

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**

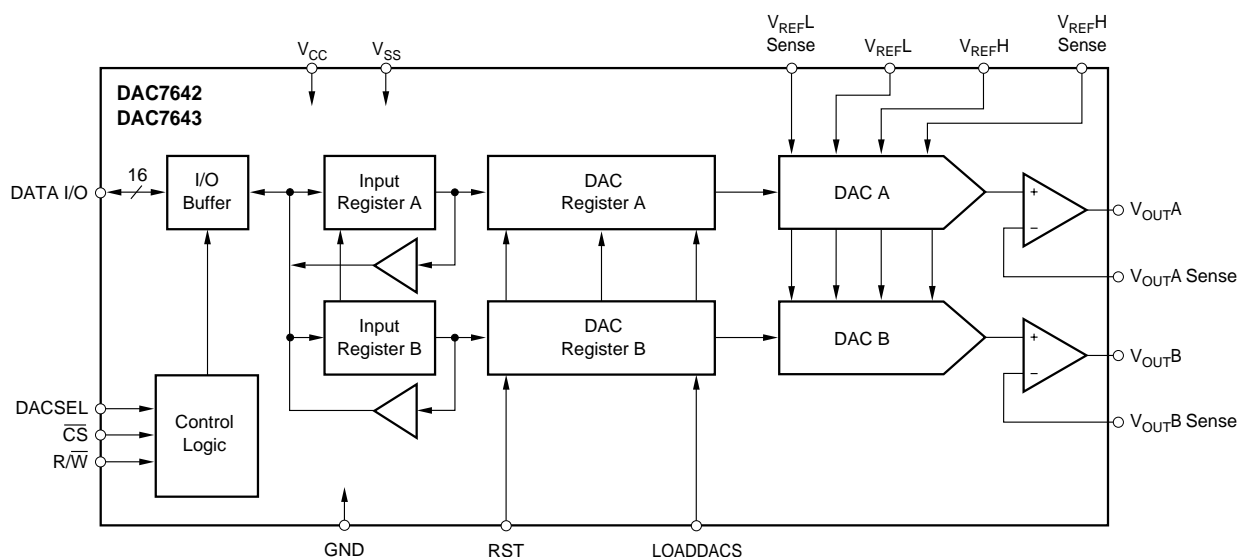
APPLICATIONS

- 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 $+85^{\circ}\text{C}$ 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 | Tape and Reel, 250 |
| " | " | " | " | " | " | DAC7642VFR | Tape and Reel, 1000 |
| DAC7642VFB | 15 Bits | LQFP-32 | VF | –40°C to +85°C | DAC7642B | DAC7642VFBT | Tape and Reel, 250 |
| " | " | " | " | " | " | DAC7642VFB R | Tape and Reel, 1000 |
| DAC7643VF | 14 Bits | LQFP-32 | VF | –40°C to +85°C | DAC7643 | DAC7643VFT | Tape and Reel, 250 |
| " | " | " | " | " | " | DAC7643VFR | Tape and Reel, 1000 |
| DAC7643VFB | 15 Bits | LQFP-32 | VF | –40°C to +85°C | DAC7643B | DAC7643VFBT | Tape and Reel, 250 |
| " | " | " | " | " | " | DAC7643VFB R | 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 | | | | | | | | |
| Linearity Error | | | ±3 | ±4 | | ±2 | ±3 | LSB |
| Linearity Match | | | ±4 | | | ±2 | | LSB |
| Differential Linearity Error | | | ±2 | ±3 | | ±1 | ±2 | LSB |
| Monotonicity, T_{MIN} to T_{MAX} | | 14 | | | 15 | | | Bits |
| Bipolar Zero Error | | | ±1 | ±3 | | * | * | mV |
| Bipolar Zero Error Drift | | | 5 | 10 | | * | * | ppm/°C |
| Full-Scale Error | | | ±1 | ±3 | | * | * | mV |
| Full-Scale Error Drift | | | 5 | 10 | | * | * | ppm/°C |
| Bipolar Zero Matching | Channel-to-Channel Matching | | ±1 | ±3 | | ±1 | ±3 | mV |
| Full-Scale Matching | Channel-to-Channel Matching | | ±1 | ±3 | | ±1 | ±3 | mV |
| Power-Supply Rejection Ratio (PSRR) | At Full-Scale | | 10 | 100 | | * | * | ppm/V |
| ANALOG OUTPUT | | | | | | | | |
| Voltage Output | $R_L = 10k\Omega$ | V_{REFL} -1.25 | | V_{REFH} +1.25 | * | | * | V |
| Output Current | | | | | * | | * | mA |
| Maximum Load Capacitance | No Oscillation | | 500 | | | * | | pF |
| Short-Circuit Current | | | -10, +30 | | | * | | mA |
| Short-Circuit Duration | GND, V_{CC} or V_{SS} | | Indefinite | | | * | | |
| REFERENCE INPUT | | | | | | | | |
| Ref High Input Voltage Range | | $V_{REFL} + 1.25$ -2.5 | | +2.5 $V_{REFH} - 1.25$ | * | | * | V |
| Ref Low Input Voltage Range | | | | | * | | * | V |
| Ref High Input Current | | | 500 | | | * | | μA |
| Ref Low Input Current | | | -500 | | | * | | μA |
| DYNAMIC PERFORMANCE | | | | | | | | |
| Settling Time | To ±0.003%, 5V Output Step | | 8 | 10 | | * | * | μs |
| Channel-to-Channel Crosstalk | See Figure 5 | | 0.5 | | | * | | LSB |
| Digital Feedthrough | | | 2 | | | * | | nV-s |
| Output Noise Voltage | $f = 10kHz$ | | 60 | | | * | | nV/√Hz |
| DAC Glitch | 7FFF _H to 8000 _H or 8000 _H to 7FFF _H | | 40 | | | * | | nV-s |
| DIGITAL INPUT | | | | | | | | |
| V_{IH} | | $0.7 \cdot V_{CC}$ | | | * | | | V |
| V_{IL} | | | | $0.3 \cdot V_{CC}$ | | | * | V |
| I_{IH} | | | | ±10 | | | * | μA |
| I_{IL} | | | | ±10 | | | * | μA |
| DIGITAL OUTPUT | | | | | | | | |
| V_{OH} | $I_{OH} = -0.8mA$ | 3.6 | 4.5 | | * | * | | V |
| V_{OL} | $I_{OL} = 1.2mA$ | | 0.3 | 0.4 | | * | * | V |
| POWER SUPPLY | | | | | | | | |
| V_{CC} | | +4.75 | +5.0 | +5.25 | * | * | * | V |
| V_{SS} | | -5.25 | -5.0 | -4.75 | * | * | * | V |
| I_{CC} | | | 0.7 | 1.1 | | * | * | mA |
| I_{SS} | | -1.2 | -0.8 | | * | * | * | mA |
| Power | | | 7.5 | 11.5 | | * | * | mW |
| TEMPERATURE RANGE | | | | | | | | |
| Specified Performance | | -40 | | +85 | * | | * | °C |

* Specifications same as DAC7642VF and DAC7643VF.

ELECTRICAL CHARACTERISTICS (Single Supply)

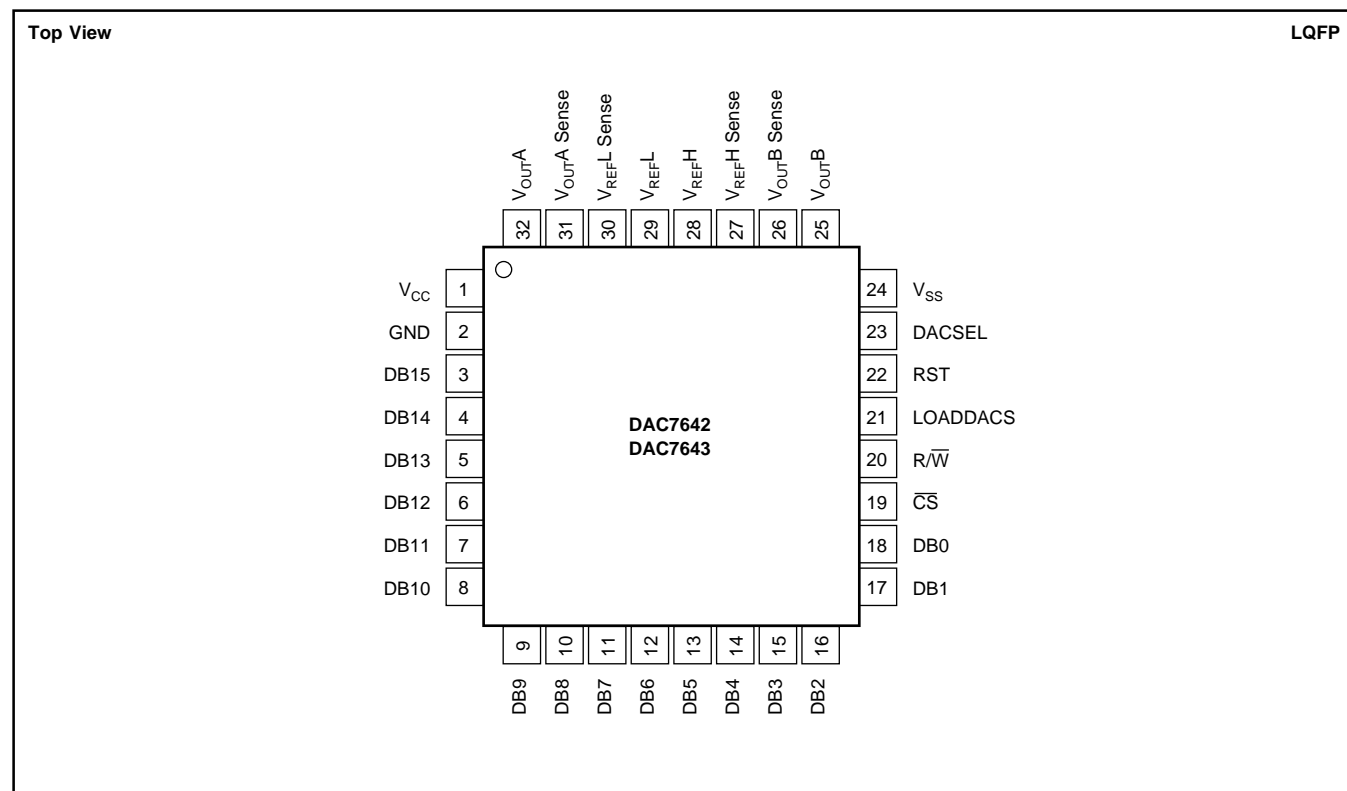
At $T_A = T_{MIN}$ to T_{MAX} , $V_{CC} = +5V$, $V_{SS} = 0V$, $V_{REFH} = +2.5V$, and $V_{REFL} = 0V$, unless otherwise noted.

