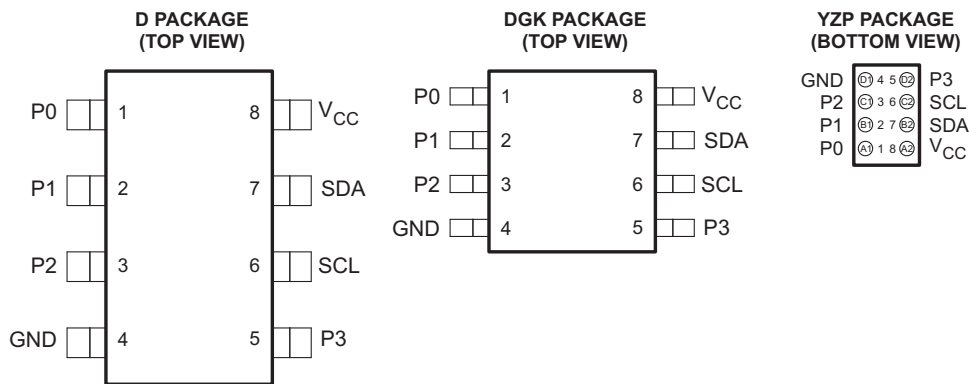


FEATURES

- Available in the Texas Instruments NanoFree™ Package
- Low Standby Current Consumption of 1 µA Max
- I²C to Parallel Port Expander
- Operating Power-Supply Voltage Range of 2.3 V to 5.5 V
- 5-V Tolerant I/O Ports
- 400-kHz Fast I²C Bus
- Input/Output Configuration Register
- Polarity Inversion Register
- Internal Power-On Reset
- No Glitch on Power Up
- Power-Up With All Channels Configured as Inputs
- Noise Filter on SCL/SDA Inputs
- Latched Outputs With High-Current Drive Maximum Capability for Directly Driving LEDs
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)
 - 1000-V Charged-Device Model (C101)



See mechanical drawings for dimensions.

DESCRIPTION/ORDERING INFORMATION

ORDERING INFORMATION

| T _A | PACKAGE ⁽¹⁾⁽²⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING ⁽³⁾ |
|----------------|--|--------------|--------------------------|---------------------------------|
| -40°C to 85°C | NanoFree™ – WCSP (DSBGA) 0.23-mm Large Bump – YZP (Pb-free) | Reel of 3000 | PCA9536YZPR | 7CH |
| | | Reel of 2500 | PCA9536DR PCA9536DRG4 | PD536 |
| | Tube of 75 | PCA9536D | | |
| | | PCA9536DG4 | | |
| | SOIC – D | Reel of 250 | PCA9536DT | |
| | | VSSOP – DGK | Reel of 2500 | PCA9536DGKR PCA9536DGKRG4 |

(1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

(3) DGK: The actual top-side marking has one additional character that designates the wafer fab/assembly site.



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.

NanoFree is a trademark of Texas Instruments.

PCA9536 REMOTE 4-BIT I²C AND SMBus I/O EXPANDER WITH CONFIGURATION REGISTERS

SCPS125E—APRIL 2006—REVISED OCTOBER 2007

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

This 4-bit I/O expander for the two-line bidirectional bus (I²C) is designed for 2.3-V to 5.5-V V_{CC} operation. It provides general-purpose remote I/O expansion for most microcontroller families via the I²C interface [serial clock (SCL), serial data (SDA)].

The PCA9536 features 4-bit Configuration (input or output selection), Input Port, Output Port, and Polarity Inversion (active high or active low) registers. At power on, the I/Os are configured as inputs with a weak pullup to V_{CC}. However, the system master can enable the I/Os as either inputs or outputs by writing to the I/O configuration bits. If no signals are applied externally to the PCA9536, the voltage level is 1, or high, because of the internal pullup resistors. The data for each input or output is stored in the corresponding Input Port or Output Port register. The polarity of the Input Port register can be inverted with the Polarity Inversion register. All registers can be read by the system master.

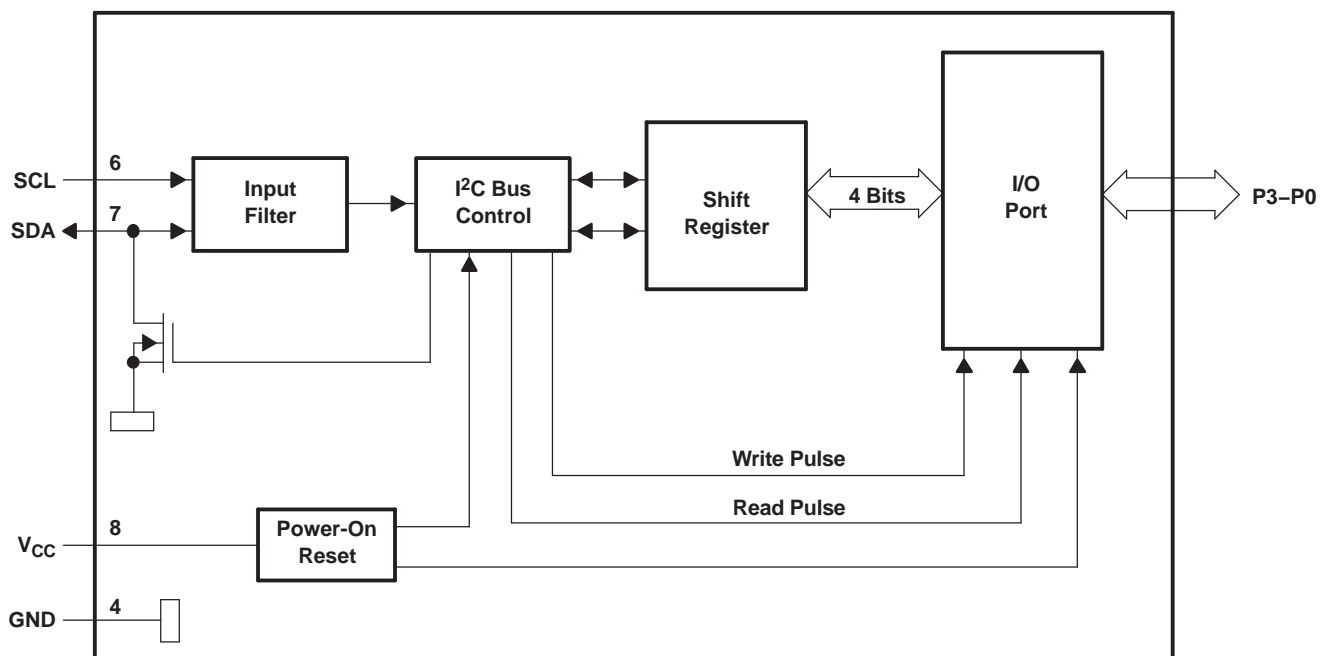
The system master can reset the PCA9536 in the event of a timeout or other improper operation by utilizing the power-on reset feature, which puts the registers in their default state and initializes the I²C/SMBus state machine.

The device's outputs (latched) have high-current drive capability for directly driving LEDs. It has low current consumption.

