



## 16-Bit, Serial Input Multiplying Digital-to-Analog Converter

### FEATURES

- $\pm 0.5$  LSB DNL
- 16-Bit Monotonic
- $\pm 1$  LSB INL
- **Low Noise:** 12 nV/ $\sqrt{\text{Hz}}$
- **Low Power:**  $I_{\text{DD}} = 2 \mu\text{A}$
- **+2.7 V to +5.5 V Analog Power Supply**
- **2 mA Full-Scale Current  $\pm 20\%$ ,** with  $V_{\text{REF}} = 10 \text{ V}$
- **50-MHz Serial Interface**
- **0.5  $\mu\text{s}$  Settling Time**
- **4-Quadrant Multiplying Reference**
- **Reference Bandwidth: 10 MHz**
- **$\pm 10 \text{ V}$  Reference Input**
- **Reference Dynamics: -105 THD**
- **Tiny 8-Lead 3 x 3 mm SON and 3 x 5 mm MSOP Packages**
- **Industry-Standard Pin Configuration**

### APPLICATIONS

- **Automatic Test Equipment**
- **Instrumentation**
- **Digitally Controlled Calibration**
- **Industrial Control PLCs**

### DESCRIPTION

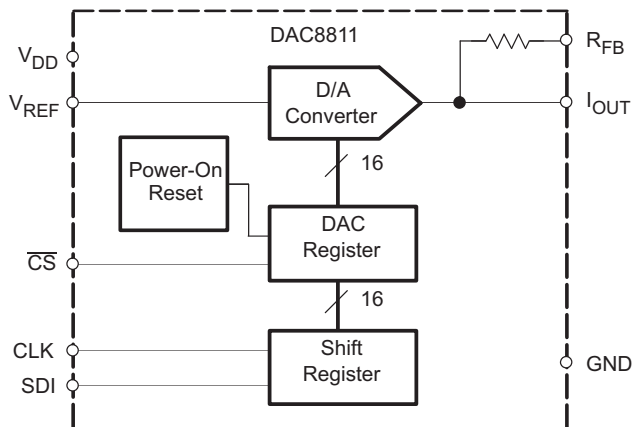
The DAC8811 multiplying digital-to-analog converter (DAC) is designed to operate from a single 2.7-V to 5.5-V supply.

The applied external reference input voltage  $V_{\text{REF}}$  determines the full-scale output current. An internal feedback resistor ( $R_{\text{FB}}$ ) provides temperature tracking for the full-scale output when combined with an external I-to-V precision amplifier.

A serial data interface offers high-speed, three-wire microcontroller-compatible inputs using data-in (SDI), clock (CLK), and chip-select ( $\overline{\text{CS}}$ ).

On power-up, the DAC register is filled with zeroes, and the DAC output is at zero scale.

The DAC8811 is packaged in space-saving 8-lead SON and MSOP packages.



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.



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<sup>(1)</sup>**

| PRODUCT  | MINIMUM RELATIVE ACCURACY (LSB) | DIFFERENTIAL NONLINEARITY (LSB) | PACKAGE-LEAD (DESIGNATOR) | SPECIFIED TEMPERATURE RANGE | PACKAGE MARKING | ORDERING NUMBER | TRANSPORT MEDIA, QUANTITY |
|----------|---------------------------------|---------------------------------|---------------------------|-----------------------------|-----------------|-----------------|---------------------------|
| DAC8811C | ±1                              | ±1                              | MSOP-8 (DGK)              | -40°C to 85°C               | D11             | DAC8811ICDGKT   | Tape and Reel, 250        |
| DAC8811C | ±1                              | ±1                              | MSOP-8 (DGK)              | -40°C to 85°C               | D11             | DAC8811ICDGKR   | Tape and Reel, 2500       |
| DAC8811C | ±1                              | ±1                              | SON-8 (DRB)               | -40°C to 85°C               | D11             | DAC8811ICDRBT   | Tape and Reel, 250        |
| DAC8811C | ±1                              | ±1                              | SON-8 (DRB)               | -40°C to 85°C               | D11             | DAC8811ICDRBR   | Tape and Reel, 2500       |
| DAC8811B | ±2                              | ±1                              | MSOP-8 (DGK)              | -40°C to 85°C               | D11             | DAC8811IBDGKT   | Tape and Reel, 250        |
| DAC8811B | ±2                              | ±1                              | MSOP-8 (DGK)              | -40°C to 85°C               | D11             | DAC8811IBDGKR   | Tape and Reel, 2500       |
| DAC8811B | ±2                              | ±1                              | SON-8 (DRB)               | -40°C to 85°C               | D11             | DAC8811IBDRBT   | Tape and Reel, 250        |
| DAC8811B | ±2                              | ±1                              | SON-8 (DRB)               | -40°C to 85°C               | D11             | DAC8811IBDRBR   | Tape and Reel, 2500       |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI Web site at [www.ti.com](http://www.ti.com).

**ABSOLUTE MAXIMUM RATINGS**

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|   | DAC8811   | UNIT |
|---|---|------|
| V <sub>DD</sub> to GND                          | -0.3 to 7   | V    |
| Digital input voltage to GND                    | -0.3 to +V <sub>DD</sub> + 0.3                            | V    |
| V (I <sub>OUT</sub> ) to GND                    | -0.3 to +V <sub>DD</sub> + 0.3                            | V    |
| Operating temperature range                     | -40 to 105  | °C   |
| V <sub>REF</sub> , R <sub>FB</sub> to GND       | -25 to 25   | V    |
| Storage temperature range                       | -65 to 150  | °C   |
| Junction temperature range (T <sub>J</sub> max) | 125   | °C   |
| Power dissipation                               | (T <sub>J</sub> max - T <sub>A</sub> ) / R <sub>θJA</sub> | W    |
| Thermal impedance, R <sub>θJA</sub>             | 55  | °C/W |
| Lead temperature, soldering                     | Vapor phase (60s)   | 215  |
| Lead temperature, soldering                     | Infrared (15s)  | 220  |
| ESD rating, HBM                                 | 4000  | V    |
| ESD rating, CDM                                 | 1000  | V    |

(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.

**ELECTRICAL CHARACTERISTICS**

$V_{DD} = 2.7\text{ V to }5.5\text{ V}$ ;  $I_{OUT} = \text{Virtual GND}$ ,  $GND = 0\text{ V}$ ;  $V_{REF} = 10\text{ V}$ ;  $T_A = \text{full operating temperature}$ . All specifications  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ , unless otherwise noted.

