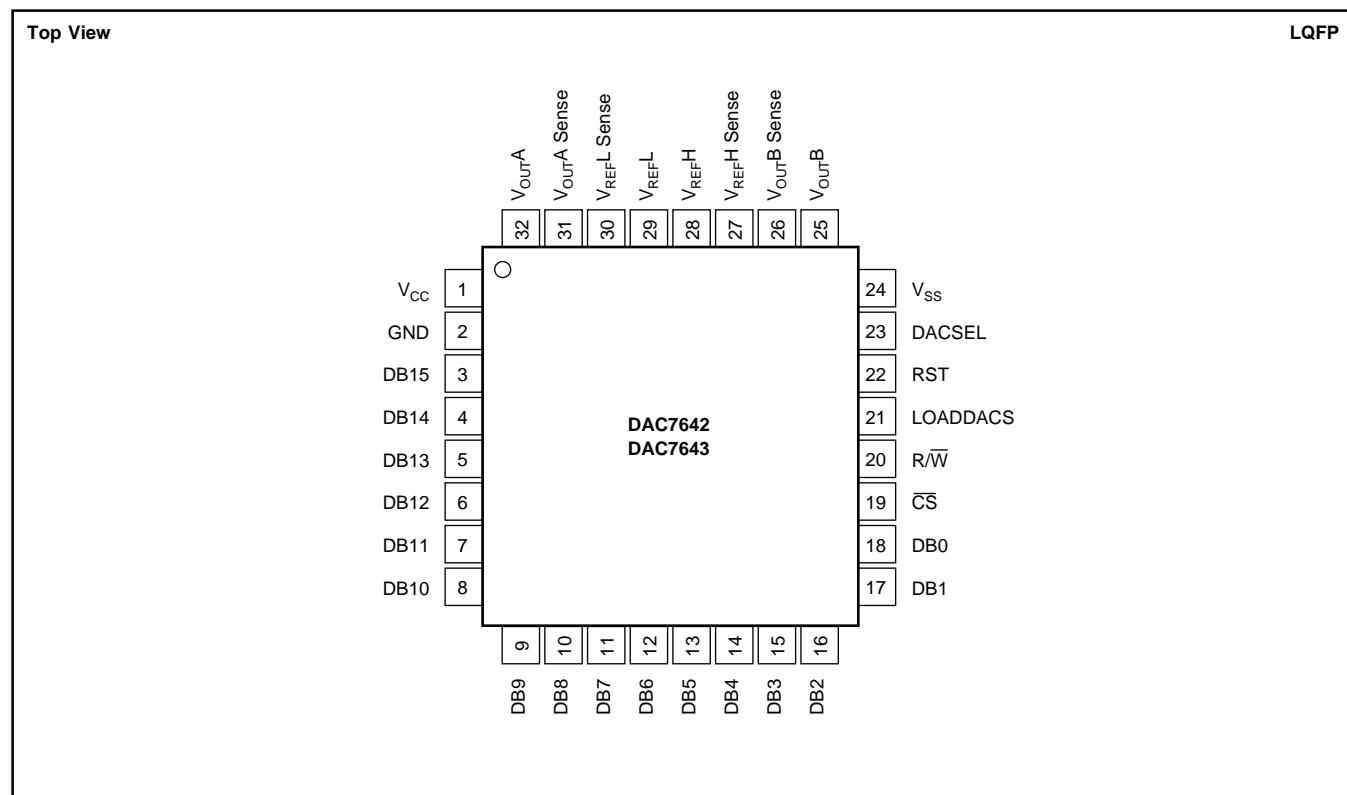
At $T_A = T_{MIN}$ to T_{MAX} , $V_{CC} = +5V$, $V_{SS} = 0V$, $V_{REFH} = +2.5V$, and $V_{REFL} = 0V$, unless otherwise noted.

PARAMETER	CONDITIONS	DAC7642VF DAC7643VF			DAC7642VFB DAC7643VFB			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
ACCURACY	Channel-to-Channel Matching Channel-to-Channel Matching At Full-Scale	14	± 3	± 4	15	± 2	± 3	LSB
			± 4	± 2		± 2	± 2	LSB
			± 2	± 3		± 1	± 2	LSB
			± 1	± 3		*	*	Bits
			5	10		*	*	mV
			± 1	± 3		*	*	ppm/ $^{\circ}$ C
			5	10		*	*	mV
			± 1	± 3		± 1	± 3	ppm/ $^{\circ}$ C
			± 1	± 3		± 1	± 3	mV
			10	100		*	*	mV
ANALOG OUTPUT	$R_L = 10k\Omega$ No Oscillation GND or V_{CC}	0 -1.25 500 -10, +30 Indefinite	$V_{REFH} + 1.25$	* * * * *	*	*	*	V mA pF mA
REFERENCE INPUT	Ref High Input Voltage Range Ref Low Input Voltage Range Ref High Input Current Ref Low Input Current	$V_{REFL} + 1.25$ 0	250 -250	+2.5 $V_{REFH} - 1.25$	* * * *	*	*	V V μ A μ A
DYNAMIC PERFORMANCE	Settling Time Channel-to-Channel Crosstalk Digital Feedthrough Output Noise Voltage, $f = 10$ kHz DAC Glitch	To $\pm 0.003\%$, 2.5V Output Step See Figure 6 $7FFF_H$ to 8000_H or 8000_H to $7FFF_H$	8 0.5 2 60 40	10	* * * * *	*	*	μ s LSB nV-s nV/ \sqrt{Hz} nV-s
DIGITAL INPUT	V_{IH} V_{IL} I_{IH} I_{IL}	0.7 • V_{CC}	0.3 • V_{CC} ± 10 ± 10	*	*	*	*	V V μ A μ A
DIGITAL OUTPUT	V_{OH} V_{OL}	$I_{OH} = -0.8mA$ $I_{OL} = 1.2mA$	3.6 0.3	4.5 0.4	*	*	*	V V
POWER SUPPLY	V_{CC} V_{SS} I_{CC} Power	+4.75 0	+5.0 0 0.5 2.5	+5.25 0 0.9 4.5	*	*	*	V V mA mW
TEMPERATURE RANGE	Specified Performance	-40		+85	*		*	°C

* Specifications same as DAC7642VF and DAC7643VF.

NOTE: (1) If $V_{SS} = 0V$, specification applies at Code 0040_H and above due to possible negative zero-scale error.

PIN CONFIGURATION



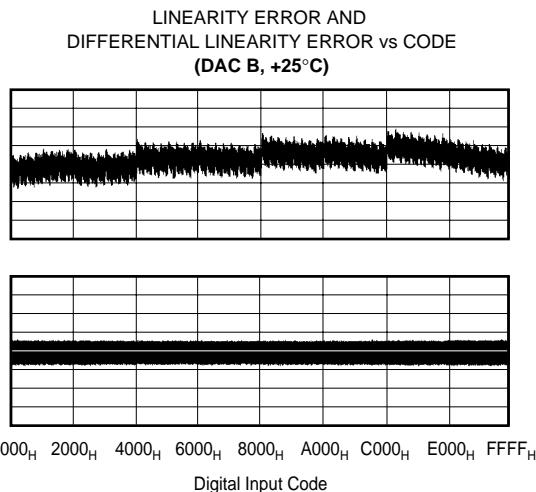
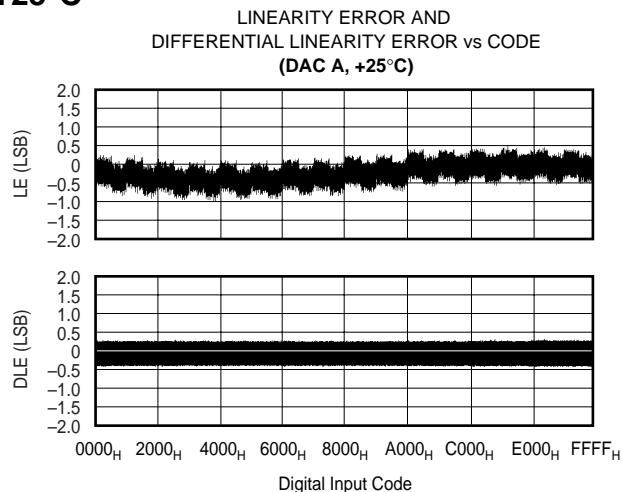
PIN DESCRIPTIONS

PIN	NAME	DESCRIPTION	PIN	NAME	DESCRIPTION
1	V _{CC}	Positive Power Supply	20	R/W	Enabled by \overline{CS} , Controls Data Read from and Write to the Input Registers.
2	GND	Ground	21	LOADDACS	DAC Output Registers Load Control. Rising edge triggered. Transfers Data from the Input Registers to the DAC Registers, Updating the DAC Output.
3	DB15	Data Bit 15, MSB	22	RST	Reset, Rising Edge Triggered. DAC7642 resets to mid-scale, DAC7643 resets to zero. (Resets Both Input Registers and DAC Registers)
4	DB14	Data Bit 14	23	DACSEL	Enabled by \overline{CS} . Selects the individual DAC Input Registers. (LOW Selects Register A, HIGH Selects Register B)
5	DB13	Data Bit 13	24	V _{SS}	Negative Power Supply
6	DB12	Data Bit 12	25	V _{OUTB}	DAC B Voltage Output
7	DB11	Data Bit 11	26	V _{OUTB} Sense	DAC B Output Amplifier Inverting Input. Used to close the feedback loop at the load.
8	DB10	Data Bit 10	27	V _{REFH} Sense	DAC A and B Reference High Sense Input
9	DB9	Data Bit 9	28	V _{REFH}	DAC A and B Reference High Input
10	DB8	Data Bit 8	29	V _{OUTL}	DAC A and B Reference Low Input
11	DB7	Data Bit 7	30	V _{REFL} Sense	DAC A and B Reference Low Sense Input
12	DB6	Data Bit 6	31	V _{OUTA} Sense	DAC A Output Amplifier Inverting Input. Used to close the feedback loop at the load.
13	DB5	Data Bit 5	32	V _{OUTA}	DAC A Output Voltage
14	DB4	Data Bit 4			
15	DB3	Data Bit 3			
16	DB2	Data Bit 2			
17	DB1	Data Bit 1			
18	DB0	Data Bit 0, LSB			
19	CS	Chip Select, Active LOW			

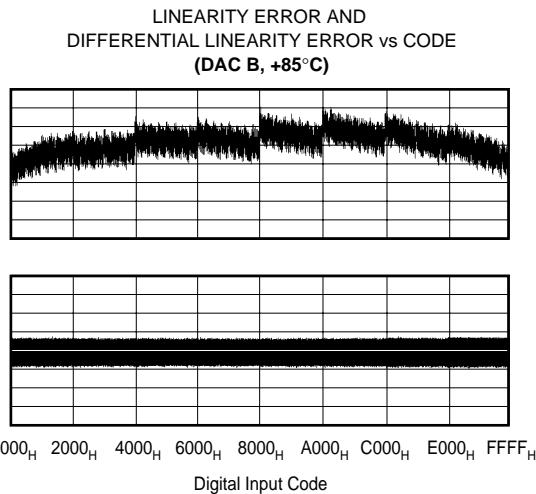
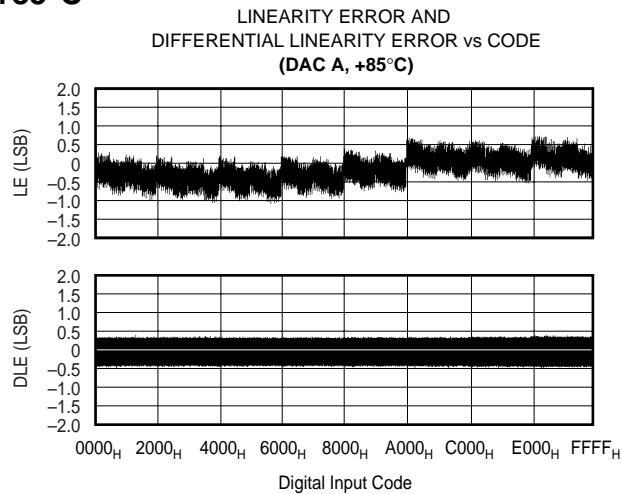
TYPICAL CHARACTERISTICS: $V_{SS} = 0V$

At $T_A = +25^\circ\text{C}$, $V_{CC} = +5\text{V}$, $V_{SS} = 0\text{V}$, $V_{REFH} = +2.5\text{V}$, $V_{REFL} = 0\text{V}$, representative unit, unless otherwise specified.

