



## 18-Bit, Single-Channel, Low-Noise, Voltage-Output DIGITAL-TO-ANALOG CONVERTER

### FEATURES

- **Relative Accuracy:  $\pm 2$  LSB**
- **18-Bit Monotonic Over Temperature Range**
- **Low-Noise:  $24\text{nV}/\sqrt{\text{Hz}}$**
- **Fast Settling:  $5\mu\text{s}$**
- **On-Chip Output Buffer Amplifier with Rail-to-Rail Operation**
- **Single Power Supply:  $+4.75\text{V}$  to  $+5.5\text{V}$**
- **DAC Loading Control**
- **Selectable Power-On Reset to Zero-Scale or Midscale**
- **Power-Down Mode**
- **Unipolar Straight Binary or 2s Complement Input Mode**
- **Fast SPI™ Interface with Schmitt-Triggered Inputs:  
Up To 50MHz, 1.8V/3V/5V Logic**
- **Small Package: QFN-24,  $4\text{mm} \times 4\text{mm}$**

### APPLICATIONS

- **Industrial Process Control**
- **Data Acquisition Systems**
- **Automatic Test Equipment**
- **Communications**
- **Optical Networking**

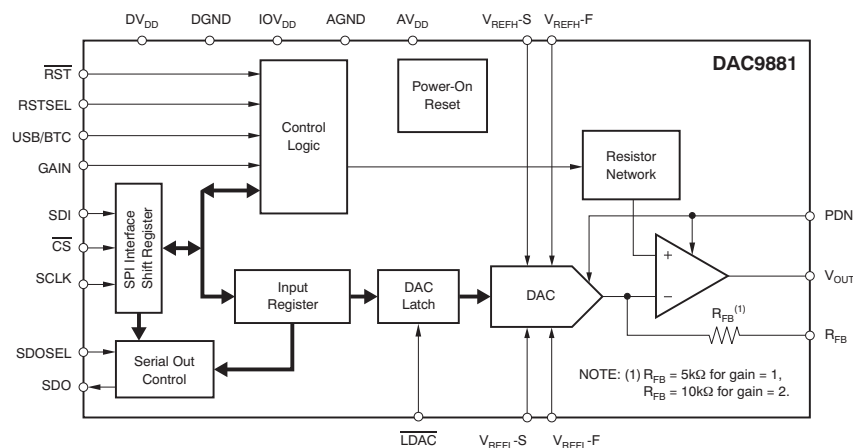
### DESCRIPTION

The DAC9881 is an 18-bit, single-channel, voltage-output digital-to-analog converter (DAC) that offers low-power operation and a flexible SPI serial interface. It also features 18-bit monotonicity, excellent linearity, and fast settling time. The on-chip precision output amplifier allows rail-to-rail output swing to be achieved over the full supply range of 4.75V to 5.5V.

The device supports a standard SPI serial interface capable of operating with input data clock frequencies up to 50MHz. The DAC9881 requires an external reference voltage to set the output range of the DAC channel. A programmable power-on reset circuit is also incorporated into the device to ensure that the DAC output powers up at zero-scale or midscale, and remains there until a valid write command.

Additionally, the device has the capability to function in either unipolar straight binary or 2s complement mode. The DAC9881 provides a power-down feature, accessed over the PDN pin, that reduces the current consumption to 25 $\mu\text{A}$  at 5V. Power consumption is 6mW at 5V, reducing to 125 $\mu\text{W}$  in power-down mode.

The DAC9881 is available in a 4mm  $\times$  4mm QFN-24 package with a specified operating temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .



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.

SPI is a trademark of Motorola, Inc.

All other trademarks are the property of their respective owners.



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.

### ORDERING INFORMATION<sup>(1)</sup>

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING
DAC9881	QFN-24	RGE	–40°C to +85°C	DAC9881

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

### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Over operating free-air temperature range (unless otherwise noted).

	DAC9881	UNIT
$AV_{DD}$ to AGND	–0.3 to 6	V
$DV_{DD}$ to DGND	–0.3 to 6	V
$IOV_{DD}$ to DGND	–0.3 to 6	V
Digital input voltage to DGND	–0.3 to $IOV_{DD} + 0.3$	V
$V_{OUT}$ to AGND	–0.3 to $AV_{DD} + 0.3$	V
Operating temperature range	–40 to +85	°C
Storage temperature range	–65 to +150	°C
Maximum junction temperature ( $T_J$ max)	+150	°C
ESD ratings	Human body model (HBM)	3000
	Charged device model (CDM)	1000

- (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

All specifications at  $T_A = T_{MIN}$  to  $T_{MAX}$ ,  $AV_{DD} = DV_{DD} = +4.75V$  to  $+5.5V$ ,  $IOV_{DD} = +1.8V$  to  $+5.5V$ , and gain = 1X mode, unless otherwise noted.