| PARAMETER                                    | CONDITIONS                                  | DAC8811  |         |     | UNITS                 |
|--|---|--|---------|-----|-----------------------|
|  |   | MIN  | TYP     | MAX |                       |
| <b>STATIC PERFORMANCE</b>                    |   |  |         |     |                       |
| Resolution                                   |   | 16   |         |     | Bits                  |
| Relative accuracy                            | DAC8811C                                    |  |         |     | $\pm 1$ LSB           |
| Relative accuracy                            | DAC8811B                                    |  |         |     | $\pm 2$ LSB           |
| Differential nonlinearity                    |   | $\pm 0.5$  | $\pm 1$ |     | LSB                   |
| Output leakage current                       | Data = 0000h, $T_A = 25^\circ\text{C}$      |  |         |     | 10 nA                 |
| Output leakage current                       | Data = 0000h, $T_A = T_{MAX}$               |  |         |     | 10 nA                 |
| Full-scale gain error                        | All ones loaded to DAC register             | $\pm 1$  | $\pm 4$ |     | mV                    |
| Full-scale tempco                            |   | $\pm 3$  |         |     | ppm/ $^\circ\text{C}$ |
| <b>OUTPUT CHARACTERISTICS<sup>(1)</sup></b>  |   |  |         |     |                       |
| Output current                               |   | 2  |         |     | mA                    |
| Output capacitance                           | Code dependent                              | 50   |         |     | pF                    |
| <b>REFERENCE INPUT<sup>(1)</sup></b>         |   |  |         |     |                       |
| $V_{REF}$ Range                              |   | -15  |         | 15  | V                     |
| Input resistance                             |   | 5  |         |     | k $\Omega$            |
| Input capacitance                            |   | 5  |         |     | pF                    |
| <b>LOGIC INPUTS AND OUTPUT<sup>(1)</sup></b> |   |  |         |     |                       |
| $V_{IL}$                                     | Input low voltage                           | $V_{DD} = 2.7\text{V}$   |         |     | 0.6 V                 |
|  |   | $V_{DD} = 5\text{V}$   |         |     | 0.8 V                 |
| $V_{IH}$                                     | Input high voltage                          | $V_{DD} = 2.7\text{V}$   | 2.1     |     | V                     |
|  |   | $V_{DD} = 5\text{V}$   | 2.4     |     | V                     |
| $I_{IL}$                                     | Input leakage current                       |  |         |     | 10 $\mu\text{A}$      |
| $C_{IL}$                                     | Input capacitance                           |  |         |     | 10 pF                 |
| <b>INTERFACE TIMING</b>                      |   |  |         |     |                       |
| $f_{CLK}$                                    | Clock input frequency                       |  |         |     | 50 MHz                |
| $t_{(CH)}$                                   | Clock pulse width high                      | 10   |         |     | ns                    |
| $t_{(CL)}$                                   | Clock pulse width low                       | 10   |         |     | ns                    |
| $t_{(CSS)}$                                  | $\overline{CS}$ to Clock setup time         | 0  |         |     | ns                    |
| $t_{(CSH)}$                                  | Clock to $\overline{CS}$ hold time          | 10   |         |     | ns                    |
| $t_{(DS)}$                                   | Data setup time                             | 5  |         |     | ns                    |
| $t_{(DH)}$                                   | Data hold time                              | 10   |         |     | ns                    |
| <b>POWER REQUIREMENTS</b>                    |   |  |         |     |                       |
| $V_{DD}$                                     |   | 2.7  |         | 5.5 | V                     |
| $I_{DD}$ (normal operation)                  | Logic inputs = 0 V                          |  |         |     | 5 $\mu\text{A}$       |
| $V_{DD} = 4.5\text{ V to }5.5\text{ V}$      | $V_{IH} = V_{DD}$ and $V_{IL} = \text{GND}$ | 3  |         | 5   | $\mu\text{A}$         |
| $V_{DD} = 2.7\text{ V to }3.6\text{ V}$      | $V_{IH} = V_{DD}$ and $V_{IL} = \text{GND}$ | 1  |         | 2.5 | $\mu\text{A}$         |
| <b>AC CHARACTERISTICS<sup>(1)(2)</sup></b>   |   |  |         |     |                       |
| $t_s$  | Output voltage settling time                | To $\pm 0.1\%$ of full-scale, Data = 0000h to FFFFh to 0000h           |         |     | 0.3                   |
|  |   | To $\pm 0.0015\%$ of full-scale, Data = 0000h to FFFFh to 0000h        |         |     | 0.5                   |
| BW -3 dB                                     | Reference multiplying BW                    | $V_{REF} = 5\text{ V}_{PP}$ , Data = FFFFh                             |         |     | 10 MHz                |
|  | DAC glitch impulse                          | $V_{REF} = 0\text{ V to }10\text{ V}$ , Data = 7FFFh to 8000h to 7FFFh |         |     | 2 nV/s                |
|  | Feedthrough error $V_{OUT}/V_{REF}$         | Data = 0000h, $V_{REF} = 100\text{ mV}_{RMS}$ , $f = 100\text{ kHz}$   |         |     | -70 dB                |

(1) Specified by design and characterization; not production tested.

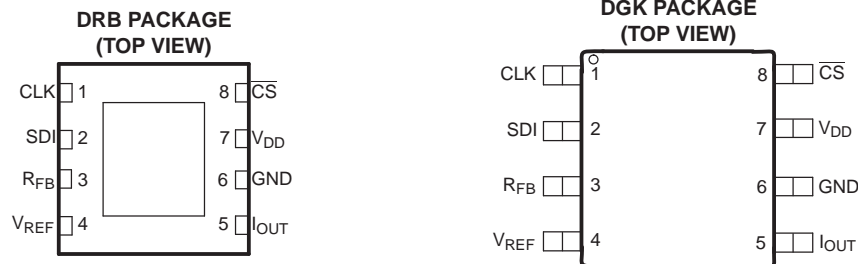
(2) All ac characteristic tests are performed in a closed-loop system using the THS4011 I-to-V converter amplifier.

**ELECTRICAL CHARACTERISTICS (continued)**

$V_{DD} = 2.7\text{ V to }5.5\text{ V}$ ;  $I_{OUT} = \text{Virtual GND}$ ,  $GND = 0\text{ V}$ ;  $V_{REF} = 10\text{ V}$ ;  $T_A = \text{full operating temperature}$ . All specifications  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ , unless otherwise noted.

| PARAMETER                 | CONDITIONS   | DAC8811 |      |     | UNITS                        |
|---------------------------|--|---------|------|-----|------------------------------|
|                           |  | MIN     | TYP  | MAX |                              |
| Digital feedthrough       | $\overline{CS} = 1$ and $f_{CLK} = 1\text{ MHz}$               |         | 2    |     | nV/s                         |
| Total harmonic distortion | $V_{REF} = 5\text{ V}_{PP}$ , Data = FFFFh, $f = 1\text{ kHz}$ |         | -105 |     | dB                           |
| Output spot noise voltage | $f = 1\text{ kHz}$ , $BW = 1\text{ Hz}$                        |         | 12   |     | $\text{nV}/\sqrt{\text{Hz}}$ |

**PIN ASSIGNMENTS**



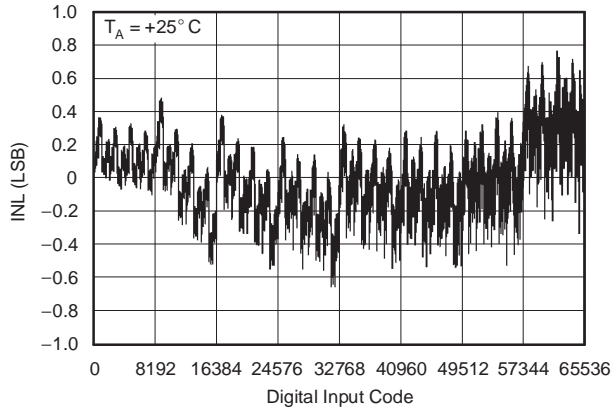
**Table 1. TERMINAL FUNCTIONS**

| PIN | NAME            | DESCRIPTION   |
|-----|-----------------|---|
| 1   | CLK             | Clock input; positive edge triggered clocks data into shift register  |
| 2   | SDI             | Serial register input; data loads directly into the shift register MSB first. Extra leading bits are ignored.                                   |
| 3   | $R_{FB}$        | Internal matching feedback resistor. Connect to external op amp output.   |
| 4   | $V_{REF}$       | DAC reference input pin. Establishes DAC full-scale voltage. Constant input resistance versus code.   |
| 5   | $I_{OUT}$       | DAC current output. Connects to inverting terminal of external precision I/V op amp.  |
| 6   | GND             | Analog and digital ground.  |
| 7   | $V_{DD}$        | Positive power supply input. Specified operating range of 2.7 V to 5.5 V.   |
| 8   | $\overline{CS}$ | Chip-select; active low digital input. Transfers shift register data to DAC register on rising edge. See <a href="#">Table 2</a> for operation. |