TERMINAL FUNCTIONS

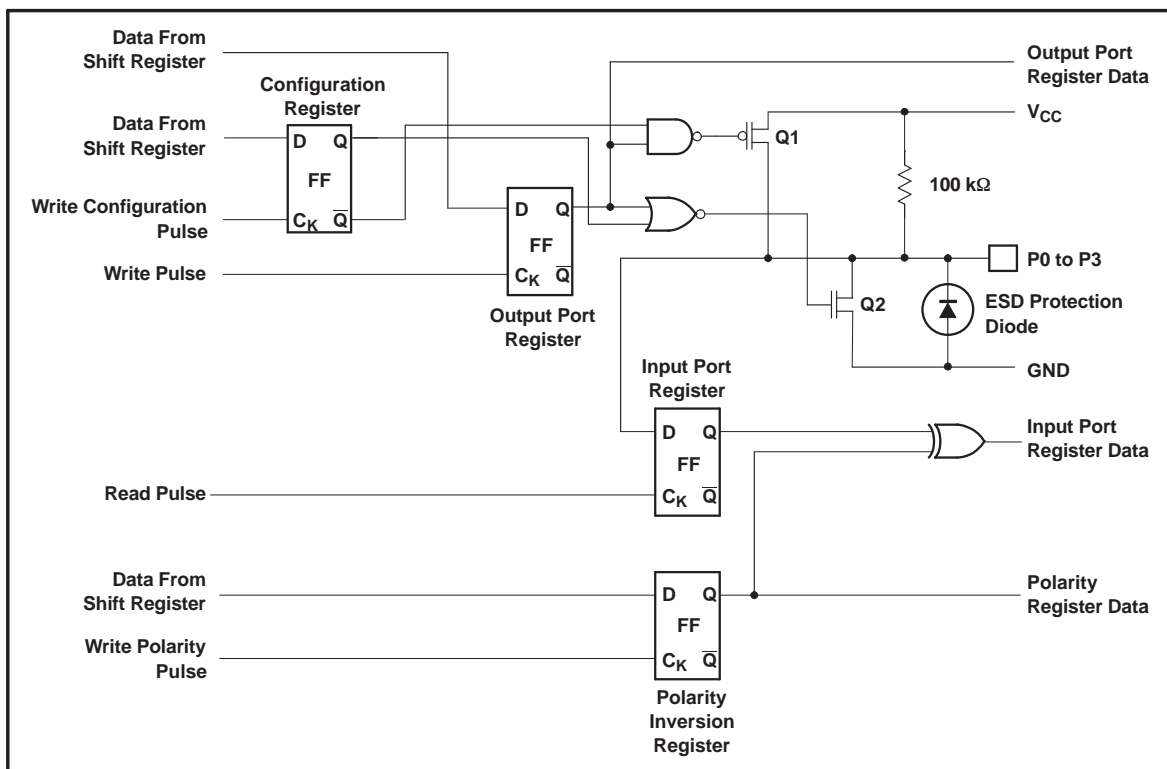
| NO. | NAME | DESCRIPTION |
|-----|-----------------|---|
| 1 | P0 | P-port input/output. Push-pull design structure. |
| 2 | P1 | P-port input/output. Push-pull design structure. |
| 3 | P2 | P-port input/output. Push-pull design structure. |
| 4 | GND | Ground |
| 5 | P3 | P-port input/output. Push-pull design structure. |
| 6 | SCL | Serial clock bus. Connect to V _{CC} through a pullup resistor. |
| 7 | SDA | Serial data bus. Connect to V _{CC} through a pullup resistor. |
| 8 | V _{CC} | Supply voltage |

LOGIC DIAGRAM



A. All I/Os are set to inputs at reset.

SIMPLIFIED SCHEMATIC OF P0 TO P3



A. At power-on reset, all registers return to default values.

I/O Port

When an I/O is configured as an input, FETs Q1 and Q2 are off, creating a high-impedance input with a weak pullup (100 kΩ typ) to V_{CC}. The input voltage may be raised above V_{CC} to a maximum of 5.5 V.

If the I/O is configured as an output, Q1 or Q2 is enabled, depending on the state of the output port register. In this case, there are low-impedance paths between the I/O pin and either V_{CC} or GND. The external voltage applied to this I/O pin should not exceed the recommended levels for proper operation.

I²C Interface

The bidirectional I²C bus consists of the serial clock (SCL) and serial data (SDA) lines. Both lines must be connected to a positive supply through a pullup resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

I²C communication with this device is initiated by a master sending a Start condition, a high-to-low transition on the SDA input/output while the SCL input is high (see Figure 1). After the Start condition, the device address byte is sent, most-significant bit (MSB) first, including the data direction bit (R/W).

After receiving the valid address byte, this device responds with an acknowledge (ACK), a low on the SDA input/output during the high of the ACK-related clock pulse.

On the I²C bus, only one data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the high pulse of the clock period, as changes in the data line at this time are interpreted as control commands (Start or Stop) (see Figure 2).

A Stop condition, a low-to-high transition on the SDA input/output while the SCL input is high, is sent by the master (see Figure 1).

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Any number of data bytes can be transferred from the transmitter to receiver between the Start and the Stop conditions. Each byte of eight bits is followed by one ACK bit. The transmitter must release the SDA line before the receiver can send an ACK bit. The device that acknowledges must pull down the SDA line during the ACK clock pulse, so that the SDA line is stable low during the high pulse of the ACK-related clock period (see Figure 3). When a slave receiver is addressed, it must generate an ACK after each byte is received. Similarly, the master must generate an ACK after each byte that it receives from the slave transmitter. Setup and hold times must be met to ensure proper operation.

A master receiver signals an end of data to the slave transmitter by not generating an acknowledge (NACK) after the last byte has been clocked out of the slave. This is done by the master receiver by holding the SDA line high. In this event, the transmitter must release the data line to enable the master to generate a Stop condition.

