

## PCF8574 Remote 8-Bit I/O Expander for I<sup>2</sup>C Bus

### 1 Features

- Low Standby-Current Consumption of 10  $\mu$ A Max
- I<sup>2</sup>C to Parallel-Port Expander
- Open-Drain Interrupt Output
- Compatible With Most Microcontrollers
- Latched Outputs With High-Current Drive Capability for Directly Driving LEDs
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II

### 2 Applications

- Telecom Shelters: Filter Units
- Servers
- Routers (Telecom Switching Equipment)
- Personal Computers
- Personal Electronics
- Industrial Automation
- Products with GPIO-Limited Processors

### 3 Description

This 8-bit input/output (I/O) expander for the two-line bidirectional bus (I<sup>2</sup>C) is designed for 2.5-V to 6-V V<sub>CC</sub> operation.

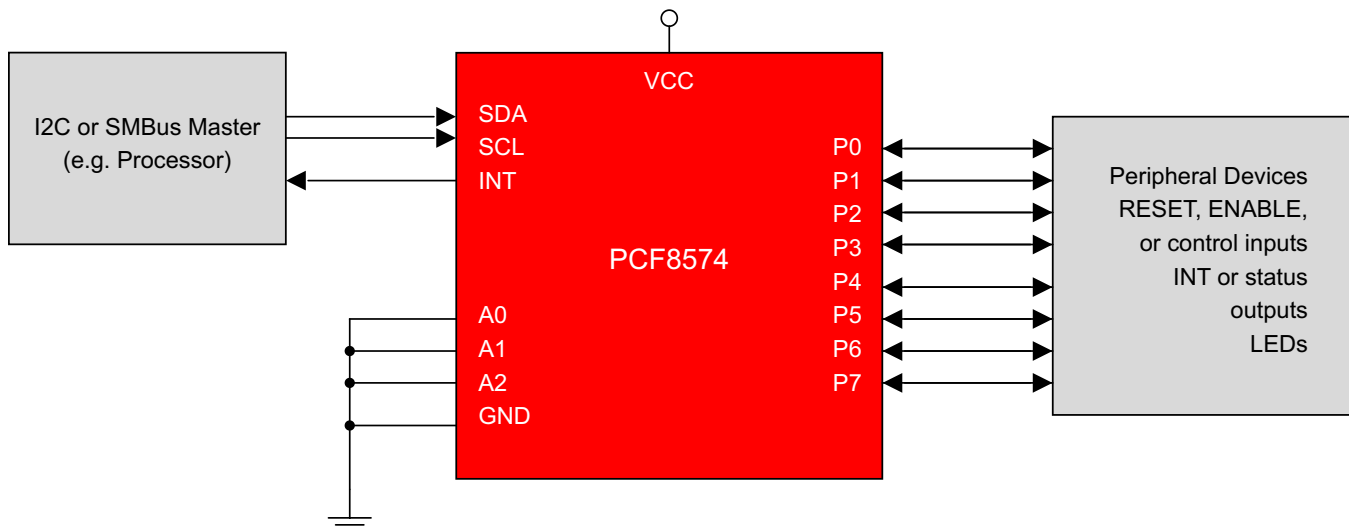
The PCF8574 device provides general-purpose remote I/O expansion for most microcontroller families by way of the I<sup>2</sup>C interface [serial clock (SCL), serial data (SDA)].

The device features an 8-bit quasi-bidirectional I/O port (P0–P7), including latched outputs with high-current drive capability for directly driving LEDs. Each quasi-bidirectional I/O can be used as an input or output without the use of a data-direction control signal. At power on, the I/Os are high. In this mode, only a current source to V<sub>CC</sub> is active.

#### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE (PIN)	BODY SIZE (NOM)
PCF8574	TVSOP (20)	5.00 mm × 4.40 mm
	SOIC (16)	10.30 mm × 7.50 mm
	PDIP (16)	19.30 mm × 6.35 mm
	TSSOP (20)	6.50 mm × 4.40 mm
	QFN (16)	3.00 mm × 3.00 mm
	VQFN (20)	4.50 mm × 3.50 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.



## Table of Contents

<b>1 Features</b> .....	<b>1</b>	8.2 Functional Block Diagram .....	<b>11</b>
<b>2 Applications</b> .....	<b>1</b>	8.3 Feature Description .....	<b>12</b>
<b>3 Description</b> .....	<b>1</b>	8.4 Device Functional Modes .....	<b>13</b>
<b>4 Revision History</b> .....	<b>2</b>	<b>9 Application and Implementation</b> .....	<b>15</b>
<b>5 Pin Configuration and Functions</b> .....	<b>3</b>	9.1 Application Information .....	<b>15</b>
<b>6 Specifications</b> .....	<b>4</b>	9.2 Typical Application .....	<b>15</b>
6.1 Absolute Maximum Ratings .....	<b>4</b>	<b>10 Power Supply Recommendations</b> .....	<b>18</b>
6.2 ESD Ratings .....	<b>4</b>	10.1 Power-On Reset Requirements .....	<b>18</b>
6.3 Recommended Operating Conditions .....	<b>4</b>	<b>11 Layout</b> .....	<b>20</b>
6.4 Thermal Information .....	<b>4</b>	11.1 Layout Guidelines .....	<b>20</b>
6.5 Electrical Characteristics .....	<b>5</b>	11.2 Layout Example .....	<b>21</b>
6.6 I <sup>2</sup> C Interface Timing Requirements .....	<b>5</b>	<b>12 Device and Documentation Support</b> .....	<b>22</b>
6.7 Switching Characteristics .....	<b>5</b>	12.1 Trademarks .....	<b>22</b>
6.8 Typical Characteristics .....	<b>6</b>	12.2 Electrostatic Discharge Caution .....	<b>22</b>
<b>7 Parameter Measurement Information</b> .....	<b>8</b>	12.3 Glossary .....	<b>22</b>
<b>8 Detailed Description</b> .....	<b>11</b>	<b>13 Mechanical, Packaging, and Orderable Information</b> .....	<b>22</b>
8.1 Overview .....	<b>11</b>		

## 4 Revision History

### Changes from Revision I (November 2015) to Revision J Page

- Corrected part number in *Device Information* table ..... **1**

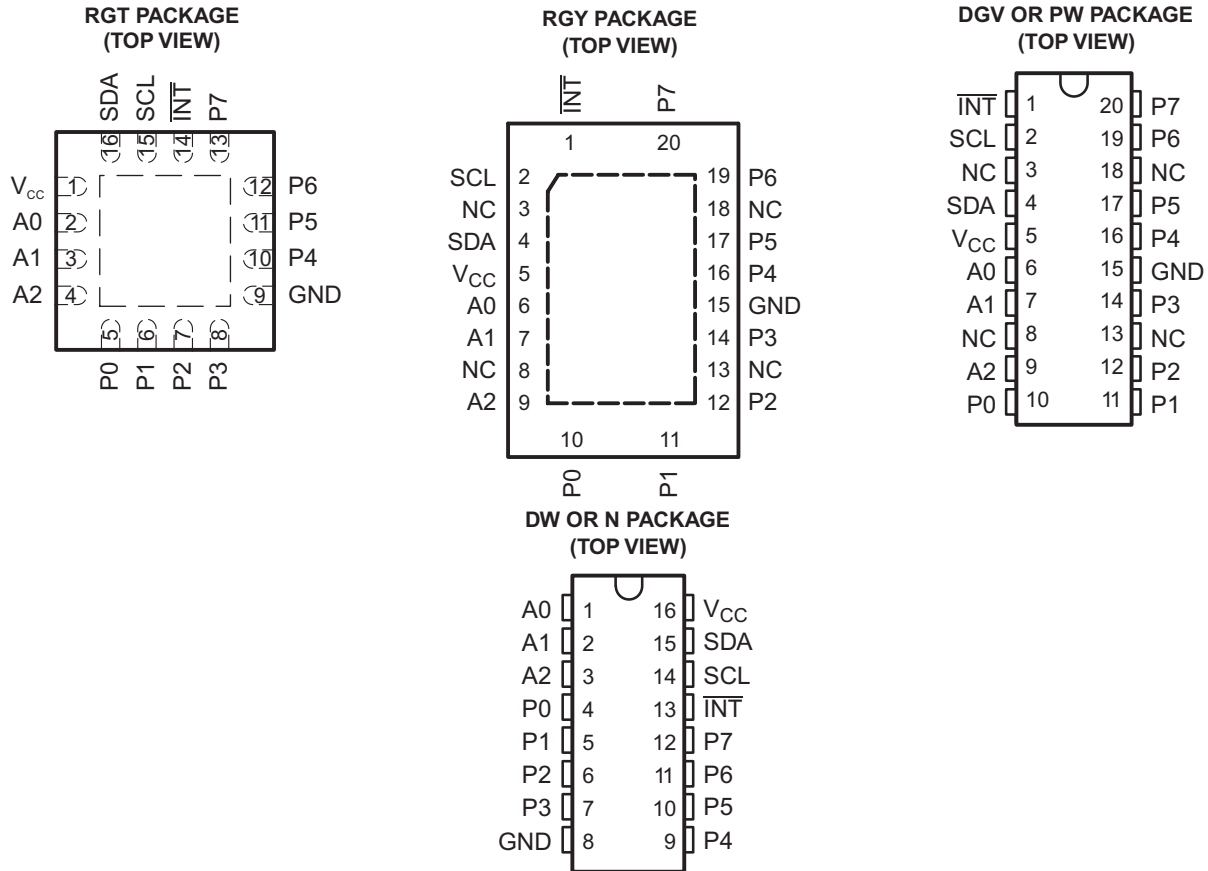
### Changes from Revision H (January 2015) to Revision I Page

- Added Junction temperature to the *Absolute Maximum Ratings* ..... **4**
- Changed Supply Current (A) To: Supply Current (μA) and  $f_{SCL} = 400$  kHz to  $f_{SCL} = 100$  kHz in [Figure 1](#) ..... **6**
- Changed Supply Current (A) To: Supply Current (μA) in [Figure 1](#) ..... **6**
- Changed Supply Current (A) To: Supply Current (μA) and  $f_{SCL} = 400$  kHz to  $f_{SCL} = 100$  kHz in [Figure 3](#) ..... **6**

### Changes from Revision G (May 2008) to Revision H Page

- Added *Applications*, *Device Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Typical Characteristics*, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. .... **1**
- Deleted *Ordering Information* table. .... **1**

## 5 Pin Configuration and Functions



### Pin Functions

NAME	PIN				TYPE	DESCRIPTION
	RGT	RGY	DGV or PW	DW or N		
A [0..2]	2, 3, 4	6, 7, 9	6, 7, 9	1, 2, 3	I	Address inputs 0 through 2. Connect directly to V <sub>CC</sub> or ground. Pullup resistors are not needed.
GND	9	15	15	8	—	Ground
$\overline{\text{INT}}$	14	1	1	13	O	Interrupt output. Connect to V <sub>CC</sub> through a pullup resistor.
NC	-	3, 8, 13, 18	3, 8, 13, 18	-	—	Do not connect
P[0..7]	5, 6, 7, 8, 10, 11, 12, 13	10, 11, 12, 14, 16, 17, 19, 20	10, 11, 12, 14, 16, 17, 19, 20	4, 5, 6, 7, 9, 10, 11, 12	I/O	P-port input/output. Push-pull design structure.
SCL	15	2	2	14	I	Serial clock line. Connect to V <sub>CC</sub> through a pullup resistor
SDA	16	4	4	15	I/O	Serial data line. Connect to V <sub>CC</sub> through a pullup resistor.
V <sub>CC</sub>	1	5	5	16	—	Voltage supply

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage range	-0.5	7	V	
V <sub>I</sub>	Input voltage range <sup>(2)</sup>	-0.5	V <sub>CC</sub> + 0.5	V	
V <sub>O</sub>	Output voltage range <sup>(2)</sup>	-0.5	V <sub>CC</sub> + 0.5	V	
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0	-20	mA	
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0	-20	mA	
I <sub>OK</sub>	Input/output clamp current	V <sub>O</sub> < 0 or V <sub>O</sub> > V <sub>CC</sub>	±400	µA	
I <sub>OL</sub>	Continuous output low current	V <sub>O</sub> = 0 to V <sub>CC</sub>	50	mA	
I <sub>OH</sub>	Continuous output high current	V <sub>O</sub> = 0 to V <sub>CC</sub>	-4	mA	
Continuous current through V <sub>CC</sub> or GND			±100	mA	
T <sub>J</sub>	Junction temperature		150	°C	
T <sub>stg</sub>	Storage temperature range		-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.

### 6.2 ESD Ratings

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	1500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	2000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

### 6.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	2.5	6	V
V <sub>IH</sub>	High-level input voltage	0.7 × V <sub>CC</sub>	V <sub>CC</sub> + 0.5	V
V <sub>IL</sub>	Low-level input voltage	-0.5	0.3 × V <sub>CC</sub>	V
I <sub>OH</sub>	High-level output current		-1	mA
I <sub>OL</sub>	Low-level output current		25	mA
T <sub>A</sub>	Operating free-air temperature	-40	85	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		PCF8574						UNIT
		DGV	DW	N	PW	RGT	RGY	
		20 PINS	16 PINS	16 PINS	20 PINS	16 PINS	20 PINS	
θ <sub>JA</sub>	Junction-to-ambient thermal resistance	92	57	67	83	53	37	°C/W

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report (SPRA953).