**TYPICAL CHARACTERISTICS:  $V_{DD} = 5\text{ V}$**

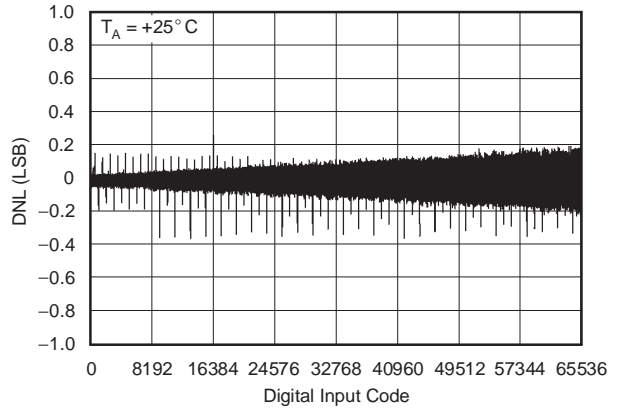
At  $T_A = 25^\circ\text{C}$ ,  $+V_{DD} = 5\text{ V}$ , unless otherwise noted.

**LINEARITY ERROR  
vs DIGITAL INPUT CODE**



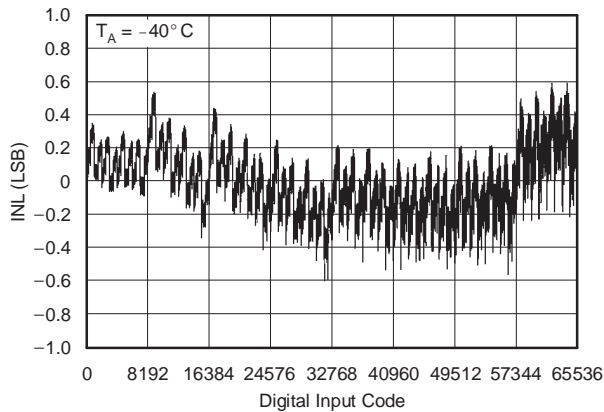
**Figure 1.**

**DIFFERENTIAL LINEARITY ERROR  
vs DIGITAL INPUT CODE**



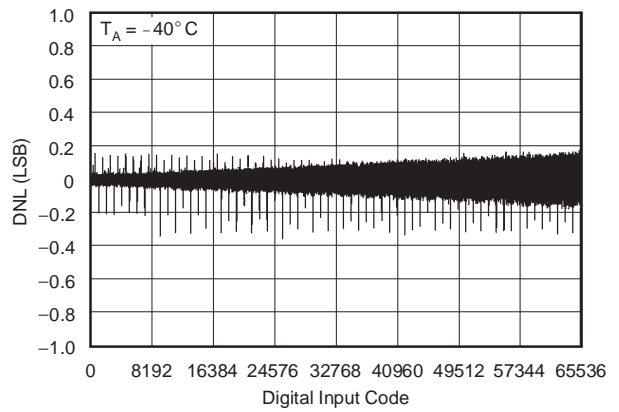
**Figure 2.**

**LINEARITY ERROR  
vs DIGITAL INPUT CODE**



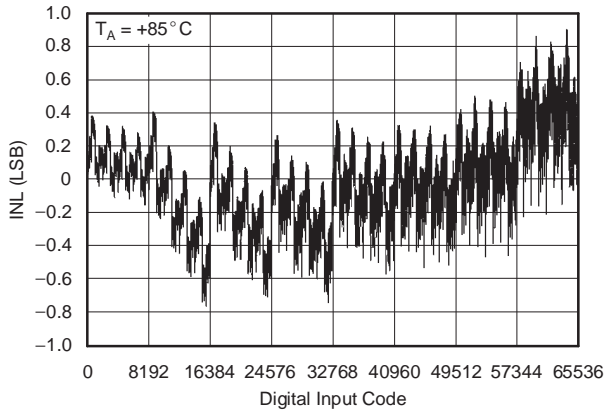
**Figure 3.**

**DIFFERENTIAL LINEARITY ERROR  
vs DIGITAL INPUT CODE**



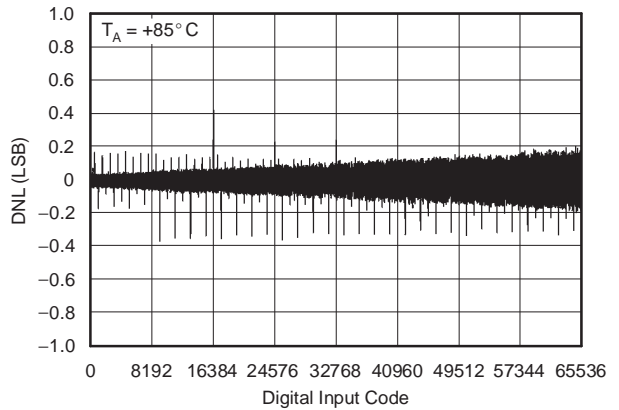
**Figure 4.**

**LINEARITY ERROR  
vs DIGITAL INPUT CODE**



**Figure 5.**

**DIFFERENTIAL LINEARITY ERROR  
vs DIGITAL INPUT CODE**



**Figure 6.**

**TYPICAL CHARACTERISTICS:  $V_{DD} = 5\text{ V}$  (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $+V_{DD} = 5\text{ V}$ , unless otherwise noted.

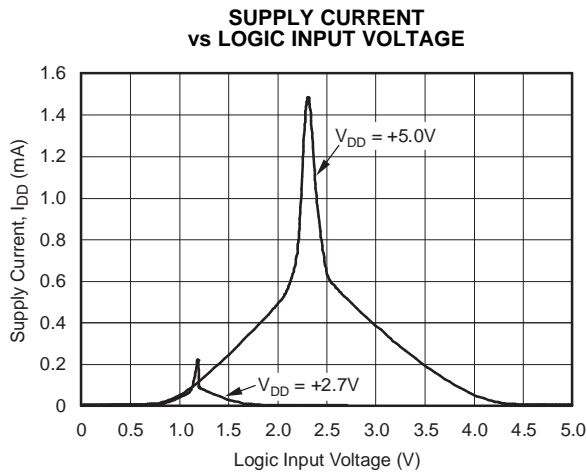


Figure 7.