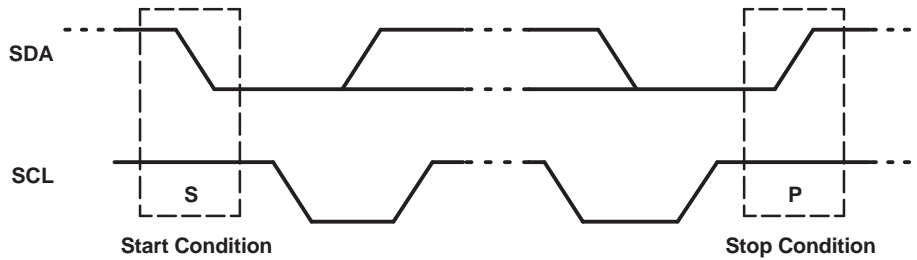


Figure 1. Definition of Start and Stop Conditions

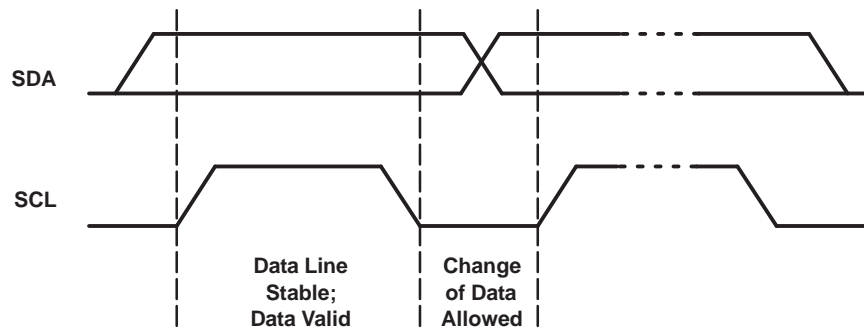


Figure 2. Bit Transfer

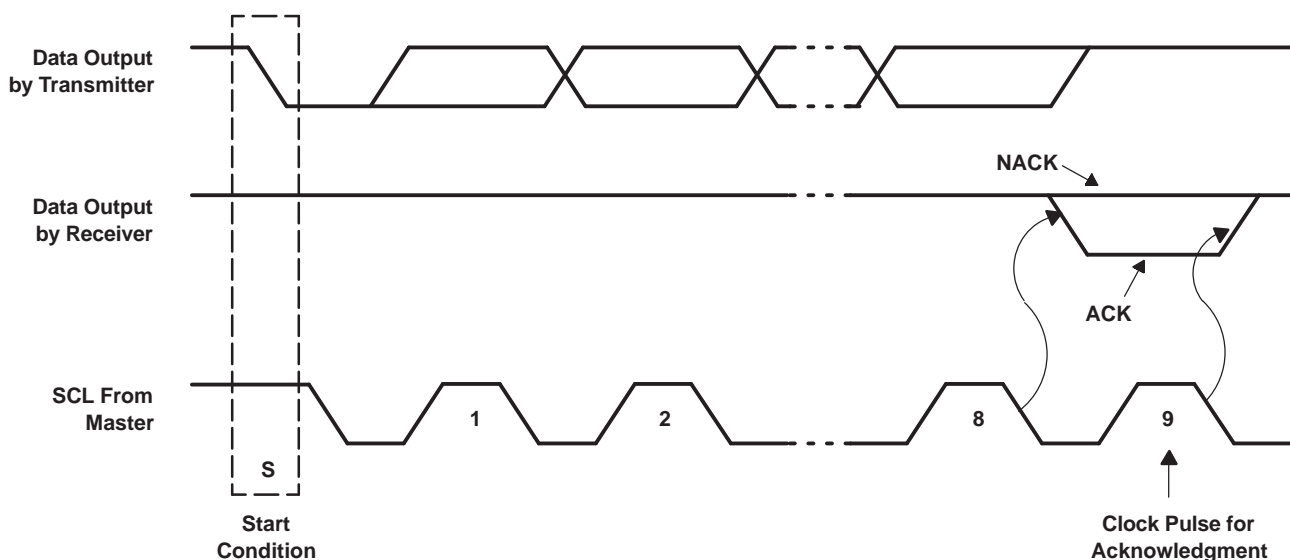


Figure 3. Acknowledgment on the I²C Bus

Interface Definition

| BYTE | BIT | | | | | | | |
|--------------------------------|--|----|----|----|----|----|----|---------|
| | 7 (MSB) | 6 | 5 | 4 | 3 | 2 | 1 | 0 (LSB) |
| I ² C slave address | H | L | L | L | L | L | H | R/W |
| Px I/O data bus | Does not affect operation of the PCA9536 | | | | P3 | P2 | P1 | P0 |
| | P7 | P6 | P5 | P4 | | | | |

Device Address

Figure 4 shows the address byte of the PCA9536.

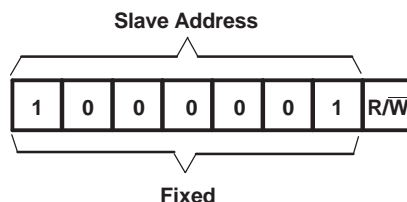


Figure 4. PCA9536 Address

The slave address equates to 65 (decimal) and 41 (hexadecimal).

The last bit of the slave address defines the operation (read or write) to be performed. When it is high (1), a read is selected, while a low (0) selects a write operation.

Control Register and Command Byte

Following the successful acknowledgment of the address byte, the bus master sends a command byte that is stored in the control register in the PCA9536. Two bits of this data byte state the operation (read or write) and the internal register (Input, Output, Polarity Inversion, or Configuration) that will be affected. This register can be written or read through the I²C bus. The command byte is sent only during a write transmission.

Once a command byte has been sent, the register that was addressed continues to be accessed by reads until a new command byte has been sent.

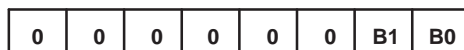


Figure 5. Control Register Bits

Command Byte

| CONTROL REGISTER BITS | | COMMAND BYTE (HEX) | REGISTER | PROTOCOL | POWER-UP DEFAULT |
|-----------------------|----|--------------------|--------------------|-----------------|------------------|
| B1 | B0 | | | | |
| 0 | 0 | 0x00 | Input Port | Read byte | 1111 XXXX |
| 0 | 1 | 0x01 | Output Port | Read/write byte | 1111 1111 |
| 1 | 0 | 0x02 | Polarity Inversion | Read/write byte | 0000 0000 |
| 1 | 1 | 0x03 | Configuration | Read/write byte | 1111 1111 |

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Register Descriptions

The Input Port register (register 0) reflects the incoming logic levels of the pins, regardless of whether the pin is defined as an input or an output by the Configuration register. It only acts on read operation. Writes to these registers have no effect. The default value, X, is determined by the externally applied logic level.

Before a read operation, a write transmission is sent with the command byte to instruct the I²C device that the Input Port register will be accessed next.

Register 0 (Input Port Register)

| BIT | I7 | I6 | I5 | I4 | I3 | I2 | I1 | I0 |
|---------|----------|----|----|----|----|----|----|----|
| | Not Used | | | | | | | |
| DEFAULT | 1 | 1 | 1 | 1 | X | X | X | X |

The Output Port register (register 1) shows the outgoing logic levels of the pins defined as outputs by the Configuration register. Bit values in this register have no effect on pins defined as inputs. In turn, reads from this register reflect the value that is in the flip-flop controlling the output selection, not the actual pin value.

Register 1 (Output Port Register)

| BIT | O7 | O6 | O5 | O4 | O3 | O2 | O1 | O0 |
|---------|----------|----|----|----|----|----|----|----|
| | Not Used | | | | | | | |
| DEFAULT | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

The Polarity Inversion register (register 2) allows polarity inversion of pins defined as inputs by the Configuration register. If a bit in this register is set (written with 1), the corresponding port pin's polarity is inverted. If a bit in this register is cleared (written with a 0), the corresponding port pin's original polarity is retained.

Register 2 (Polarity Inversion Register)

| BIT | N7 | N6 | N5 | N4 | N3 | N2 | N1 | N0 |
|---------|----------|----|----|----|----|----|----|----|
| | Not Used | | | | | | | |
| DEFAULT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The Configuration register (register 3) configures the directions of the I/O pins. If a bit in this register is set to 1, the corresponding port pin is enabled as an input with high-impedance output driver. If a bit in this register is cleared to 0, the corresponding port pin is enabled as an output.

Register 3 (Configuration Register)

| BIT | C7 | C6 | C5 | C4 | C3 | C2 | C1 | C0 |
|---------|----------|----|----|----|----|----|----|----|
| | Not Used | | | | | | | |
| DEFAULT | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Power-On Reset

When power (from 0 V) is applied to V_{CC}, an internal power-on reset holds the PCA9536 in a reset condition until V_{CC} has reached V_{POR}. At that time, the reset condition is released and the PCA9536 registers and I²C/SMBus state machine initialize to their default states. After that, V_{CC} must be lowered to below 0.2 V and then back up to the operating voltage for a power-reset cycle.

Bus Transactions

Data is exchanged between the master and PCA9536 through write and read commands.