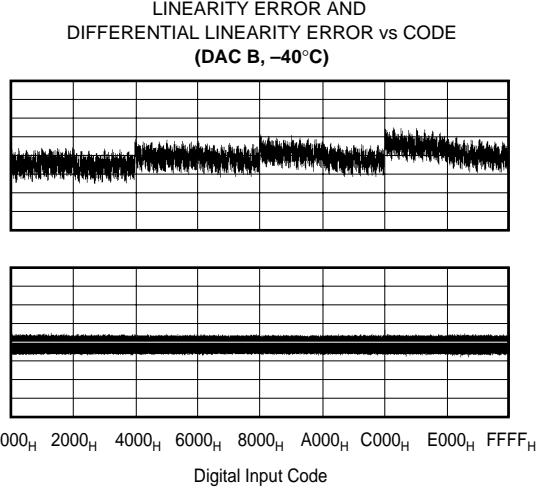
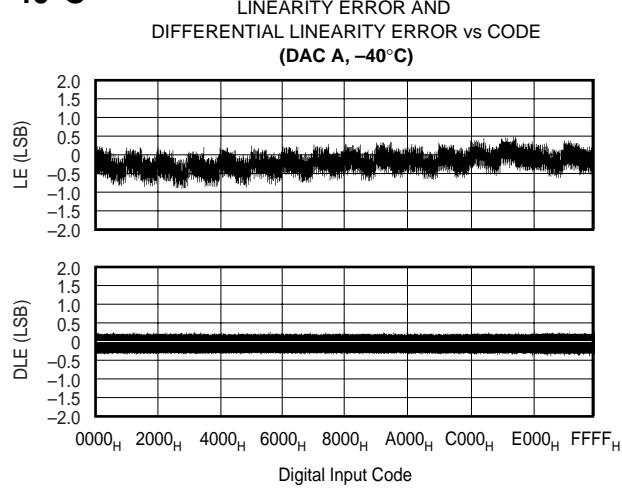
+25°C



+85°C

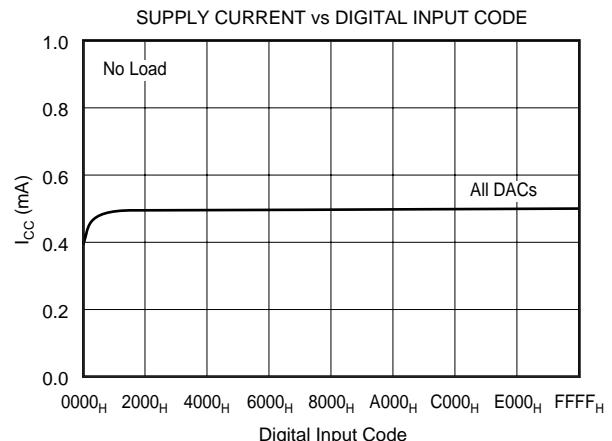
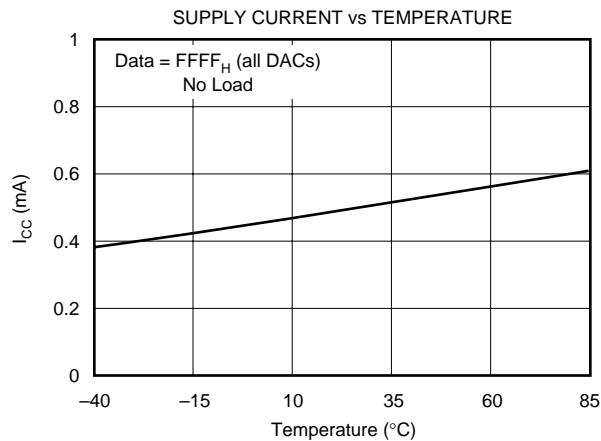
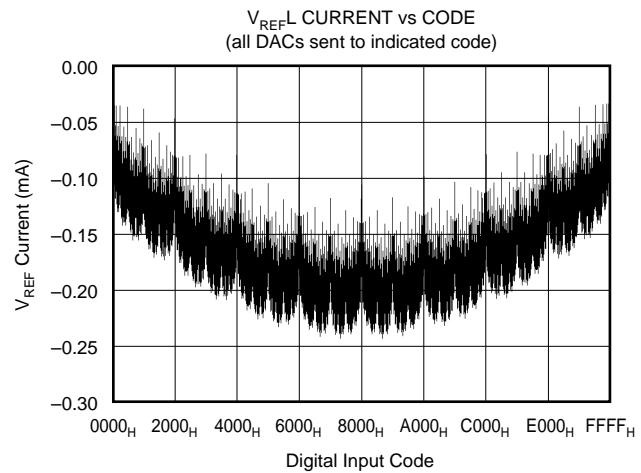
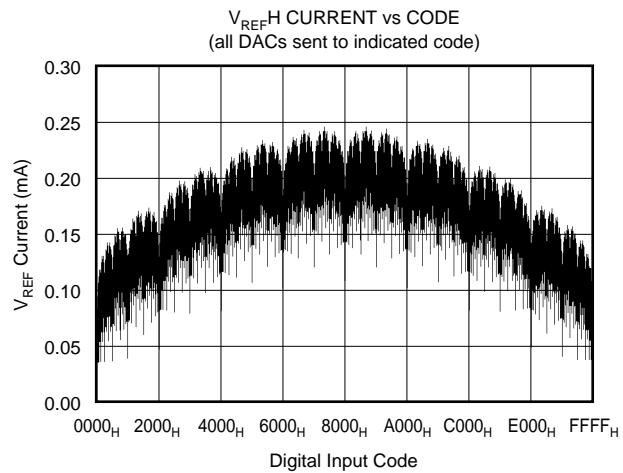
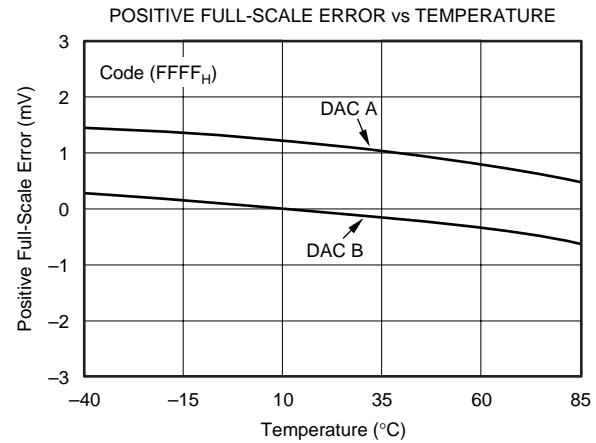
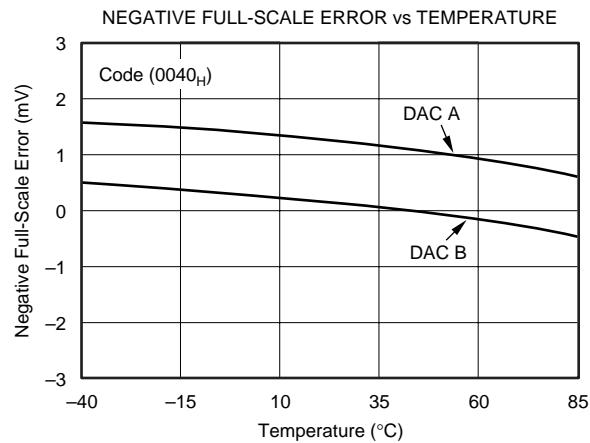


-40°C



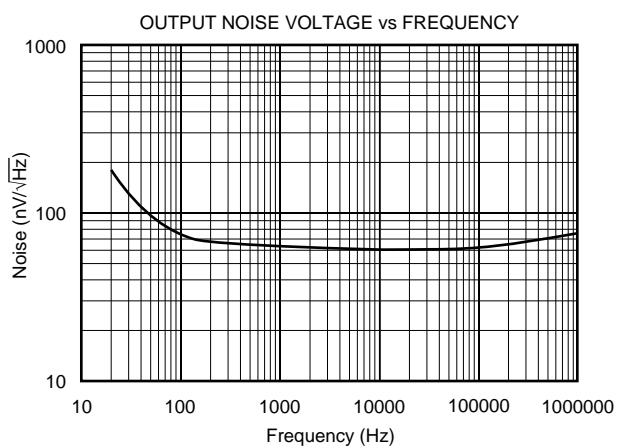
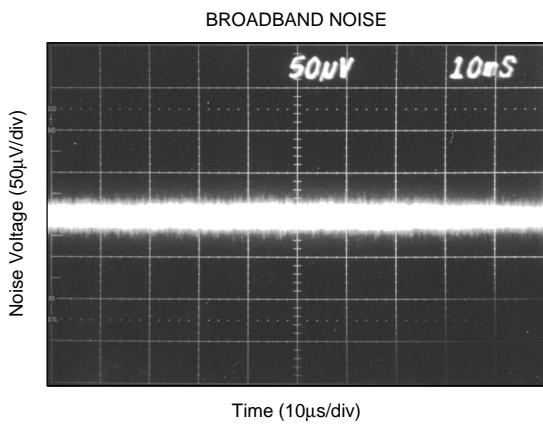
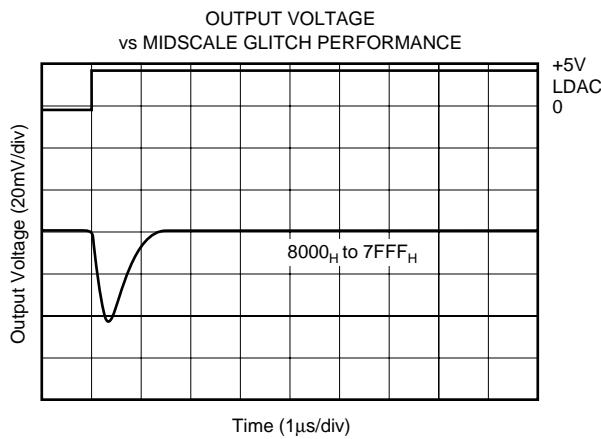
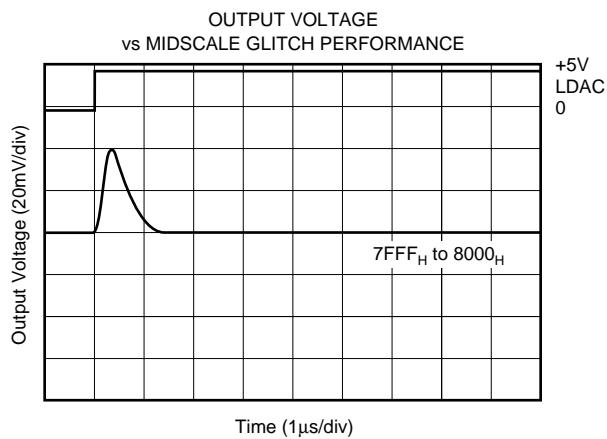
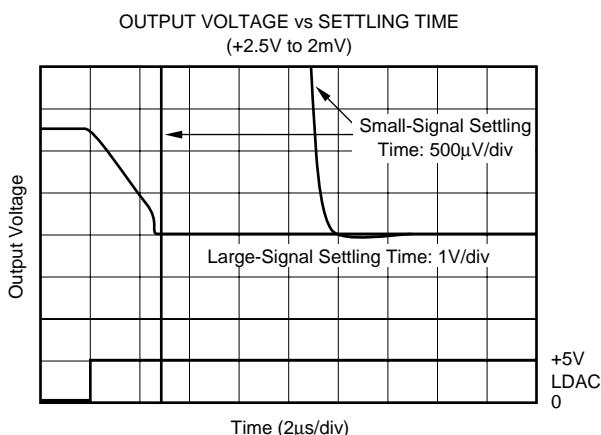
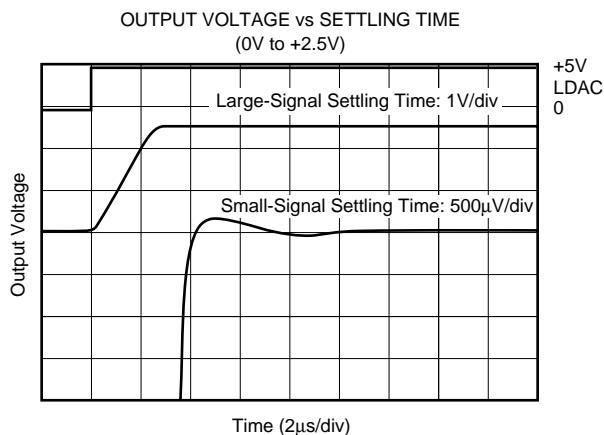
TYPICAL CHARACTERISTICS: $V_{SS} = 0V$ (Cont.)

At $T_A = +25^\circ\text{C}$, $V_{CC} = +5\text{V}$, $V_{SS} = 0\text{V}$, $V_{REFH} = +2.5\text{V}$, $V_{REFL} = 0\text{V}$, representative unit, unless otherwise specified.