## 6.5 Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP <sup>(1)</sup>	MAX	UNIT
V <sub>IK</sub>	Input diode clamp voltage	I <sub>I</sub> = -18 mA	2.5 V to 6 V	-1.2			V
V <sub>POR</sub>	Power-on reset voltage <sup>(2)</sup>	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0	6 V		1.3	2.4	V
I <sub>OH</sub>	P port	V <sub>O</sub> = GND	2.5 V to 6 V	30		300	μA
I <sub>OHT</sub>	P port transient pullup current	High during acknowledge, V <sub>OH</sub> = GND	2.5 V		-1		mA
I <sub>OL</sub>	SDA	V <sub>O</sub> = 0.4 V	2.5 V to 6 V	3			mA
	P port	V <sub>O</sub> = 1 V	5 V	10	25		
	$\overline{\text{INT}}$	V <sub>O</sub> = 0.4 V	2.5 V to 6 V	1.6			
I <sub>I</sub>	SCL, SDA	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V to 6 V			±5	μA
	$\overline{\text{INT}}$					±5	
	A0, A1, A2					±5	
I <sub>IHL</sub>	P port	V <sub>I</sub> ≥ V <sub>CC</sub> or V <sub>I</sub> ≤ GND	2.5 V to 6 V			±400	μA
I <sub>CC</sub>	Operating mode	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0, f <sub>SCL</sub> = 100 kHz	6 V		40	100	μA
	Standby mode	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0			2.5	10	
C <sub>i</sub>	SCL	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V to 6 V	1.5		7	pF
C <sub>io</sub>	SDA	V <sub>IO</sub> = V <sub>CC</sub> or GND	2.5 V to 6 V		3	7	pF
	P port				4	10	

(1) All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

(2) The power-on reset circuit resets the I<sup>2</sup>C-bus logic with V<sub>CC</sub> < V<sub>POR</sub> and sets all I/Os to logic high (with current source to V<sub>CC</sub>).

## 6.6 I<sup>2</sup>C Interface Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 12)

		MIN	MAX	UNIT
f <sub>scl</sub>	I <sup>2</sup> C clock frequency		100	kHz
t <sub>sch</sub>	I <sup>2</sup> C clock high time	4		μs
t <sub>scl</sub>	I <sup>2</sup> C clock low time	4.7		μs
t <sub>sp</sub>	I <sup>2</sup> C spike time		100	ns
t <sub>sds</sub>	I <sup>2</sup> C serial data setup time	250		ns
t <sub>sdh</sub>	I <sup>2</sup> C serial data hold time	0		ns
t <sub>icr</sub>	I <sup>2</sup> C input rise time		1	μs
t <sub>icf</sub>	I <sup>2</sup> C input fall time		0.3	μs
t <sub>ocf</sub>	I <sup>2</sup> C output fall time (10-pF to 400-pF bus)		300	ns
t <sub>buf</sub>	I <sup>2</sup> C bus free time between stop and start	4.7		μs
t <sub>sts</sub>	I <sup>2</sup> C start or repeated start condition setup	4.7		μs
t <sub>sth</sub>	I <sup>2</sup> C start or repeated start condition hold	4		μs
t <sub>sps</sub>	I <sup>2</sup> C stop condition setup	4		μs
t <sub>vd</sub>	Valid data time	SCL low to SDA output valid		3.4 μs
C <sub>b</sub>	I <sup>2</sup> C bus capacitive load		400	pF

## 6.7 Switching Characteristics

over recommended operating free-air temperature range, C<sub>L</sub> ≤ 100 pF (unless otherwise noted) (see Figure 13)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
t <sub>pV</sub>	Output data valid	P port		4	μs
t <sub>sU</sub>	Input data setup time	SCL	0		μs
t <sub>h</sub>	Input data hold time	SCL	4		μs
t <sub>iV</sub>	Interrupt valid time	$\overline{\text{INT}}$		4	μs
t <sub>iR</sub>	Interrupt reset delay time	$\overline{\text{INT}}$		4	μs

## 6.8 Typical Characteristics

T<sub>A</sub> = 25°C (unless otherwise noted)

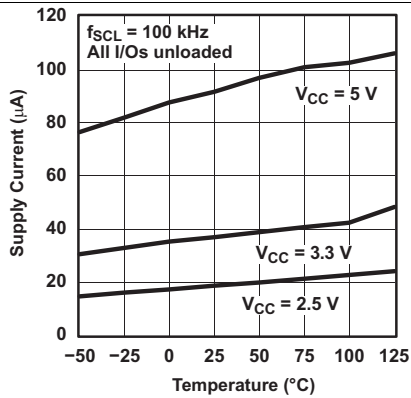


Figure 1. Supply Current vs Temperature

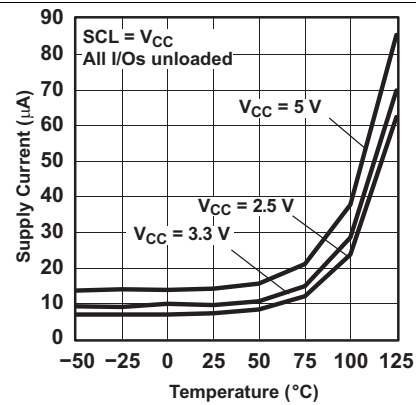


Figure 2. Standby Supply Current vs Temperature

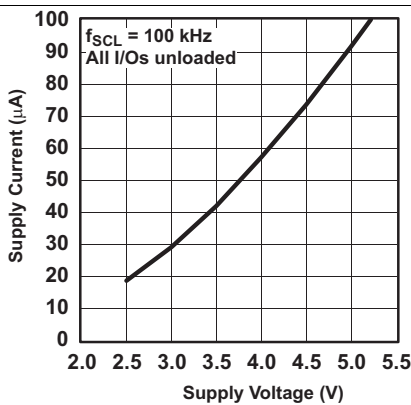


Figure 3. Supply Current vs Supply Voltage

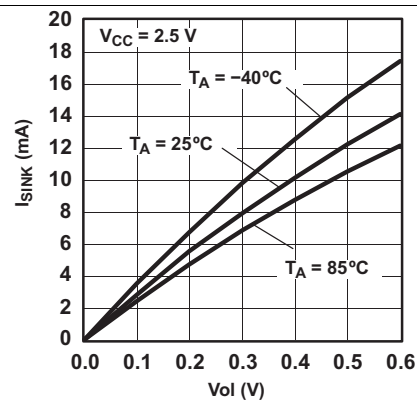


Figure 4. I/O Sink Current vs Output Low Voltage

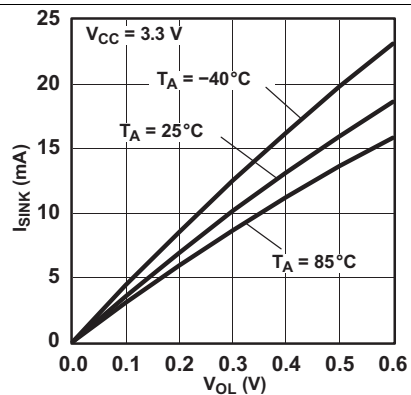


Figure 5. I/O Sink Current vs Output Low Voltage

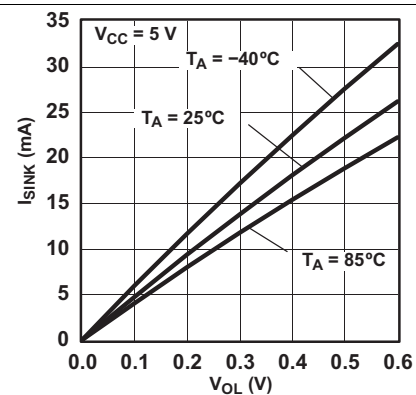


Figure 6. I/O Sink Current vs Output Low Voltage

Typical Characteristics (continued)

T<sub>A</sub> = 25°C (unless otherwise noted)

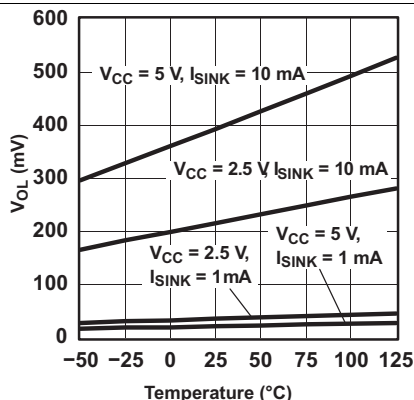


Figure 7. I/O Output Low Voltage vs Temperature

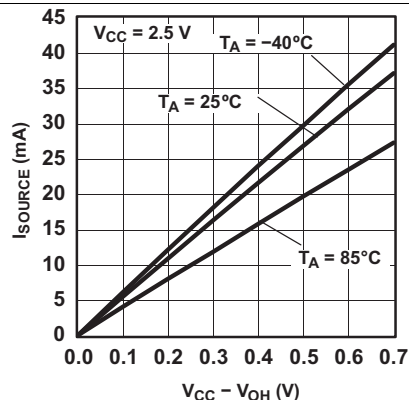


Figure 8. I/O Source Current vs Output High Voltage

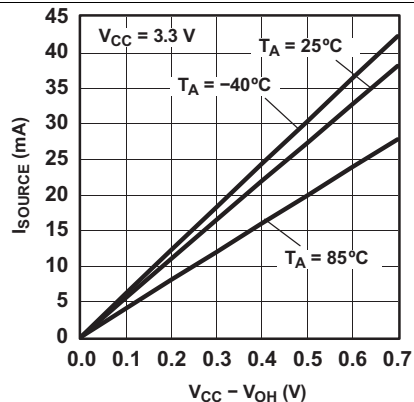


Figure 9. I/O Source Current vs Output High Voltage

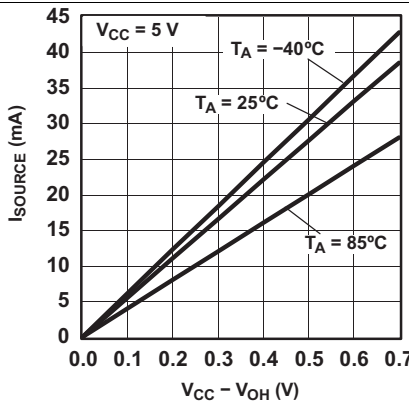


Figure 10. I/O Source Current vs Output High Voltage

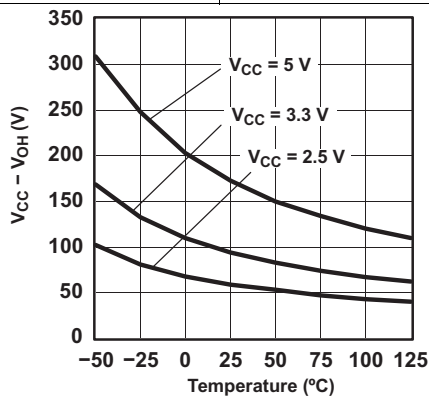


Figure 11. I/O High Voltage vs Temperature





Parameter Measurement Information (continued)