Writes

Data is transmitted to the PCA9536 by sending the device address and setting the least-significant bit (LSB) to a logic 0 (see Figure 4 for device address). The command byte is sent after the address and determines which register receives the data that follows the command byte. There is no limitation on the number of data bytes sent in one write transmission (see Figure 6 and Figure 7).

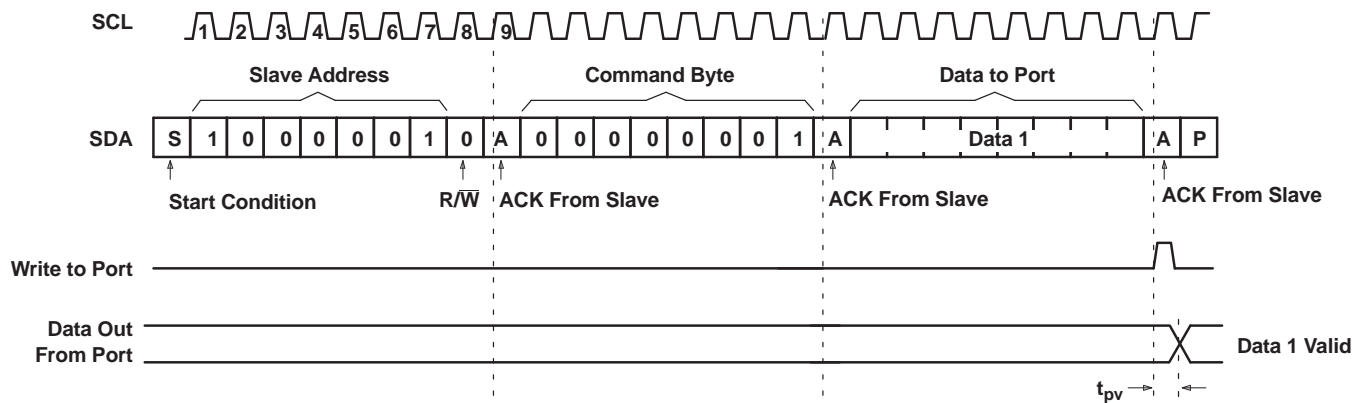


Figure 6. Write to Output Port Register

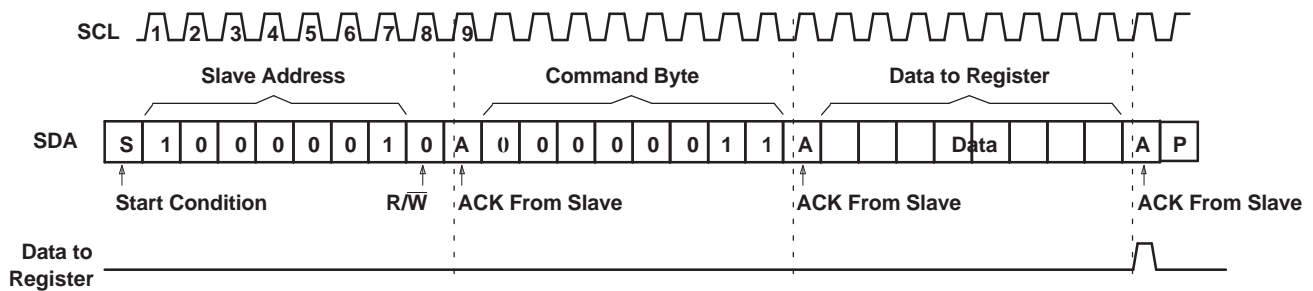


Figure 7. Write to Configuration or Polarity Inversion Registers

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Reads

The bus master first must send the PCA9536 address with the LSB set to a logic 0 (see Figure 4 for device address). The command byte is sent after the address and determines which register is accessed. After a restart, the device address is sent again but, this time, the LSB is set to a logic 1. Data from the register defined by the command byte then is sent by the PCA9536 (see Figure 8 and Figure 9). After a restart, the value of the register defined by the command byte matches the register being accessed when the restart occurred. Data is clocked into the register on the rising edge of the ACK clock pulse. There is no limitation on the number of data bytes received in one read transmission, but when the final byte is received, the bus master must not acknowledge the data.

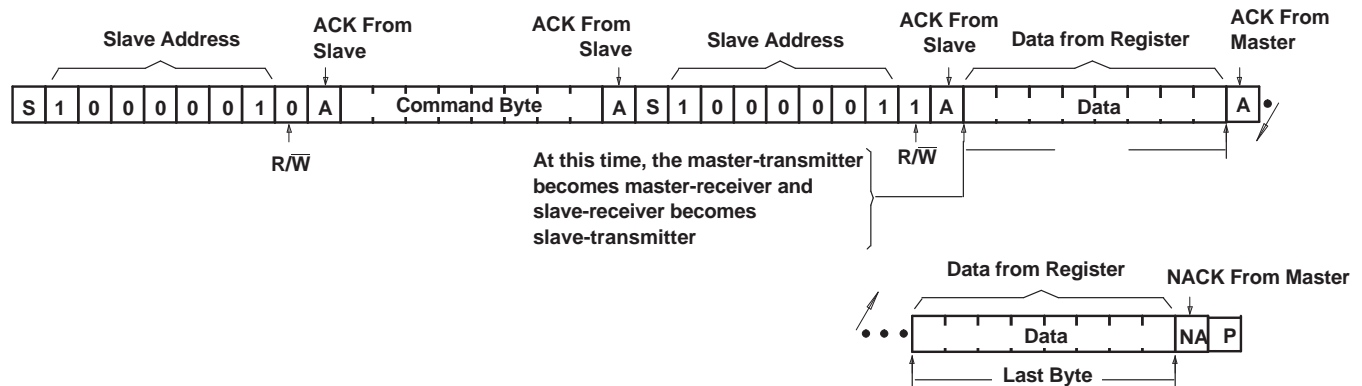
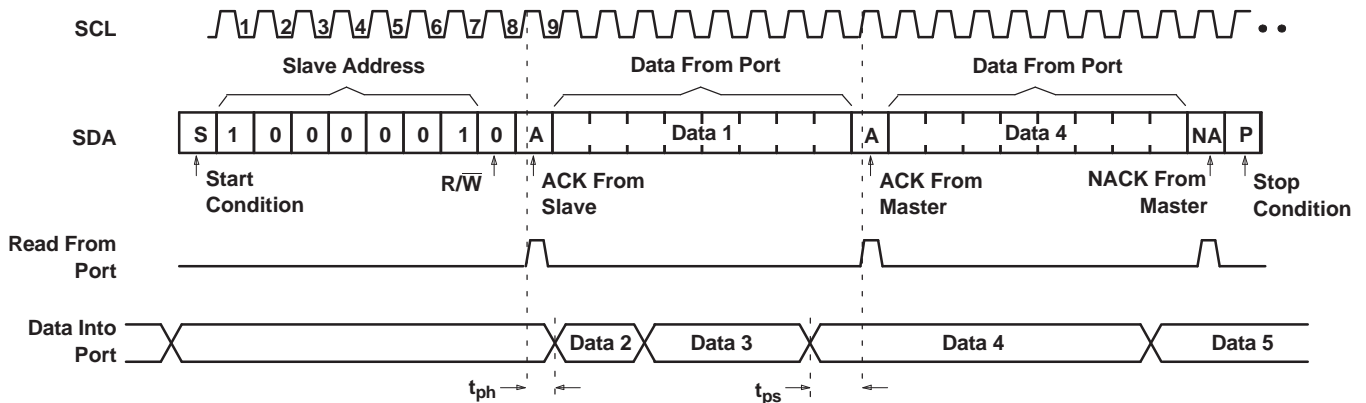


Figure 8. Read From Register



- This figure assumes that the command byte previously has been programmed with 00h.
- Transfer of data can be stopped at any moment by a Stop condition.
- This figure eliminates the command byte transfer, a restart, and the slave address call between the initial slave address call and actual data transfer from the P-port (see Figure 8).