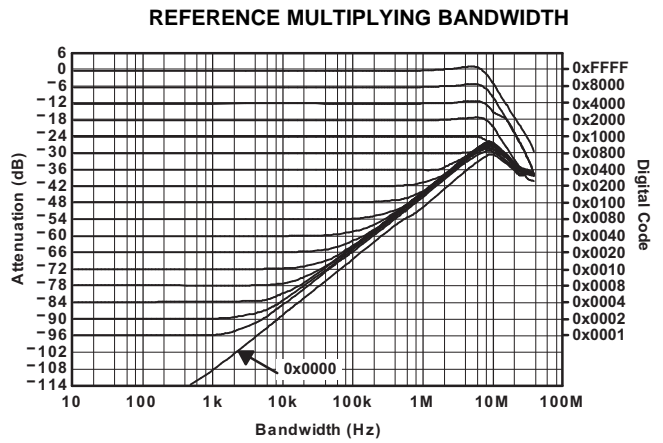


Figure 8.

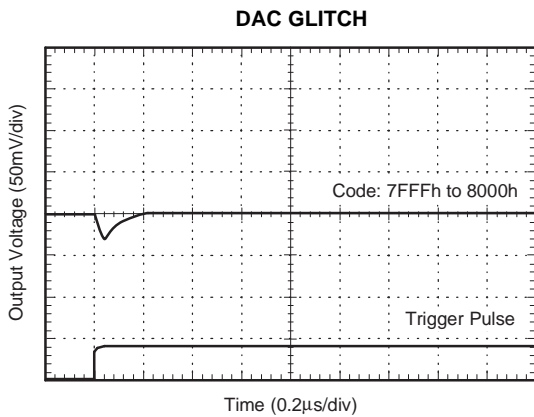


Figure 9.

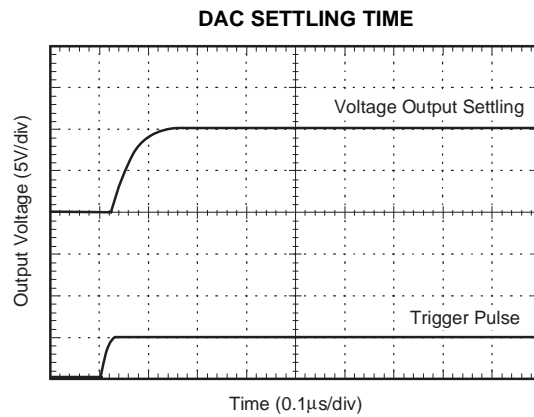
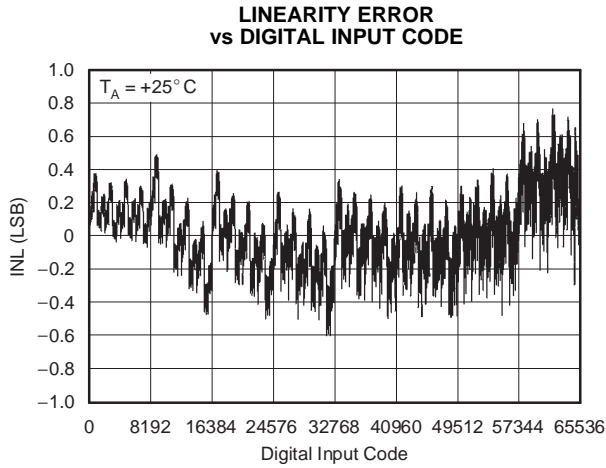


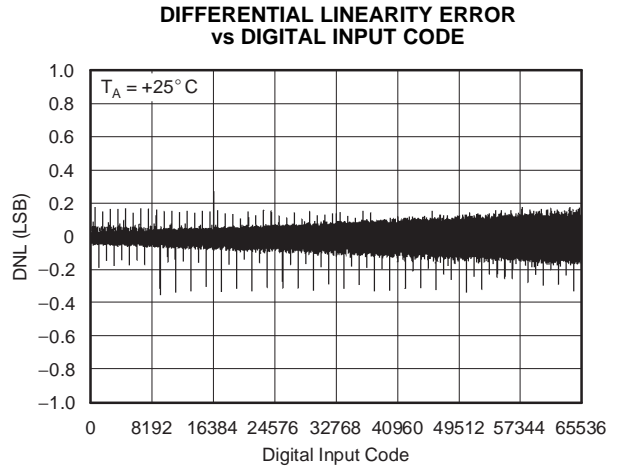
Figure 10.

**TYPICAL CHARACTERISTICS:  $V_{DD} = 2.7\text{ V}$**

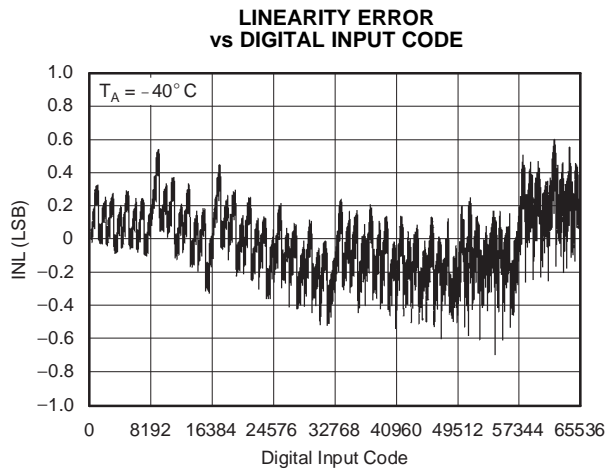
At  $T_A = 25^\circ\text{C}$ ,  $+V_{DD} = 2.7\text{ V}$ , unless otherwise noted.