| PARAMETER | CONDITIONS | DAC7642VF DAC7643VF | | | DAC7642VFB DAC7643VFB | | | UNITS |
|---|---|---|-----|-----|--------------------------|-----|-----|-------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| ACCURACY Linearity Error ⁽¹⁾ Linearity Match Differential Linearity Error Monotonicity, T _{MIN} to T _{MAX} Zero-Scale Error Zero-Scale Error Drift Full-Scale Error Full-Scale Error Drift Zero-Scale Matching Full-Scale Matching Power-Supply Rejection Ratio (PSRR) | Channel-to-Channel Matching Channel-to-Channel Matching At Full-Scale | 14 < | | | | | | |

* 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

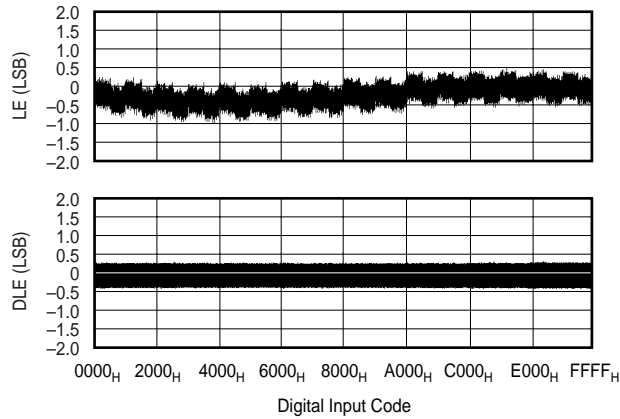
| PIN | NAME | DESCRIPTION | PIN | NAME | DESCRIPTION |
|-----|-----------------|-------------------------|-----|-------------------------|--|
| 1 | V _{CC} | Positive Power Supply | 20 | R/ \overline{W} | Enabled by \overline{CS} , Controls Data Read from and Write to the Input Registers. |
| 2 | GND | 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: $V_{SS} = 0V$

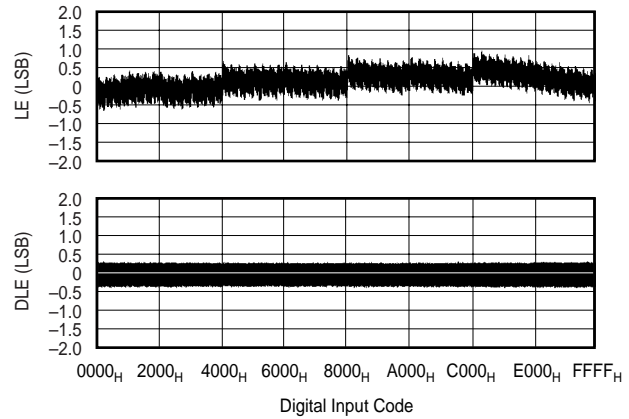
At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = 0V$, $V_{REFH} = +2.5V$, $V_{REFL} = 0V$, representative unit, unless otherwise specified.

+25°C

LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC A, +25°C)

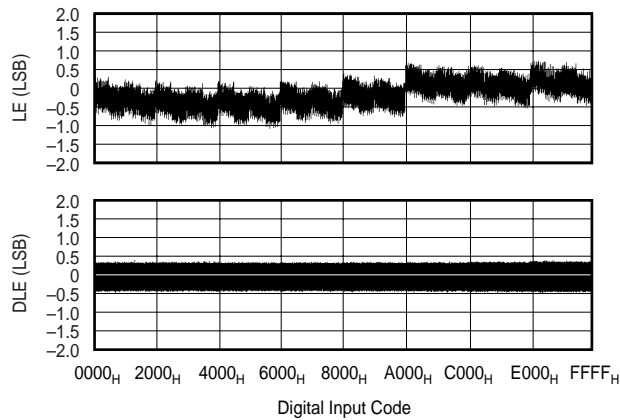


LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC B, +25°C)

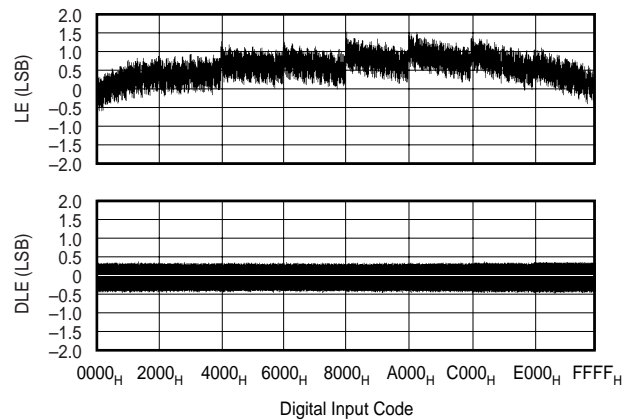


+85°C

LINEARITY ERROR AND
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(DAC A, +85°C)

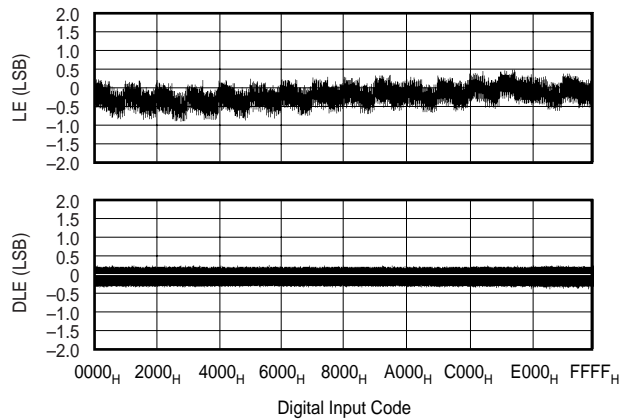


LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC B, +85°C)

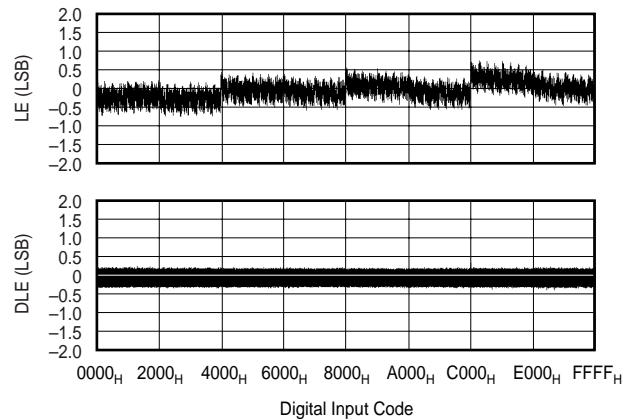


-40°C

LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC A, -40°C)

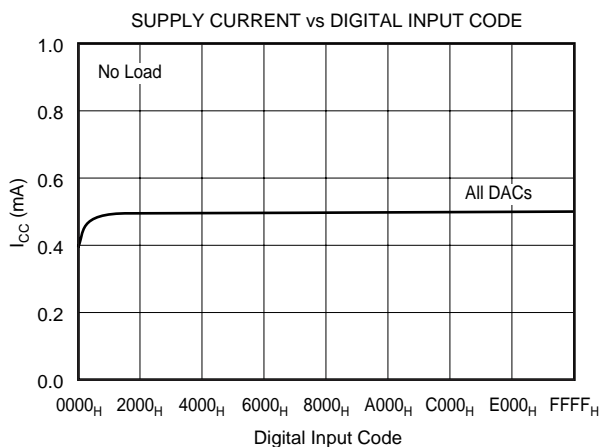
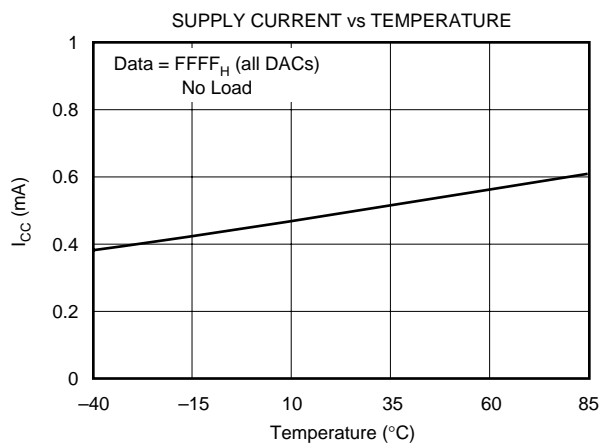
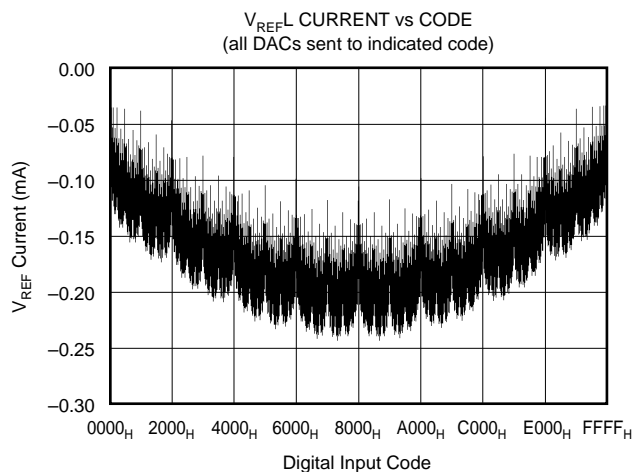
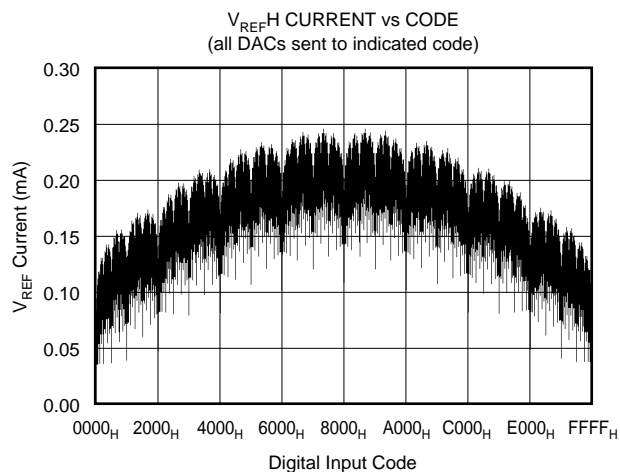
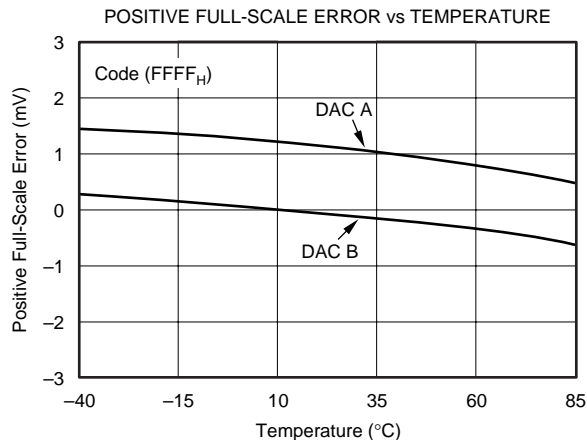
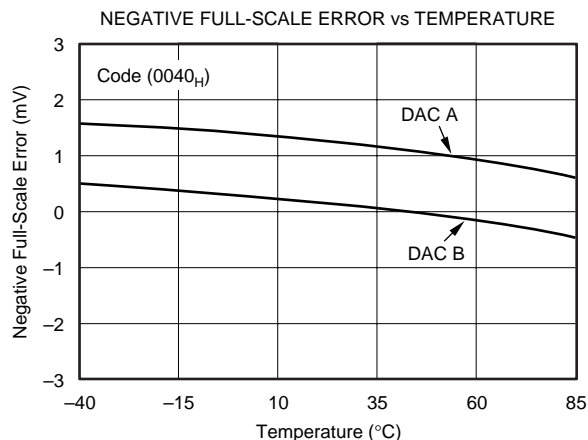


LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC B, -40°C)



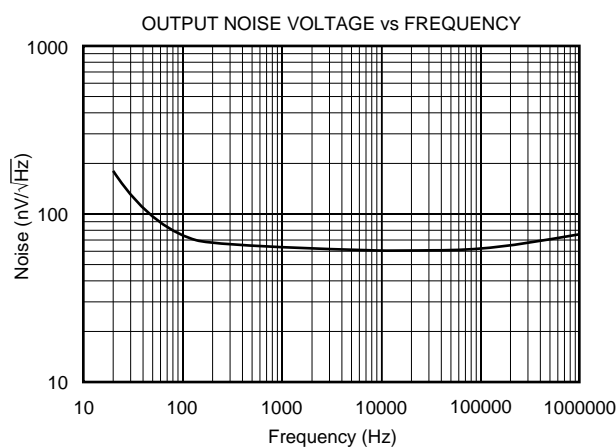
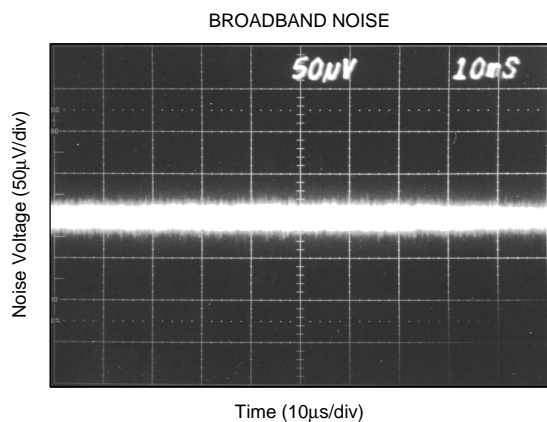
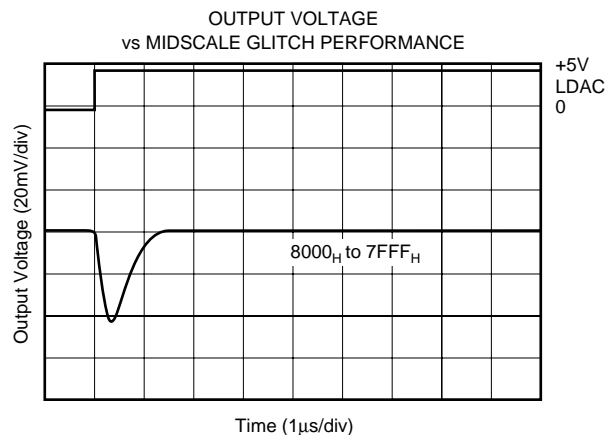
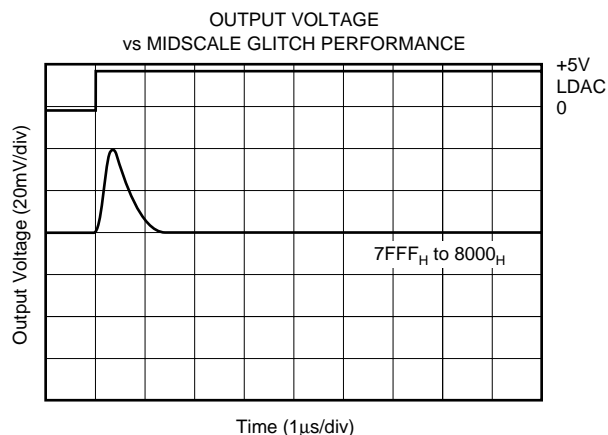
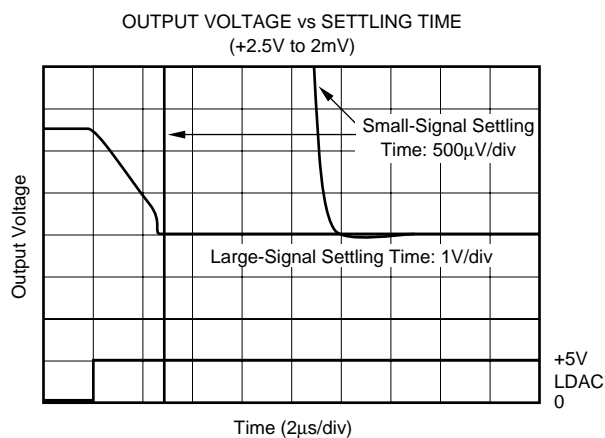
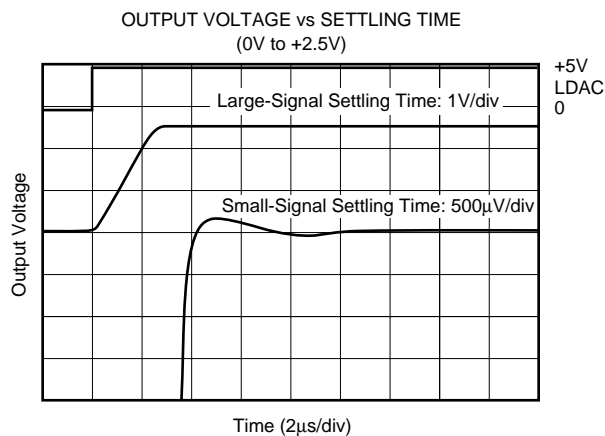
TYPICAL CHARACTERISTICS: $V_{SS} = 0V$ (Cont.)

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



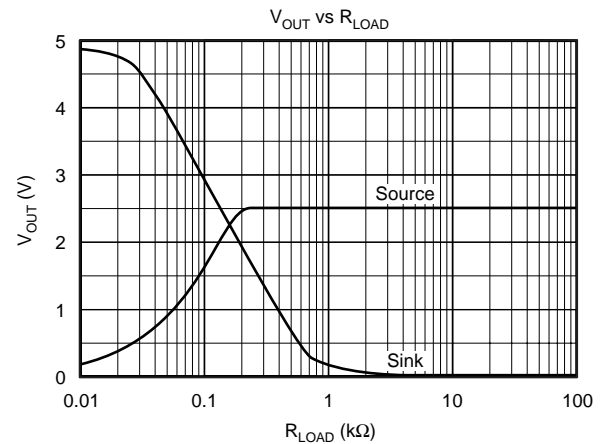
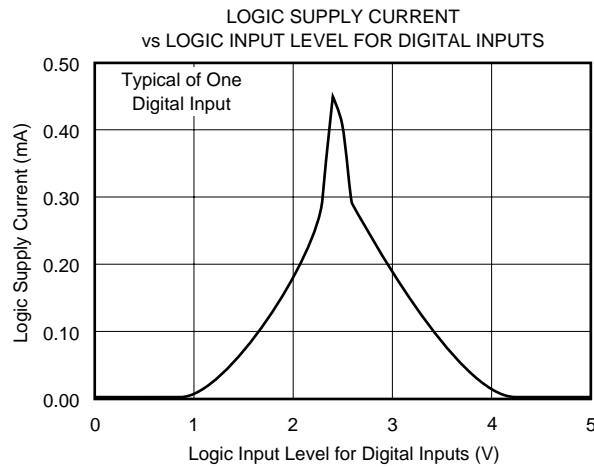
TYPICAL CHARACTERISTICS: $V_{SS} = 0V$ (Cont.)

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



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

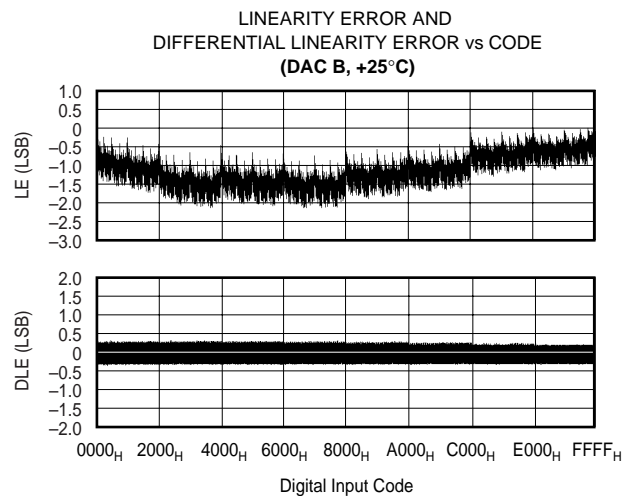
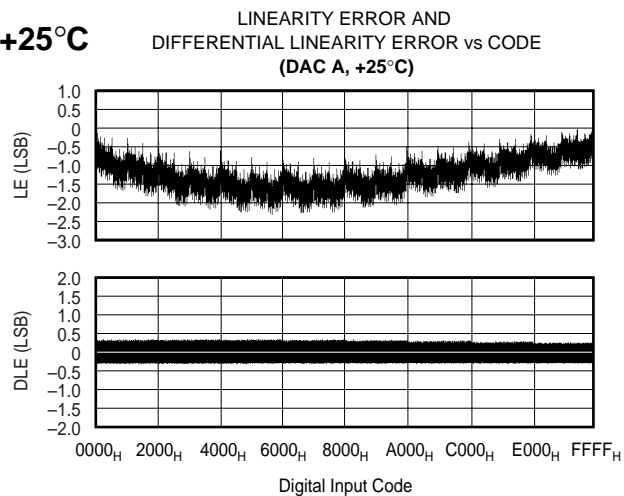
At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = 0V$, $V_{REFH} = +2.5V$, $V_{REFL} = 0V$, representative unit, unless otherwise specified.