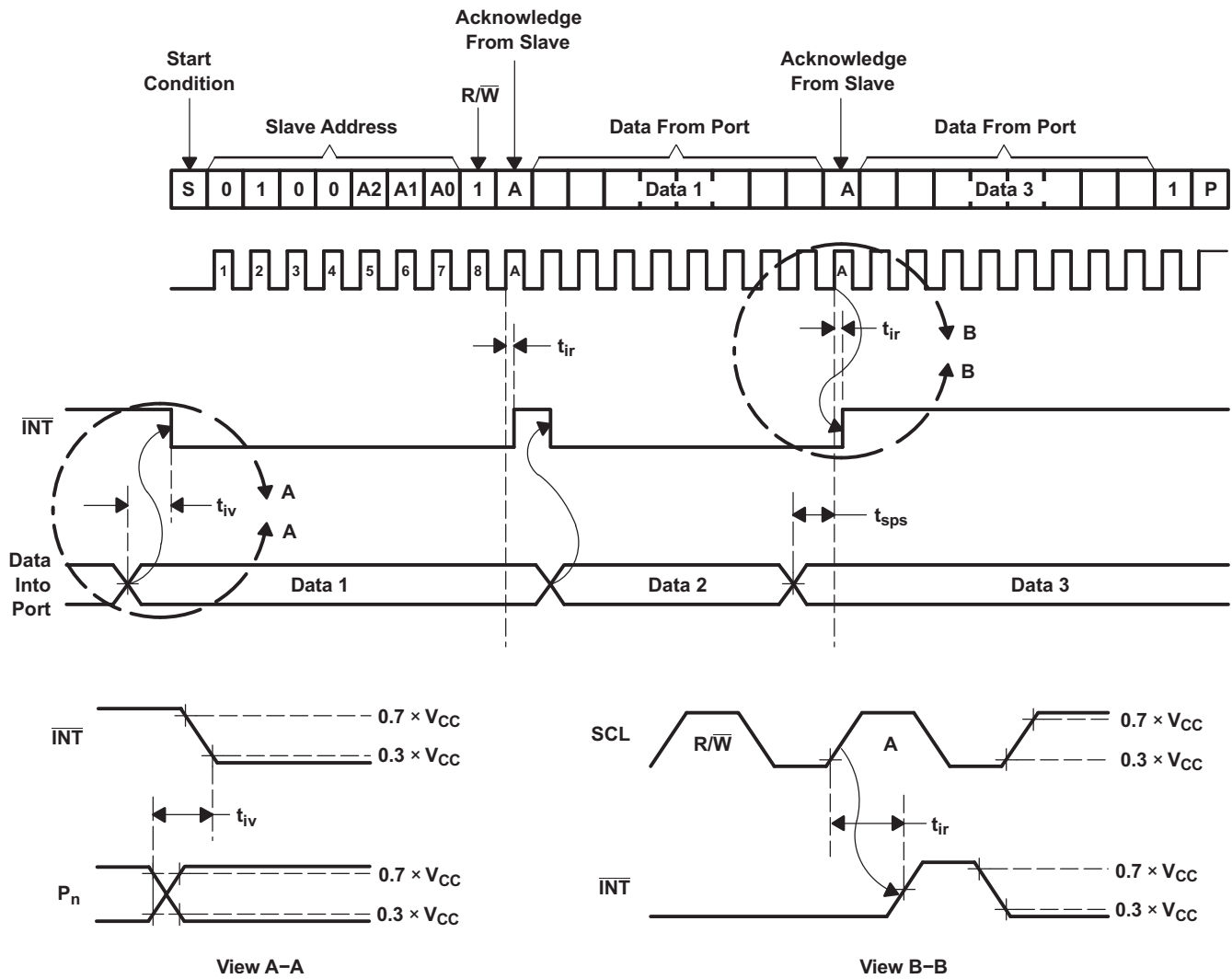


Figure 13. Interrupt Voltage Waveforms

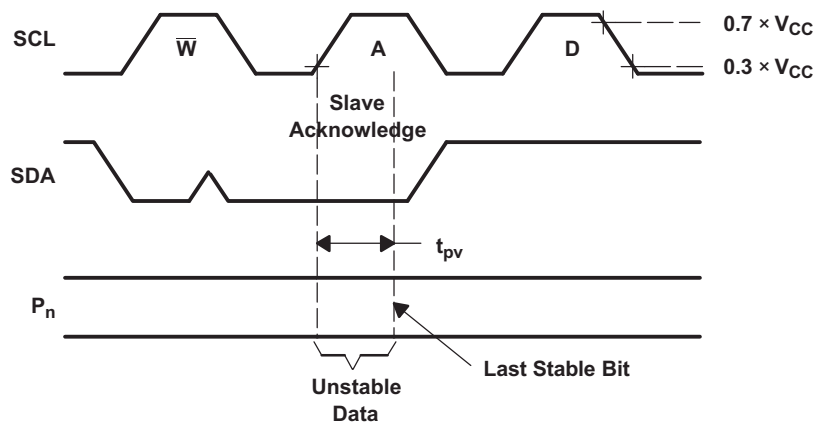
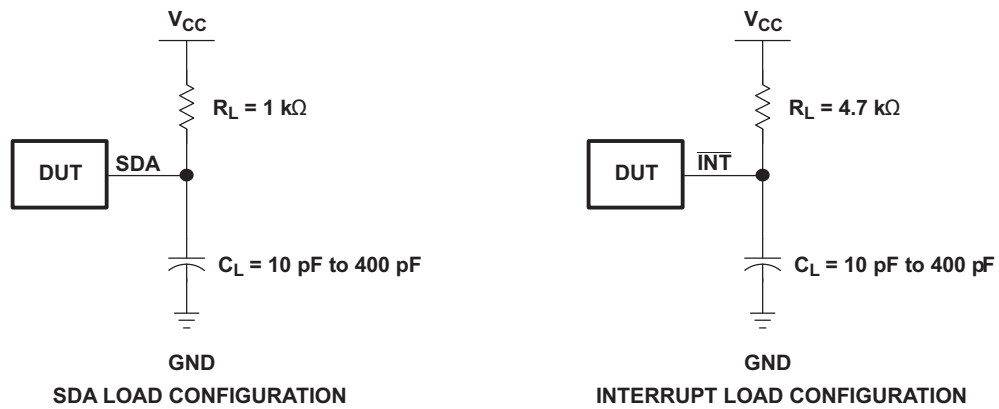


Figure 14. I<sup>2</sup>C Write Voltage Waveforms

**Parameter Measurement Information (continued)**

**Figure 15. Load Circuits**

## 8 Detailed Description

### 8.1 Overview

The PCF8574 device is an 8-bit I/O expander for the two-line bidirectional bus (I<sup>2</sup>C) is designed for 2.5-V to 5.5-V V<sub>CC</sub> operation. It provides general-purpose remote I/O expansion for most micro-controller families via the I<sup>2</sup>C interface (serial clock, SCL, and serial data, SDA, pins).

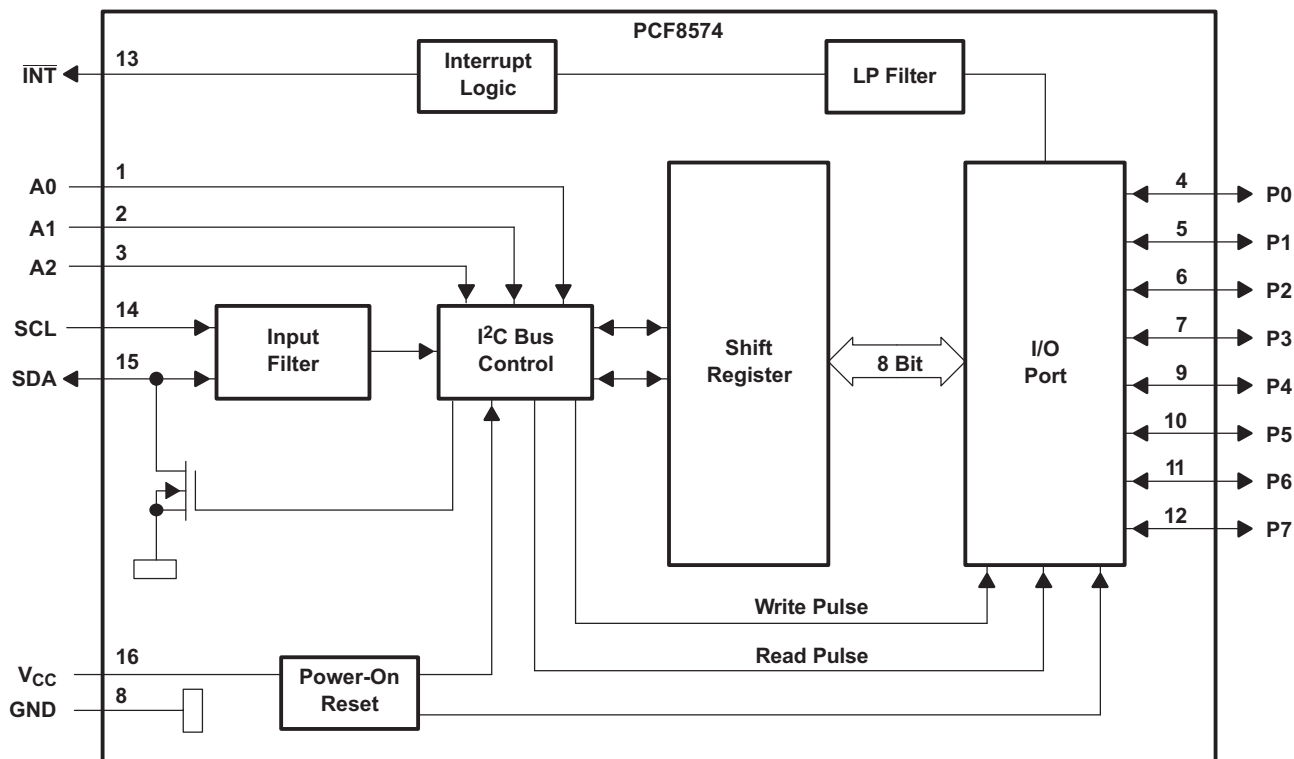
The PCF8574 device provides an open-drain output ( $\overline{\text{INT}}$ ) that can be connected to the interrupt input of a microcontroller. An interrupt is generated by any rising or falling edge of the port inputs in the input mode. After time, t<sub>v</sub>,  $\overline{\text{INT}}$  is valid. Resetting and reactivating the interrupt circuit is achieved when data on the port is changed to the original setting or data is read from, or written to, the port that generated the interrupt. Resetting occurs in the read mode at the acknowledge bit after the rising edge of the SCL signal, or in the write mode at the acknowledge bit after the high-to-low transition of the SCL signal. Interrupts that occur during the acknowledge clock pulse can be lost (or be very short) due to the resetting of the interrupt during this pulse. Each change of the I/Os after resetting is detected and, after the next rising clock edge, is transmitted as  $\overline{\text{INT}}$ . Reading from, or writing to, another device does not affect the interrupt circuit. This device does not have internal configuration or status registers. Instead, read or write to the device I/Os directly after sending the device address (see Figure 16 and Figure 17).

By sending an interrupt signal on this line, the remote I/O can inform the microcontroller if there is incoming data on its ports without having to communicate by way of the I<sup>2</sup>C bus. Therefore, PCF8574 can remain a simple slave device.

An additional strong pullup to V<sub>CC</sub> allows fast rising edges into heavily loaded outputs. This device turns on when an output is written high and is switched off by the negative edge of SCL. The I/Os should be high before being used as inputs.

### 8.2 Functional Block Diagram

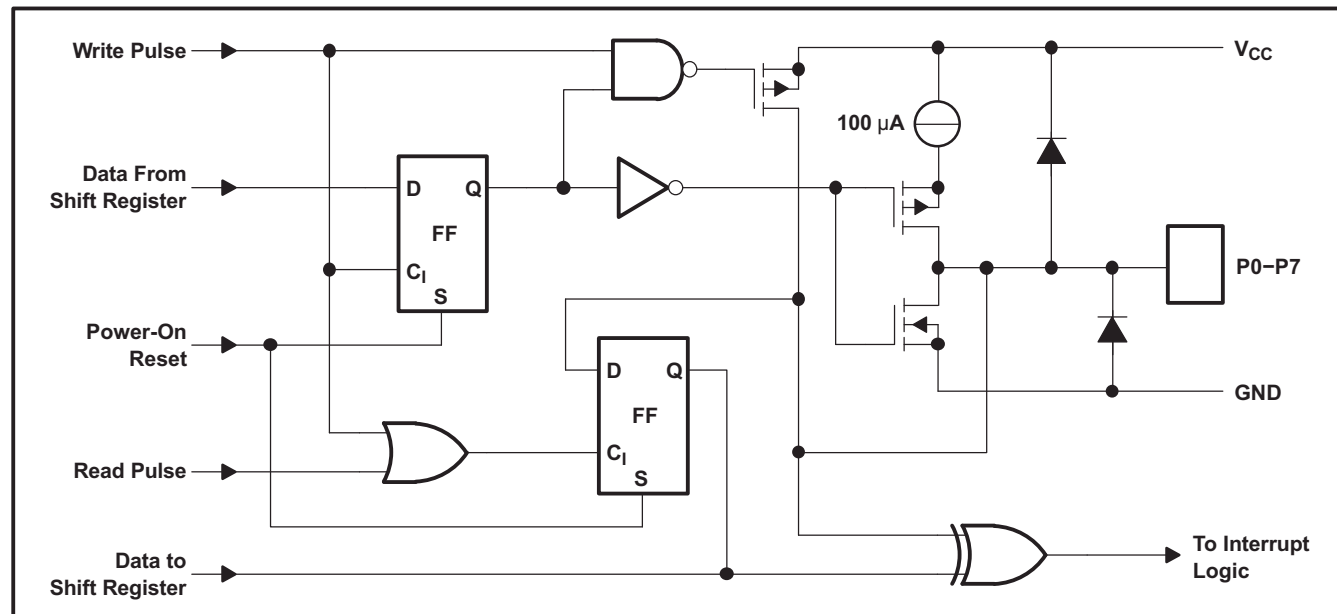
#### 8.2.1 Simplified Block Diagram of Device



Pin numbers shown are for the DW and N packages.

## Functional Block Diagram (continued)

### 8.2.2 Simplified Schematic Diagram of Each P-Port Input/Output



## 8.3 Feature Description

### 8.3.1 I<sup>2</sup>C Interface

I<sup>2</sup>C communication with this device is initiated by a master sending a start condition, a high-to-low transition on the SDA I/O while the SCL input is high. After the start condition, the device address byte is sent, most-significant bit (MSB) first, including the data direction bit (R/W). This device does not respond to the general call address. After receiving the valid address byte, this device responds with an acknowledge, a low on the SDA I/O during the high of the acknowledge-related clock pulse. The address inputs (A0–A2) of the slave device must not be changed between the start and the stop conditions.

The data byte follows the address acknowledge. If the R/W bit is high, the data from this device are the values read from the P port. If the R/W bit is low, the data are from the master, to be output to the P port. The data byte is followed by an acknowledge sent from this device. If other data bytes are sent from the master, following the acknowledge, they are ignored by this device. Data are output only if complete bytes are received and acknowledged. The output data will be valid at time,  $t_{pv}$ , after the low-to-high transition of SCL and during the clock cycle for the acknowledge.

A stop condition, which is a low-to-high transition on the SDA I/O while the SCL input is high, is sent by the master.

### 8.3.2 Interface Definition

BYTE	BIT							
	7 (MSB)	6	5	4	3	2	1	0 (LSB)
I <sup>2</sup> C slave address	L	H	L	L	A2	A1	A0	R/W
I/O data bus	P7	P6	P5	P4	P3	P2	P1	P0

### 8.3.3 Address Reference

INPUTS			I <sup>2</sup> C BUS SLAVE 8-BIT READ ADDRESS	I <sup>2</sup> C BUS SLAVE 8-BIT WRITE ADDRESS
A2	A1	A0		
L	L	L	65 (decimal), 41 (hexadecimal)	64 (decimal), 40 (hexadecimal)
L	L	H	67 (decimal), 43 (hexadecimal)	66 (decimal), 42 (hexadecimal)
L	H	L	69 (decimal), 45 (hexadecimal)	68 (decimal), 44 (hexadecimal)
L	H	H	71 (decimal), 47 (hexadecimal)	70 (decimal), 46 (hexadecimal)
H	L	L	73 (decimal), 49 (hexadecimal)	72 (decimal), 48 (hexadecimal)
H	L	H	75 (decimal), 4B (hexadecimal)	74 (decimal), 4A (hexadecimal)
H	H	L	77 (decimal), 4D (hexadecimal)	76 (decimal), 4C (hexadecimal)
H	H	H	79 (decimal), 4F (hexadecimal)	78 (decimal), 4E (hexadecimal)

### 8.4 Device Functional Modes

Figure 16 and Figure 17 show the address and timing diagrams for the write and read modes, respectively.