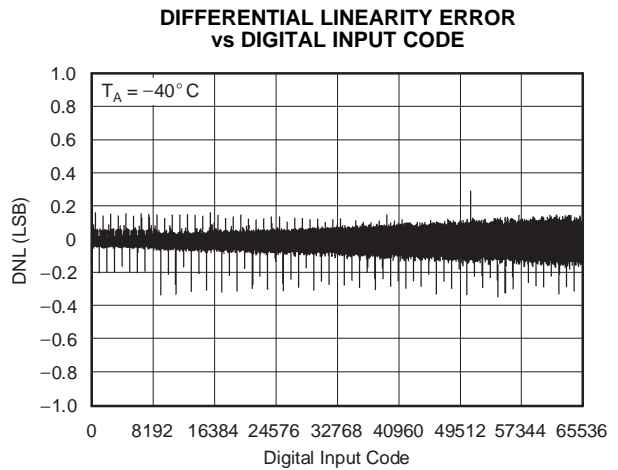
**Figure 11.**



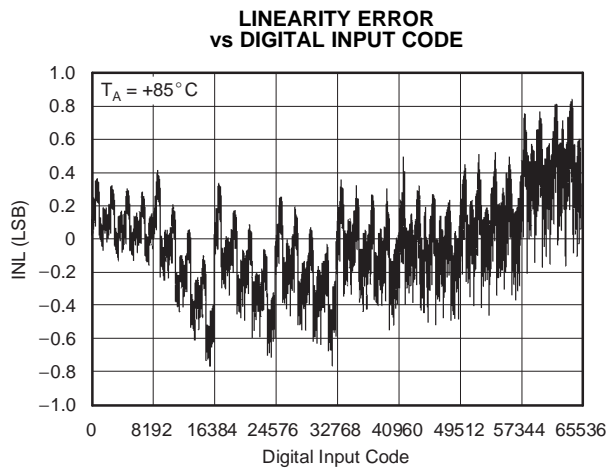
**Figure 12.**



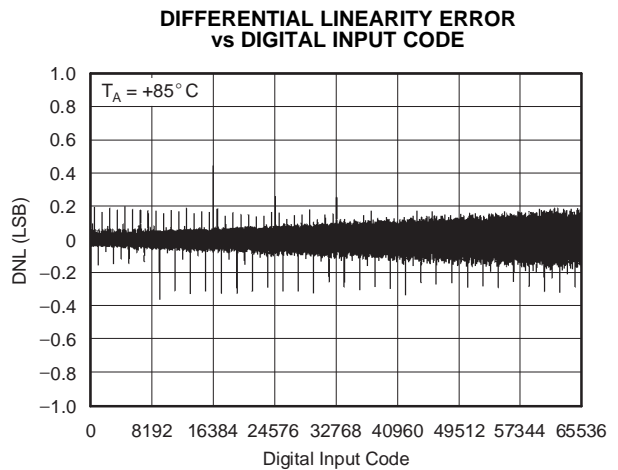
**Figure 13.**



**Figure 14.**



**Figure 15.**



**Figure 16.**

### THEORY OF OPERATION

The DAC8811 is a single channel current output, 16-bit digital-to-analog converter (DAC). The architecture, illustrated in Figure 17, is an R-2R ladder configuration with the three MSBs segmented. Each 2R leg of the ladder is either switched to GND or the I<sub>OUT</sub> terminal. The I<sub>OUT</sub> terminal of the DAC is held at a virtual GND potential by the use of an external I/V converter op amp. The R-2R ladder is connected to an external reference input V<sub>REF</sub> that determines the DAC full-scale current. The R-2R ladder presents a code independent load impedance to the external reference of 5 kΩ ±25%. The external reference voltage can vary in a range of -15 V to 15 V, thus providing bipolar I<sub>OUT</sub> current operation. By using an external I/V converter and the DAC8811 R<sub>FB</sub> resistor, output voltage ranges of -V<sub>REF</sub> to V<sub>REF</sub> can be generated.

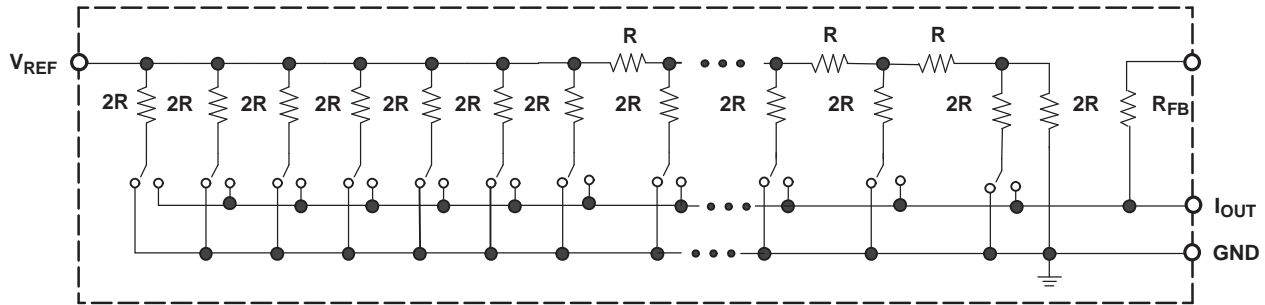


Figure 17. Equivalent R-2R DAC Circuit

When using an external I/V converter and the DAC8811 R<sub>FB</sub> resistor, the DAC output voltage is given by Equation 1:

$$V_{OUT} = -V_{REF} \times \frac{CODE}{65536} \tag{1}$$

Each DAC code determines the 2R leg switch position to either GND or I<sub>OUT</sub>. Because the DAC output impedance as seen looking into the I<sub>OUT</sub> terminal changes versus code, the external I/V converter noise gain will also change. Because of this, the external I/V converter op amp must have a sufficiently low offset voltage such that the amplifier offset is not modulated by the DAC I<sub>OUT</sub> terminal impedance change. External op amps with large offset voltages can produce INL errors in the transfer function of the DAC8811 due to offset modulation versus DAC code. For best linearity performance of the DAC8811, an op amp (OPA277) is recommended (Figure 18). This circuit allows V<sub>REF</sub> swinging from -10 V to +10 V.

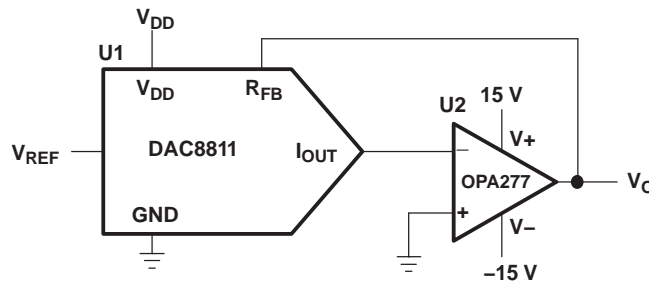


Figure 18. Voltage Output Configuration



THEORY OF OPERATION (continued)

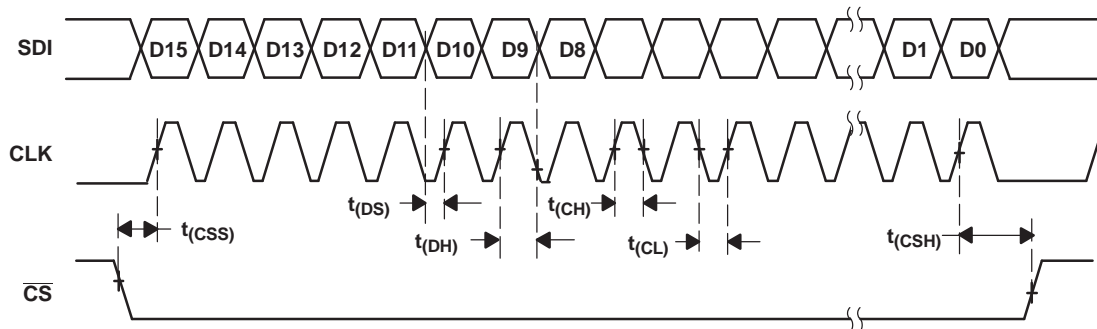


Figure 19. DAC8811 Timing Diagram

Table 2. Control Logic Truth Table<sup>(1)</sup>

| CLK         | $\overline{\text{CS}}$ | Serial Shift Register                           | DAC Register                         |
|-------------|------------------------|---|--------------------------------------|
| X           | H                      | No effect                                       | Latched                              |
| $\uparrow+$ | L                      | Shift register data advanced one bit            | Latched                              |
| X           | H                      | No effect                                       | Latched                              |
| X           | $\uparrow+$            | Shift register data transferred to DAC register | New data loaded from serial register |

(1)  $\uparrow+$  Positive logic transition; X = Don't care

Table 7.1. Serial Input Register Data Format, Data Loaded MSB First

| Bit  | B15 (MSB) | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 (LSB) |
|------|-----------|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|----------|
| Data | D15       | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0       |

APPLICATION INFORMATION

Stability Circuit

For a current-to-voltage design (see Figure 20), the DAC8811 current output ( $I_{\text{OUT}}$ ) and the connection with the inverting node of the op amp should be as short as possible and according to correct PCB layout design. For each code change there is a step function. If the GBP of the op amp is limited and parasitic capacitance is excessive at the inverting node then gain peaking is possible. Therefore, for circuit stability, a compensation capacitor C1 (4 pF to 20 pF typ) can be added to the design, as shown in Figure 20.