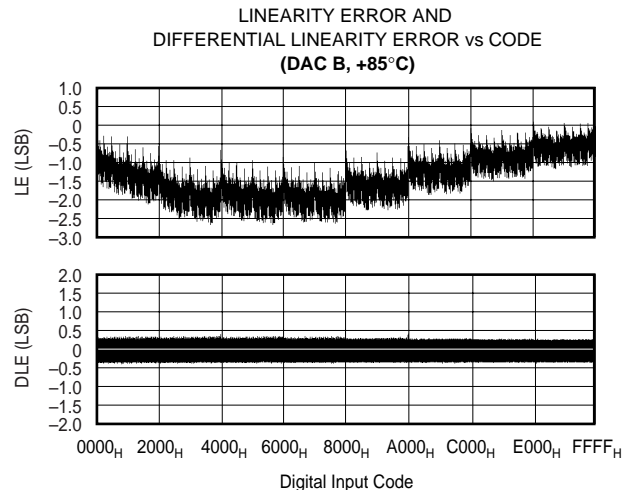
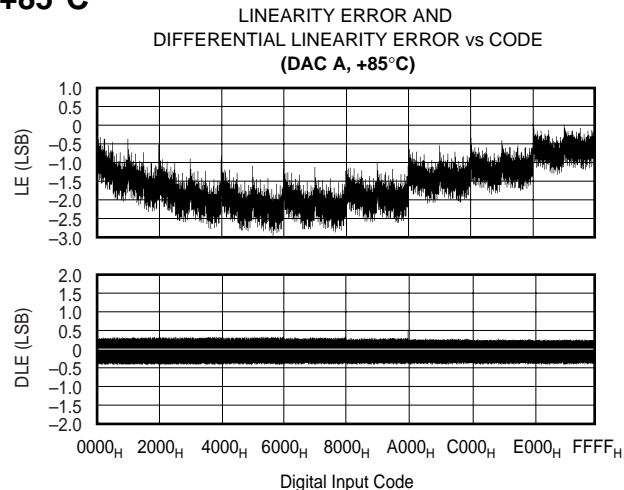
$V_{SS} = -5V$

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.

+25°C



+85°C

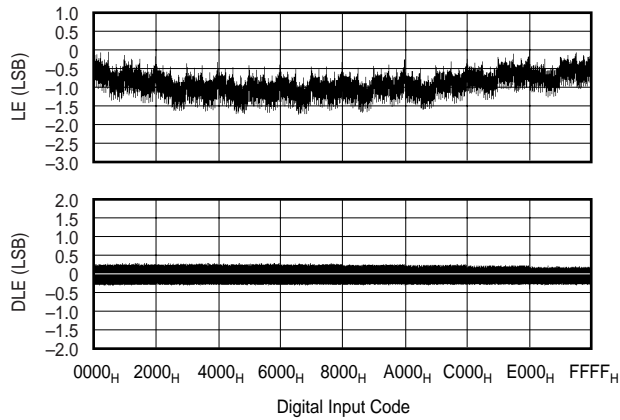


TYPICAL CHARACTERISTICS: $V_{SS} = -5V$ (Cont.)

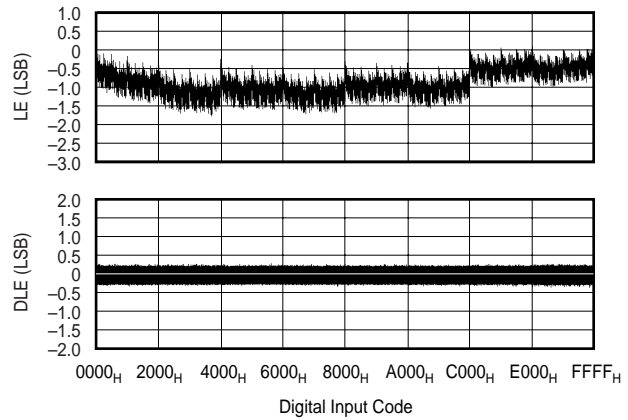
At $T_A = +25^\circ C$, $V_{CC} = +5V$, $V_{SS} = -5V$, $V_{REFH} = +2.5V$, $V_{REFL} = -2.5V$, representative unit, unless otherwise specified.

-40°C

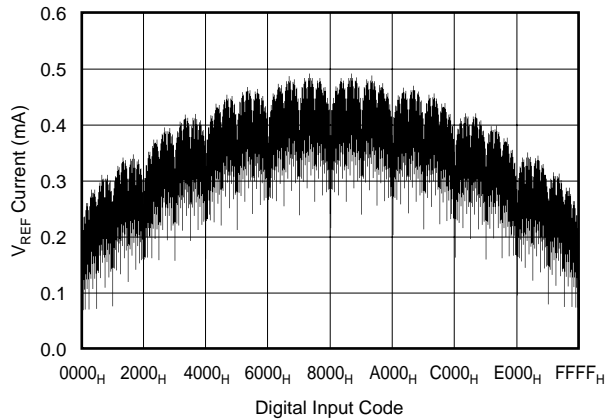
LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC A, -40°C)



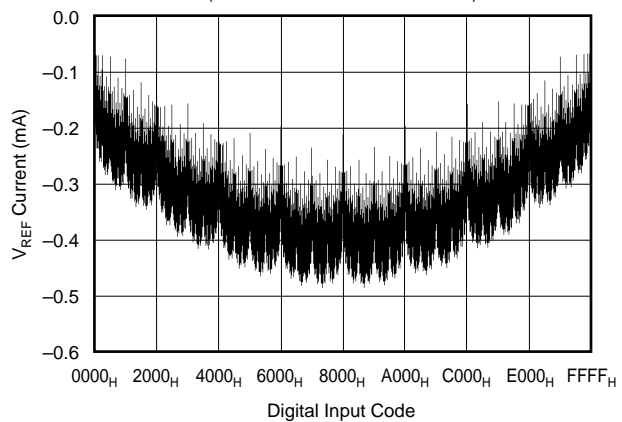
LINEARITY ERROR AND
DIFFERENTIAL LINEARITY ERROR vs CODE
(DAC B, -40°C)



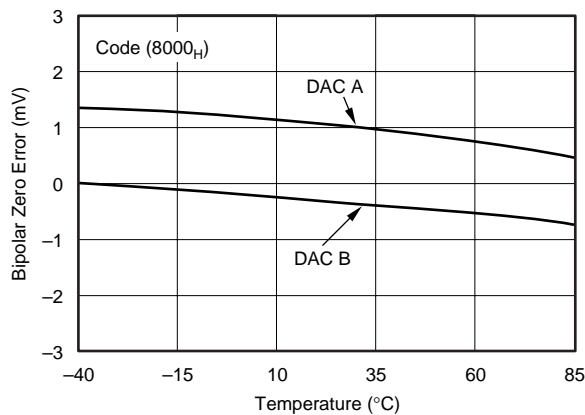
V_{REFH} CURRENT vs CODE
(all DACs sent to indicated code)



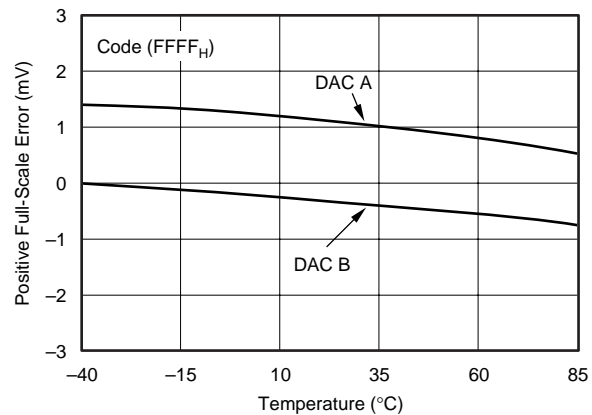
V_{REFL} CURRENT vs CODE
(all DACs sent to indicated code)



BIPOLAR ZERO ERROR vs TEMPERATURE

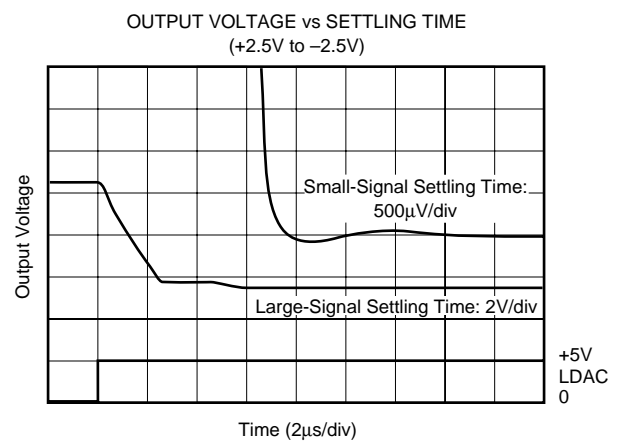
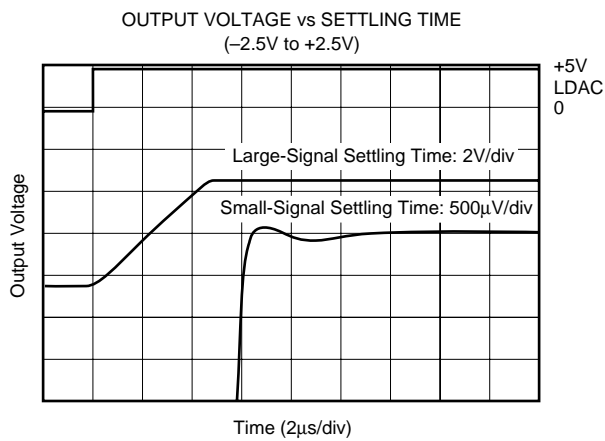
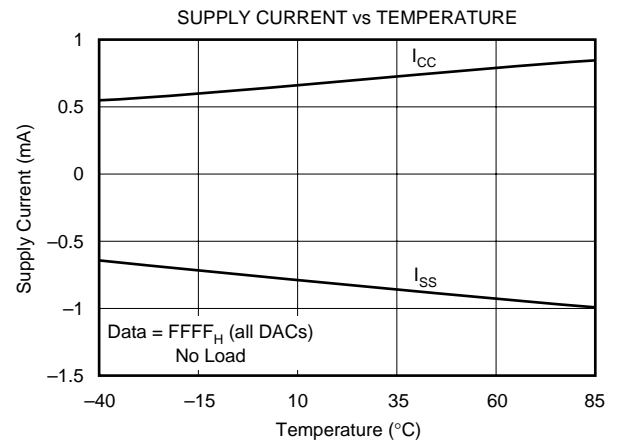
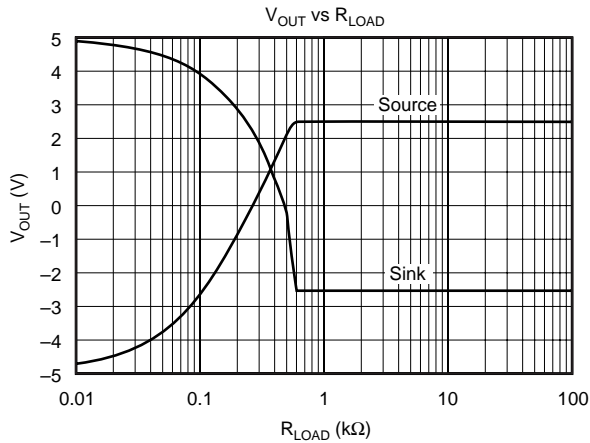
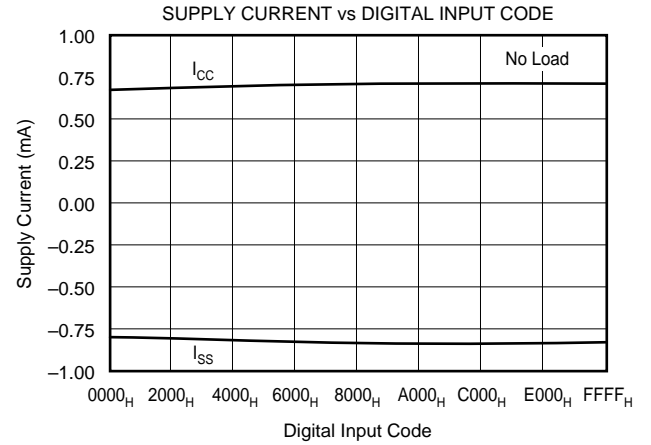
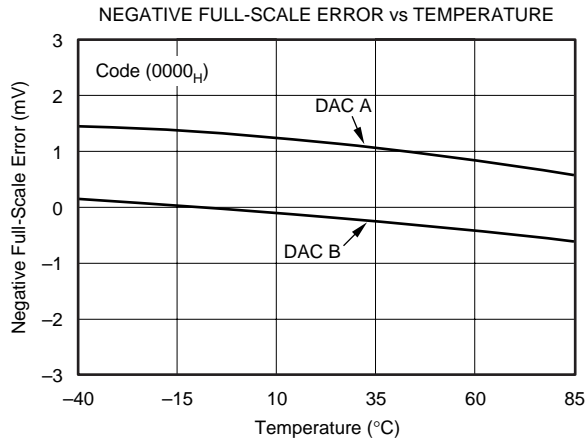