PARAMETER	CONDITIONS	DAC9881			UNIT	
		MIN	TYP	MAX		
<b>ACCURACY</b>						
Linearity error	Measured by line passing through codes 2048 and 260096		±1	±2	LSB	
Differential linearity error	Measured by line passing through codes 2048 and 260096		±0.5	±1	LSB	
Monotonicity		18			Bits	
Zero-scale error	$T_A = +25^\circ C$ , code = 2048			±16	LSB	
	$T_{MIN}$ to $T_{MAX}$ , code = 2048			±32	LSB	
Zero-scale drift	Code = 2048		±0.5	±1	ppm/°C of FSR	
Gain error	$T_A = +25^\circ C$ , measured by line passing through codes 2048 and 260096		±16	±32	LSB	
Gain temperature drift	Measured by line passing through codes 2048 and 260096		±0.5	±1	ppm/°C	
PSRR	$V_{OUT} = \text{full-scale}$ , $AV_{DD} = +5V \pm 10\%$			32	LSB/V	
<b>ANALOG OUTPUT<sup>(1)</sup></b>						
Voltage output <sup>(2)</sup>		0		$AV_{DD}$	V	
Output voltage drift vs time	Device operating for 500 hours		5		ppm of FSR	
	Device operating for 1000 hours		8		ppm of FSR	
Output current			2.5		mA	
Maximum load capacitance			200		pF	
Short-circuit current			+31, -50		mA	
<b>REFERENCE INPUT<sup>(1)</sup></b>						
$V_{REFH}$ input voltage range	$AV_{DD} = +5.5V$	1.25	5.0	$AV_{DD}$	V	
$V_{REFH}$ input capacitance			5		pF	
$V_{REFH}$ input impedance			4.5		kΩ	
$V_{REFL}$ input voltage range		-0.2	0	+0.2	V	
$V_{REFL}$ input capacitance			4.5		pF	
$V_{REFL}$ input impedance			5		kΩ	
<b>DYNAMIC PERFORMANCE<sup>(1)</sup></b>						
Settling time	To ±0.003% FS, $R_L = 10k\Omega$ , $C_L = 50pF$ , code 04000h to 3C000h		5		μs	
Slew rate	From 10% to 90% of 0V to +5V		2.5		V/μs	
Code change glitch	Code = 1FFFFh to 20000h to 1FFFFh	$V_{REFH} = 5V$ , gain = 1X mode		37		nV-s
		$V_{REFH} = 2.5V$ , gain = 1X mode		18		nV-s
		$V_{REFH} = 1.25V$ , gain = 1X mode		9		nV-s
		$V_{REFH} = 2.5V$ , gain = 2X mode		21		nV-s
		$V_{REFH} = 1.25V$ , gain = 2X mode		10		nV-s
Digital feedthrough			1		nV-s	
Output noise voltage density	f = 1kHz to 100kHz, full-scale output	Gain = 1	24	30	$nV/\sqrt{Hz}$	
		Gain = 2	40	48	$nV/\sqrt{Hz}$	
Output noise voltage	f = 0.1Hz to 10Hz, full-scale output		2		μV <sub>PP</sub>	

(1) Ensured by design. Not production tested.

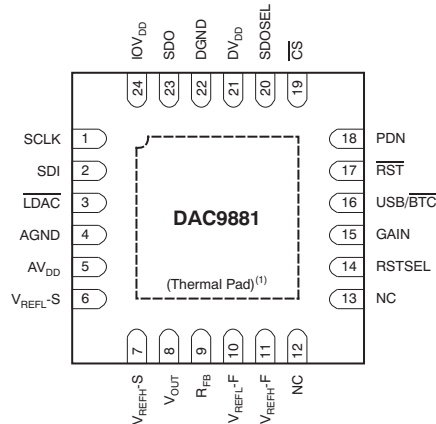
(2) The output from the  $V_{OUT}$  pin is  $[(V_{REFH} - V_{REFL})/262144] \times \text{CODE} \times \text{Buffer GAIN} + V_{REFL}$ . The maximum range of  $V_{OUT}$  is 0V to  $AV_{DD}$ . The full-scale of the output must be less than  $AV_{DD}$ ; otherwise, output saturation occurs.

**ELECTRICAL CHARACTERISTICS (continued)**

All specifications at  $T_A = T_{MIN}$  to  $T_{MAX}$ ,  $AV_{DD} = DV_{DD} = +4.75V$  to  $+5.5V$ ,  $IOV_{DD} = +1.8V$  to  $+5.5V$ , and gain = 1X mode, unless otherwise noted.