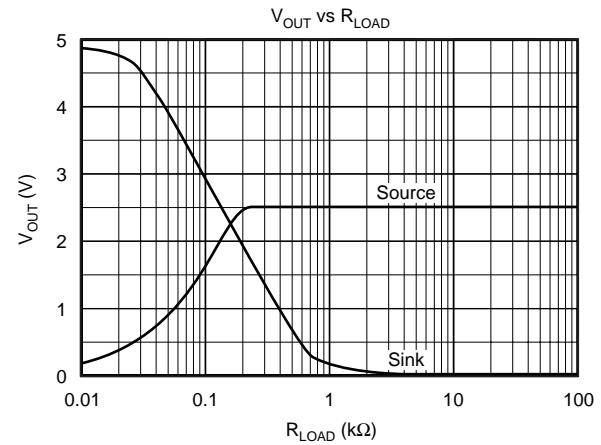
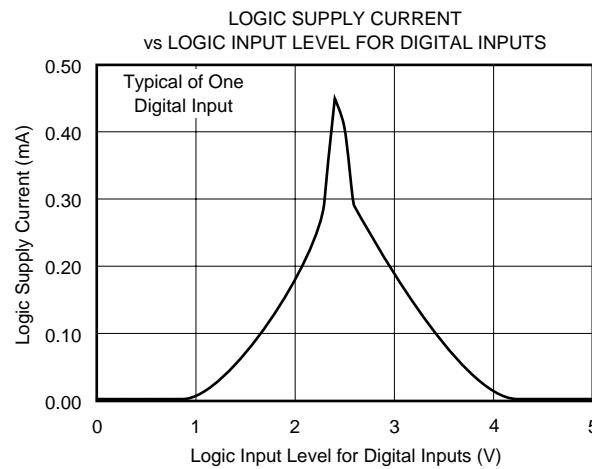
TYPICAL CHARACTERISTICS: $V_{SS} = 0V$ (Cont.)

At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = 0V$, $V_{REFH} = +2.5V$, $V_{REFL} = 0V$, representative unit, unless otherwise specified.



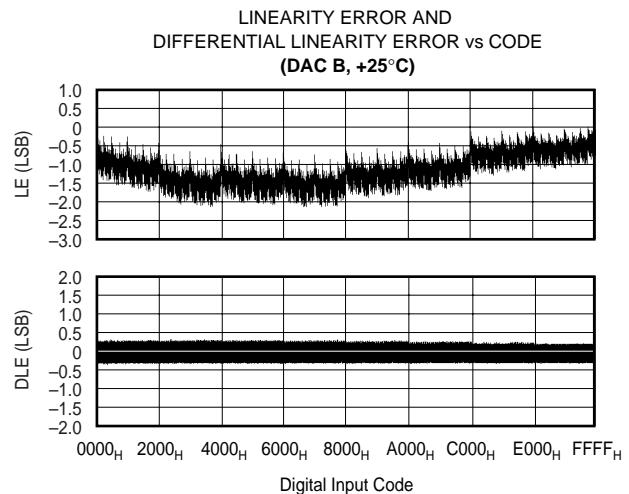
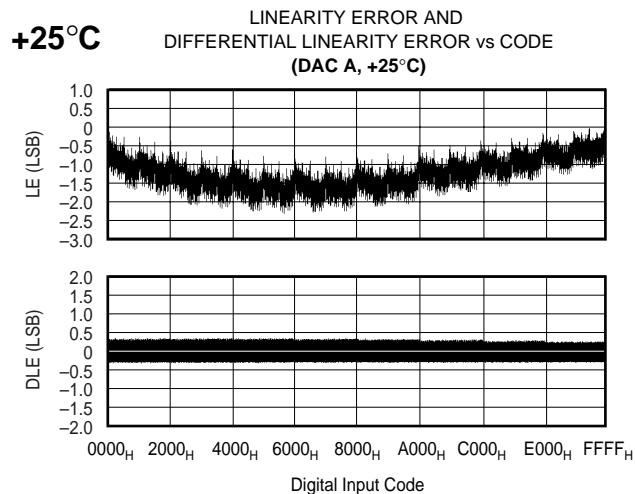
TYPICAL CHARACTERISTICS: $V_{SS} = 0V$ (Cont.)

At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = 0V$, $V_{REFH} = +2.5V$, $V_{REFL} = 0V$, representative unit, unless otherwise specified.

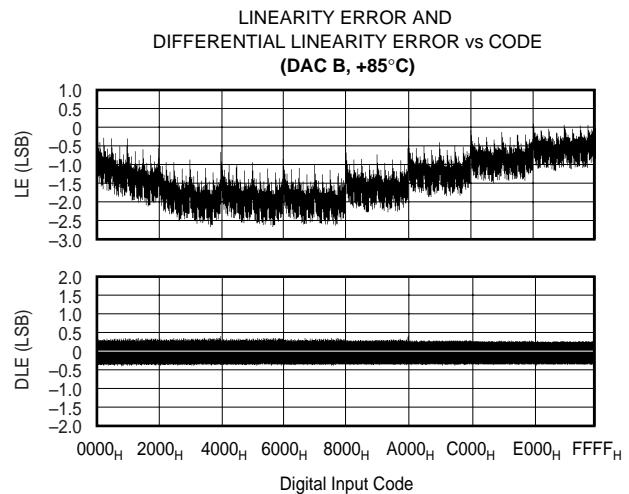
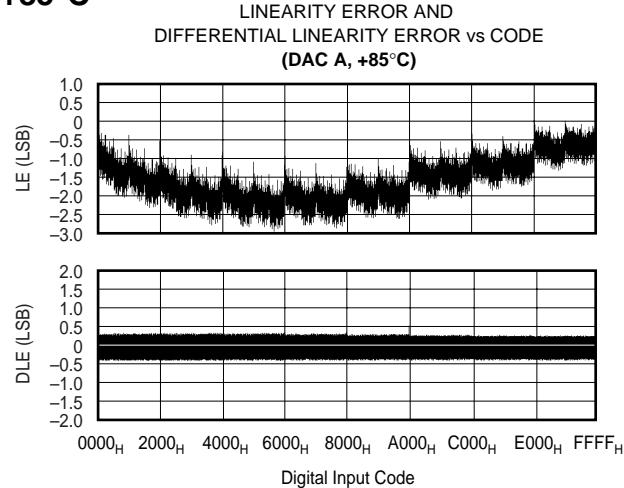


$V_{SS} = -5V$

At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = -5V$, $V_{REFH} = +2.5V$, $V_{REFL} = -2.5V$, representative unit, unless otherwise specified.



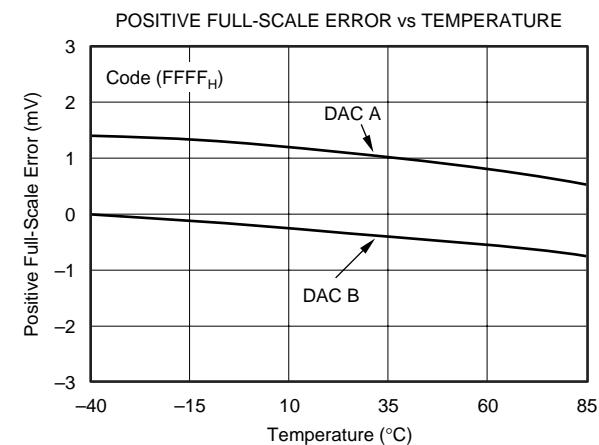
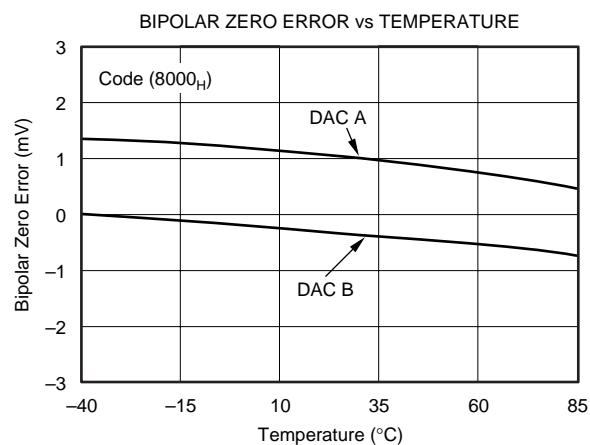
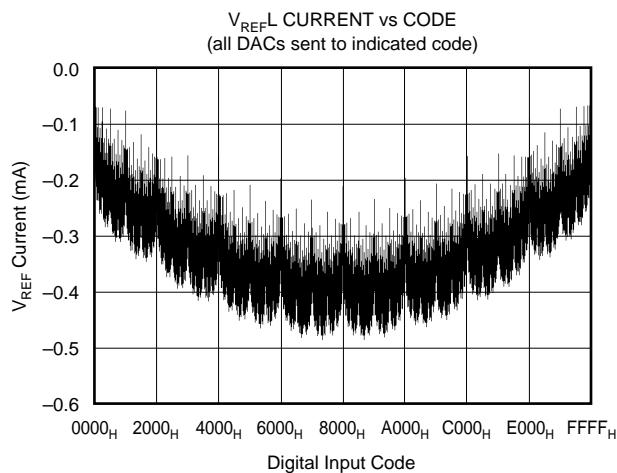
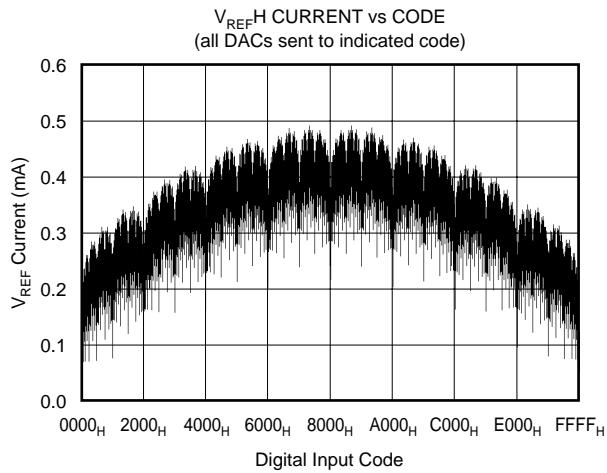
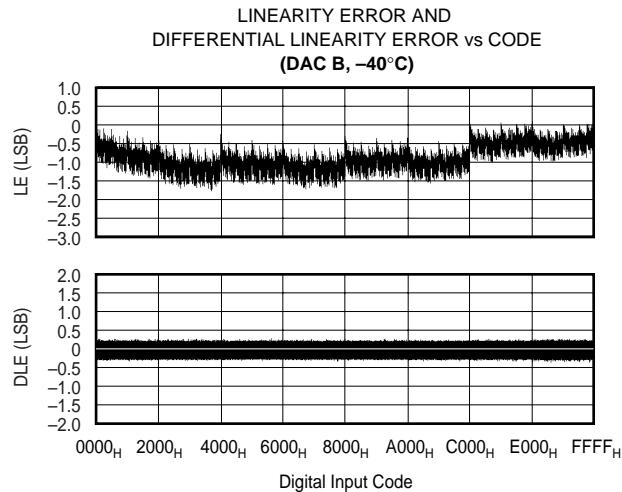
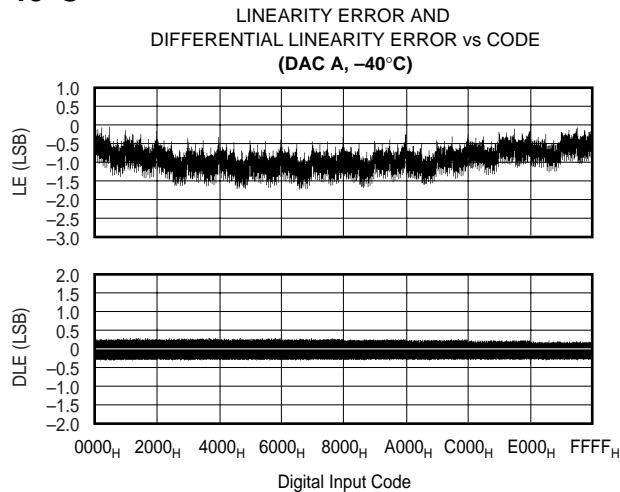
$+85^\circ C$



TYPICAL CHARACTERISTICS: $V_{SS} = -5V$ (Cont.)