POSITIVE FULL-SCALE ERROR vs TEMPERATURE



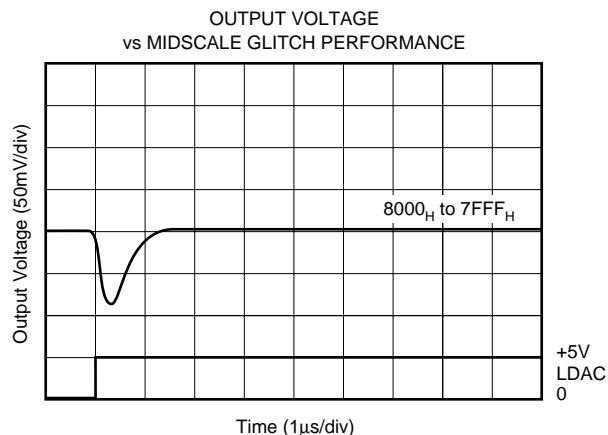
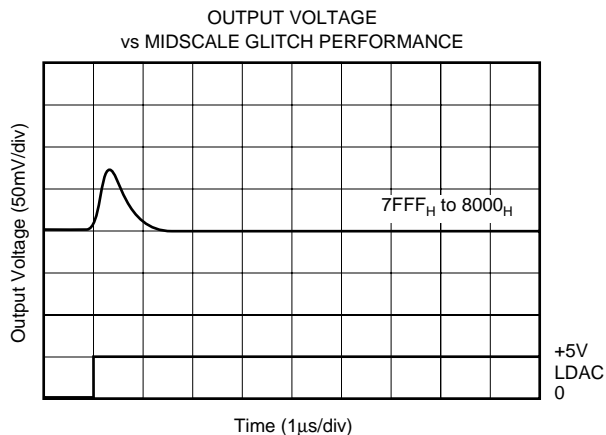
TYPICAL CHARACTERISTICS: $V_{SS} = -5V$ (Cont.)

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.



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.

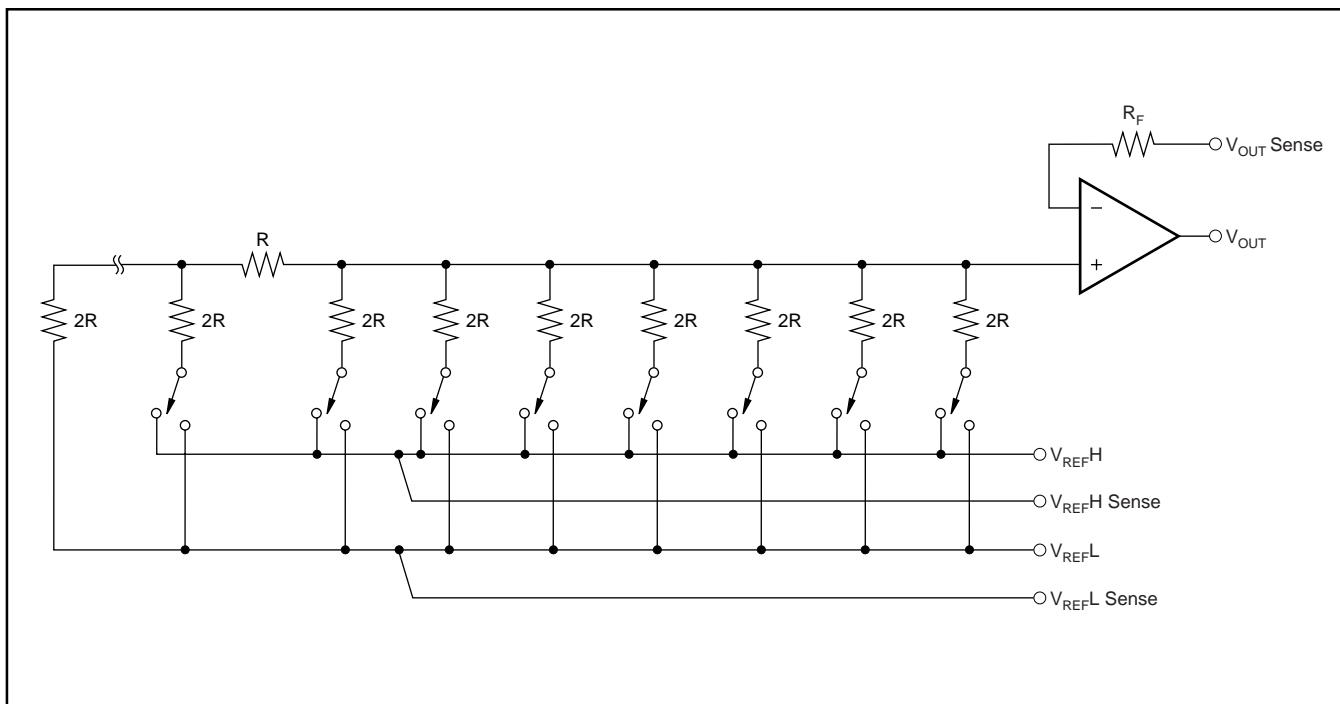


FIGURE 1. DAC7642 and DAC7643 Architecture.

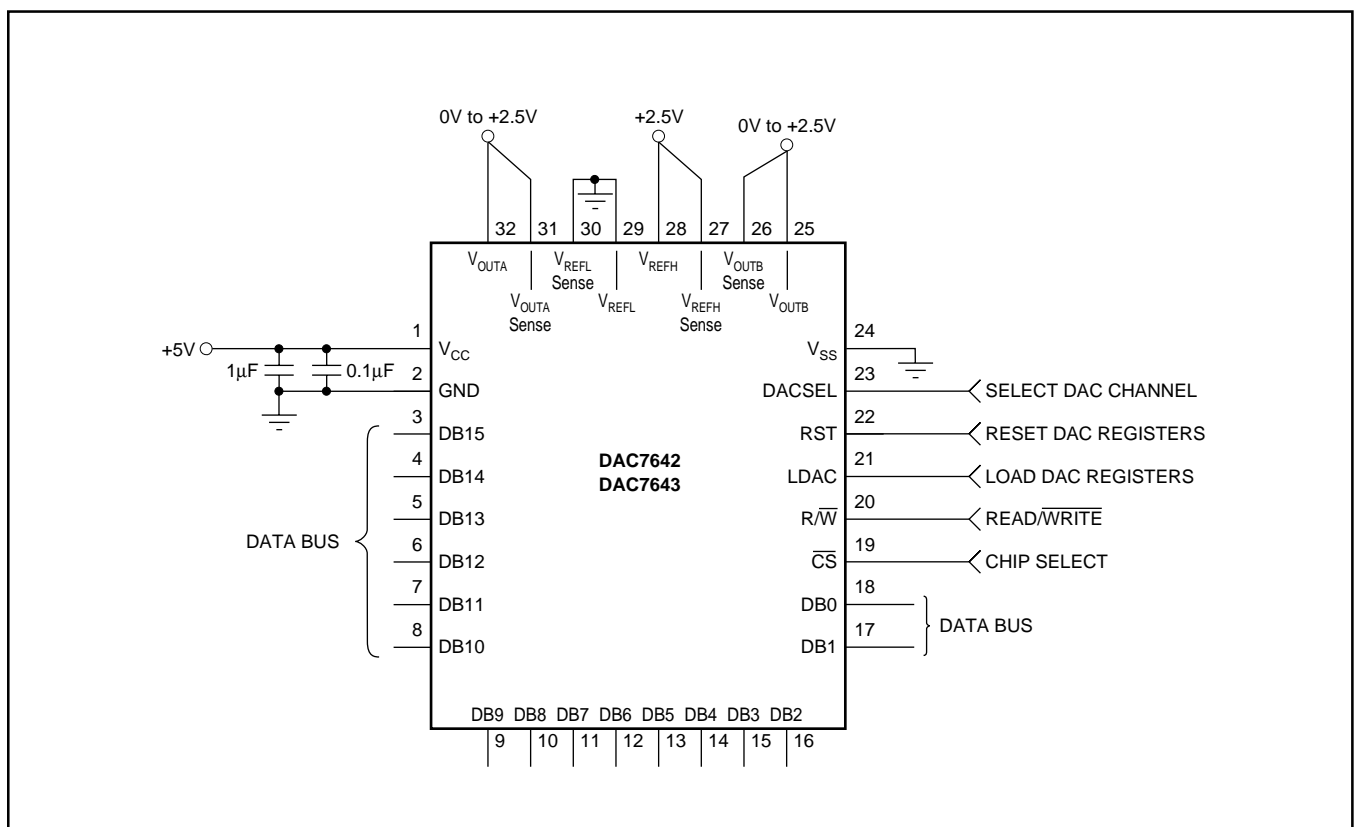


FIGURE 2. Basic Single-Supply Operation of the DAC7642 and DAC7643.