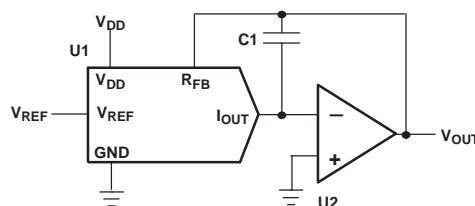


Figure 20. Gain Peaking Prevention Circuit With Compensation Capacitor

Positive Voltage Output Circuit

As Figure 21 illustrates, in order to generate a positive voltage output, a negative reference is input to the DAC8811. This design is suggested instead of using an inverting amp to invert the output due to tolerance errors of the resistor. For a negative reference,  $V_{\text{OUT}}$  and GND of the reference are level-shifted to a virtual ground and a -2.5 V input to the DAC8811 with an op amp.

APPLICATION INFORMATION (continued)

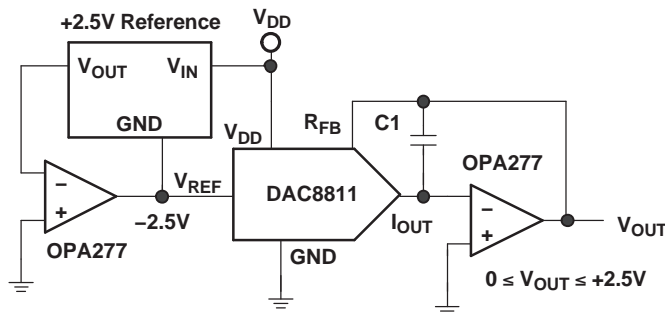


Figure 21. Positive Voltage Output Circuit

Bipolar Output Circuit

The DAC8811, as a 2-quadrant multiplying DAC, can be used to generate a unipolar output. The polarity of the full-scale output  $I_{OUT}$  is the inverse of the input reference voltage at  $V_{REF}$ .

Some applications require full 4-quadrant multiplying capabilities or bipolar output swing. As shown in Figure 22, external op amp U4 is added as a summing amp and has a gain of 2X that widens the output span to 5 V. A 4-quadrant multiplying circuit is implemented by using a 2.5-V offset of the reference voltage to bias U4. According to the circuit transfer equation given in Equation 2, input data (D) from code 0 to full scale produces output voltages of  $V_{OUT} = -2.5\text{ V}$  to  $V_{OUT} = +2.5\text{ V}$ .

$$V_{OUT} = \left( \frac{D}{32,768} - 1 \right) \times V_{REF} \tag{2}$$

External resistance mismatching is the significant error in Figure 22.

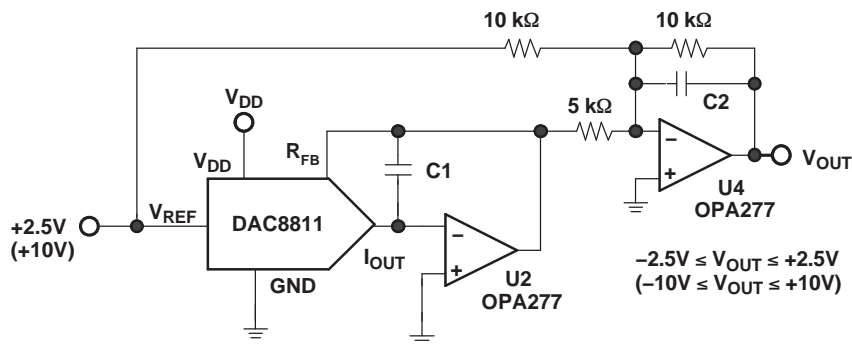


Figure 22. Bipolar Output Circuit

Programmable Current Source Circuit

A DAC8811 can be integrated into the circuit in Figure 23 to implement an improved Howland current pump for precise voltage to current conversions. Bidirectional current flow and high voltage compliance are two features of the circuit. With a matched resistor network, the load current of the circuit is shown by Equation 3:

$$I_L = \frac{(R2 + R3) / R1}{R3} \times V_{REF} \times D \tag{3}$$

### APPLICATION INFORMATION (continued)

The value of R3 in the previous equation can be reduced to increase the output current drive of U3. U3 can drive  $\pm 20$  mA in both directions with voltage compliance limited up to 15 V by the U3 voltage supply. Elimination of the circuit compensation capacitor C1 in the circuit is not suggested as a result of the change in the output impedance  $Z_o$ , according to Equation 4:

$$Z_o = \frac{R1'R3(R1+R2)}{R1(R2'+R3') - R1'(R2+R3)} \quad (4)$$

As shown in Equation 4, with matched resistors,  $Z_o$  is infinite and the circuit is optimum for use as a current source. However, if unmatched resistors are used,  $Z_o$  is positive or negative with negative output impedance being a potential cause of oscillation. Therefore, by incorporating C1 into the circuit, possible oscillation problems are eliminated. The value of C1 can be determined for critical applications; for most applications, however, a value of several pF is suggested.

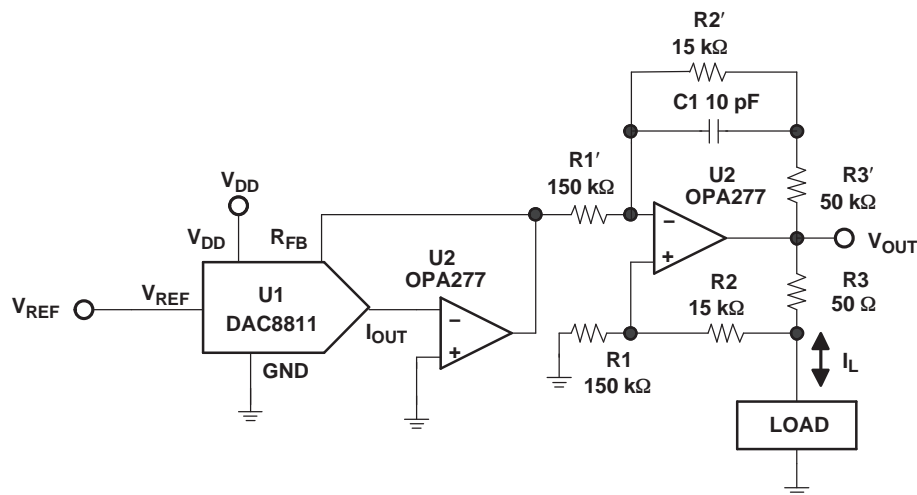


Figure 23. Programmable Bidirectional Current Source Circuit

### Cross-Reference

The DAC8811 has an industry-standard pinout. Table 3 provides the cross-reference information.