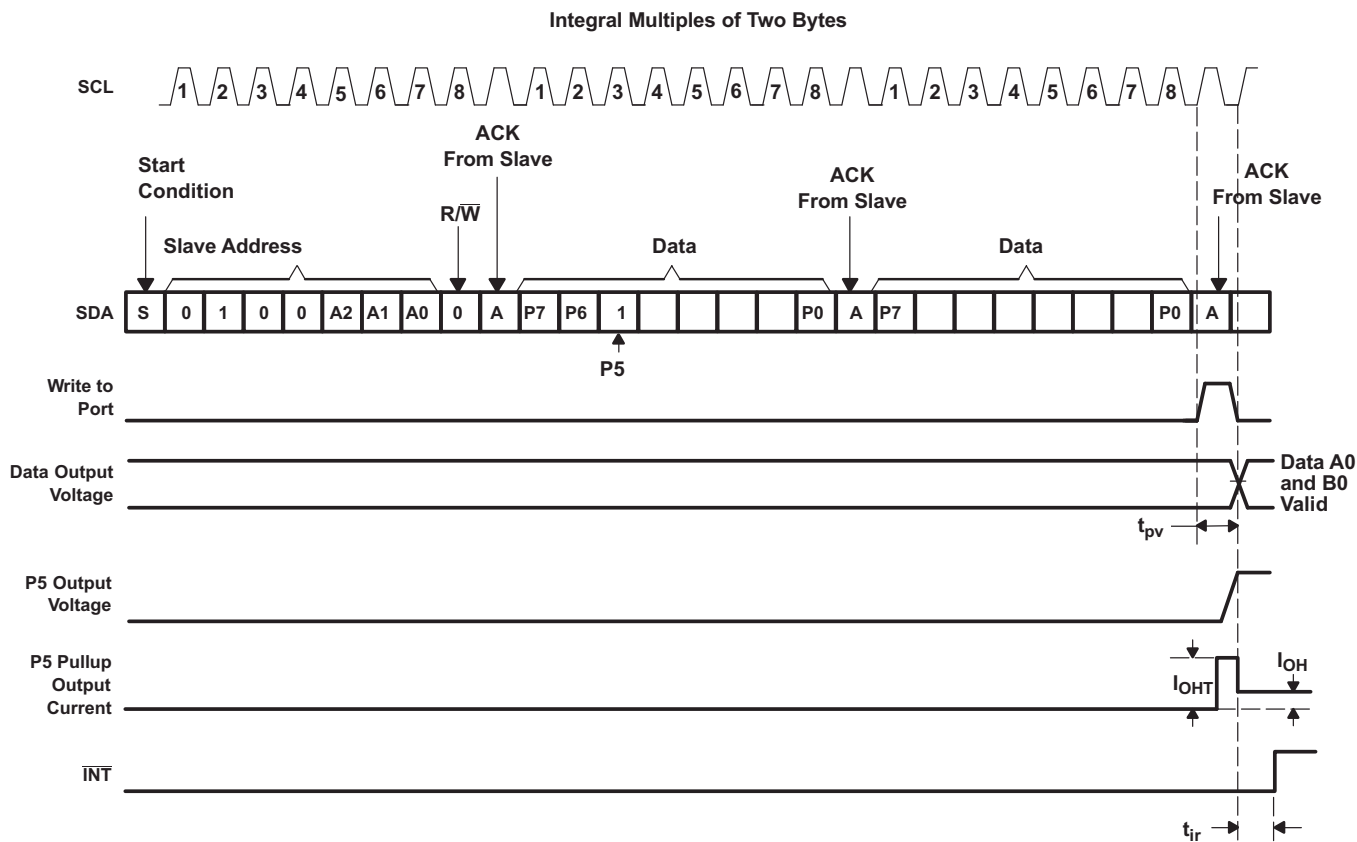
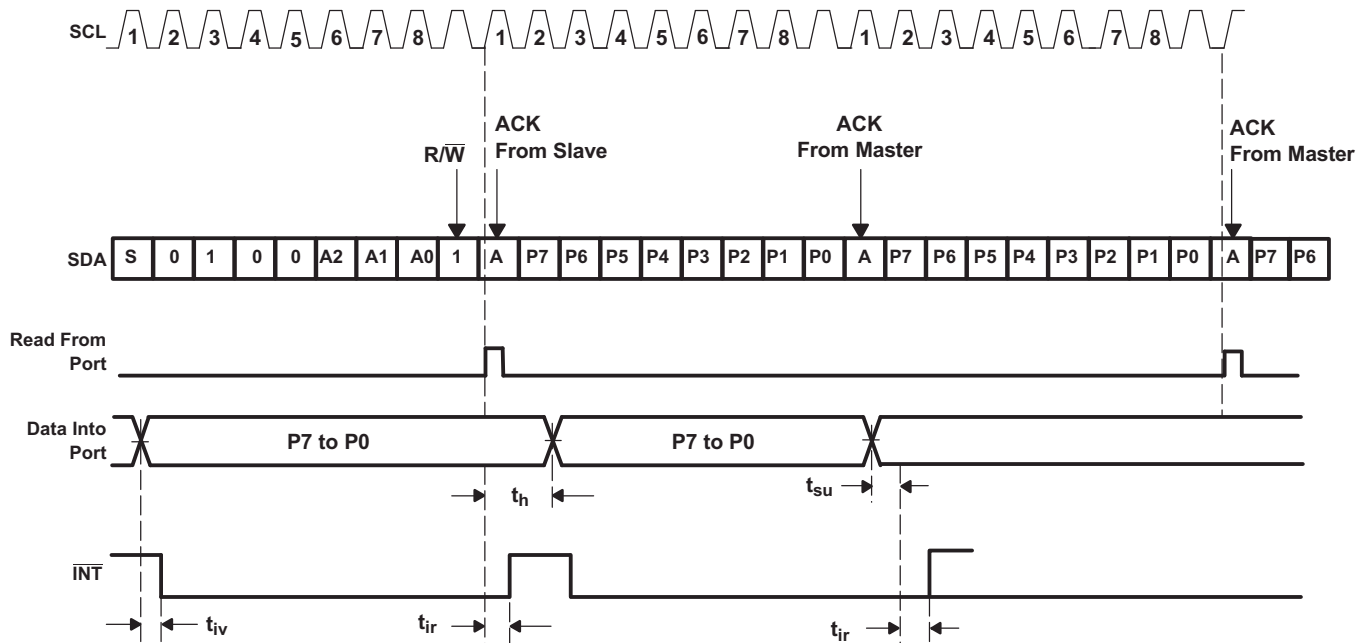


Figure 16. Write Mode (Output)

**Device Functional Modes (continued)**


- A. A low-to-high transition of SDA while SCL is high is defined as the stop condition (P). The transfer of data can be stopped at any moment by a stop condition. When this occurs, data present at the latest ACK phase is valid (output mode). Input data is lost.

**Figure 17. Read Mode (Input)**

## 9 Application and Implementation

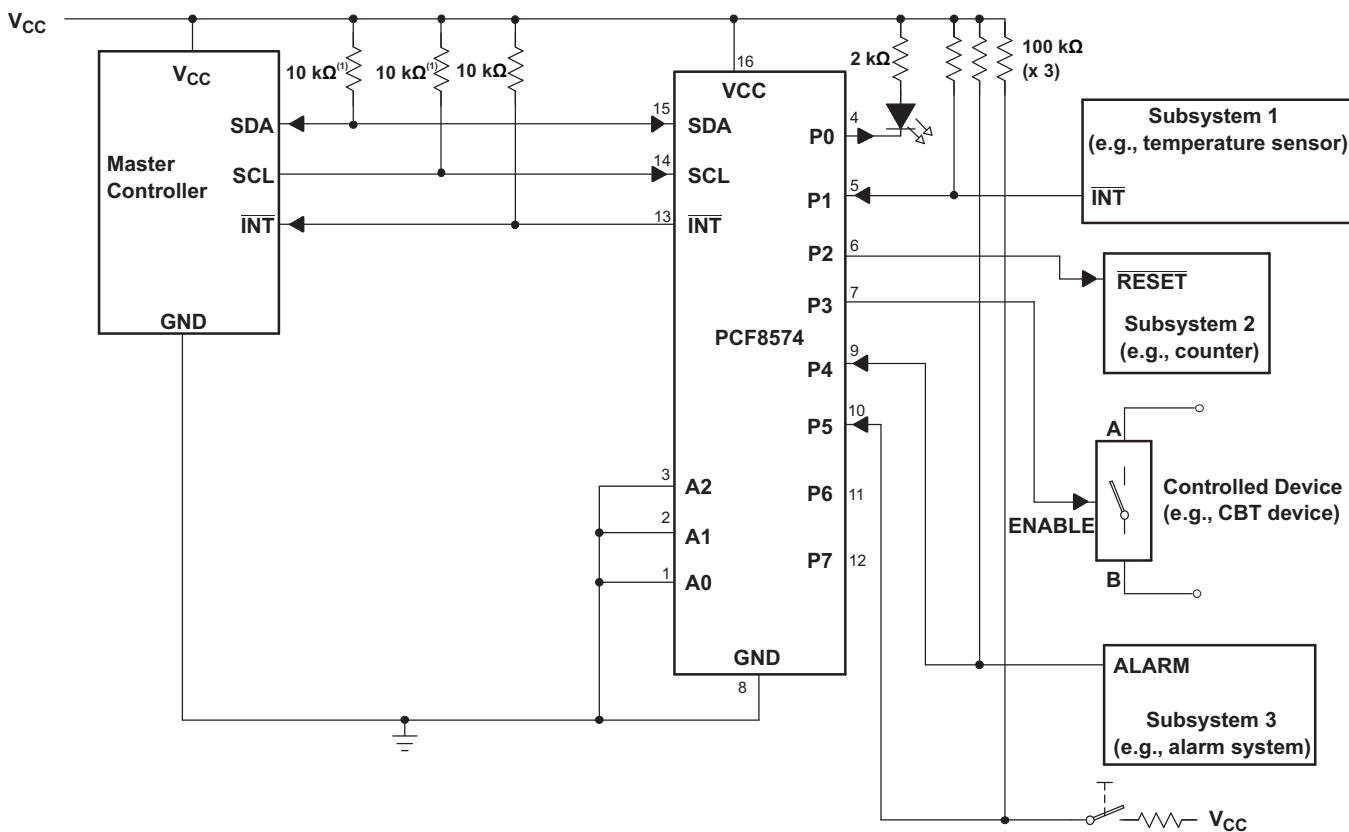
### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

Figure 18 shows an application in which the PCF8574 device can be used.

### 9.2 Typical Application



- (1) The SCL and SDA pins must be tied directly to  $V_{CC}$  because if SCL and SDA are tied to an auxiliary power supply that could be powered on while  $V_{CC}$  is powered off, then the supply current,  $I_{CC}$ , will increase as a result.
- A. Device address is configured as 0100000 for this example.
- B. P0, P2, and P3 are configured as outputs.
- C. P1, P4, and P5 are configured as inputs.
- D. P6 and P7 are not used and must be configured as outputs.

Figure 18. Application Schematic

## Typical Application (continued)

### 9.2.1 Design Requirements

#### 9.2.1.1 Minimizing $I_{CC}$ When I/Os Control LEDs

When the I/Os are used to control LEDs, normally they are connected to  $V_{CC}$  through a resistor as shown in Figure 18. For a P-port configured as an input,  $I_{CC}$  increases as  $V_I$  becomes lower than  $V_{CC}$ . The LED is a diode, with threshold voltage  $V_T$ , and when a P-port is configured as an input the LED will be off but  $V_I$  is a  $V_T$  drop below  $V_{CC}$ .

For battery-powered applications, it is essential that the voltage of P-ports controlling LEDs is greater than or equal to  $V_{CC}$  when the P-ports are configured as input to minimize current consumption. Figure 19 shows a high-value resistor in parallel with the LED. Figure 20 shows  $V_{CC}$  less than the LED supply voltage by at least  $V_T$ . Both of these methods maintain the I/O  $V_I$  at or above  $V_{CC}$  and prevents additional supply current consumption when the P-port is configured as an input and the LED is off.