PARAMETER	CONDITIONS	DAC9881			UNIT
		MIN	TYP	MAX	
<b>DIGITAL INPUTS<sup>(3)</sup></b>					
High-level input voltage, $V_{IH}$	$IOV_{DD} = 4.5V$ to $5.5V$	3.8		$IOV_{DD} + 0.3$	V
	$IOV_{DD} = 2.7V$ to $3.3V$	2.1		$IOV_{DD} + 0.3$	V
	$IOV_{DD} = 1.7V$ to $2.0V$	1.5		$IOV_{DD} + 0.3$	V
Low-level input voltage, $V_{IL}$	$IOV_{DD} = 4.5V$ to $5.5V$	-0.3		0.8	V
	$IOV_{DD} = 2.7V$ to $3.3V$	-0.3		0.6	V
	$IOV_{DD} = 1.7V$ to $2.0V$	-0.3		0.3	V
Digital input current ( $I_{IN}$ )			$\pm 1$	$\pm 10$	$\mu A$
Digital input capacitance			5		pF
<b>DIGITAL OUTPUT<sup>(3)</sup></b>					
High-level output voltage, $V_{OH}$	$IOV_{DD} = 2.7V$ to $5.5V$ , $I_{OH} = -1mA$	$IOV_{DD} - 0.2$			V
	$IOV_{DD} = 1.7V$ to $2.0V$ , $I_{OH} = -500\mu A$	$IOV_{DD} - 0.2$			V
Low-level output voltage, $V_{OL}$	$IOV_{DD} = 2.7V$ to $5.5V$ , $I_{OL} = 1mA$			0.2	V
	$IOV_{DD} = 1.7$ to $2.0V$ , $I_{OL} = 500\mu A$			0.2	V
<b>POWER SUPPLY</b>					
$AV_{DD}$		+4.75		+5.5	V
$DV_{DD}$		+4.75		+5.5	V
$IOV_{DD}$		+1.7		$DV_{DD}$	V
$AI_{DD}$	$V_{IH} = IOV_{DD}$ , $V_{IL} = DGND$			1.5	mA
$DI_{DD}$	$V_{IH} = IOV_{DD}$ , $V_{IL} = DGND$		1	10	$\mu A$
$IOI_{DD}$	$V_{IH} = IOV_{DD}$ , $V_{IL} = DGND$		1	10	$\mu A$
$AI_{DD}$ power-down	$PDN = IOV_{DD}$		25	50	$\mu A$
Power dissipation	$AV_{DD} = DV_{DD} = 5.0V$		6	7.5	mW
<b>TEMPERATURE RANGE</b>					
Specified performance		-40		+85	$^{\circ}C$

(3) Ensured by design. Not production tested.

**PIN CONFIGURATION**
**RGE PACKAGE<sup>(1)</sup>  
QFN-24  
(TOP VIEW)**


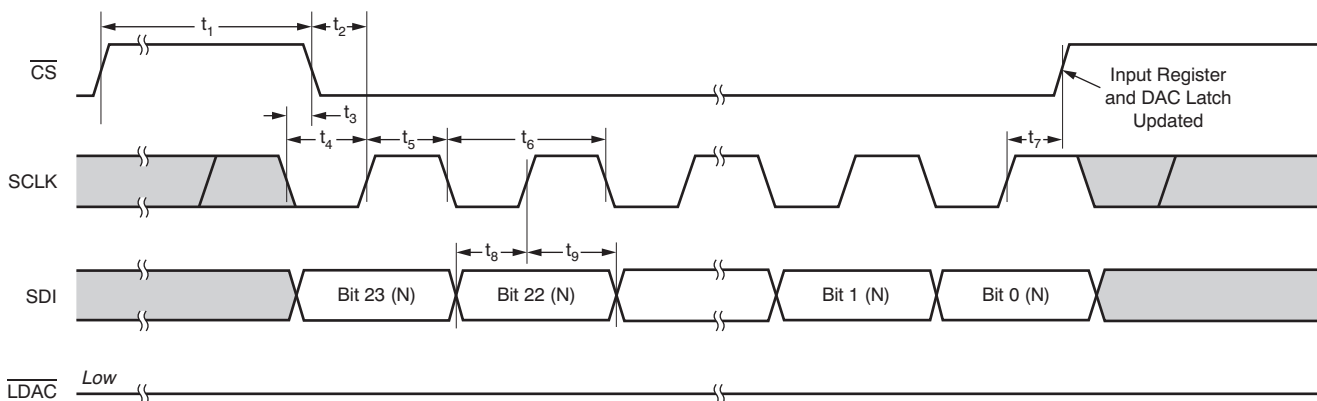
- (1) The thermal pad is internally connected to the substrate. This pad can be connected to the analog ground or left floating. Keep the thermal pad separate from the digital ground, if possible.