Table 3. Cross-Reference

| PRODUCT       | INL (LSB) | DNL (LSB) | SPECIFIED TEMPERATURE RANGE | PACKAGE DESCRIPTION  | PACKAGE OPTION | CROSS-REFERENCE PART |
|---------------|-----------|-----------|-----------------------------|----------------------|----------------|----------------------|
| DAC8811ICD GK | $\pm 1$   | $\pm 1$   | -40°C to +85°C              | 8-Lead MicroSOIC     | MSOP-8         | N/A                  |
| DAC8811IBD GK | $\pm 2$   | $\pm 1$   | -40°C to +85°C              | 8-Lead MicroSOIC     | MSOP-8         | AD5543BRM            |
| DAC8811ICDRB  | $\pm 1$   | $\pm 1$   | -40°C to +85°C              | 8-Lead Small Outline | SON-8          | N/A                  |
| DAC8811IBDRB  | $\pm 2$   | $\pm 1$   | -40°C to +85°C              | 8-Lead Small Outline | SON-8          | N/A                  |
| N/A           | $\pm 2$   | $\pm 1$   | -40°C to +85°C              | 8-Lead SOIC          | SOIC-8         | AD5543BR             |

**Table 4. DAC8811 Revision History**

| Revision | Date  | Description  |
|----------|-------|--|
| A        | 12/04 | Removed the <i>Product Preview</i> label.  |
|          |       | Added information to the Features.   |
|          |       | Added Output leakage current Data = 0000h, $T_A = T_{MAX}$ in the <i>Electrical Characteristics</i> table.                     |
|          |       | Added Input high voltage for 2.7 V and 5 V in the Electrical Characteristics table.  |
|          |       | Changed the values of the <i>Power Requirements</i> and the <i>AC characteristics</i> in the Electrical Characteristics table. |
| B        | 10/06 | Changed the ESD rating, HBM from 1500 to 4000 in the <i>Absolute Maximum Ratings</i> .   |
|          |       | Revised <a href="#">Figure 8</a> .   |
|          |       | Added new paragraph to the <i>Description</i> text.  |
|          |       | Added test condition to the AC Characteristics in the <i>Electrical Characteristics</i> table.                                 |
|          |       | Added Table Note 3 to the <i>Electrical Characteristics</i> .  |
|          |       | Added row to ABS MAX table, Corrected AC Characteristics section in Electrical Characteristics table                           |

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| DAC8811IBDGKR    | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDGKRG4  | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDGKT    | ACTIVE                | MSOP         | DGK             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDGKTG4  | ACTIVE                | MSOP         | DGK             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDRBR    | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDRBRG4  | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDRBT    | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811IBDRBTG4  | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDGKR    | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDGKRG4  | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDGKT    | ACTIVE                | MSOP         | DGK             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDGKTG4  | ACTIVE                | MSOP         | DGK             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDRBR    | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDRBRG4  | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDRBT    | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| DAC8811ICDRBTG4  | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

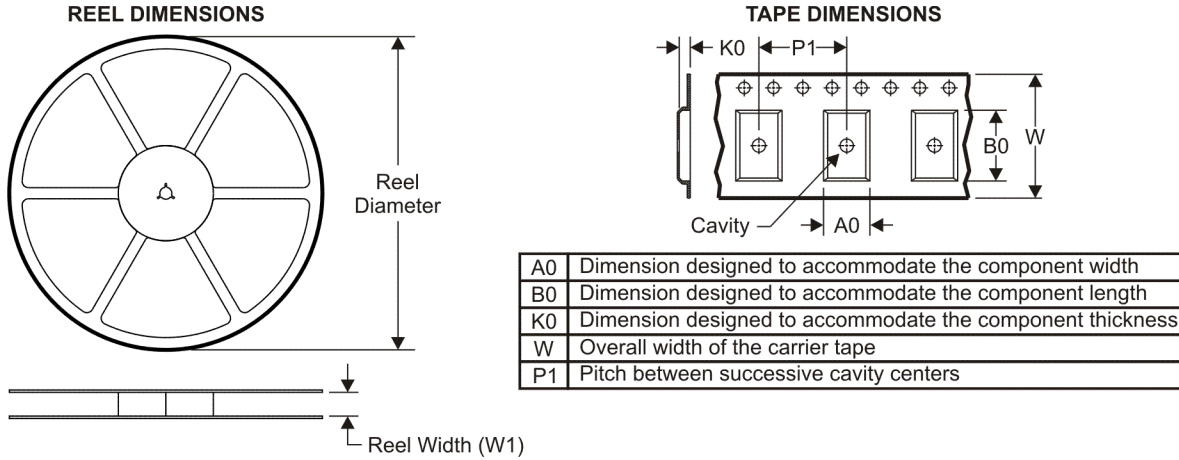
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DAC8811IBDGKR | MSOP         | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| DAC8811IBDGKT | MSOP         | DGK             | 8    | 250  | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| DAC8811IBDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| DAC8811IBDRBT | SON          | DRB             | 8    | 250  | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| DAC8811ICDGKR | MSOP         | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| DAC8811ICDGKT | MSOP         | DGK             | 8    | 250  | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| DAC8811ICDRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| DAC8811ICDRBT | SON          | DRB             | 8    | 250  | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |

**TAPE AND REEL BOX DIMENSIONS**



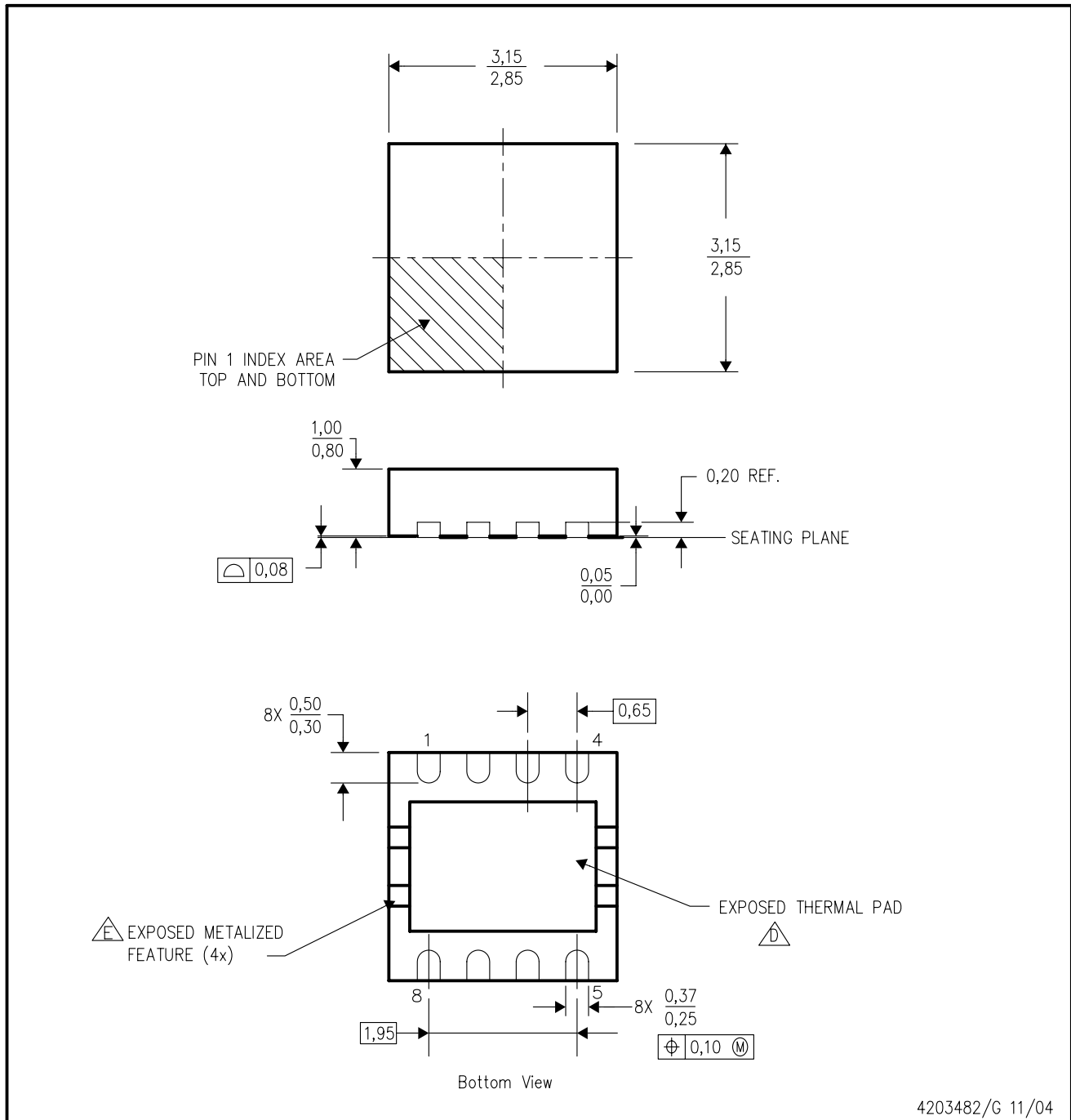
\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DAC8811IBDGKR | MSOP         | DGK             | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| DAC8811IBDGKT | MSOP         | DGK             | 8    | 250  | 346.0       | 346.0      | 29.0        |
| DAC8811IBDRBR | SON          | DRB             | 8    | 3000 | 346.0       | 346.0      | 29.0        |
| DAC8811IBDRBT | SON          | DRB             | 8    | 250  | 346.0       | 346.0      | 29.0        |
| DAC8811ICDGKR | MSOP         | DGK             | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| DAC8811ICDGKT | MSOP         | DGK             | 8    | 250  | 346.0       | 346.0      | 29.0        |
| DAC8811ICDRBR | SON          | DRB             | 8    | 3000 | 346.0       | 346.0      | 29.0        |
| DAC8811ICDRBT | SON          | DRB             | 8    | 250  | 346.0       | 346.0      | 29.0        |