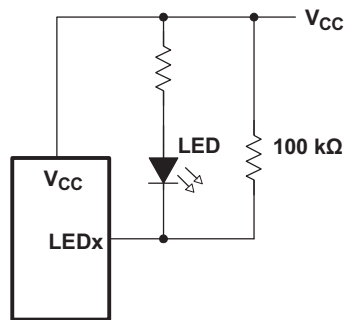


Figure 19. High-Value Resistor in Parallel With LED

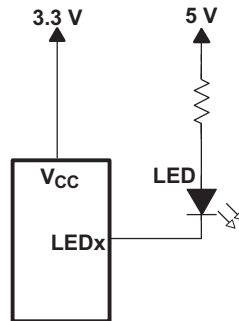


Figure 20. Device Supplied by a Lower Voltage



## Typical Application (continued)

### 9.2.2 Detailed Design Procedure

The pull-up resistors,  $R_p$ , for the SCL and SDA lines need to be selected appropriately and take into consideration the total capacitance of all slaves on the I<sup>2</sup>C bus. The minimum pull-up resistance is a function of  $V_{CC}$ ,  $V_{OL(max)}$ , and  $I_{OL}$ :

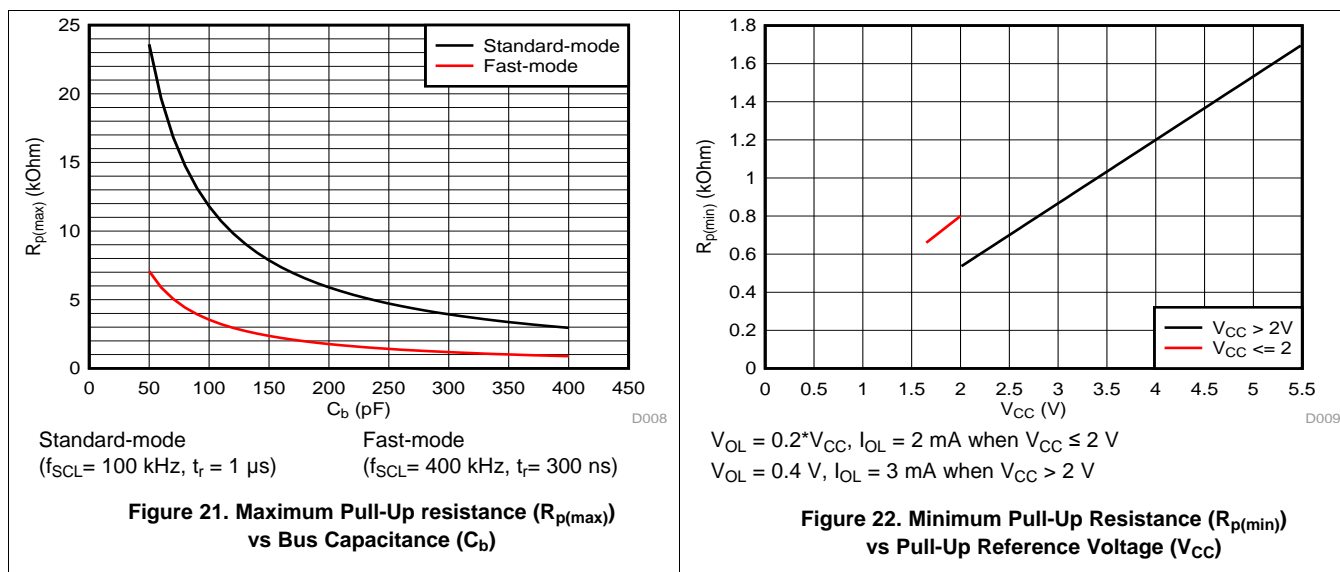
$$R_{p(min)} = \frac{V_{CC} - V_{OL(max)}}{I_{OL}} \tag{1}$$

The maximum pull-up resistance is a function of the maximum rise time,  $t_r$  (300 ns for fast-mode operation,  $f_{SCL} = 400$  kHz) and bus capacitance,  $C_b$ :

$$R_{p(max)} = \frac{t_r}{0.8473 \times C_b} \tag{2}$$

The maximum bus capacitance for an I<sup>2</sup>C bus must not exceed 400 pF for standard-mode or fast-mode operation. The bus capacitance can be approximated by adding the capacitance of the PCF8574 device,  $C_i$  for SCL or  $C_{i0}$  for SDA, the capacitance of wires/connections/traces, and the capacitance of additional slaves on the bus.

### 9.2.3 Application Curves

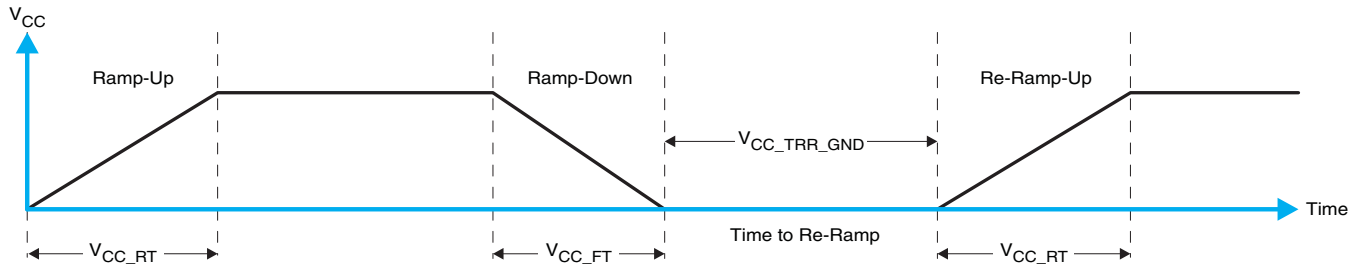


## 10 Power Supply Recommendations

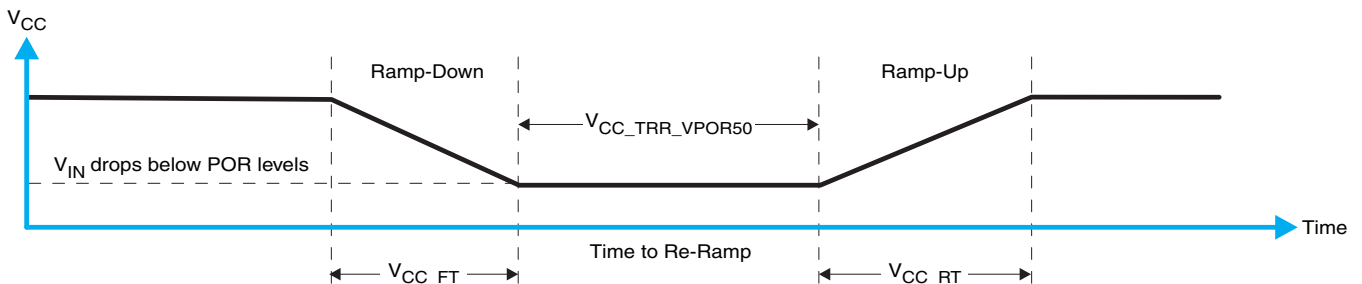
### 10.1 Power-On Reset Requirements

In the event of a glitch or data corruption, the PCF8574 device can be reset to its default conditions by using the power-on reset feature. Power-on reset requires that the device go through a power cycle to be completely reset. This reset also happens when the device is powered on for the first time in an application.

The two types of power-on reset are shown in [Figure 23](#) and [Figure 24](#).



**Figure 23.  $V_{CC}$  is Lowered Below 0.2 V or 0 V and Then Ramped Up to  $V_{CC}$**



**Figure 24.  $V_{CC}$  is Lowered Below the POR Threshold, Then Ramped Back Up to  $V_{CC}$**

[Table 1](#) specifies the performance of the power-on reset feature for PCF8574 for both types of power-on reset.

**Table 1. Recommended Supply Sequencing and Ramp Rates<sup>(1)</sup>**

PARAMETER			MIN	TYP	MAX	UNIT
$V_{CC\_FT}$	Fall rate	See <a href="#">Figure 23</a>	1	100		ms
$V_{CC\_RT}$	Rise rate	See <a href="#">Figure 23</a>	0.01	100		ms
$V_{CC\_TRR\_GND}$	Time to re-ramp (when $V_{CC}$ drops to GND)	See <a href="#">Figure 23</a>	0.001			ms
$V_{CC\_TRR\_POR50}$	Time to re-ramp (when $V_{CC}$ drops to $V_{POR\_MIN} - 50$ mV)	See <a href="#">Figure 24</a>	0.001			ms
$V_{CC\_GH}$	Level that $V_{CCP}$ can glitch down to, but not cause a functional disruption when $V_{CCX\_GW} = 1$ $\mu$ s	See <a href="#">Figure 25</a>			1.2	V
$V_{CC\_GW}$	Glitch width that will not cause a functional disruption when $V_{CCX\_GH} = 0.5 \times V_{CCx}$	See <a href="#">Figure 25</a>				$\mu$ s
$V_{PORF}$	Voltage trip point of POR on falling $V_{CC}$		0.767	1.144		V
$V_{PORR}$	Voltage trip point of POR on rising $V_{CC}$		1.033	1.428		V

(1)  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted)

Glitches in the power supply can also affect the power-on reset performance of this device. The glitch width ( $V_{CC\_GW}$ ) and height ( $V_{CC\_GH}$ ) are dependent on each other. The bypass capacitance, source impedance, and device impedance are factors that affect power-on reset performance. Figure 25 and Table 1 provide more information on how to measure these specifications.



Figure 25. Glitch Width and Glitch Height

$V_{POR}$  is critical to the power-on reset.  $V_{POR}$  is the voltage level at which the reset condition is released and all the registers and the I<sup>2</sup>C/SMBus state machine are initialized to their default states. The value of  $V_{POR}$  differs based on the  $V_{CC}$  being lowered to or from 0. Figure 26 and Table 1 provide more details on this specification.

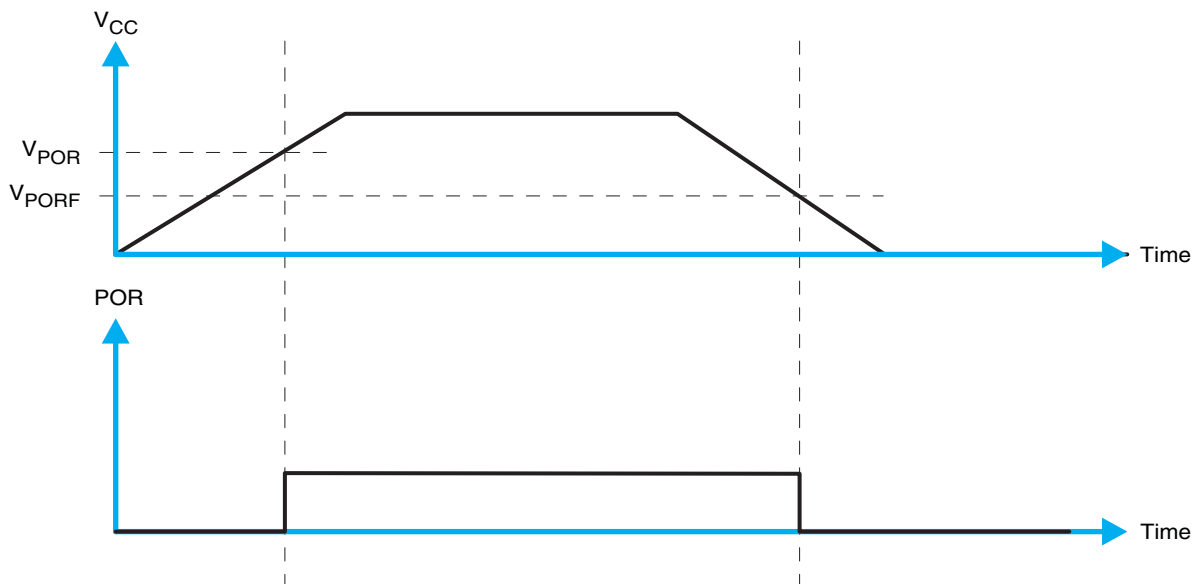


Figure 26.  $V_{POR}$

## 11 Layout

### 11.1 Layout Guidelines

For printed circuit board (PCB) layout of the PCF8574 device, common PCB layout practices should be followed but additional concerns related to high-speed data transfer such as matched impedances and differential pairs are not a concern for I2C signal speeds.

In all PCB layouts, it is a best practice to avoid right angles in signal traces, to fan out signal traces away from each other upon leaving the vicinity of an integrated circuit (IC), and to use thicker trace widths to carry higher amounts of current that commonly pass through power and ground traces. By-pass and de-coupling capacitors are commonly used to control the voltage on the VCC pin, using a larger capacitor to provide additional power in the event of a short power supply glitch and a smaller capacitor to filter out high-frequency ripple. These capacitors should be placed as close to the PCF8574 device as possible. These best practices are shown in [Figure 27](#).

For the layout example provided in [Figure 27](#), it would be possible to fabricate a PCB with only 2 layers by using the top layer for signal routing and the bottom layer as a split plane for power (VCC) and ground (GND). However, a 4 layer board is preferable for boards with higher density signal routing. On a 4 layer PCB, it is common to route signals on the top and bottom layer, dedicate one internal layer to a ground plane, and dedicate the other internal layer to a power plane. In a board layout using planes or split planes for power and ground, vias are placed directly next to the surface mount component pad which needs to attach to VCC or GND and the via is connected electrically to the internal layer or the other side of the board. Vias are also used when a signal trace needs to be routed to the opposite side of the board, but this technique is not demonstrated in [Figure 27](#).

### 11.2 Layout Example

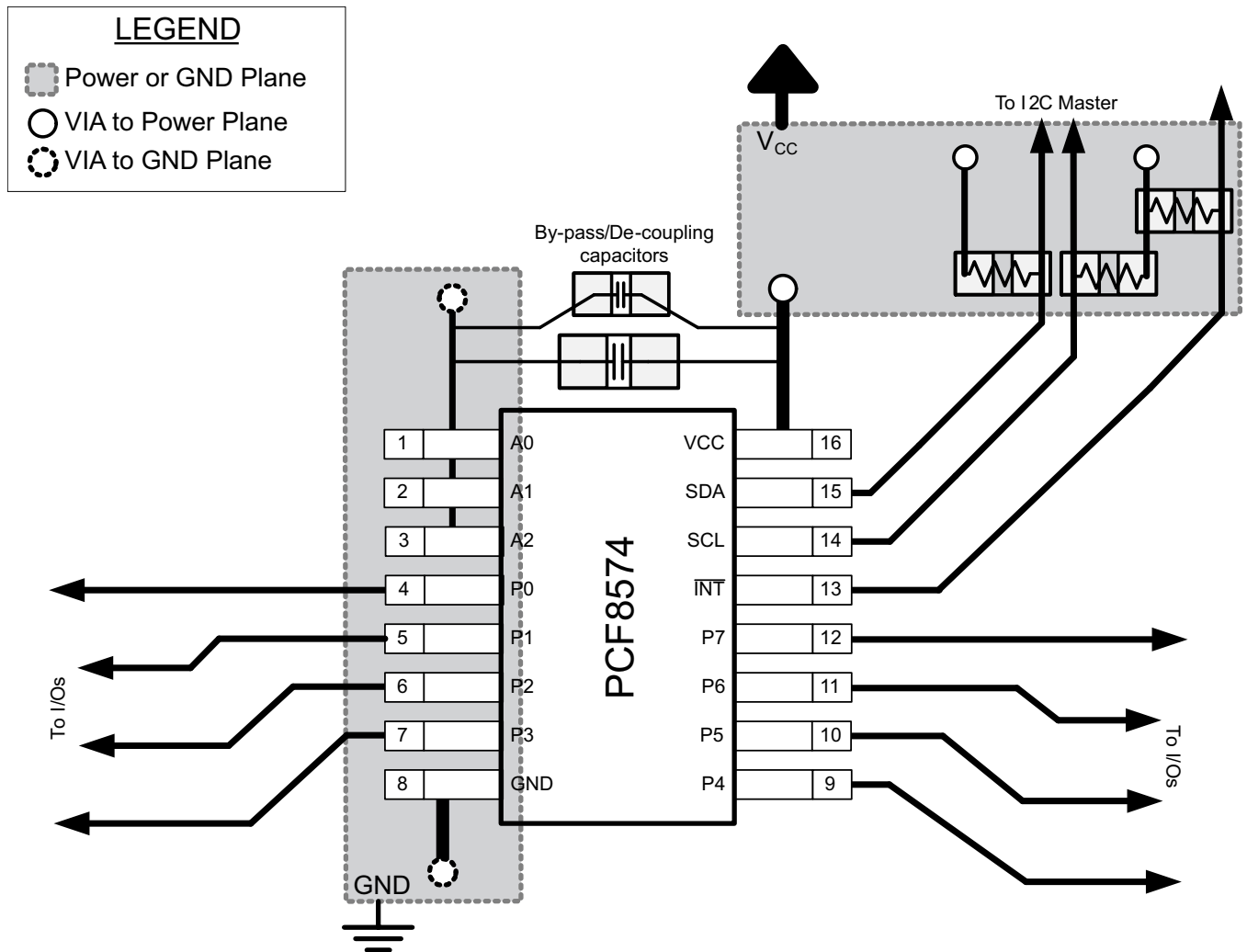


Figure 27. Layout Example for PCF8574

## 12 Device and Documentation Support

### 12.1 Trademarks

All trademarks are the property of their respective owners.