Figure 9. Read Input Port Register

Absolute Maximum Ratings⁽¹⁾

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

| | | MIN | MAX | UNIT |
|------------------|--|--|------|------|
| V _{CC} | Supply voltage range | -0.5 | 6 | V |
| V _I | Input voltage range ⁽²⁾ | -0.5 | 6 | V |
| V _O | Output voltage range ⁽²⁾ | -0.5 | 6 | V |
| I _{IK} | Input clamp current | V _I < 0 | -20 | mA |
| I _{OK} | Output clamp current | V _O < 0 | -20 | mA |
| I _{IOK} | Input/output clamp current | V _O < 0 or V _O > V _{CC} | ±20 | mA |
| I _{OL} | Continuous output low current | V _O = 0 to V _{CC} | 50 | mA |
| I _{OH} | Continuous output high current | V _O = 0 to V _{CC} | -50 | mA |
| I _{CC} | Continuous current through GND | | -200 | mA |
| | Continuous current through V _{CC} | | 160 | |
| θ _{JA} | Package thermal impedance ⁽³⁾ | D package | 97 | °C/W |
| | | DGK package | 172 | |
| | | YZP package | 102 | |
| T _{stg} | 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.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions

| | | MIN | MAX | UNIT |
|-----------------|--------------------------------|----------|-----------------------|-----------------------|
| V _{CC} | Supply voltage | 2.3 | 5.5 | V |
| V _{IH} | High-level input voltage | SCL, SDA | 0.7 × V _{CC} | 5.5 |
| | | P3-P0 | 2 | 5.5 |
| V _{IL} | Low-level input voltage | SCL, SDA | -0.5 | 0.3 × V _{CC} |
| | | P3-P0 | -0.5 | 0.8 |
| I _{OH} | High-level output current | P3-P0 | -10 | mA |
| I _{OL} | Low-level output current | P3-P0 | 25 | mA |
| T _A | Operating free-air temperature | -40 | 85 | °C |

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REMOTE 4-BIT I²C AND SMBus I/O EXPANDER WITH CONFIGURATION REGISTERS

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Electrical Characteristics

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

| PARAMETER | | TEST CONDITIONS | V _{CC} | MIN | TYP ⁽¹⁾ | MAX | UNIT | |
|------------------|---|--|---|----------------|--------------------|------|------|----|
| V _{IK} | Input diode clamp voltage | I _I = -18 mA | 2.3 V to 5.5 V | -1.2 | | | V | |
| V _{POR} | Power-on reset voltage | V _I = V _{CC} or GND, I _O = 0 | V _{POR} | | 1.5 | 1.65 | V | |
| V _{OH} | P-port high-level output voltage ⁽²⁾ | I _{OH} = -8 mA | 2.3 V | 1.8 | | | V | |
| | | | 3 V | 2.6 | | | | |
| | | | 4.5 V | 4.1 | | | | |
| | | | 4.75 V | 4.1 | | | | |
| | | I _{OH} = -10 mA | 2.3 V | 1.7 | | | | |
| | | | 3 V | 2.5 | | | | |
| | | | 4.5 V | 4 | | | | |
| | | | 4.75 V | 4 | | | | |
| I _{OL} | SDA | V _{OL} = 0.4 V | 2.3 V to 5.5 V | 3 | 10 | | mA | |
| | P-port ⁽³⁾ | V _{OL} = 0.5 V | 2.3 V | 8 | 10 | | | |
| | | | 3 V | 8 | 14 | | | |
| | | | 4.5 V | 8 | 17 | | | |
| | | | 4.75 V | 8 | 32 | | | |
| | | V _{OL} = 0.7 V | 2.3 V | 10 | 13 | | | |
| | | | 3 V | 10 | 19 | | | |
| | | | 4.5 V | 10 | 24 | | | |
| | | | 4.75 V | 10 | 44 | | | |
| | I _I | SCL, SDA | V _I = V _{CC} or GND | 2.3 V to 5.5 V | | ±1 | | μA |
| | I _{IH} | P-port | V _I = V _{CC} | 2.3 V to 5.5 V | | 1 | | μA |
| | I _{IL} | P-port | V _I = GND | 2.3 V to 5.5 V | | -100 | | μA |
| I _{CC} | Operating mode | V _I = V _{CC} , I _O = 0, I/O = inputs, f _{scl} = 400 kHz | 5.5 V | | 73 | 150 | μA | |
| | | | 3.6 V | | 9 | 50 | | |
| | | | 2.7 V | | 7 | 30 | | |
| | | V _I = V _{CC} , I _O = 0, I/O = inputs, f _{scl} = 100 kHz | 5.5 V | | 14 | 25 | | |
| | | | 3.6 V | | 9 | 20 | | |
| | | | 2.7 V | | 6 | 15 | | |
| | Standby mode | V _I = GND, I _O = 0, I/O = inputs, f _{scl} = 0 kHz | 5.5 V | | 225 | 350 | | |
| | | | 3.6 V | | 175 | 250 | | |
| | | | 2.7 V | | 125 | 200 | | |
| | | V _I = V _{CC} , I _O = 0, I/O = inputs, f _{scl} = 0 kHz | 5.5 V | | 0.25 | 1 | | |
| | | | 3.6 V | | 0.2 | 0.9 | | |
| | | | 2.7 V | | 0.1 | 0.8 | | |
| ΔI _{CC} | Additional current in standby mode | One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND | 2.3 V to 5.5 V | | | 0.35 | mA | |
| | | Every LED I/O at V _I = 4.3 V, f _{scl} = 0 kHz | 5.5 V | | | 0.4 | | |
| C _i | SCL | V _I = V _{CC} or GND | 2.3 V to 5.5 V | | 4 | 5 | pF | |
| C _{io} | SDA | V _{IO} = V _{CC} or GND | 2.3 V to 5.5 V | | 5 | 6.5 | pF | |
| | P-port | | | | 7.5 | 9.5 | | |

(1) All typical values are at nominal supply voltage (2.5-V, 3.3-V, or 5-V V_{CC}) and T_A = 25°C.

(2) The total current sourced by all I/Os must be limited to 85 mA.

(3) Each I/O must be limited externally to a maximum of 25 mA, and the P-port (P3–P0) must be limited to a maximum current of 100 mA.