DRB (S-PDSO-N8)

PLASTIC SMALL OUTLINE



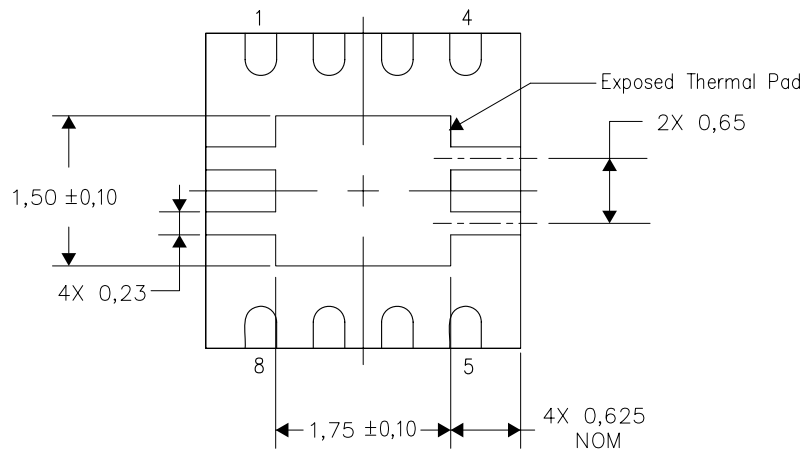
- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Small Outline No-Lead (SON) package configuration.
  - The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
  - Metalized features are supplier options and may not be on the package.

**THERMAL INFORMATION**

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, Quad Flatpack No-Lead Logic Packages, Texas Instruments Literature No. SCBA017. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.

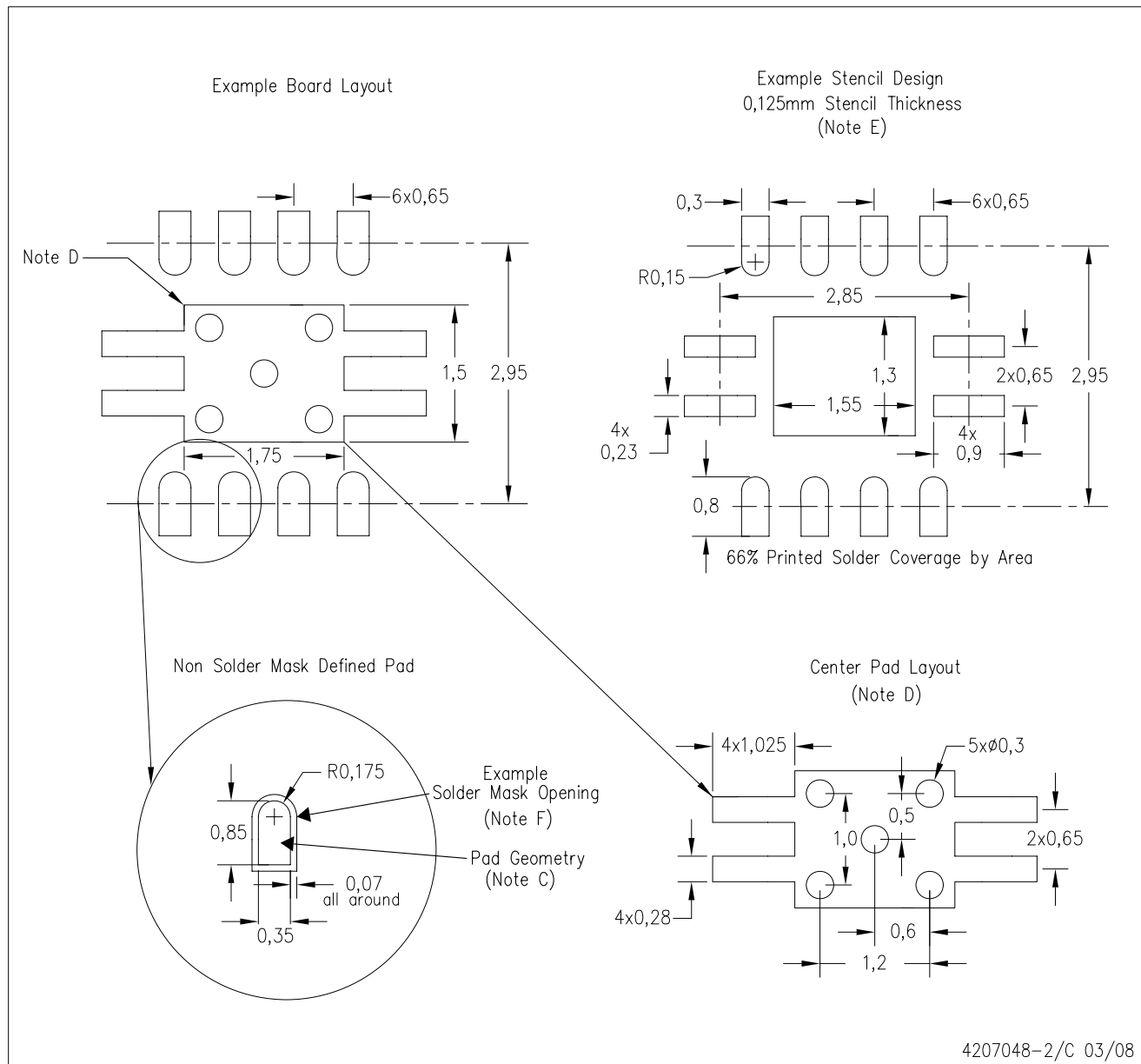


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

DRB (S-VSON-N8)



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN Packages, Texas Instruments Literature No. SCBA017, SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - F. Customers should contact their board fabrication site for solder mask tolerances.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
  - E. Falls within JEDEC MO-187 variation AA, except interlead flash.

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| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
| Military           | <a href="http://www.ti.com/military">www.ti.com/military</a>             |
| Optical Networking | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
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