**TERMINAL FUNCTIONS**

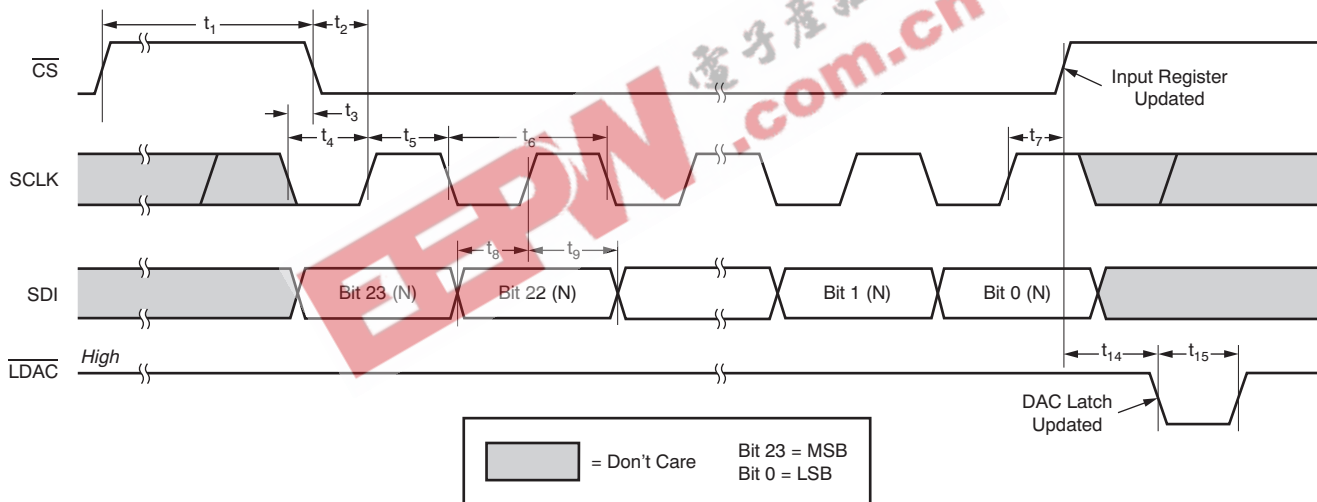
TERMINAL NO.	NAME	I/O	DESCRIPTION
1	SCLK	I	SPI bus serial clock input
2	SDI	I	SPI bus serial data input
3	LDAC	I	Load DAC latch control input (active low). When LDAC is low, the DAC latch is transparent, and the contents of the input register are transferred to the DAC latch. The DAC output changes to the corresponding level simultaneously when the DAC latch is updated.
4	AGND	I	Analog ground
5	AVDD	I	Analog power supply
6	VREFL-S	I	Reference low input sense
7	VREFH-S	I	Reference high input sense
8	VOUT	O	Output of output buffer
9	RFB	I	Feedback resistor connected to the inverting input of the output buffer.
10	VREFL-F	I	Reference low input force
11	VREFH-F	I	Reference high input force
12	NC	—	Do not connect.
13	NC	—	Do not connect.
14	RSTSEL	I	Selects the value of the output from the VOUT pin after power-on or hardware reset. If RSTSEL = IOVDD, then register data = 20000h. If RSTSEL = DGND, then register data = 00000h.
15	GAIN	I	Buffer gain setting. Gain = 1 when the pin is connected to DGND; Gain = 2 when the pin is connected to IOVDD.
16	USB/BTC	I	Input data format selection. Input data are straight binary format when the pin is connected to IOVDD, and in two's complement format when the pin is connected to DGND.
17	RST	I	Reset input (active low). Logic low on this pin causes the device to perform a reset.
18	PDN	I	Power-down input (active high). Logic high on this pin forces the device into power-down status. In power-down, the VOUT pin connects to AGND through a 10kΩ resistor.
19	CS	I	SPI bus chip select input (active low). Data bits are not clocked into the serial shift register unless CS is low. When CS is high, SDO is in a high-impedance state.
20	SDOSEL	I	SPI serial data output selection. When SDOSEL is tied to IOVDD, the contents of the existing input register are shifted out from the SDO pin; this is Stand-Alone mode. When SDOSEL is tied to DGND, the contents in the SPI input shift register are shifted out from the SDO pin; this is Daisy-Chain mode for daisy-chained communication.
21	DVDD	I	Digital power supply (connect to AVDD, pin 5)
22	DGND	I	Digital ground
23	SDO	O	SPI bus serial data output. Refer to the <i>Timing Diagrams</i> for further detail.
24	IOVDD	I	Interface power. Connect to +1.8V for 1.8V logic, +3V for 3V logic, and to +5V for 5V logic.