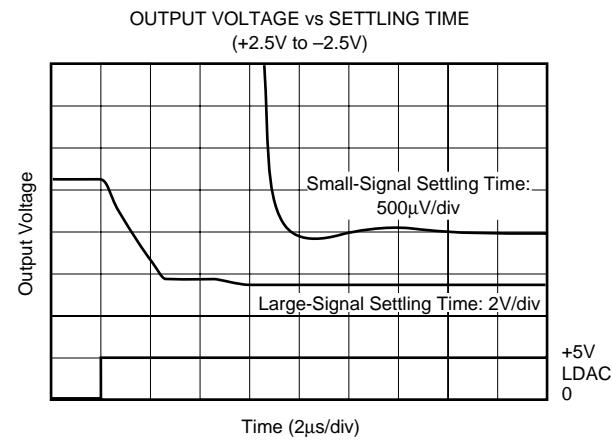
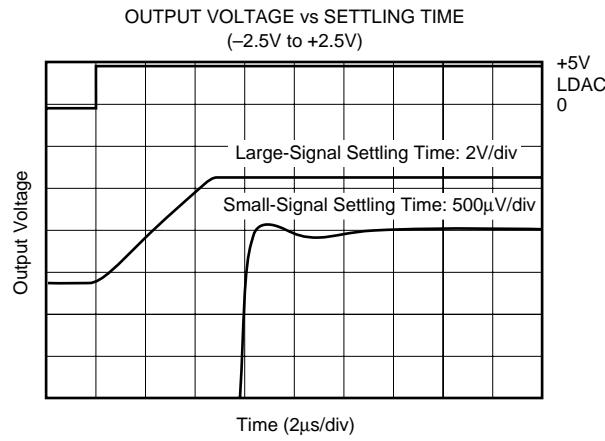
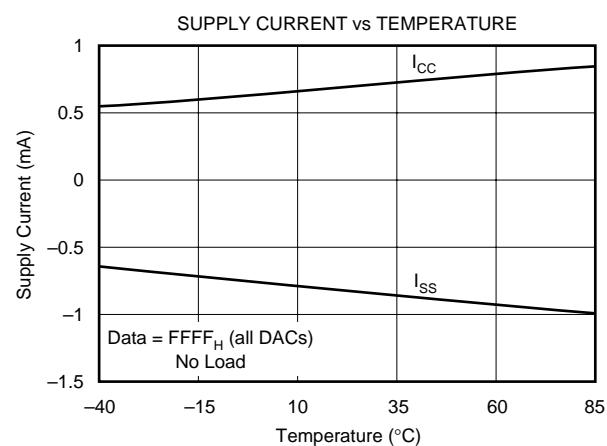
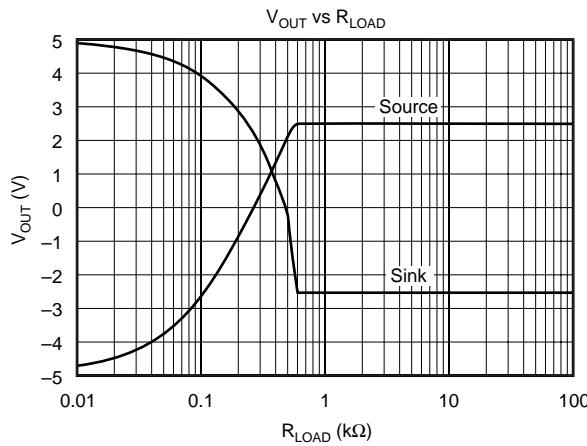
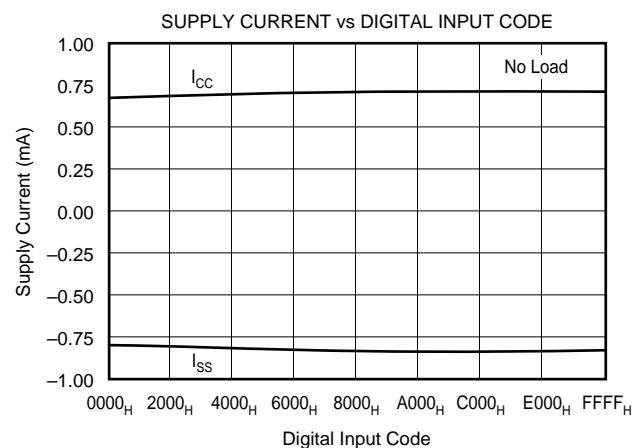
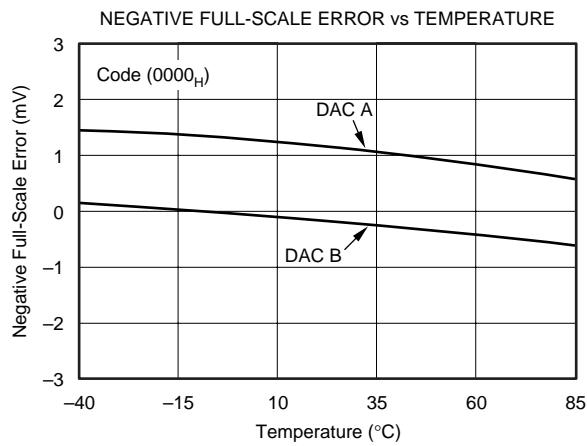
At $T_A = +25^\circ\text{C}$, $V_{CC} = +5\text{V}$, $V_{SS} = -5\text{V}$, $V_{REFH} = +2.5\text{V}$, $V_{REFL} = -2.5\text{V}$, representative unit, unless otherwise specified.

-40°C



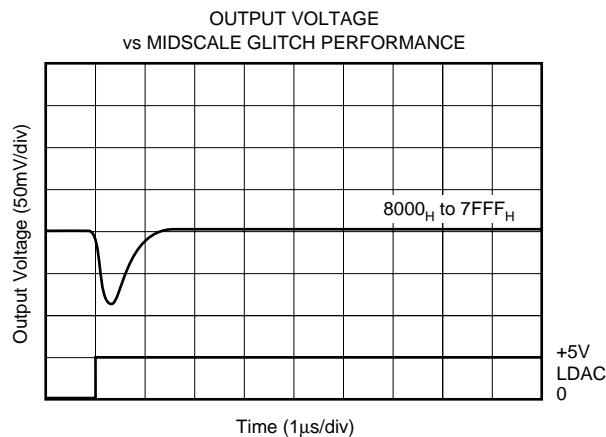
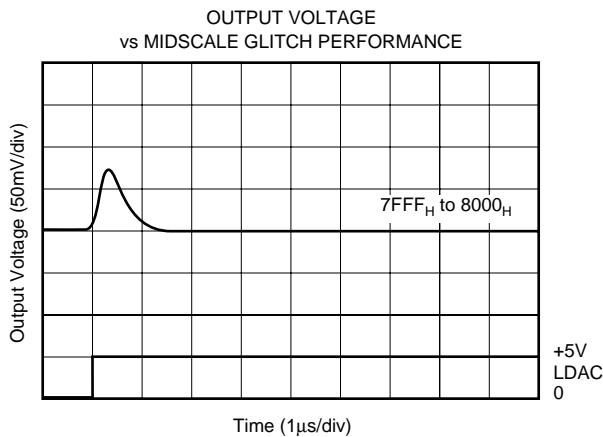
TYPICAL CHARACTERISTICS: $V_{SS} = -5V$ (Cont.)

At $T_A = +25^\circ\text{C}$, $V_{CC} = +5\text{V}$, $V_{SS} = -5\text{V}$, $V_{REFH} = +2.5\text{V}$, $V_{REFL} = -2.5\text{V}$, representative unit, unless otherwise specified.



TYPICAL CHARACTERISTICS: $V_{SS} = -5V$ (Cont.)

At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = -5V$, $V_{REFH} = +2.5V$, $V_{REFL} = -2.5V$, representative unit, unless otherwise specified.



THEORY OF OPERATION

The DAC7642 and DAC7643 are dual channel, voltage output, 16-bit DACs. The architecture is an R-2R ladder configuration with the three MSB's segmented followed by an operational amplifier that serves as a buffer. Each DAC has its own R-2R ladder network, segmented MSBs, and output op amp, as shown in Figure 1. The minimum voltage output (zero-scale) and maximum voltage output (full-scale) are set

by the external voltage references V_{REFL} and V_{REFH} , respectively. The digital input is a 16-bit parallel word and the DAC input registers offer a readback capability. The converters can be powered from either a single +5V supply or a dual $\pm 5V$ supply. Each device offers a reset function which immediately sets all DAC output voltages, DAC registers and Input registers to mid-scale, code 8000_H (DAC7642), or to zero-scale, code 0000_H (DAC7643). See Figures 2 and 3 for the basic configurations of the DAC7642 and DAC7643.

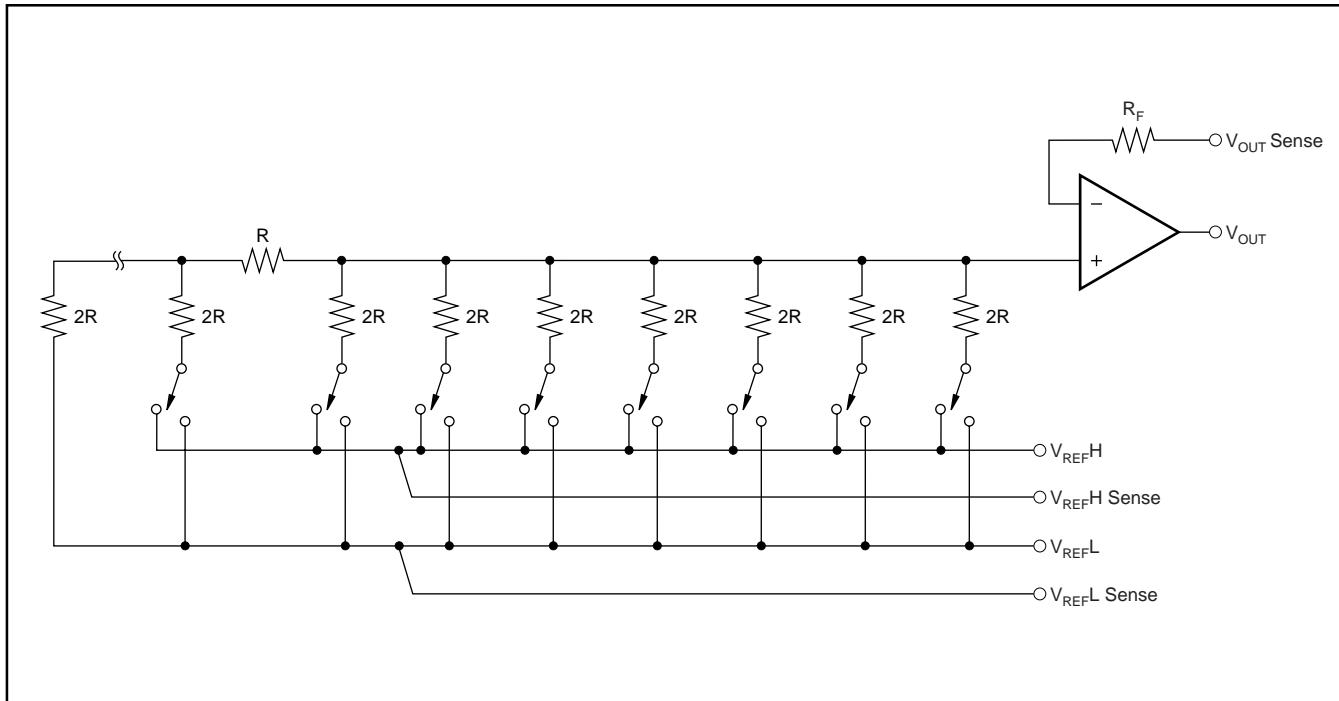


FIGURE 1. DAC7642 and DAC7643 Architecture.