I²C Interface Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 10](#))

| | | STANDARD MODE I ² C BUS | | FAST MODE I ² C BUS | | UNIT |
|-----------------------|--|---------------------------------------|------|---------------------------------------|-----|------|
| | | MIN | MAX | MIN | MAX | |
| t _{scl} | I ² C clock frequency | 0 | 100 | 0 | 400 | kHz |
| t _{sch} | I ² C clock high time | 4 | | 0.6 | | μs |
| t _{scl} | I ² C clock low time | 4.7 | | 1.3 | | μs |
| t _{sp} | I ² C spike time | | 50 | | 50 | ns |
| t _{sds} | I ² C serial-data setup time | 250 | | 100 | | ns |
| t _{sdh} | I ² C serial-data hold time | 0 | | 0 | | ns |
| t _{icr} | I ² C input rise time | | 1000 | 20 + 0.1C _b ⁽¹⁾ | 300 | ns |
| t _{icf} | I ² C input fall time | | 300 | 20 + 0.1C _b ⁽¹⁾ | 300 | ns |
| t _{ocf} | I ² C output fall time, 10-pF to 400-pF bus | | 300 | 20 + 0.1C _b ⁽¹⁾ | 300 | ns |
| t _{buf} | I ² C bus free time between Stop and Start | 4.7 | | 1.3 | | μs |
| t _{sts} | I ² C Start or repeated Start condition setup time | 4.7 | | 0.6 | | μs |
| t _{sth} | I ² C Start or repeated Start condition hold time | 4 | | 0.6 | | μs |
| t _{sps} | I ² C Stop condition setup time | 4 | | 0.6 | | μs |
| t _{vd(data)} | Valid data time, SCL low to SDA output valid | | 1 | | 0.9 | μs |
| t _{vd(ack)} | Valid data time of ACK condition, ACK signal from SCL low to SDA (out) low | | 1 | | 0.9 | μs |
| C _b | I ² C bus capacitive load | | 400 | | 400 | pF |

(1) C_b = Total capacitive load of one bus in pF

Switching Characteristics

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

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | STANDARD MODE I ² C BUS | | FAST MODE I ² C BUS | | UNIT |
|-----------------|-----------------------|----------------|---------------------------------------|-----|-----------------------------------|-----|------|
| | | | MIN | MAX | MIN | MAX | |
| t _{pv} | Output data valid | SCL | | 200 | | 200 | ns |
| t _{ps} | Input data setup time | P-port | 100 | | 100 | | ns |
| t _{ph} | Input data hold time | P-port | 1 | | 1 | | μs |

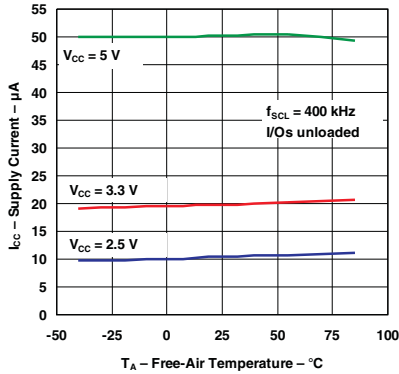
PCA9536 REMOTE 4-BIT I²C AND SMBus I/O EXPANDER WITH CONFIGURATION REGISTERS

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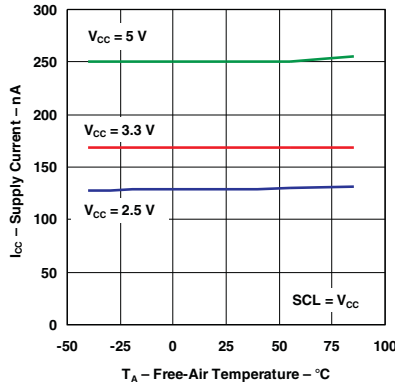
TYPICAL CHARACTERISTICS

T_A = 25°C (unless otherwise noted)

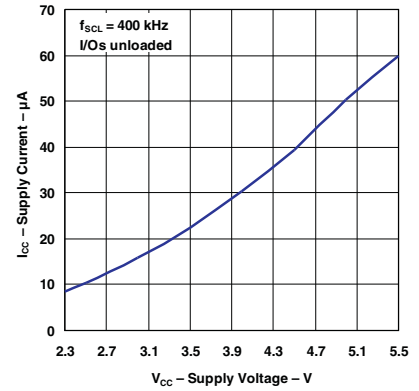
**SUPPLY CURRENT
VS
TEMPERATURE**



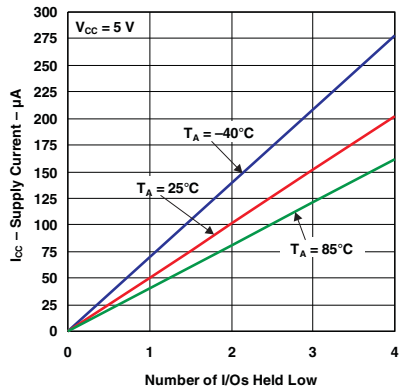
**QUIESCENT SUPPLY CURRENT
VS
TEMPERATURE**



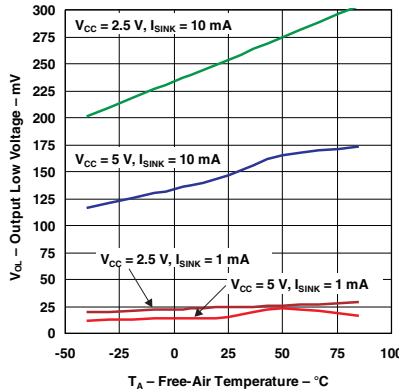
**SUPPLY CURRENT
VS
SUPPLY VOLTAGE**



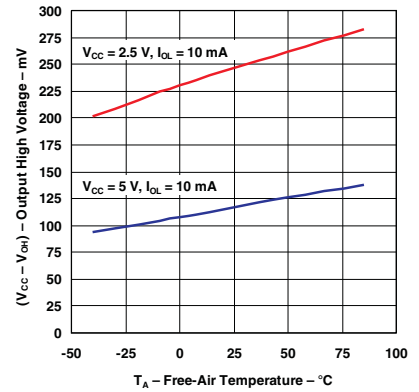
**SUPPLY CURRENT
VS
NUMBER OF I/Os HELD LOW**



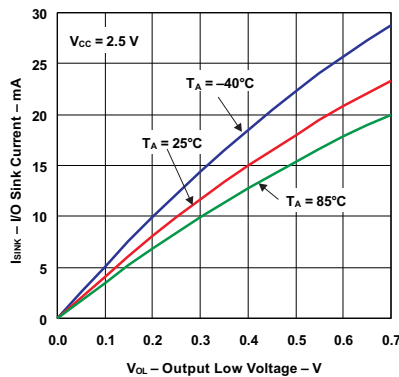
**I/O OUTPUT LOW VOLTAGE
VS
TEMPERATURE**



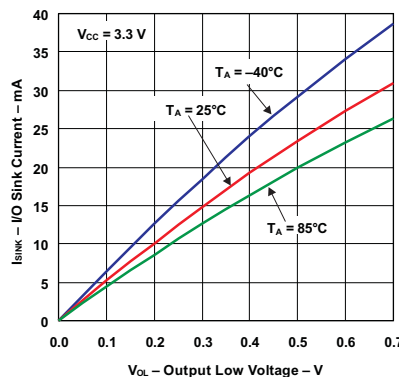
**I/O OUTPUT HIGH VOLTAGE
VS
TEMPERATURE**



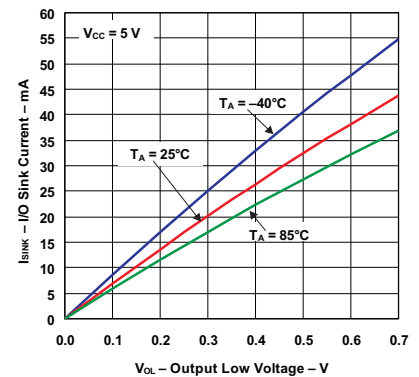
**I/O SINK CURRENT
VS
OUTPUT LOW VOLTAGE**