**TIMING DIAGRAMS**

**Case 1:** Standalone operation without SDO,  $\overline{\text{LDAC}}$  tied low.



**Case 2:** Standalone operation without SDO,  $\overline{\text{LDAC}}$  active.



**Figure 1. Timing Diagram for Standalone Operation without SDO**

PRODUCT PREVIEW

**TIMING CHARACTERISTICS for Figure 1** <sup>(1)(2)(3)</sup>

At –40°C to +85°C, unless otherwise noted.

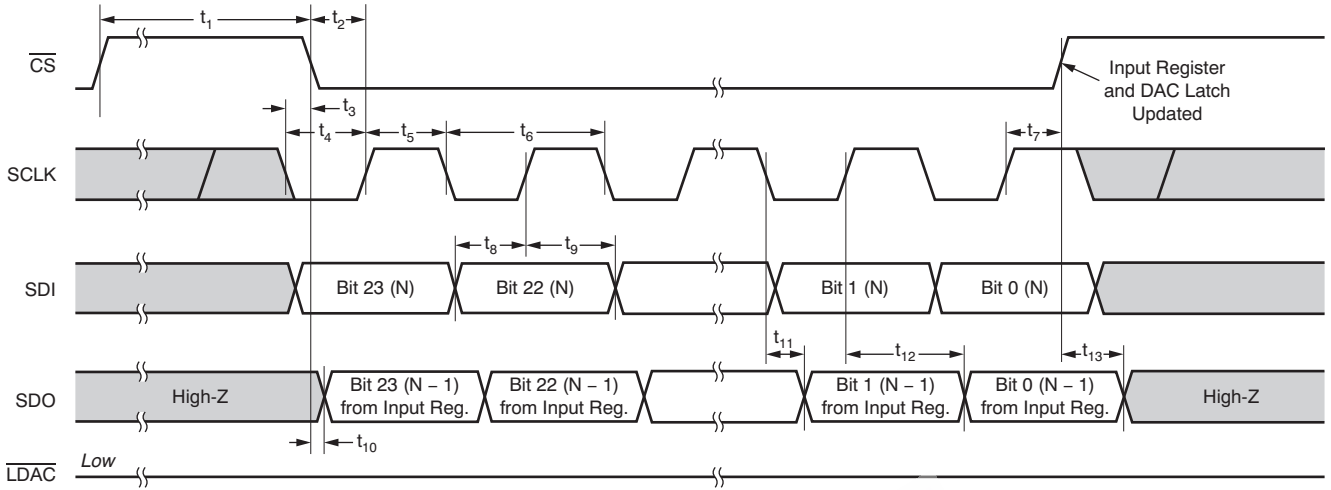
PARAMETER		CONDITIONS	MIN	MAX	UNIT
f <sub>SCLK</sub>	Maximum clock frequency	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		40	MHz
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		50	MHz
t <sub>1</sub>	Minimum $\overline{CS}$ high time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	50		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	30		ns
t <sub>2</sub>	$\overline{CS}$ falling edge to SCLK rising edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	8		ns
t <sub>3</sub>	SCLK falling edge to $\overline{CS}$ falling edge setup time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
t <sub>4</sub>	SCLK low time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
t <sub>5</sub>	SCLK high time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	15		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
t <sub>6</sub>	SCLK cycle time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	25		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	20		ns
t <sub>7</sub>	SCLK rising edge to $\overline{CS}$ rising edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
t <sub>8</sub>	Input data setup time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	8		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
t <sub>9</sub>	Input data hold time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
t <sub>14</sub>	$\overline{CS}$ rising edge to $\overline{LDAC}$ falling edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
t <sub>15</sub>	$\overline{LDAC}$ pulse width	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	15		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns

 (1) All input signals are specified with t<sub>R</sub> = t<sub>F</sub> = 2ns (10% to 90% of IOV<sub>DD</sub>) and timed from a voltage level of IOV<sub>DD</sub>/2.

(2) Ensured by design. Not production tested.

(3) Sample tested during the initial release and after any redesign or process changes that may affect these parameters.