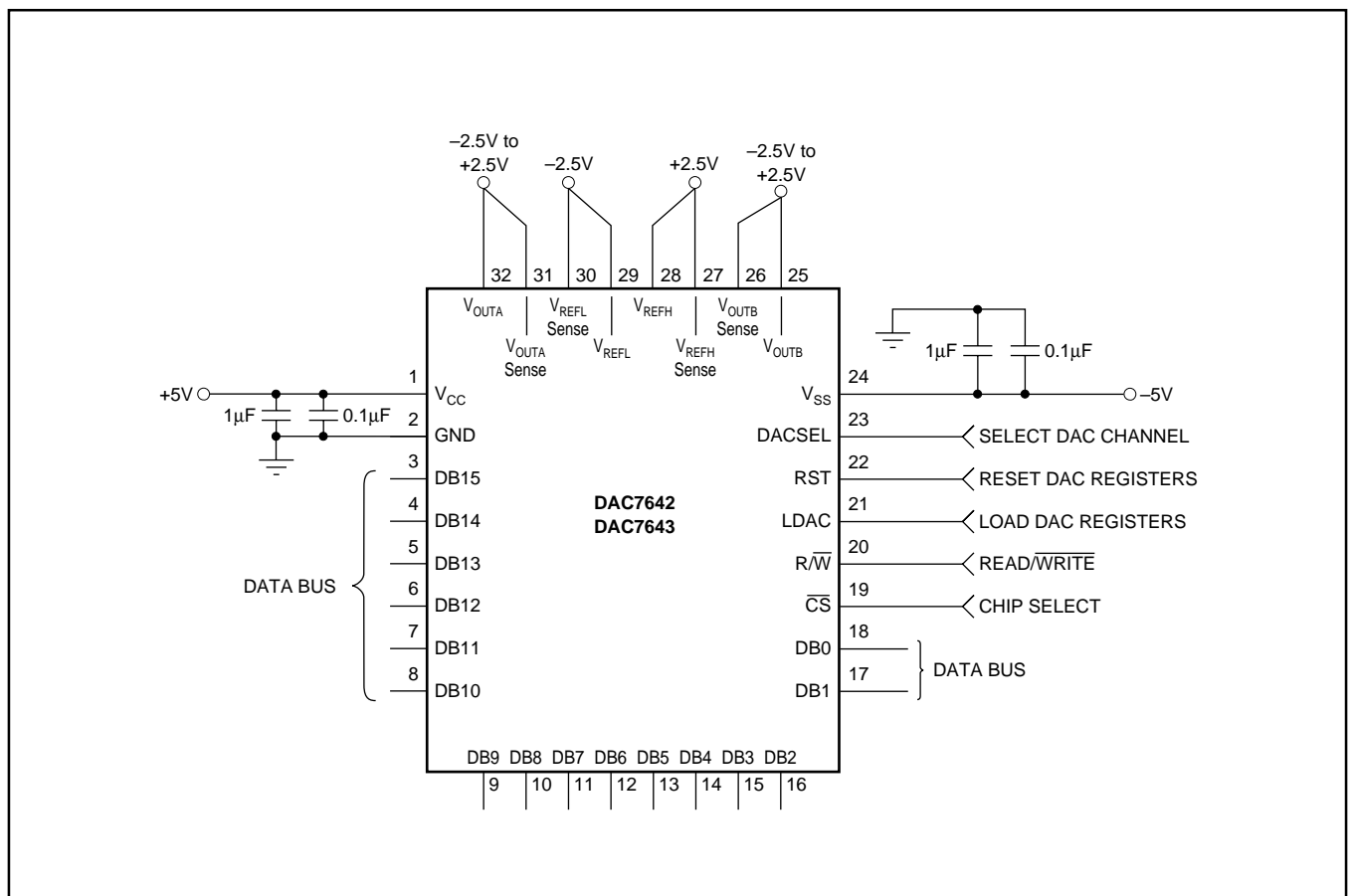


FIGURE 3. Basic Dual-Supply Operation of the DAC7642 and DAC7643.

ANALOG OUTPUTS

When $V_{SS} = -5V$ (dual-supply operation), the output amplifier can swing to within 2.25V of the supply rails over the $-40^{\circ}C$ to $+85^{\circ}C$ 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 $38\mu V$. With a load current of 1mA, a series wiring and connector resistance of only $40m\Omega$ (R_{W2}) will cause a voltage drop of $40\mu V$, 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 $1/2 m\Omega$ 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 $30\mu V$.

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

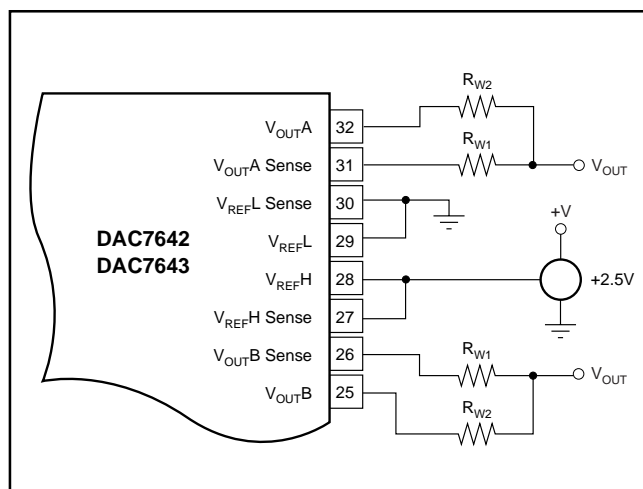


FIGURE 4. Analog Output Closed-Loop Configuration. R_W represents wiring resistances.

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.

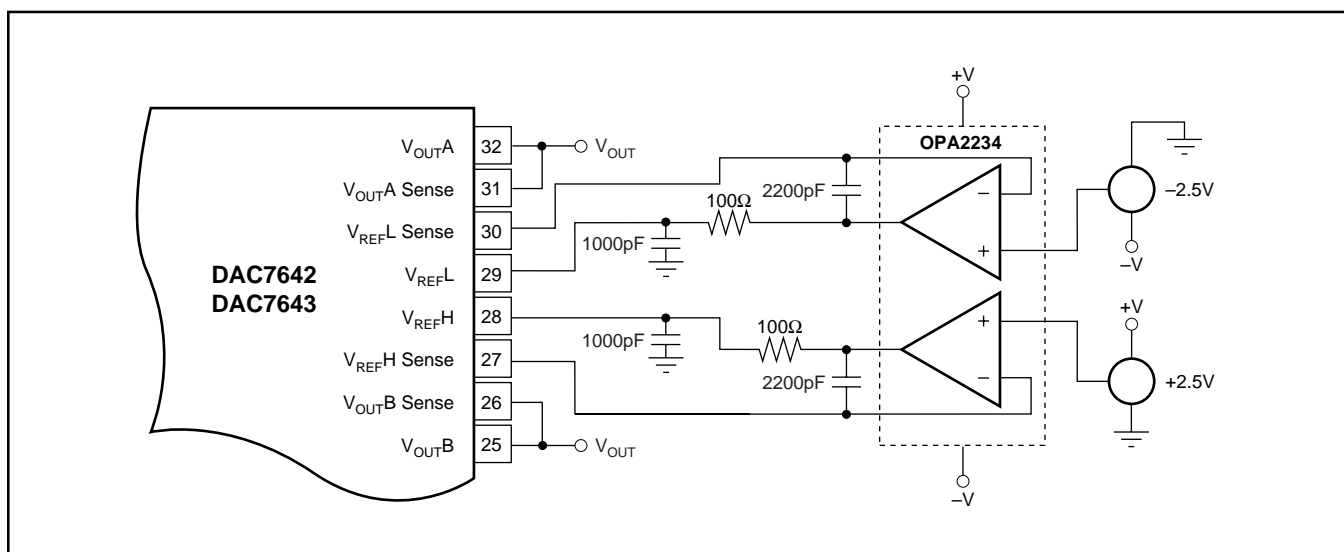


FIGURE 5. Dual Supply Configuration-Buffered References, Used for Dual-Supply Characteristic Curves.

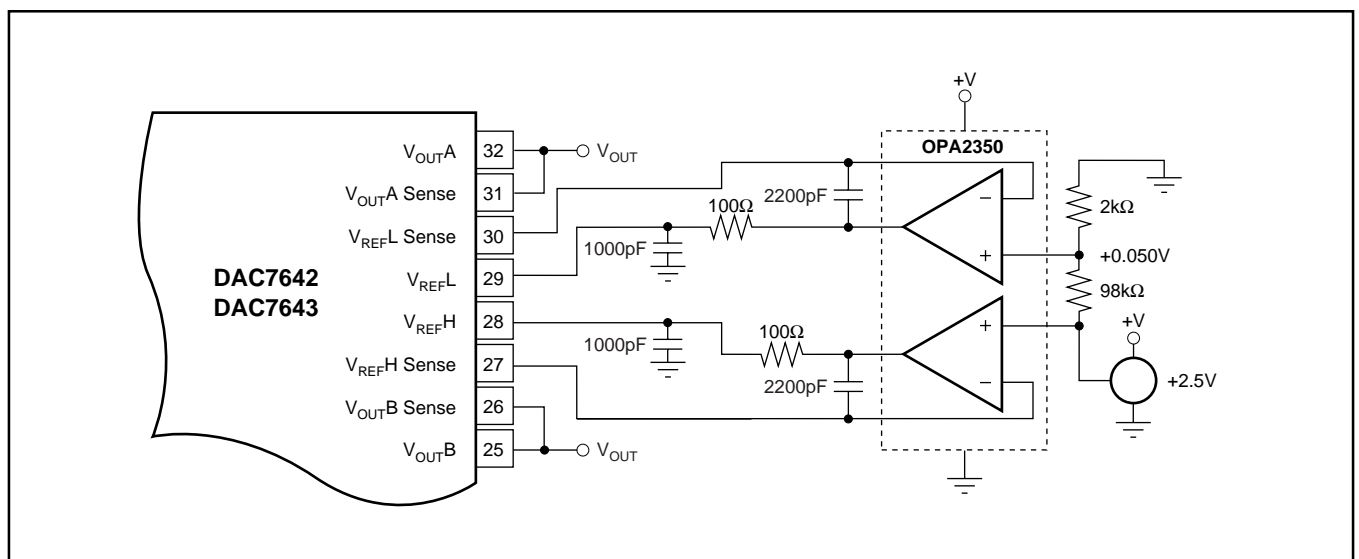


FIGURE 6. Single-Supply Buffered Reference with V_{REFL} of 50mV.