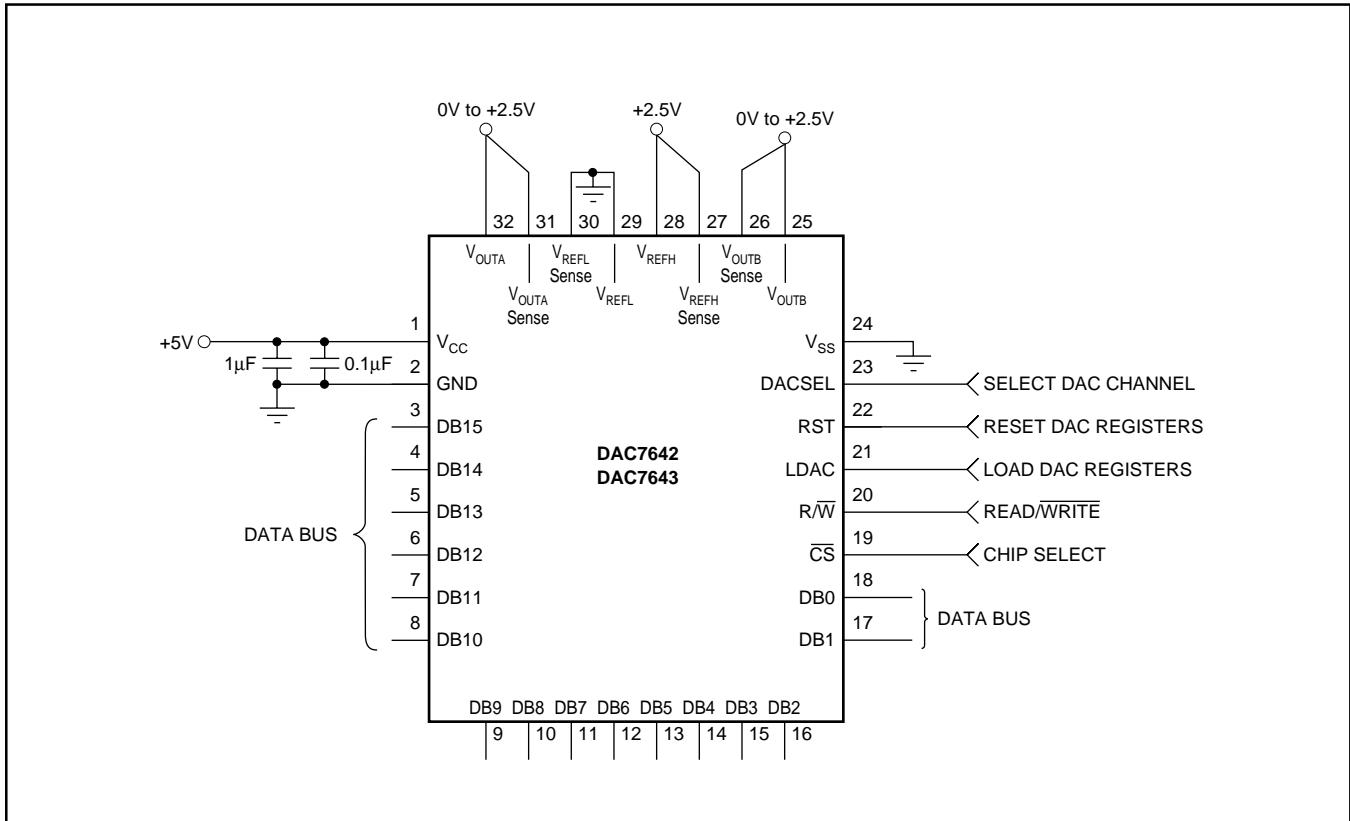


FIGURE 2. Basic Single-Supply Operation of the DAC7642 and DAC7643.

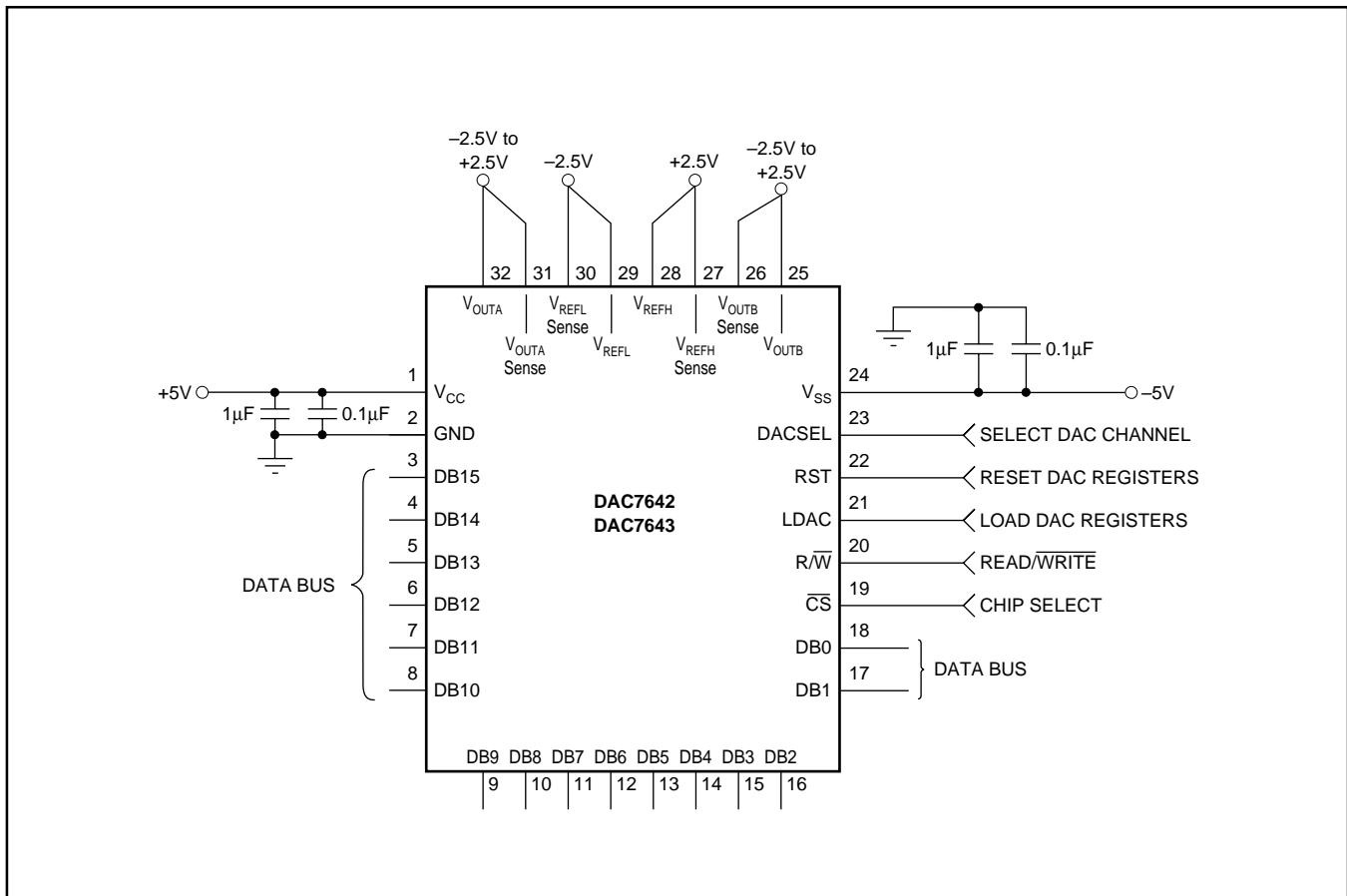


FIGURE 3. Basic Dual-Supply Operation of the DAC7642 and DAC7643.

ANALOG OUTPUTS

When $V_{SS} = -5V$ (dual-supply operation), the output amplifier can swing to within 2.25V of the supply rails over the -40°C to $+85^{\circ}\text{C}$ temperature range. When $V_{SS} = 0V$ (single-supply operation), and with R_{LOAD} also connected to ground, the output can swing to ground. Care must also be taken when measuring the zero-scale error when $V_{SS} = 0V$. Since the DAC output cannot swing below ground, the output voltage may not change for the first few digital input codes (0000_H , 0001_H , 0002_H , etc.) if the output amplifier has a negative offset. At the negative limit of -2mV , the first specified output starts at code 0040_H .

Due to the high accuracy of these DACs, system design problems such as grounding and contact resistance become very important. A 16-bit converter with a 2.5V full-scale range has a 1LSB value of $38\mu\text{V}$. With a load current of 1mA, a series wiring and connector resistance of only $40\text{m}\Omega$ (R_{W2}) will cause a voltage drop of $40\mu\text{V}$, as shown in Figure 4. To understand what this means in terms of a system layout, the resistivity of a typical 1 ounce copper-clad printed circuit board is $1/2\text{ m}\Omega$ per square. For a 1mA load, a 10 milli-inch wide printed circuit conductor 600 milli-inches long will result in a voltage drop of $30\mu\text{V}$.

The DAC7642 and DAC7643 offer a force and sense output configuration for the high open-loop gain output amplifiers. This feature allows the loop around the output amplifier to be closed at the load (shown in Figure 4), thus ensuring an accurate output voltage.

REFERENCE INPUTS

The reference inputs, V_{REFL} and V_{REFH} , can be any voltage between $V_{SS} + 2.5V$ and $V_{CC} - 2.5V$ provided that V_{REFH} is at least 1.25V greater than V_{REFL} . The minimum output of each DAC is equal to V_{REFL} plus a small offset voltage (essentially, the offset of the output op amp). The maximum output is equal to V_{REFH} plus a similar offset voltage. Note

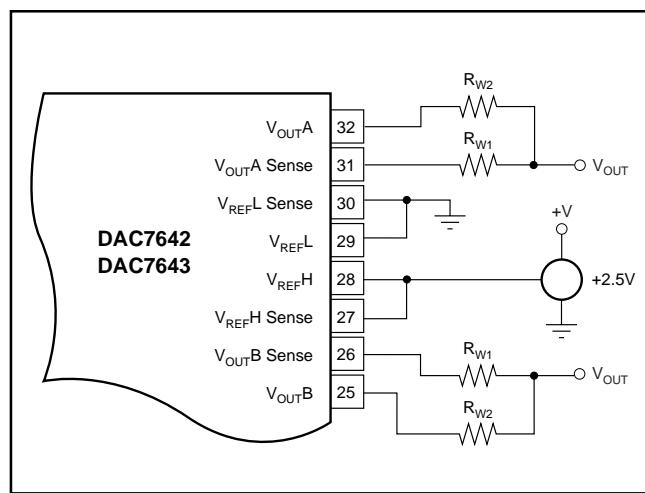


FIGURE 4. Analog Output Closed-Loop Configuration. R_W represents wiring resistances.

that V_{SS} (the negative power supply) must either be connected to ground or must be in the range of $-4.75V$ to $-5.25V$. The voltage on V_{SS} sets several bias points within the converter. If V_{SS} is not in one of these two configurations, the bias values may be in error and proper operation of the device may be affected.

The current into the V_{REFH} input and out of V_{REFL} depends on the DAC output voltages and can vary from a few microamps to approximately 0.5mA. The reference input appears as a varying load to the reference. If the references applied can sink or source the required current, a reference buffer is not required. The DAC7642 and DAC7643 feature reference drive and sense connections such that the internal errors caused by the changing reference current and the circuit impedances can be minimized. Figures 5 through 13 show different reference configurations and the effect on the linearity and differential linearity.

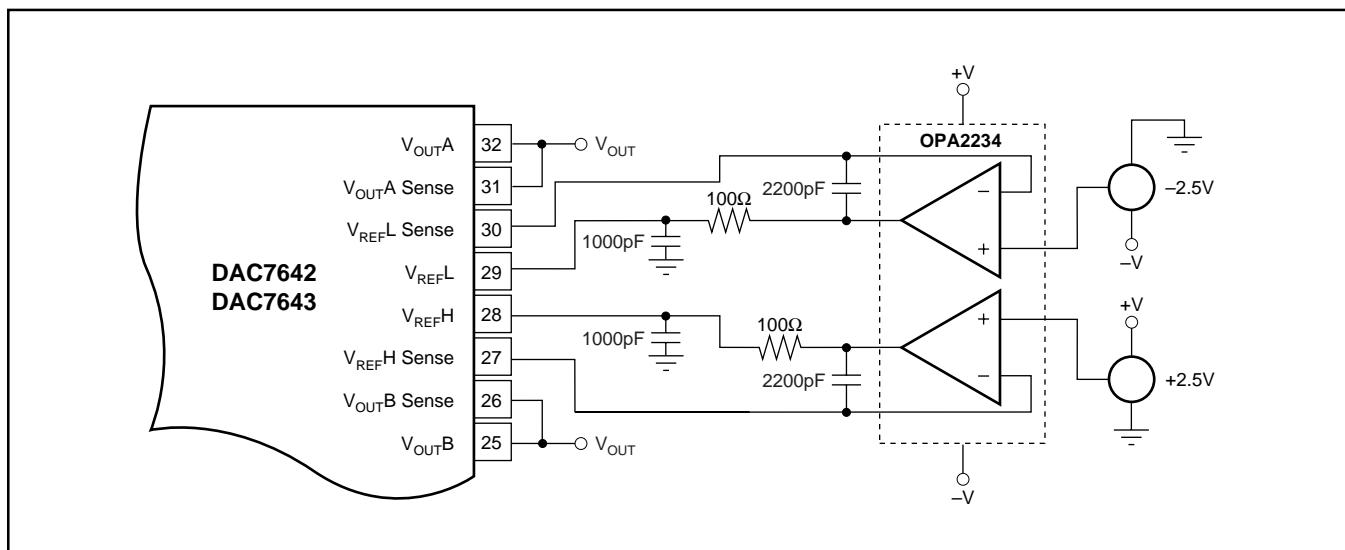


FIGURE 5. Dual Supply Configuration-Buffered References, Used for Dual-Supply Characteristic Curves.