**Case 1:** Standalone operation with output from SDO,  $\overline{\text{LDAC}}$  tied low.



**Case 2:** Standalone operation with output from SDO,  $\overline{\text{LDAC}}$  active.

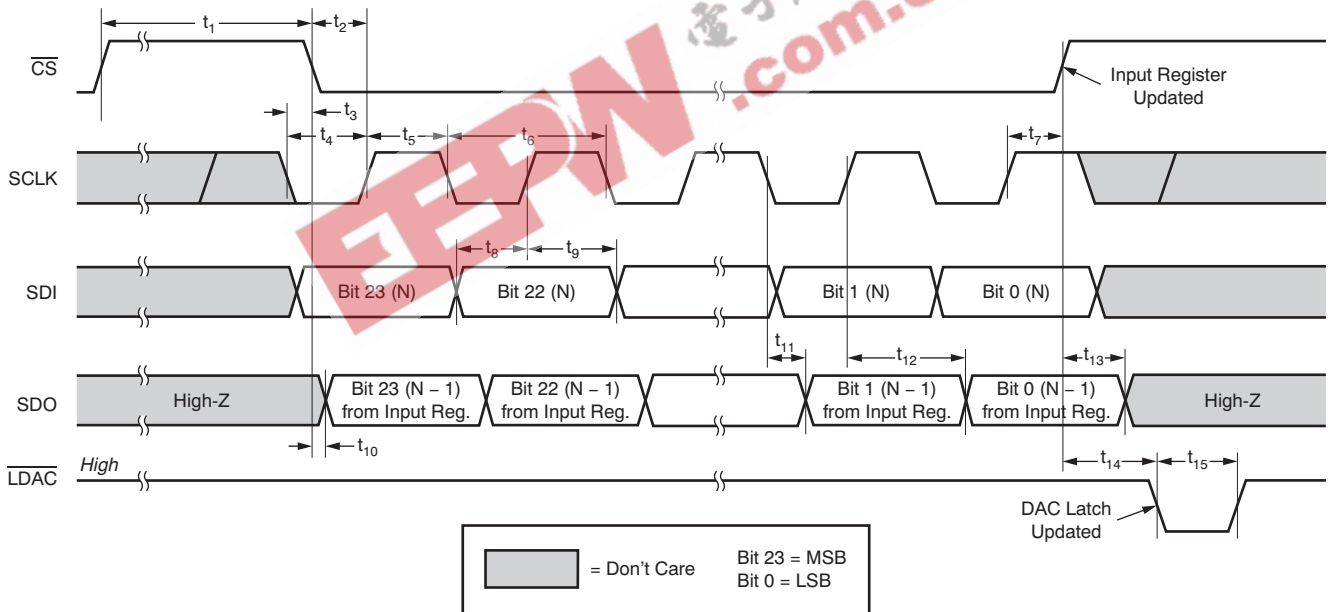
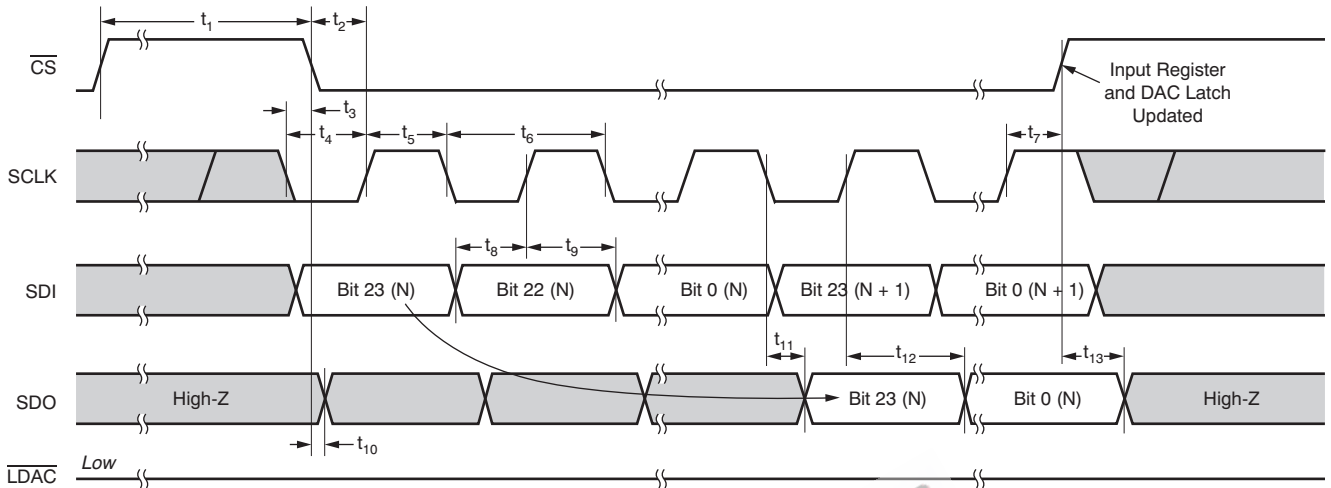