### 12.2 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 12.3 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PCF8574DGVR	ACTIVE	TVSOP	DGV	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574DGVRG4	ACTIVE	TVSOP	DGV	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574DW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8574	<a href="#">Samples</a>
PCF8574DWE4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8574	<a href="#">Samples</a>
PCF8574DWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8574	<a href="#">Samples</a>
PCF8574DWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8574	<a href="#">Samples</a>
PCF8574DWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8574	<a href="#">Samples</a>
PCF8574DWRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8574	<a href="#">Samples</a>
PCF8574N	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	PCF8574N	<a href="#">Samples</a>
PCF8574NE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	PCF8574N	<a href="#">Samples</a>
PCF8574PW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574PWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574PWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574PWRE4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574PWRG4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF574	<a href="#">Samples</a>
PCF8574RGTR	ACTIVE	QFN	RGT	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ZWJ	<a href="#">Samples</a>
PCF8574RGYR	ACTIVE	VQFN	RGY	20	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PF574	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PCF8574RGYRG4	ACTIVE	VQFN	RGY	20	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PF574	<b>Samples</b>

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

**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.

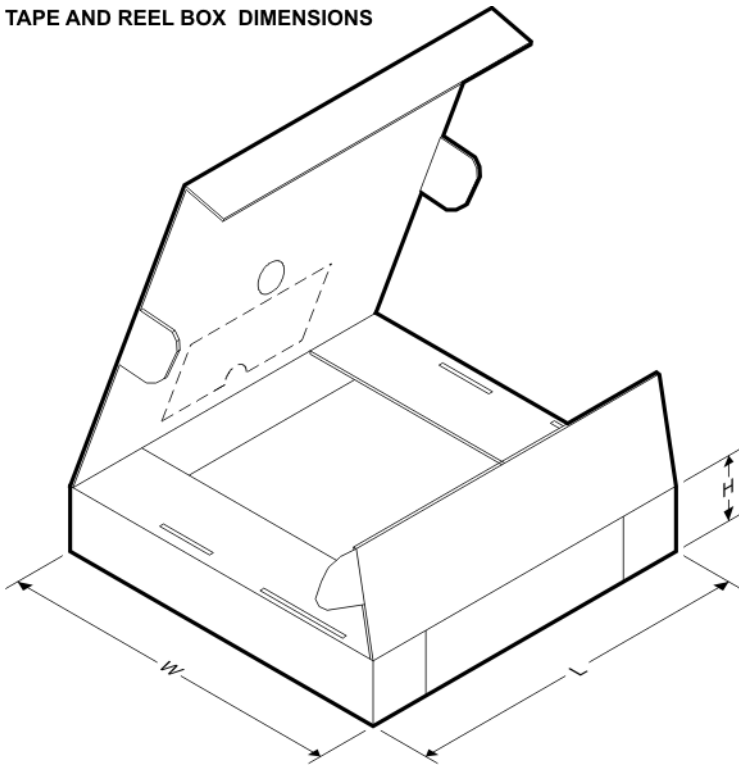


**TAPE AND REEL INFORMATION**

**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
PCF8574DGVR	TVSOP	DGV	20	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
PCF8574DWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
PCF8574DWRG4	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
PCF8574PWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
PCF8574RGTR	QFN	RGT	16	3000	330.0	12.4	3.3	3.3	1.0	8.0	12.0	Q2
PCF8574RGYR	VQFN	RGY	20	3000	330.0	12.4	3.8	4.8	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
PCF8574DGVR	TVSOP	DGV	20	2000	367.0	367.0	35.0
PCF8574DWR	SOIC	DW	16	2000	367.0	367.0	38.0
PCF8574DWRG4	SOIC	DW	16	2000	367.0	367.0	38.0
PCF8574PWR	TSSOP	PW	20	2000	367.0	367.0	38.0
PCF8574RGTR	QFN	RGT	16	3000	346.0	346.0	35.0
PCF8574RGYR	VQFN	RGY	20	3000	367.0	367.0	35.0

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

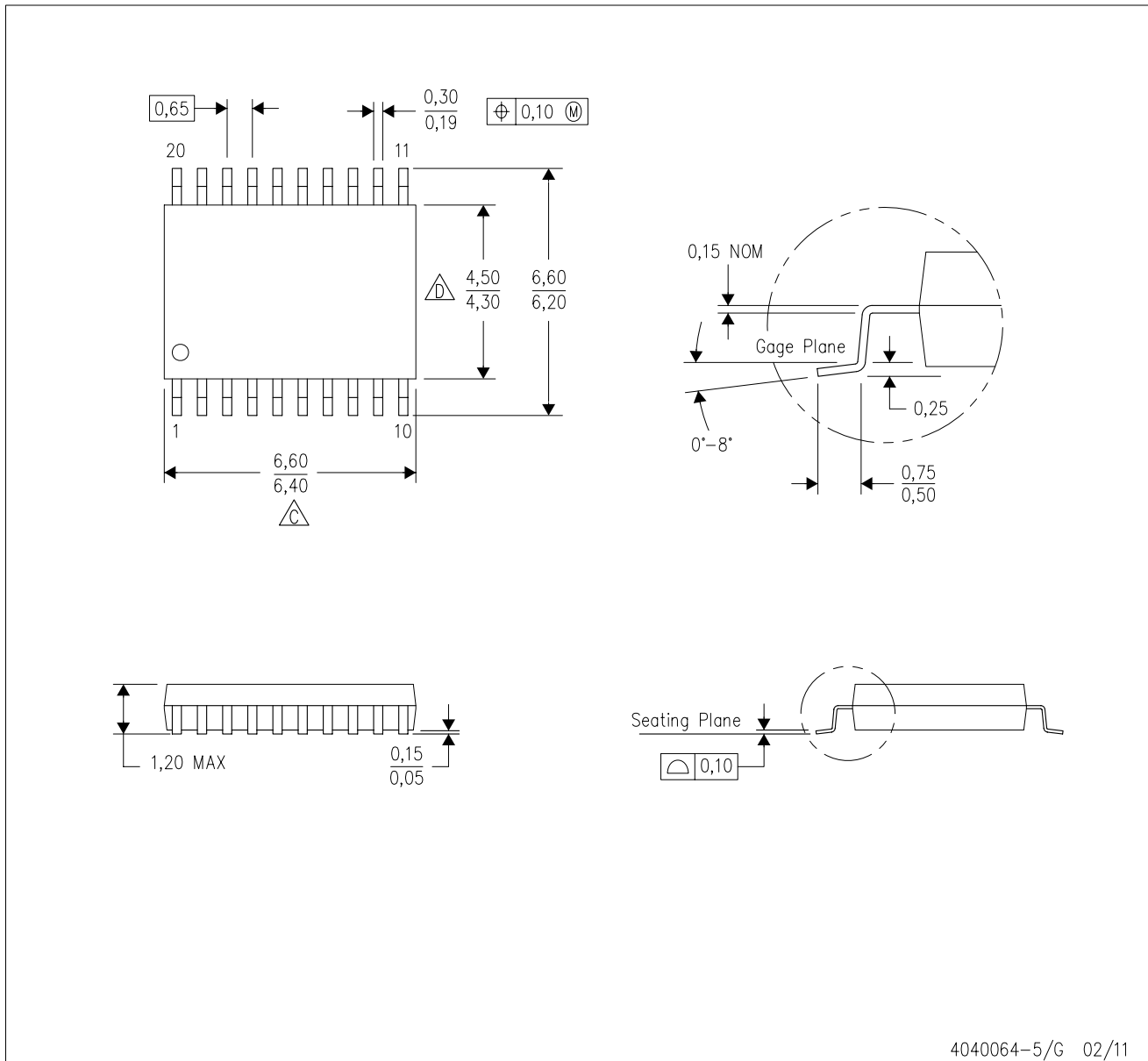
16 PINS SHOWN





- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE

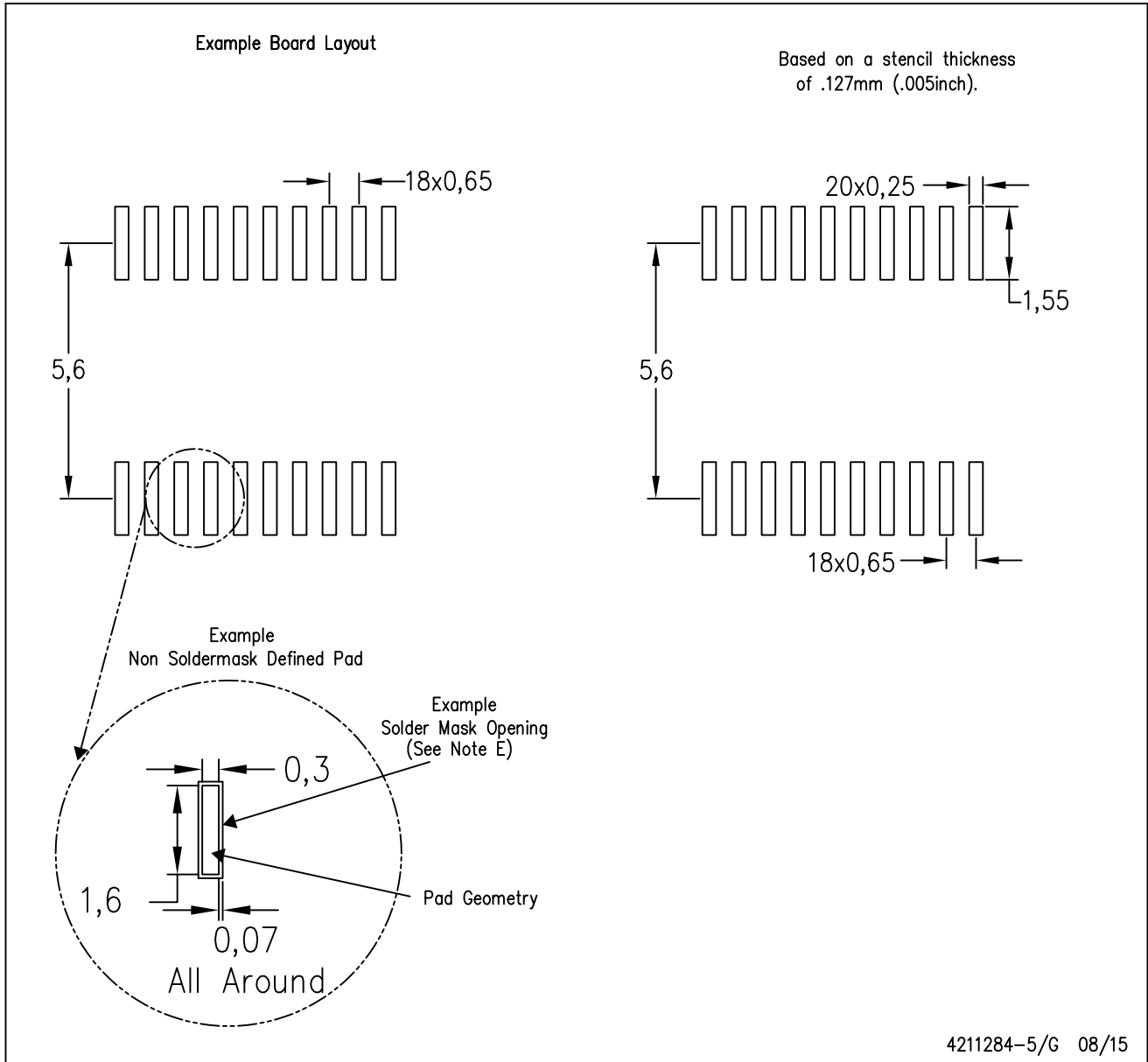


4040064-5/G 02/11

- 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.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G20)