**I/O SINK CURRENT
VS
OUTPUT LOW VOLTAGE**



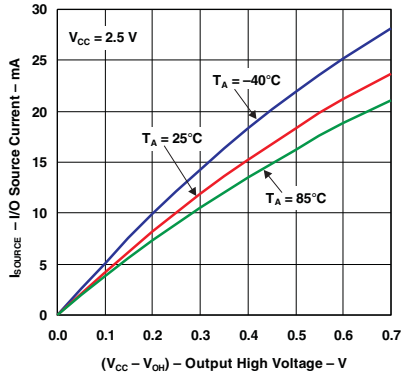
**I/O SINK CURRENT
VS
OUTPUT LOW VOLTAGE**



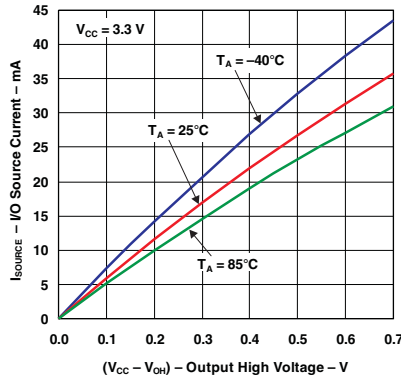
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$ (unless otherwise noted)

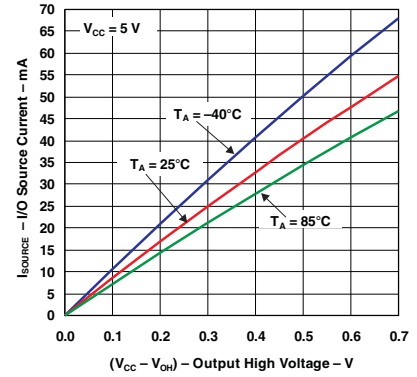
**I/O SOURCE CURRENT
VS
OUTPUT HIGH VOLTAGE**



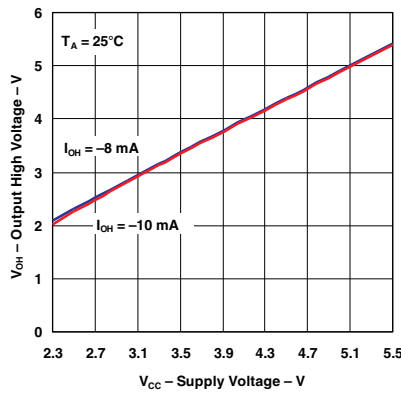
**I/O SOURCE CURRENT
VS
OUTPUT HIGH VOLTAGE**



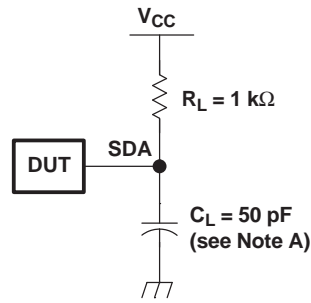
**I/O SOURCE CURRENT
VS
OUTPUT HIGH VOLTAGE**



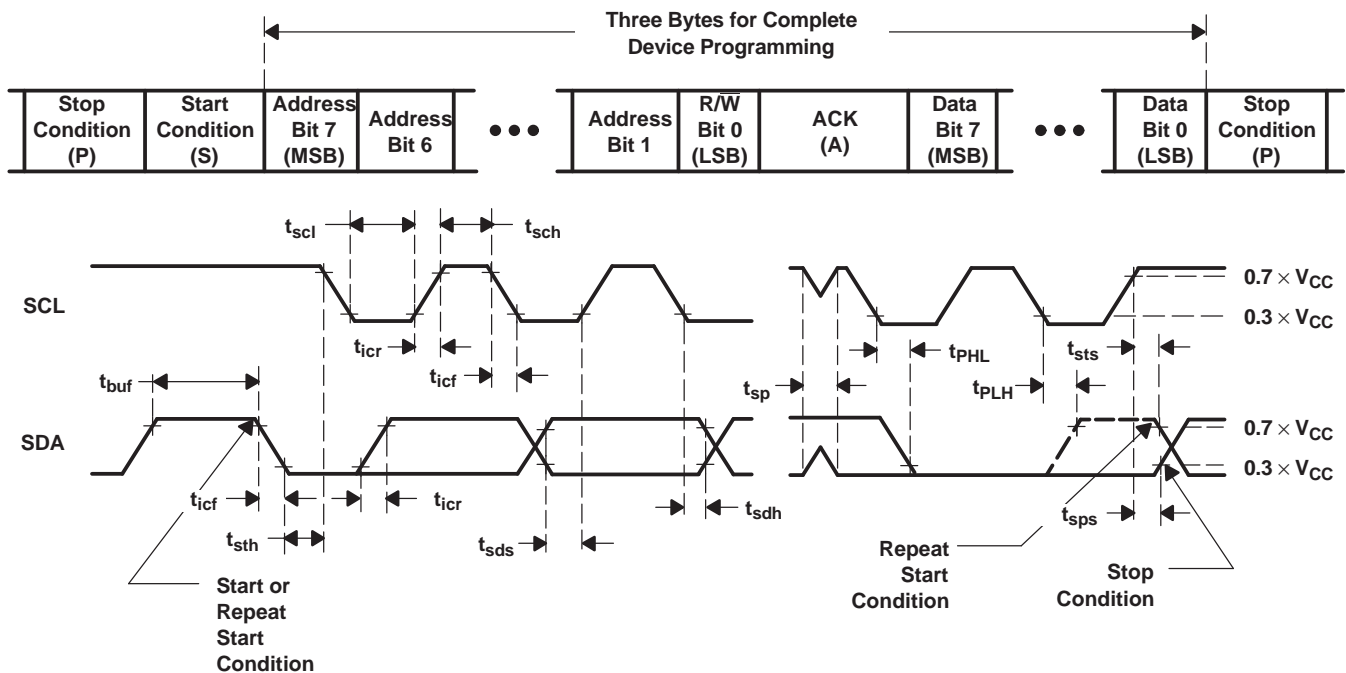
**OUTPUT HIGH VOLTAGE
VS
SUPPLY VOLTAGE**



PARAMETER MEASUREMENT INFORMATION



SDA LOAD CONFIGURATION



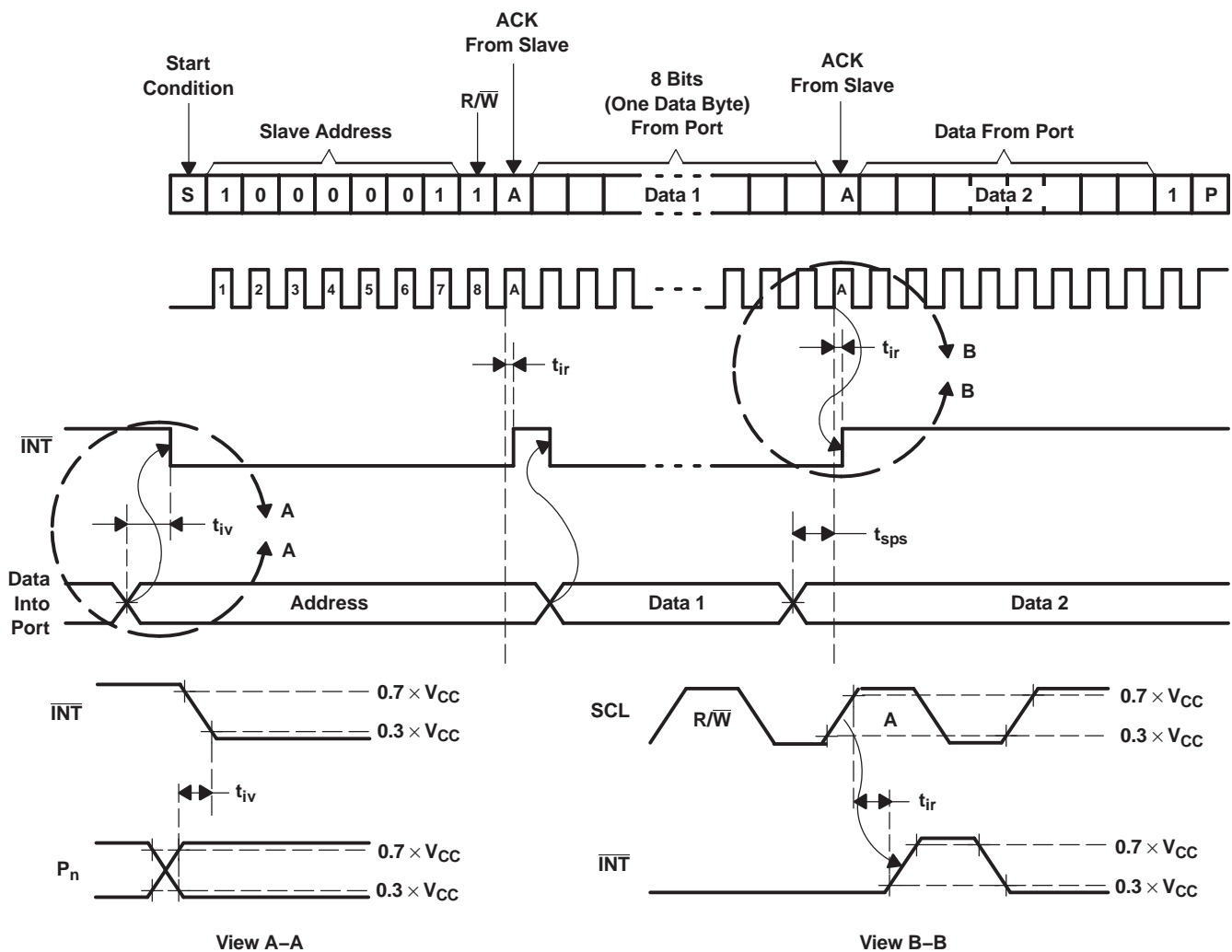
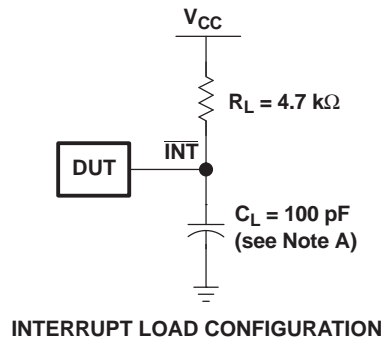
VOLTAGE WAVEFORMS

| BYTE | DESCRIPTION |
|------|--------------------------|
| 1 | I ² C address |
| 2, 3 | P-port data |

- A. C_L include probe and jig capacitance.
- B. All inputs are supplied by generators having the following characteristics: PRR $\leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r/t_f \leq 30\text{ ns}$.
- C. All parameters and waveforms are not applicable to all devices.