Figure 2. Timing Diagram for Standalone Operation with SDO

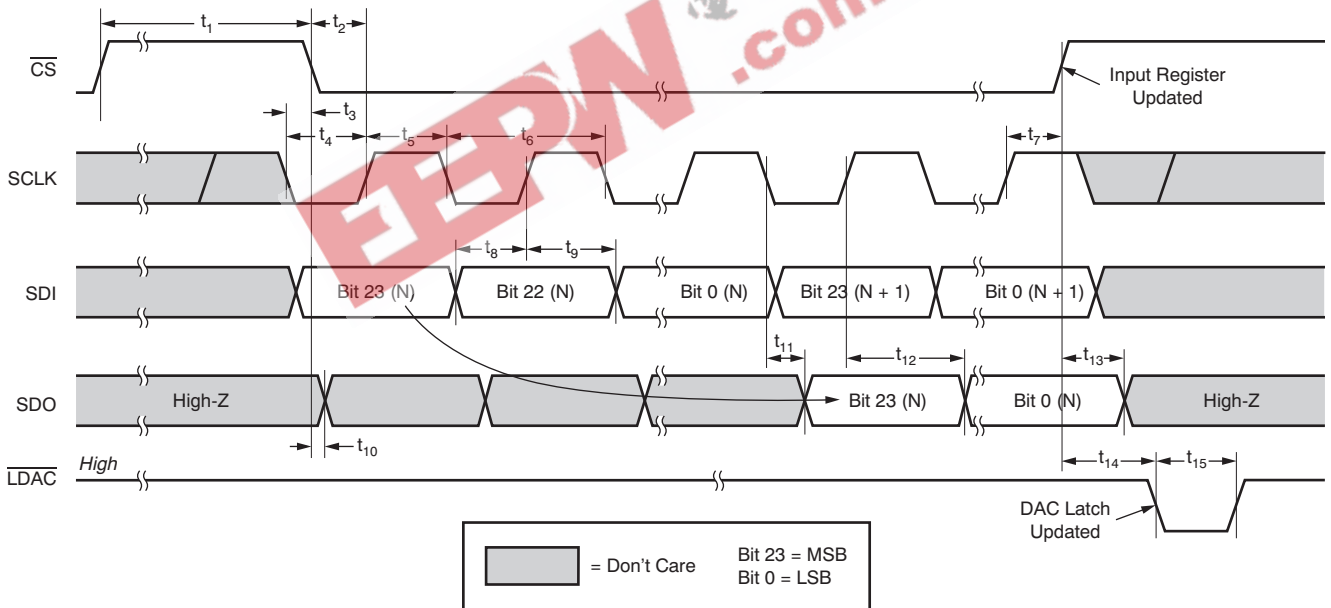
PRODUCT PREVIEW



**Case 1: Daisy Chain,  $\overline{\text{LDAC}}$  tied low.**



**Case 2: Daisy Chain,  $\overline{\text{LDAC}}$  active.**



**Figure 3. Timing Diagram for Daisy Chain Mode, Two Cascaded Devices**

**TIMING CHARACTERISTICS for Figure 2 and Figure 3<sup>(1)(2)(3)</sup>**

At –40°C to +85°C, unless otherwise noted.

PARAMETER		CONDITIONS	MIN	MAX	UNIT
f <sub>SCLK</sub>	Maximum clock frequency	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		20	MHz
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		25	MHz
t <sub>1</sub>	Minimum $\overline{CS}$ high time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	50		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	30		ns
t <sub>2</sub>	$\overline{CS}$ falling edge to SCLK rising edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	8		ns
t <sub>3</sub>	SCLK falling edge to $\overline{CS}$ falling edge setup time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
t <sub>4</sub>	SCLK low time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	25		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	20		ns
t <sub>5</sub>	SCLK high time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	25		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	20		ns
t <sub>6</sub>	SCLK cycle time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	50		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	40		ns
t <sub>7</sub>	SCLK rising edge to $\overline{CS}$ rising edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
t <sub>8</sub>	Input data setup time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
t <sub>9</sub>	Input data hold time	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
t <sub>10</sub>	SDO active from $\overline{CS}$ falling edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		15	ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		10	ns
t <sub>11</sub>	SDO data valid from SCLK falling edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		20	ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		15	ns
t <sub>12</sub>	SDO data hold from SCLK rising edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	25		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	20		ns
t <sub>13</sub>	SDO High-Z from $\overline{CS}$ rising edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		8	ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>		5	ns
t <sub>14</sub>	$\overline{CS}$ rising edge to $\overline{LDAC}$ falling edge	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	5		ns
t <sub>15</sub>	$\overline{LDAC}$ pulse width	2.7 ≤ DV <sub>DD</sub> < 3.6V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	15		ns
		3.6 ≤ DV <sub>DD</sub> ≤ 5.5V, 2.7 ≤ IOV <sub>DD</sub> ≤ DV <sub>DD</sub>	10		ns

 (1) All input signals are specified with t<sub>R</sub> = t<sub>F</sub> = 2ns (10% to 90% of IOV<sub>DD</sub>) and timed from a voltage level of IOV<sub>DD</sub>/2.