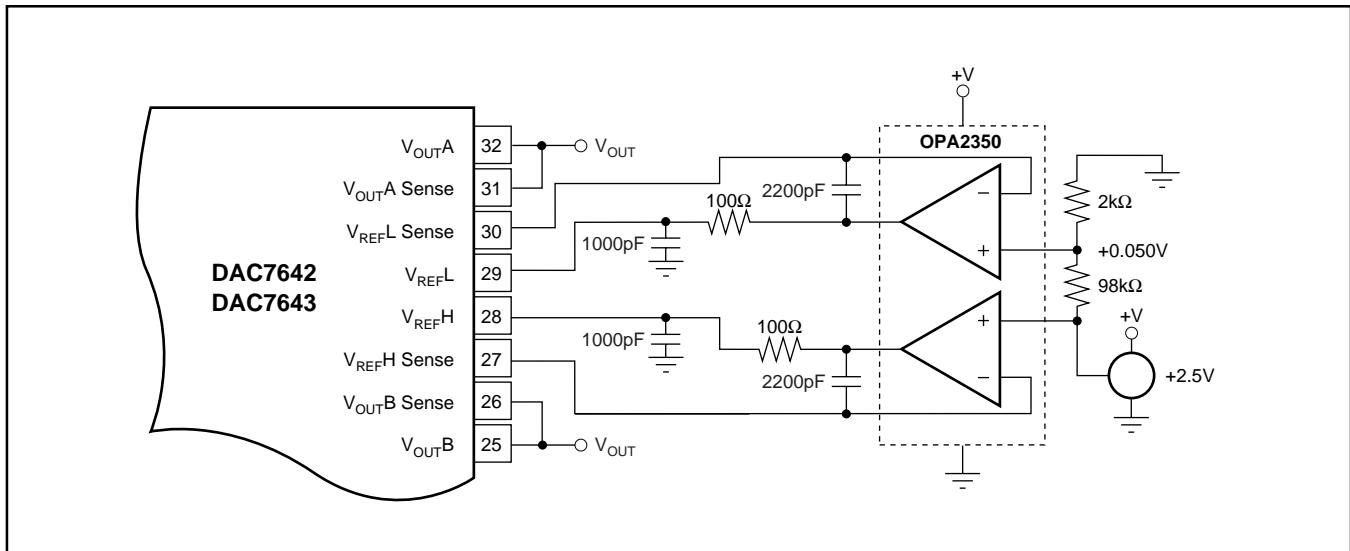


FIGURE 6. Single-Supply Buffered Reference with V_{REFL} of 50mV.

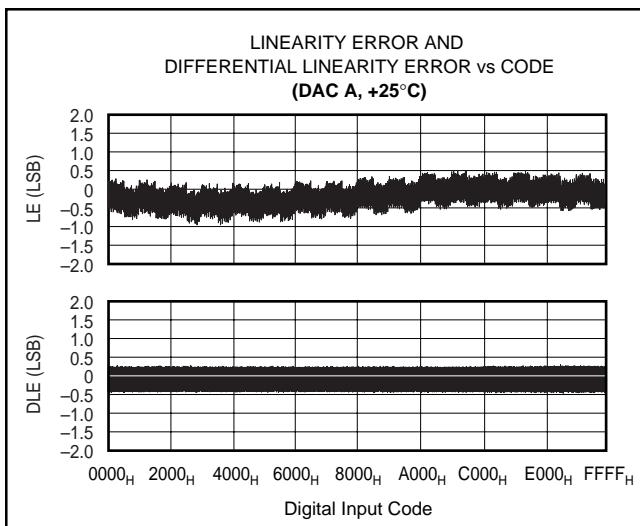


FIGURE 7. Integral Linearity and Differential Linearity Error Curves for Figure 6.

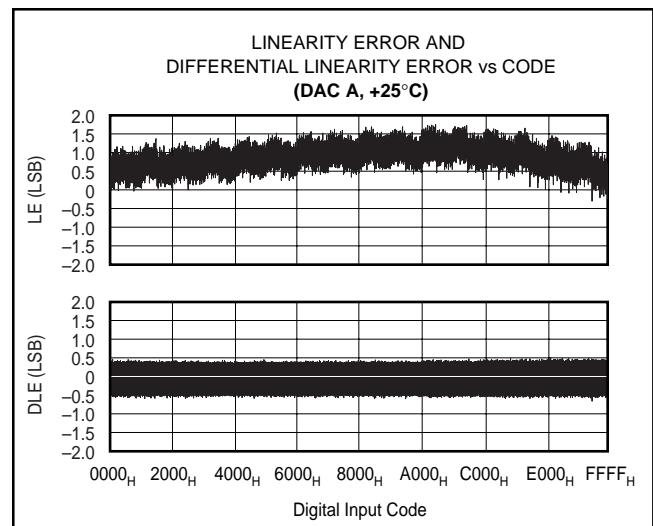


FIGURE 8. Integral Linearity and Differential Linearity Error Curves for Figure 9.

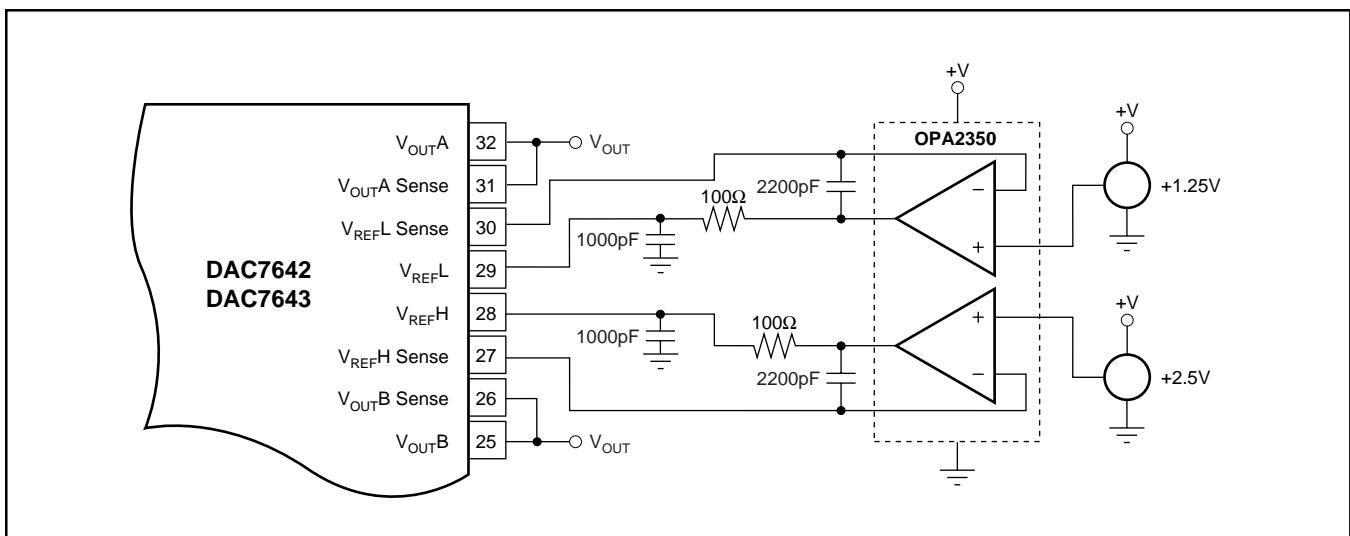


FIGURE 9. Single-Supply Buffered Reference with $V_{REFL} = +1.25V$ and $V_{REFH} = +2.5V$.

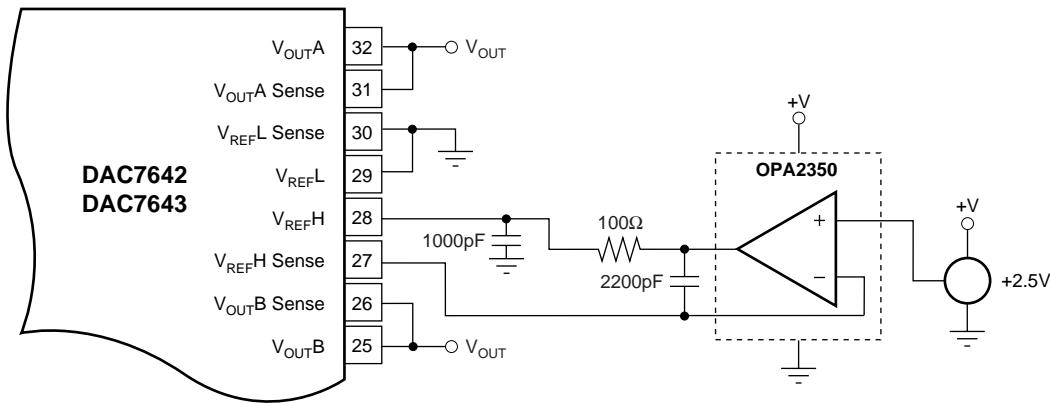


FIGURE 10. Single-Supply Buffered V_{REFH} .

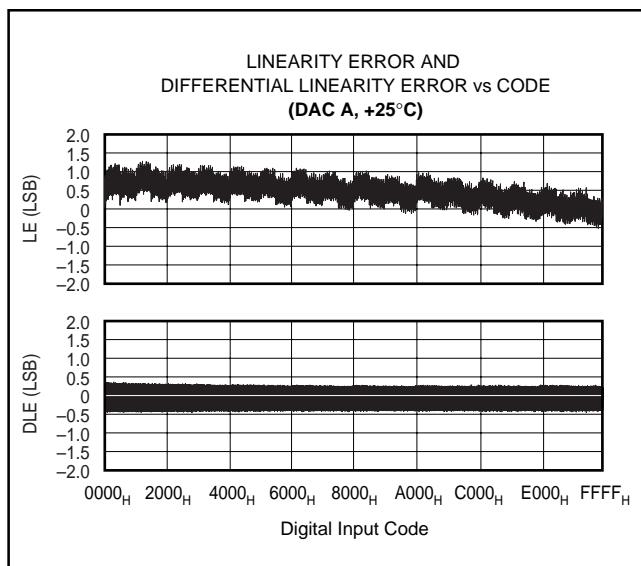


FIGURE 11. Linearity and Differential Linearity Error Curves for Figure 10.

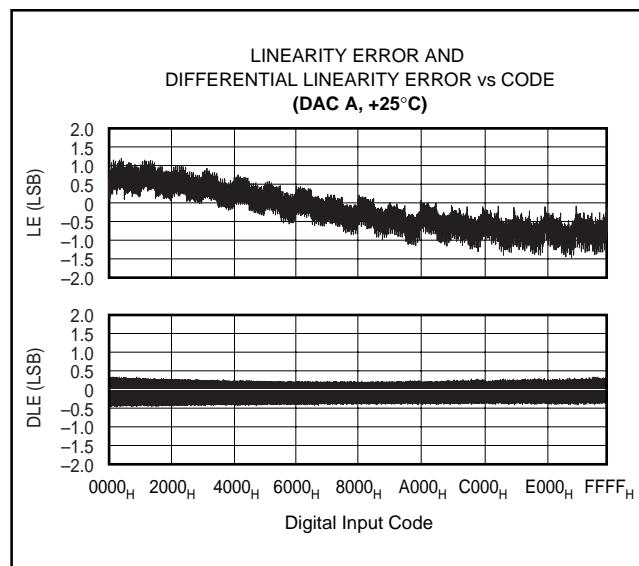


FIGURE 13. Linearity and Differential Linearity Error Curves for Figure 12.

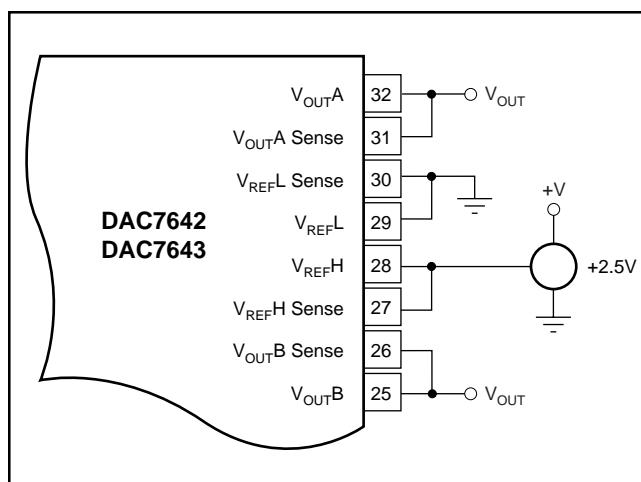


FIGURE 12. Low-Cost Single-Supply Configuration.