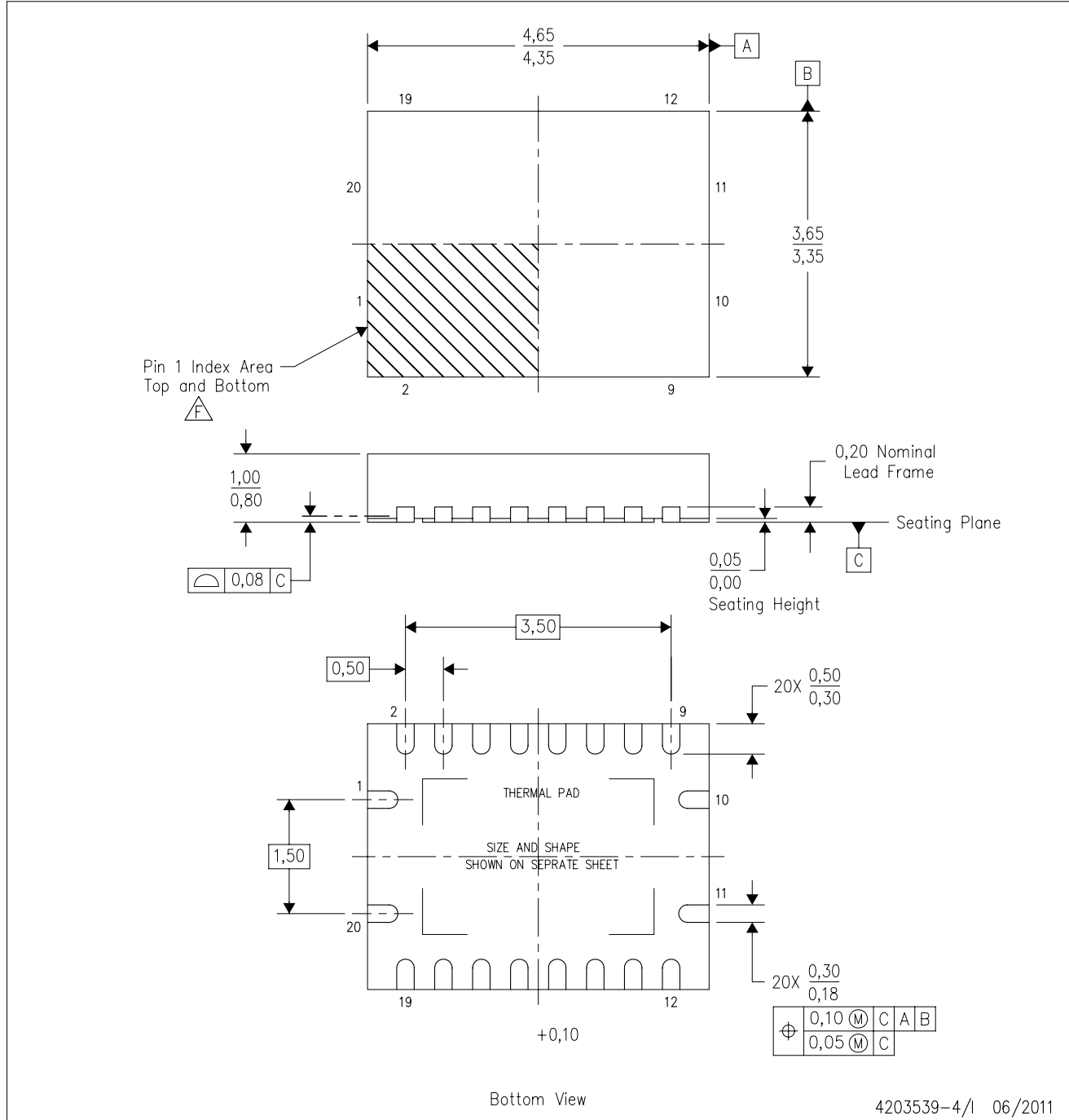
PLASTIC SMALL OUTLINE



- 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 design.
  - D. 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 other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

RGY (R-PVQFN-N20)

PLASTIC QUAD FLATPACK NO-LEAD



- 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. QFN (Quad Flatpack No-Lead) package configuration.
  - D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - △ Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
  - G. Package complies to JEDEC MO-241 variation BA.

RGY (R-PVQFN-N20)

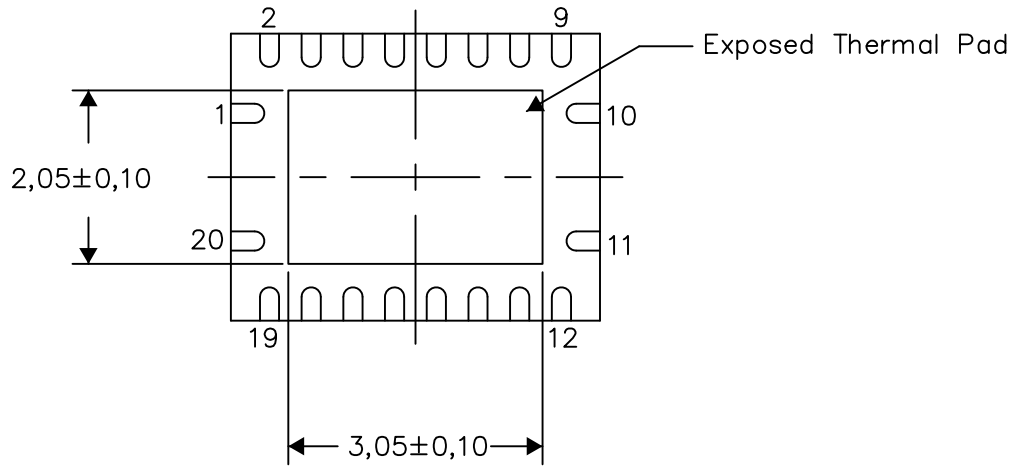
PLASTIC QUAD FLATPACK NO-LEAD

**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, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. 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

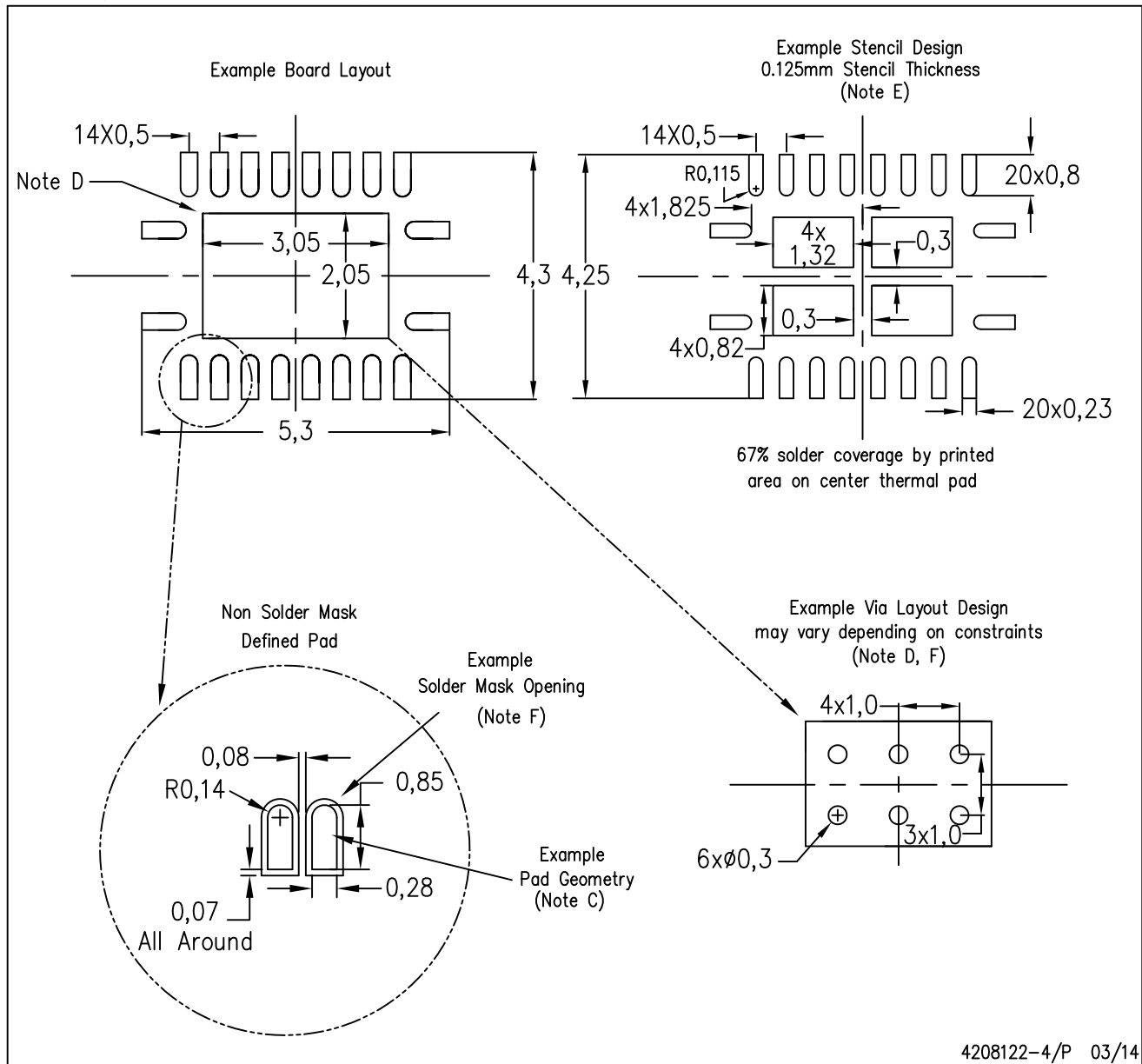
Exposed Thermal Pad Dimensions

4206353-4/P 03/14

NOTE: All linear dimensions are in millimeters

RGY (R-PVQFN-N20)

PLASTIC QUAD FLATPACK NO-LEAD

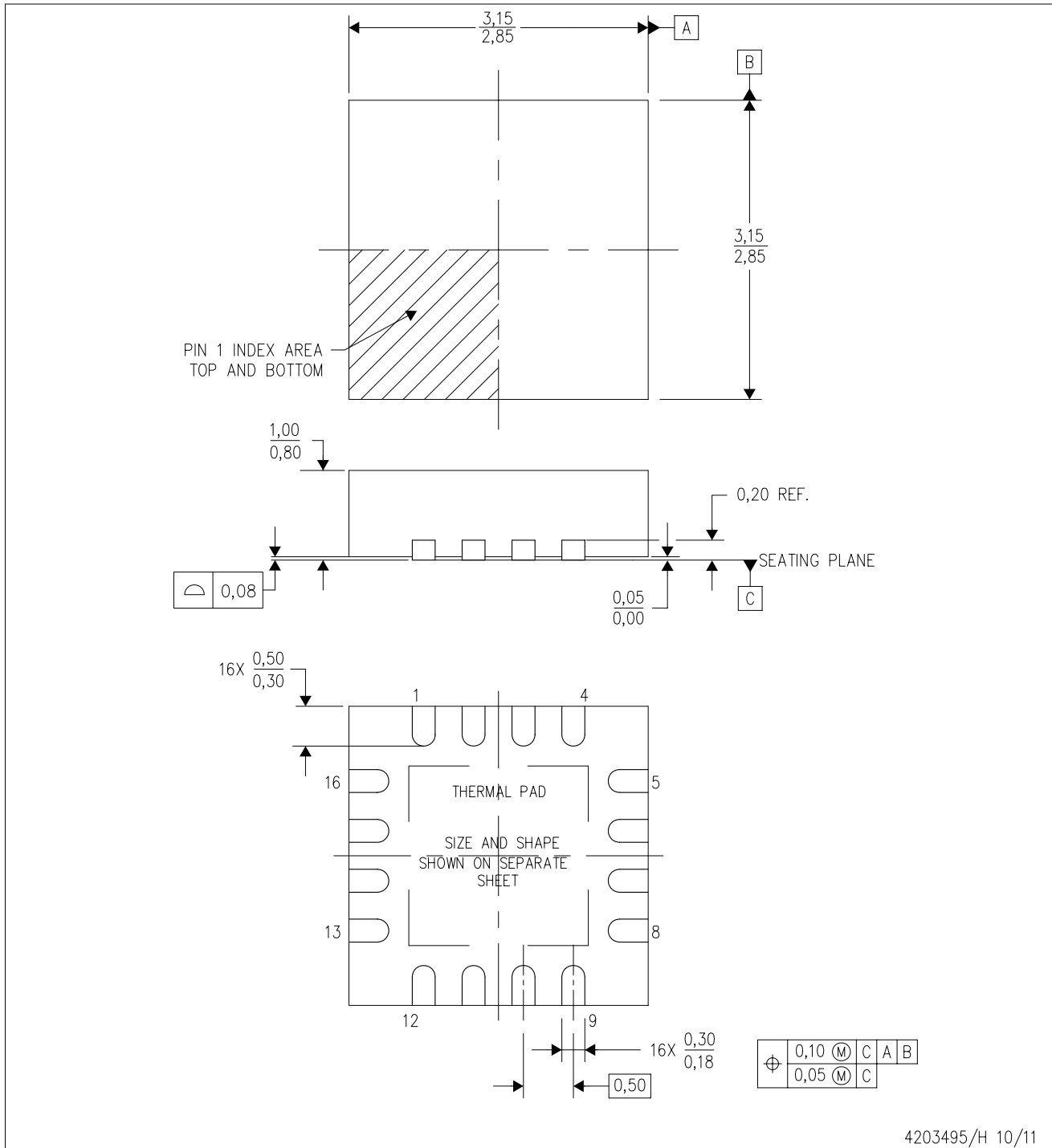


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack QFN/SON PCB Attachment, Texas Instruments Literature No. 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 minimum solder mask web tolerances between signal pads.



RGT (S-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



- 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 additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - Falls within JEDEC MO-220.