(2) Ensured by design. Not production tested.

(3) Sample tested during the initial release and after any redesign or process changes that may affect these parameters.

**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>
DAC9881IRGER	PREVIEW	VQFN	RGE	24	3000	TBD	Call TI	Call TI
DAC9881IRGET	PREVIEW	VQFN	RGE	24	250	TBD	Call TI	Call TI

<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)

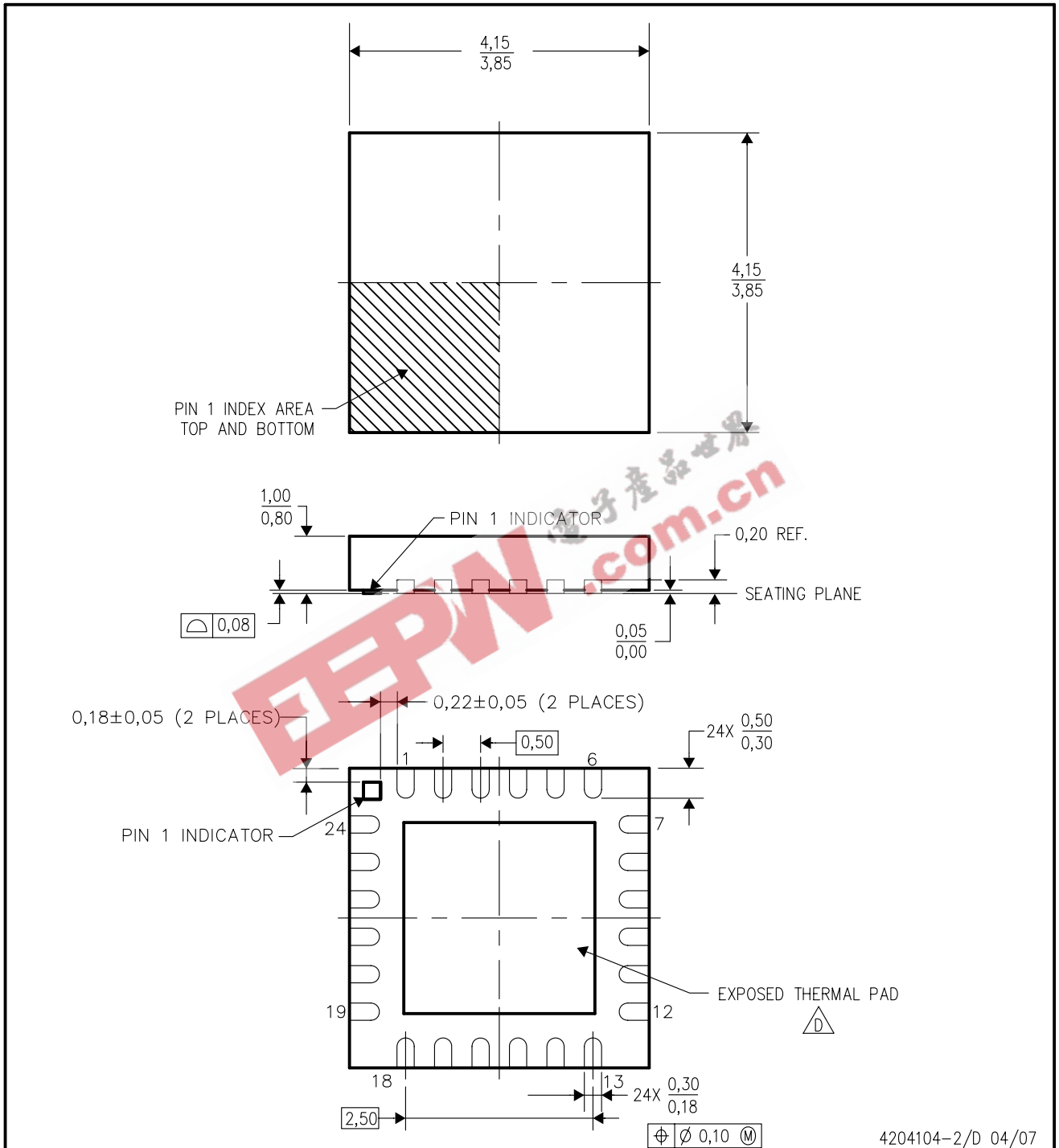
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

# MECHANICAL DATA

## RGE (S-PQFP-N24) PIN 1 BUMP OPTION PLASTIC QUAD FLATPACK



- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - Quad Flatpack, No-Leads (QFN) 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.
  - Falls within JEDEC MO-220.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
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>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2008, Texas Instruments Incorporated