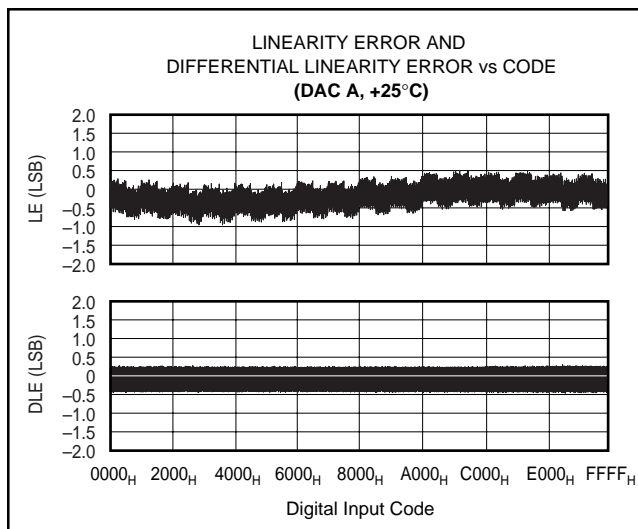


FIGURE 7. Integral Linearity and Differential Linearity Error Curves for Figure 6.

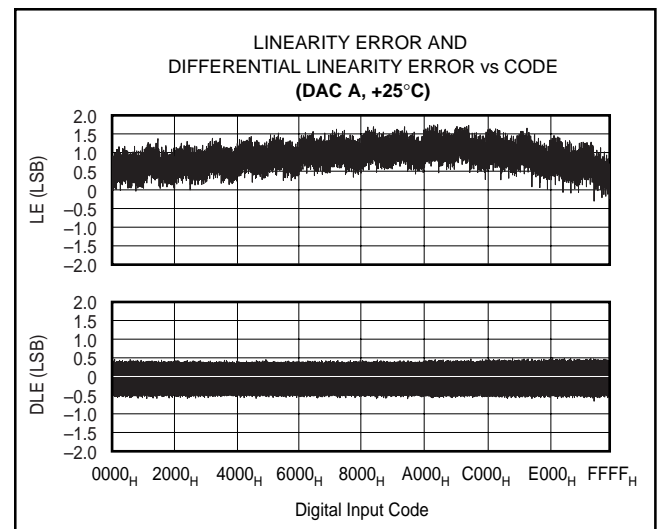


FIGURE 8. Integral Linearity and Differential Linearity Error Curves for Figure 9.

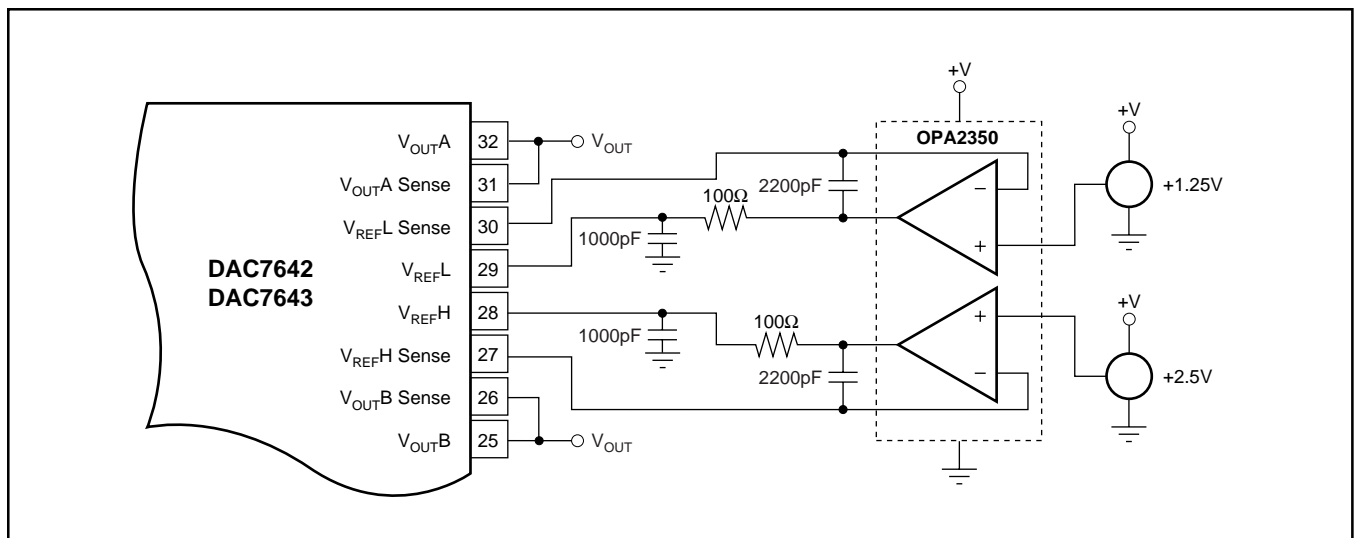


FIGURE 9. Single-Supply Buffered Reference with $V_{REFL} = +1.25V$ and $V_{REFH} = +2.5V$.

| 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 | ↑ | Hold | Write | 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.

$$V_{OUT} = V_{REF}L + \frac{(V_{REF}H - V_{REF}L) \cdot N}{65,536} \quad (1)$$

DIGITAL INPUT CODING

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

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

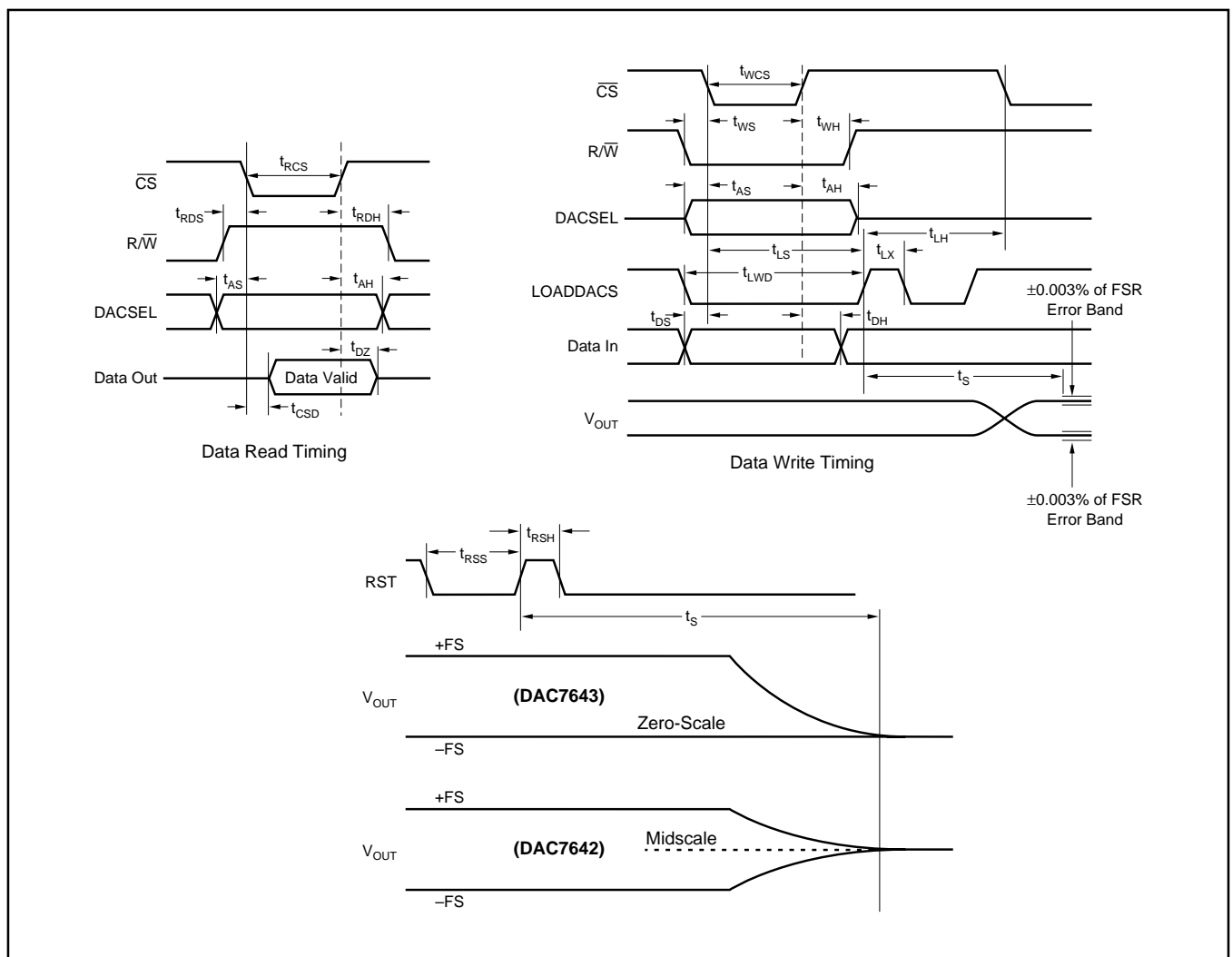


FIGURE 14. Digital Input and Output Timing.

| SYMBOL | DESCRIPTION | MIN | TYP | MAX | UNITS |
|------------------|--|-----|-----|-----|-------|
| t _{RCS} | \overline{CS} LOW for Read | 150 | | | ns |
| t _{RDS} | R/ \overline{W} HIGH to \overline{CS} LOW | 10 | | | ns |
| t _{RDH} | R/ \overline{W} HIGH after \overline{CS} HIGH | 10 | | | ns |
| t _{DZ} | \overline{CS} HIGH to Data Bus in High Impedance | 10 | | | ns |
| t _{CSD} | \overline{CS} LOW to Data Bus Valid | | 100 | 100 | ns |
| t _{WCS} | \overline{CS} LOW for Write | 40 | | 150 | ns |
| t _{WS} | R/ \overline{W} LOW to \overline{CS} LOW | 0 | | | ns |
| t _{WH} | R/ \overline{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 \overline{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 | μs |

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:

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

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

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

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 ($0.5V/125\Omega$).