DACSEL	R/W	CS	RST	LOADDACS	INPUT REGISTER	DAC REGISTER	MODE	DAC
L	L	L	L, H	X	Write	Hold	Write Input	A
H	L	L	L, H	X	Write	Hold	Write Input	B
L	H	L	L, H	X	Read	Hold	Read Input	A
H	H	L	L, H	X	Read	Hold	Read Input	B
X	X	H	L, H	↑	Read	Hold	Update	All
X	X	H	L, H	L, H	Hold	Hold	Hold	All
X	X	X	↑	L, H	Reset	Reset	Reset	All

TABLE I. DAC7642 and DAC7643 Logic Truth Table.

DIGITAL TIMING

Figure 14 and Table II provide detailed timing for the digital interface of the DAC7642 and DAC7643.

DIGITAL INPUT CODING

The DAC7642 and DAC7643 input data is in Straight Binary format. The output voltage is given by Equation 1:

$$V_{OUT} = V_{REFL} + \frac{(V_{REFH} - V_{REFL}) \cdot N}{65,536} \quad (1)$$

where N is the digital input code. This equation does not include the effects of offset (zero-scale) or gain (full-scale) errors.

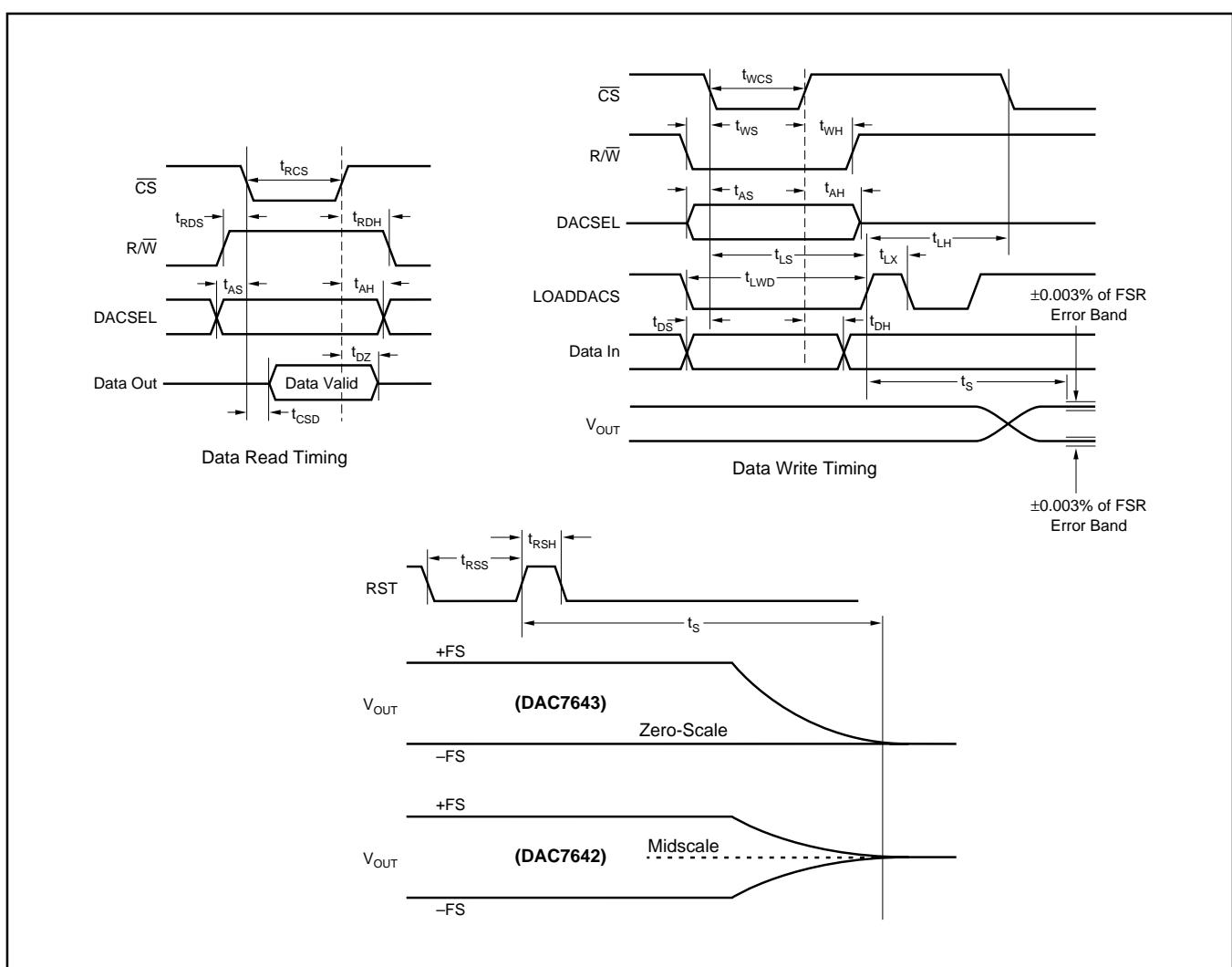


FIGURE 14. Digital Input and Output Timing.

SYMBOL	DESCRIPTION	MIN	TYP	MAX	UNITS
t_{RCS}	\overline{CS} LOW for Read	150			ns
t_{RDS}	R/W HIGH to \overline{CS} LOW	10			ns
t_{RDH}	R/W HIGH after \overline{CS} HIGH	10			ns
t_{DZ}	\overline{CS} HIGH to Data Bus in High Impedance	10		100	ns
t_{CSD}	\overline{CS} LOW to Data Bus Valid		100	150	ns
t_{WCS}	\overline{CS} LOW for Write	40			ns
t_{WS}	R/W LOW to \overline{CS} LOW	0			ns
t_{WH}	R/W LOW after \overline{CS} HIGH	10			ns
t_{AS}	DACSEL Valid to \overline{CS} LOW	0			ns
t_{AH}	DACSEL Valid after \overline{CS} HIGH	10			ns
t_{LS}	\overline{CS} LOW to LOADDACS HIGH	30			ns
t_{LH}	\overline{CS} LOW after LOADDACS HIGH	100			ns
t_{LX}	LOADDACS HIGH	100			ns
t_{DS}	Data Valid to \overline{CS} LOW	0			ns
t_{DH}	Data Valid after CS HIGH	10			ns
t_{LWD}	LOADDACS LOW	100			ns
t_{RSS}	RESET LOW	10			ns
t_{RSH}	RESET HIGH	10			ns
t_s	Settling Time			10	μ s

TABLE II. Timing Specifications ($T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$).

DIGITALLY-PROGRAMMABLE CURRENT SOURCE

The DAC7642 and DAC7643 offer a unique set of features that allows a wide range of flexibility in designing applications circuits, such as programmable current sources. The DAC7642 and DAC7643 offer both a differential reference input, as well as an open-loop configuration around the output amplifier. The open-loop configuration around the output amplifier allows a transistor to be placed within the loop to implement a digitally-programmable, unidirectional current source. The availability of a differential reference also allows programmability for both the full-scale and zero-scale currents. The output current is calculated as:

$$I_{\text{OUT}} = \left(\left(\frac{V_{\text{REFH}} - V_{\text{REFL}}}{R_{\text{SENSE}}} \right) \cdot \left(\frac{\text{N Value}}{65,536} \right) \right) + (V_{\text{REFL}} / R_{\text{SENSE}}) \quad (2)$$

Figure 15 shows a DAC7642 and DAC7643 in a 4-20mA current output configuration. The output current can be determined by Equation 3:

$$I_{\text{OUT}} = \left(\left(\frac{2.5\text{V} - 0.5\text{V}}{125\Omega} \right) \cdot \left(\frac{\text{N Value}}{65,536} \right) \right) + \left(\frac{0.5\text{V}}{125\Omega} \right) \quad (3)$$

At full-scale, the output current is 16mA plus the 4mA for the zero current. At zero scale the output current is the offset current of 4mA ($0.5\text{V}/125\Omega$).

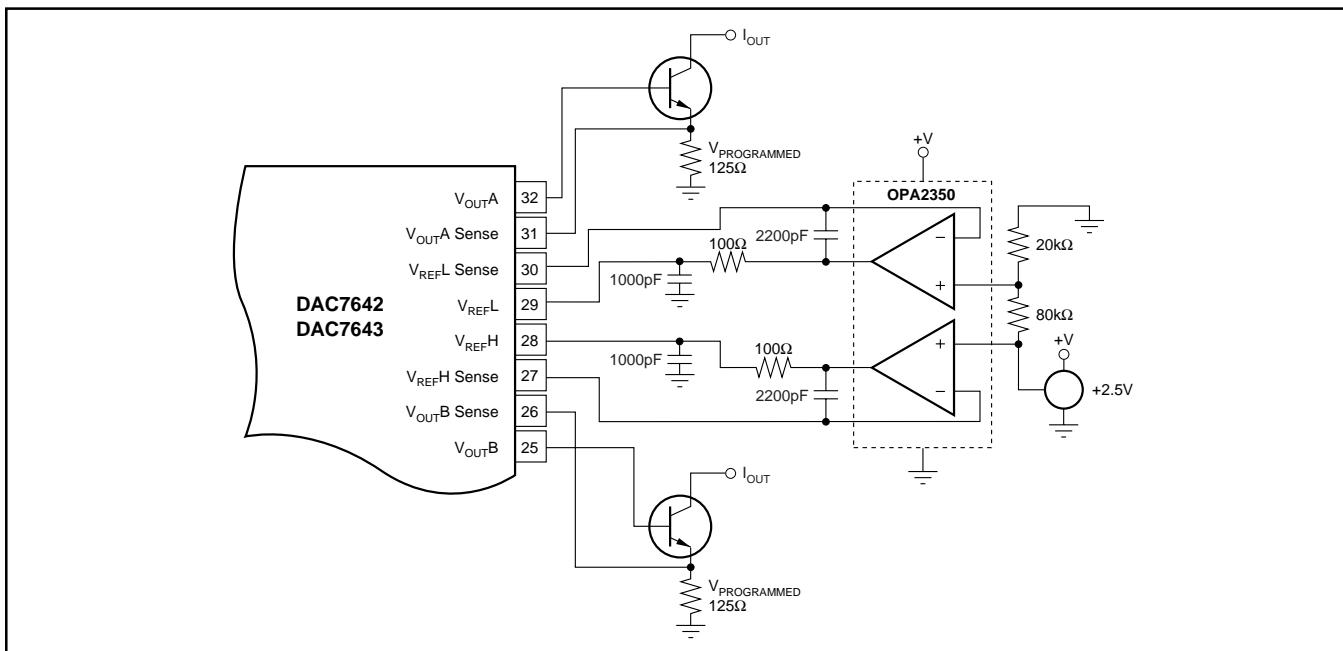
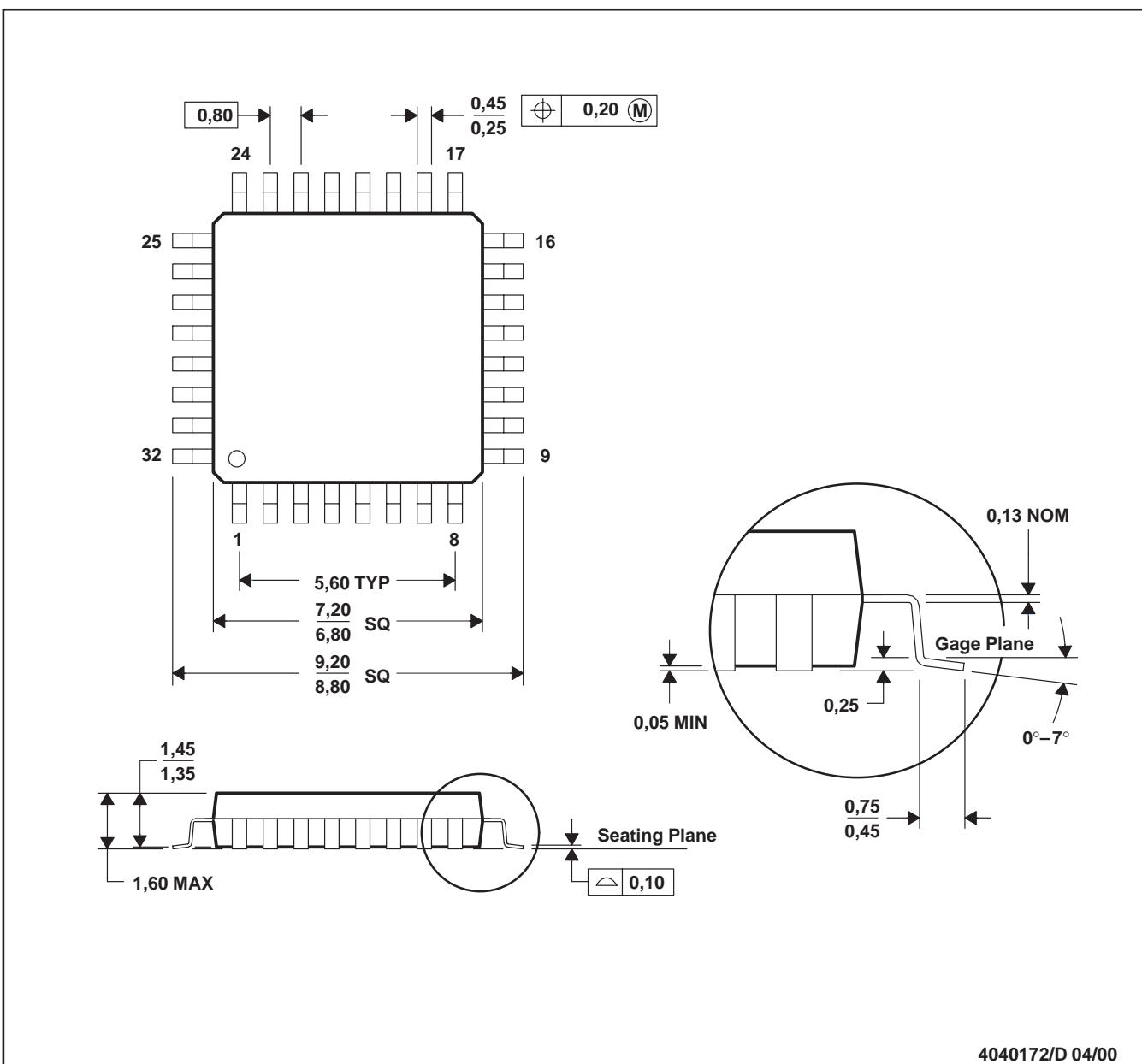