# THERMAL PAD MECHANICAL DATA

RGT (S-PVQFN-N16)

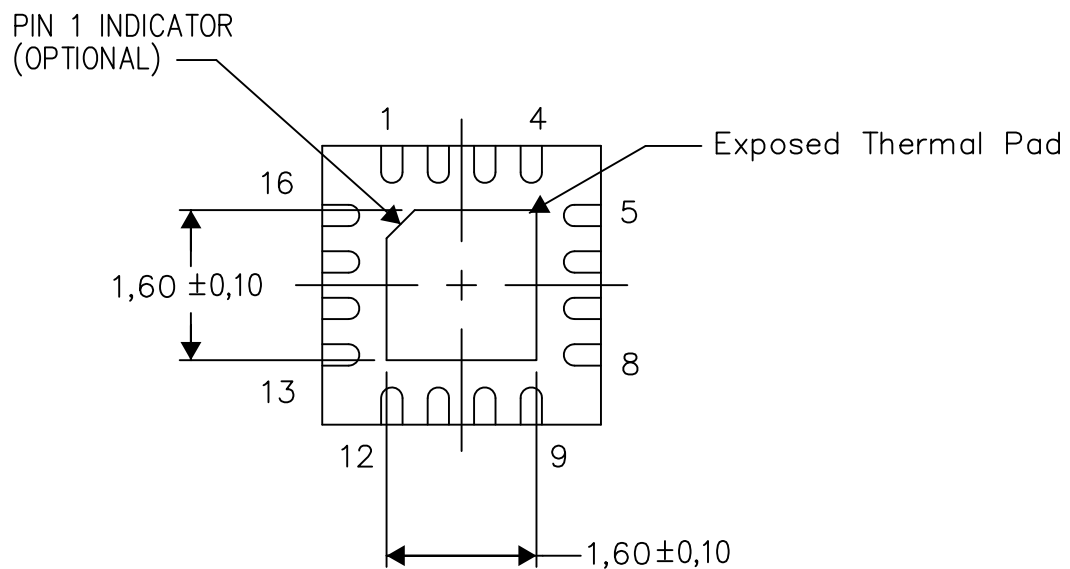
PLASTIC QUAD FLATPACK NO-LEAD

## 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, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. 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

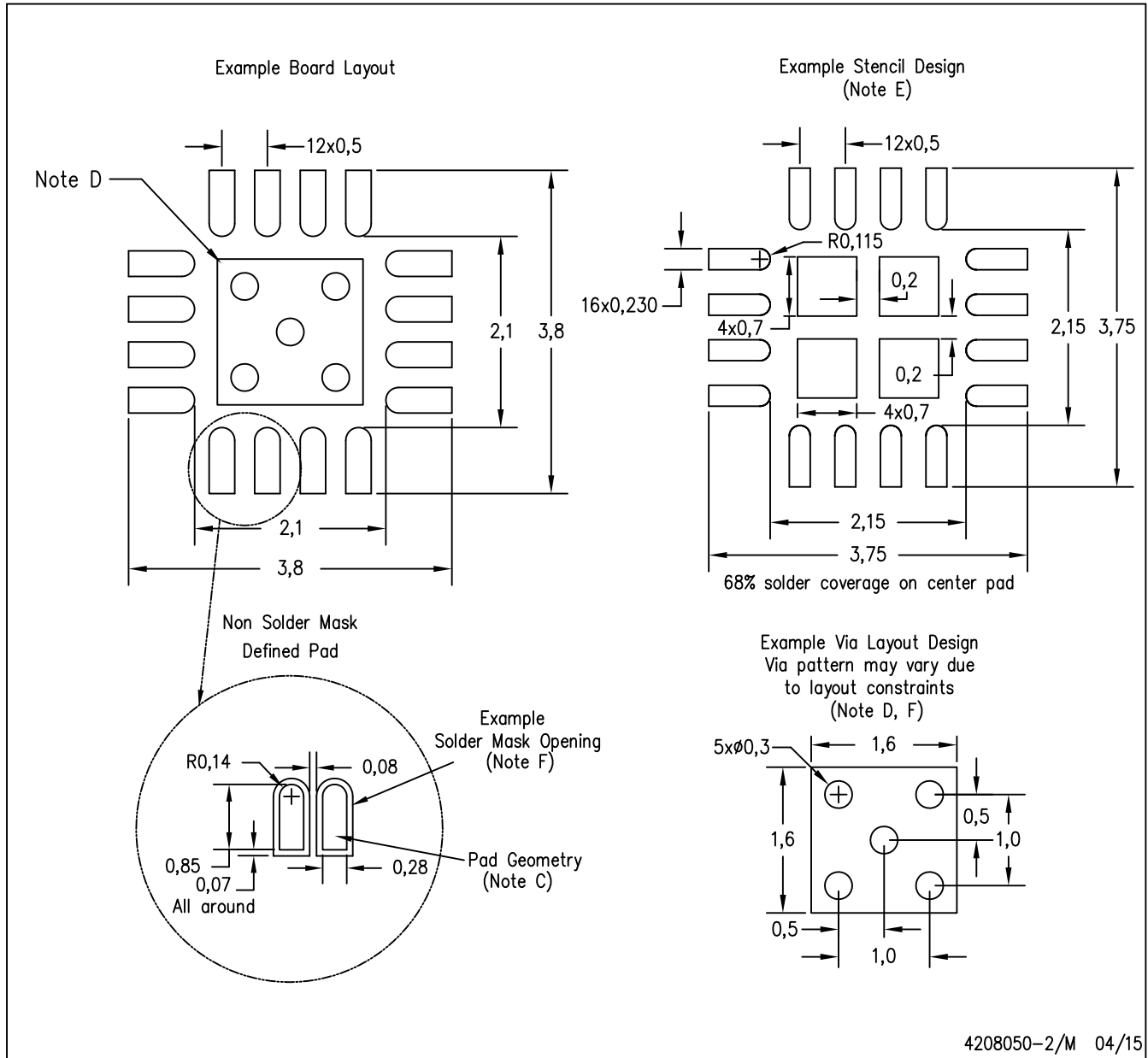
Exposed Thermal Pad Dimensions

4206349-3/Z 08/15

NOTE: All linear dimensions are in millimeters

RGT (S-PVQFN-N16)

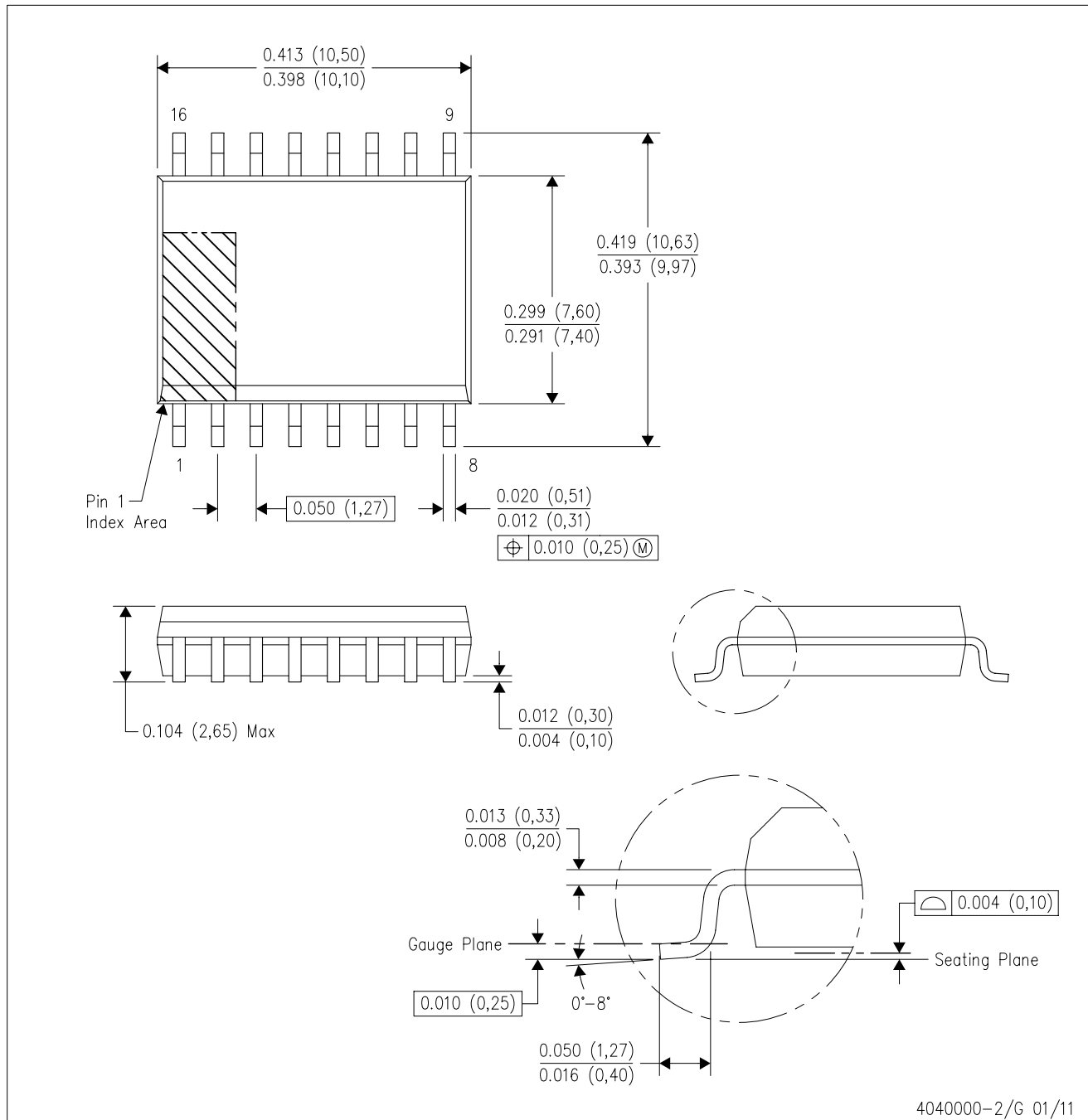
PLASTIC QUAD FLATPACK NO-LEAD



- 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/SON PCB Attachment, Texas Instruments Literature No. 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 minimum solder mask web tolerances between signal pads.

DW (R-PDSO-G16)

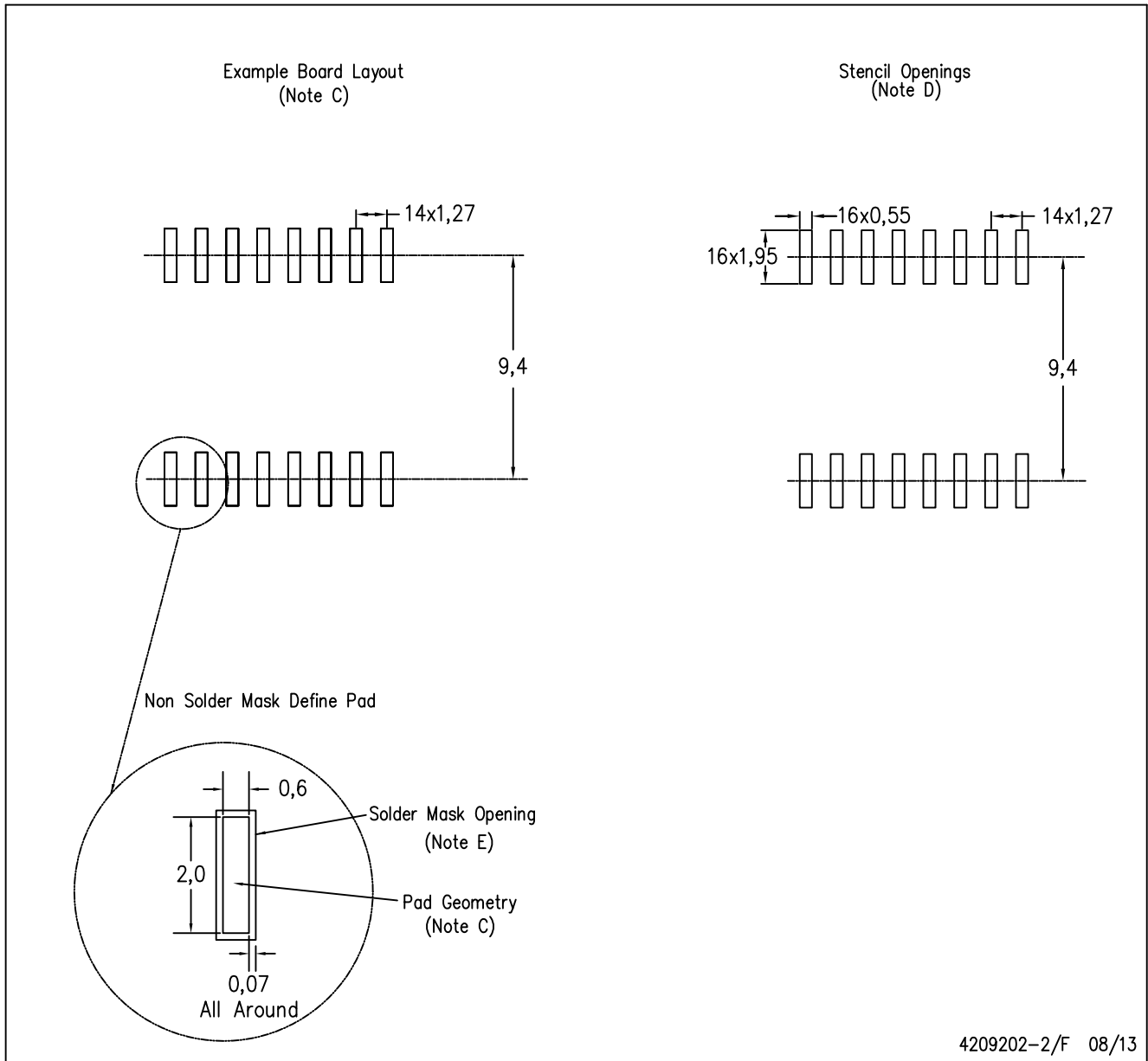
PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - Falls within JEDEC MS-013 variation AA.

DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Refer to IPC7351 for alternate board design.
  - D. 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
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.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>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)