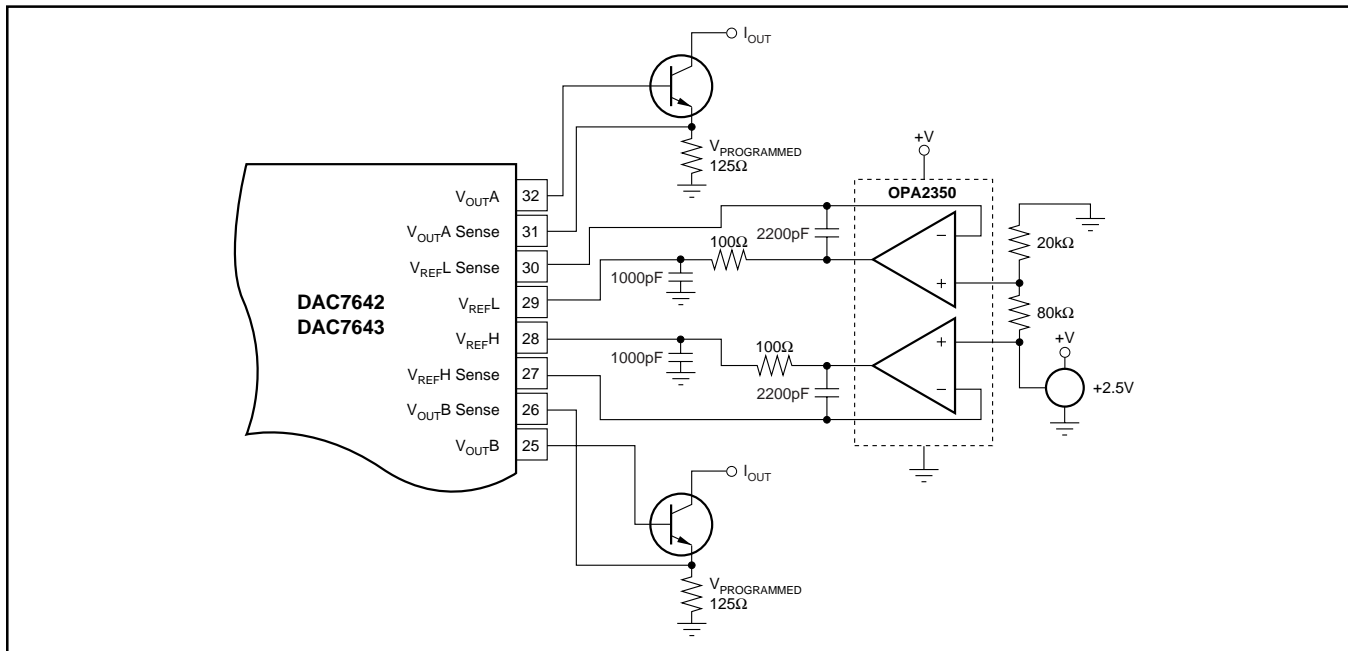
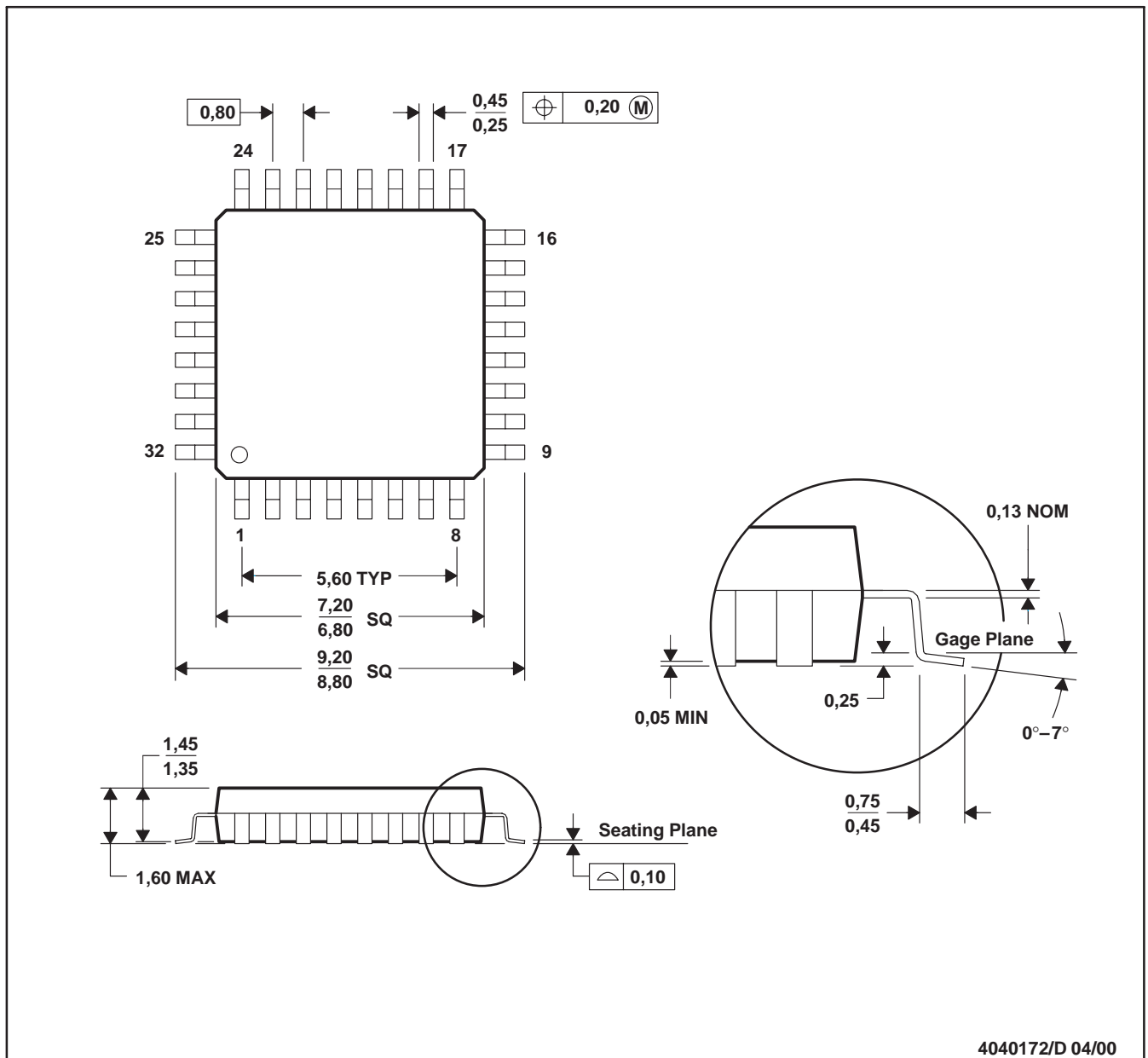


FIGURE 15. 4-20mA Digitally Controlled Current Source.

VF (S-PQFP-G32)

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

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| DAC7642VFBT | ACTIVE | LQFP | VF | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| DAC7642VFBTG4 | ACTIVE | LQFP | VF | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| DAC7642VFT | ACTIVE | LQFP | VF | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| DAC7642VFTG4 | ACTIVE | LQFP | VF | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| DAC7643VFBR | ACTIVE | LQFP | VF | 32 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| DAC7643VFBRG4 | ACTIVE | LQFP | VF | 32 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DAC7642VFBT | LQFP | VF | 32 | 250 | 177.8 | 16.4 | 9.6 | 9.6 | 1.9 | 12.0 | 16.0 | Q2 |
| DAC7642VFT | LQFP | VF | 32 | 250 | 177.8 | 16.4 | 9.6 | 9.6 | 1.9 | 12.0 | 16.0 | Q2 |
| DAC7643VFBR | LQFP | VF | 32 | 1000 | 330.0 | 16.8 | 9.6 | 9.6 | 1.9 | 12.0 | 16.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS

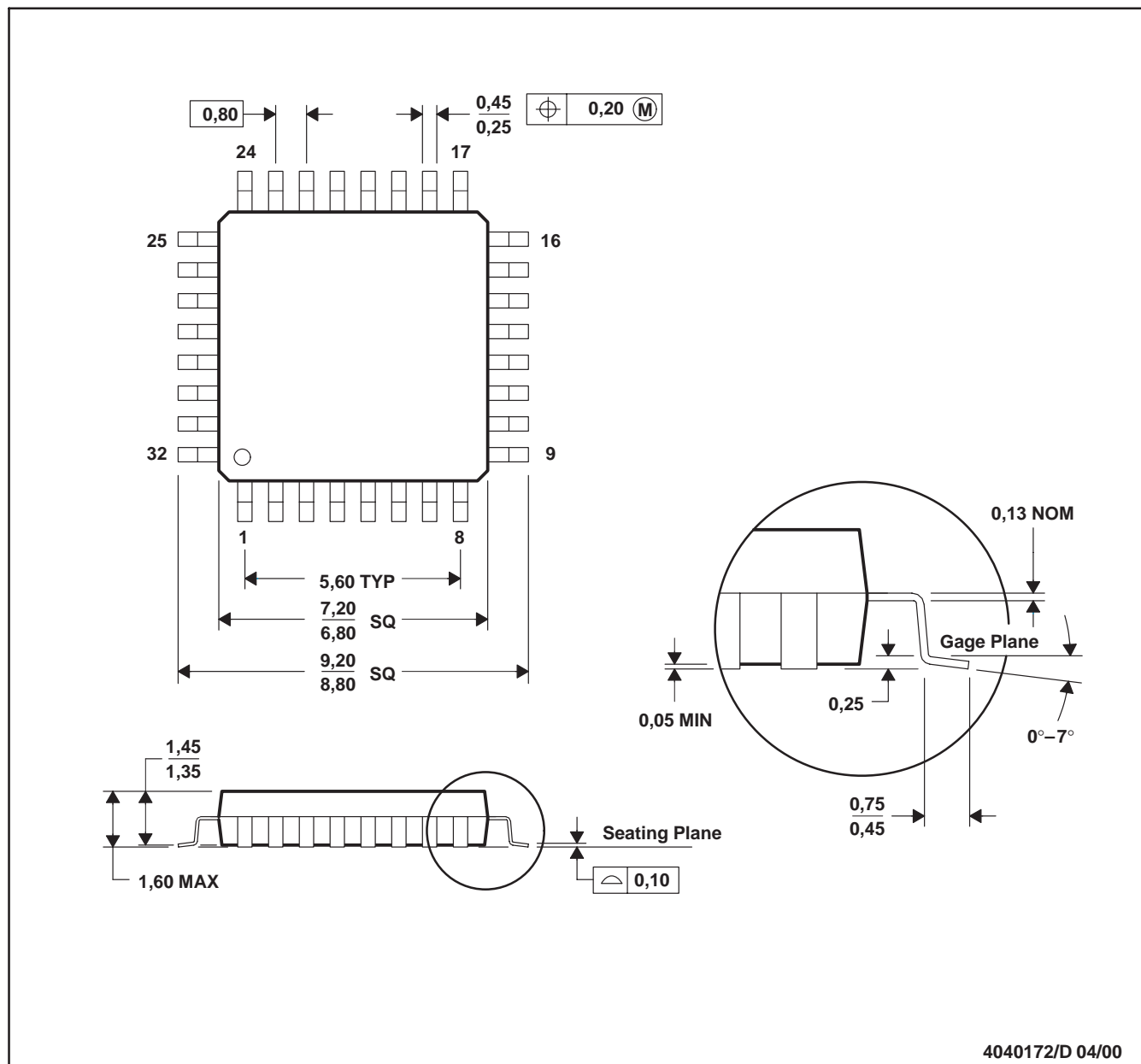


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DAC7642VFBT | LQFP | VF | 32 | 250 | 190.5 | 212.7 | 31.8 |
| DAC7642VFT | LQFP | VF | 32 | 250 | 190.5 | 212.7 | 31.8 |
| DAC7643VFBR | LQFP | VF | 32 | 1000 | 346.0 | 346.0 | 33.0 |

VF (S-PQFP-G32)

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