FIGURE 15. 4-20mA Digitally Controlled Current Source.

VF (S-PQFP-G32)

PLASTIC QUAD FLATPACK



4040172/D 04/00

NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
DAC7642VF BT	Active	Production	LQFP (VF) 32	250 SMALL T&R	Yes	Call TI	Level-1-260C-UNLIM	-40 to 85	DAC7642 B
DAC7642VF BT .A	Active	Production	LQFP (VF) 32	250 SMALL T&R	Yes	Call TI	Level-1-260C-UNLIM	-40 to 85	DAC7642 B
DAC7642VF T	Active	Production	LQFP (VF) 32	250 SMALL T&R	Yes	Call TI	Level-1-260C-UNLIM	-40 to 85	DAC7642
DAC7642VF T .A	Active	Production	LQFP (VF) 32	250 SMALL T&R	Yes	Call TI	Level-1-260C-UNLIM	-40 to 85	DAC7642

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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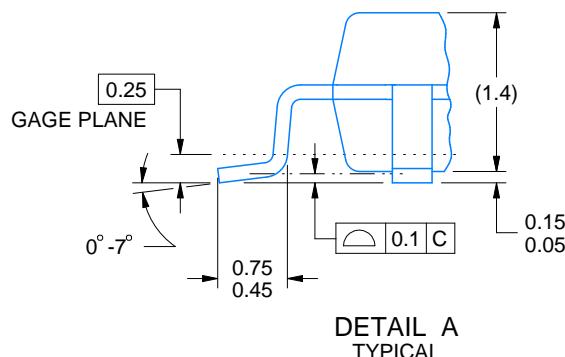
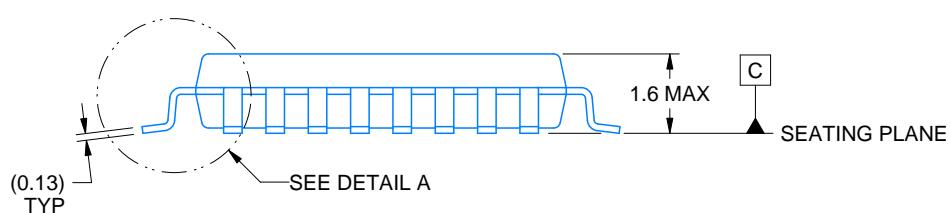
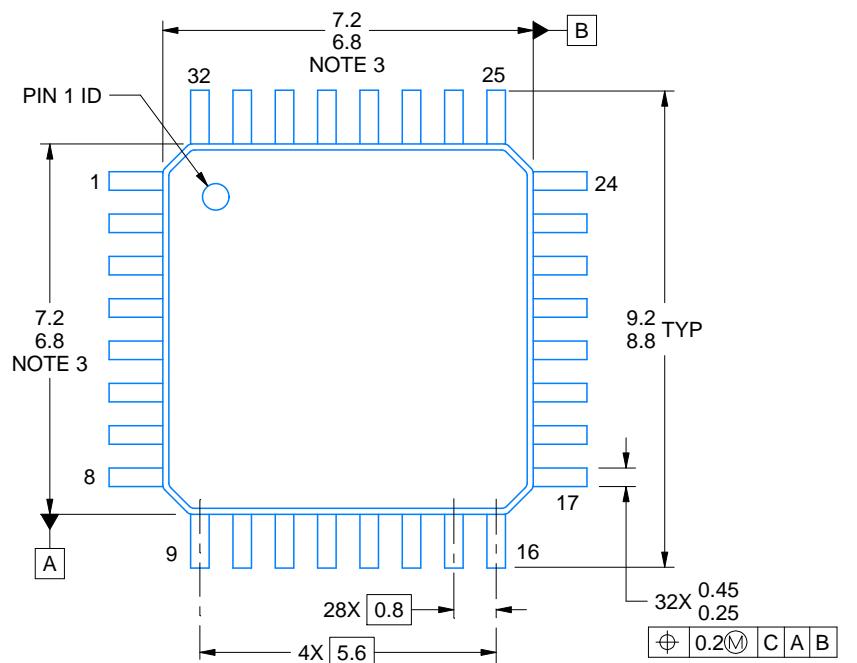


PACKAGE OUTLINE

VF0032A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



4219769/A 04/2019

NOTES:

PowerPAD is a trademark of Texas Instruments.

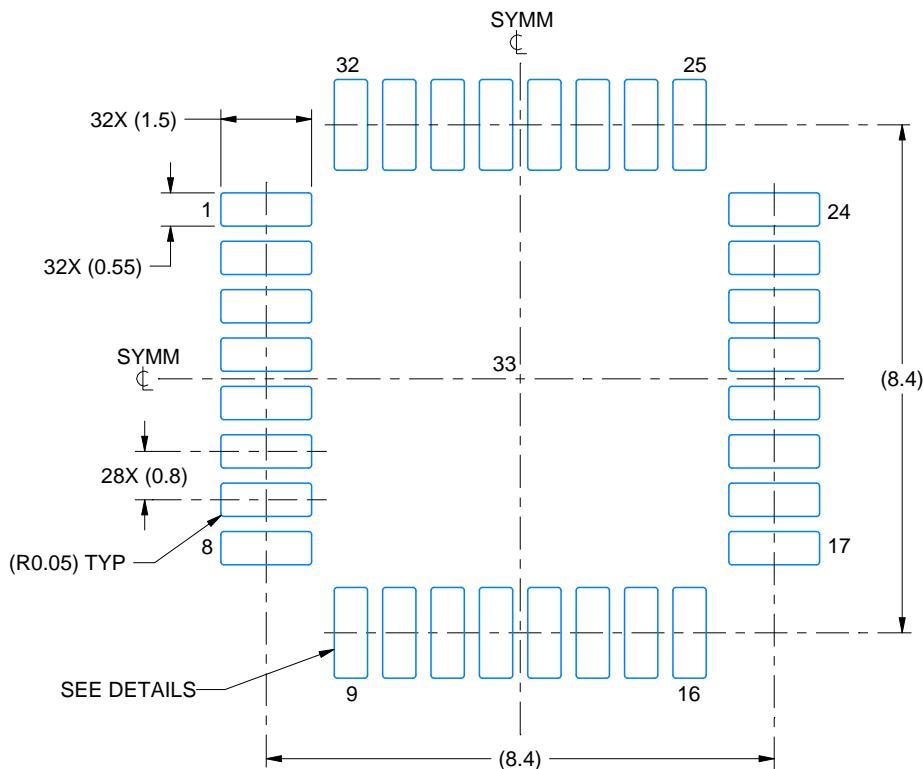
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs.
4. Reference JEDEC registration MS-026.

EXAMPLE BOARD LAYOUT

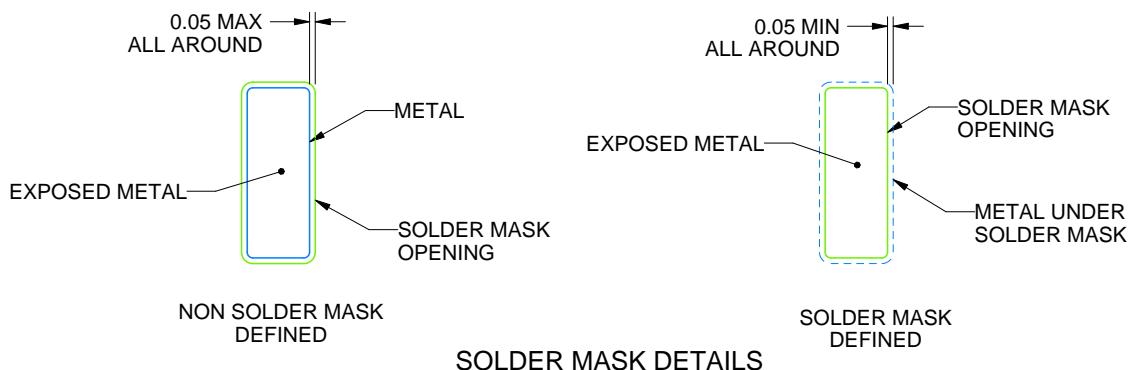
VF0032A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



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NOTES: (continued)

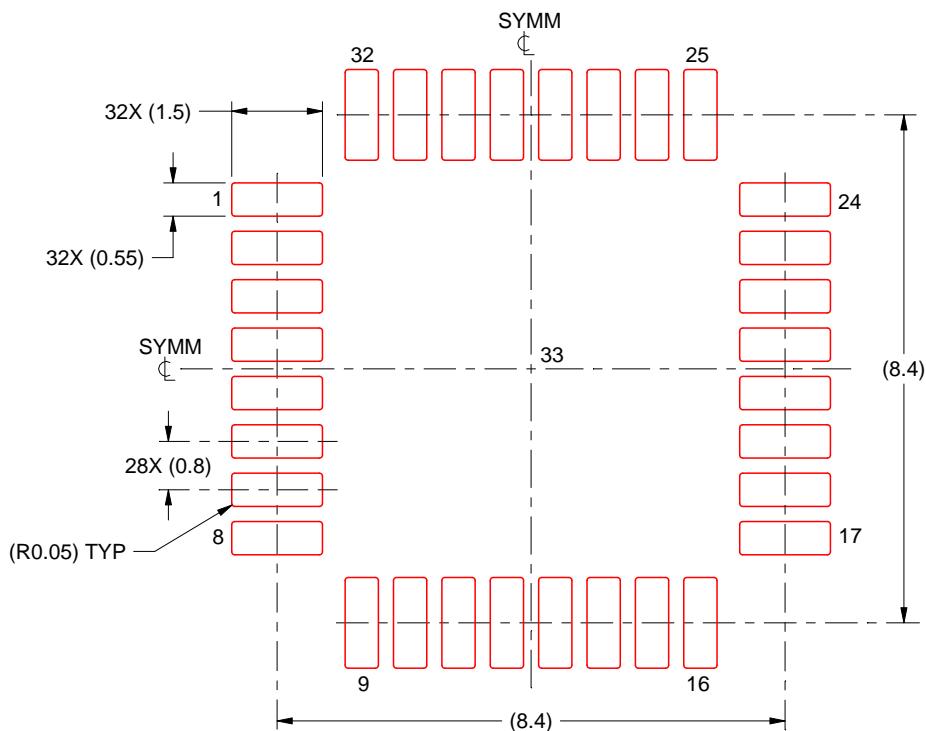
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

VF0032A

LQFP - 1.6 mm max height

PLASTIC QUAD FLATPACK



SOLDER PASTE EXAMPLE
SCALE:8X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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