Figure 10. I²C Interface Load Circuit and Voltage Waveforms

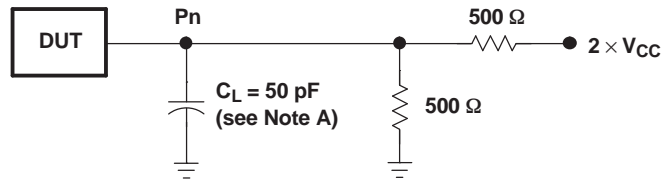
PARAMETER MEASUREMENT INFORMATION (continued)



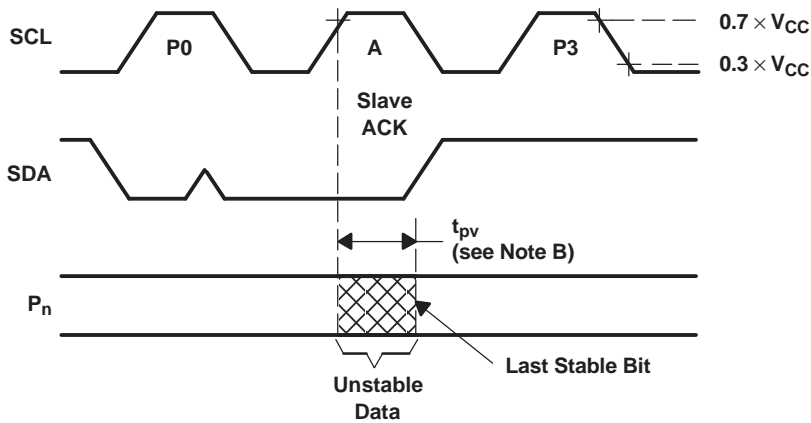
- A. C_L include probe and jig capacitance.
- B. All inputs are supplied by generators having the following characteristics: PRR \leq 10 MHz, $Z_O = 50 \Omega$, $t_r/t_f \leq 30$ ns.
- C. All parameters and waveforms are not applicable to all devices.

Figure 11. Interrupt Load Circuit and Voltage Waveforms

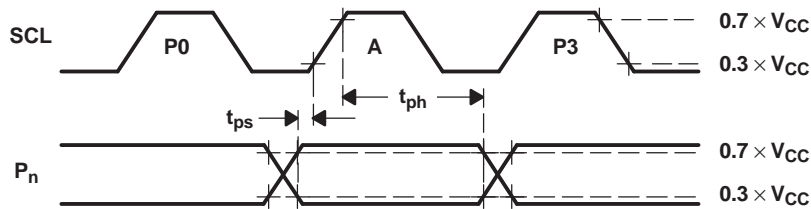
PARAMETER MEASUREMENT INFORMATION (continued)



P-PORT LOAD CONFIGURATION



WRITE MODE (R/W = 0)

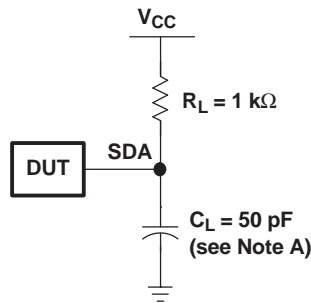


READ MODE (R/W = 1)

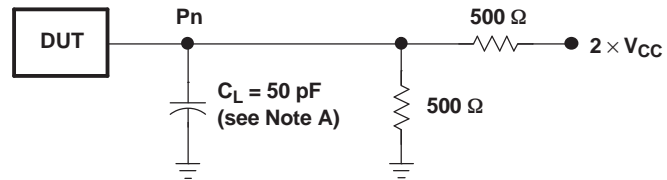
- A. C_L include probe and jig capacitance.
- B. t_{pv} is measured from 0.7 × V_{CC} on SCL to 50% I/O (P_n) output.
- C. All inputs are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r/t_f ≤ 30 ns.
- D. The outputs are measured one at a time, with one transition per measurement.
- E. All parameters and waveforms are not applicable to all devices.

Figure 12. P-Port Load Circuit and Voltage Waveforms

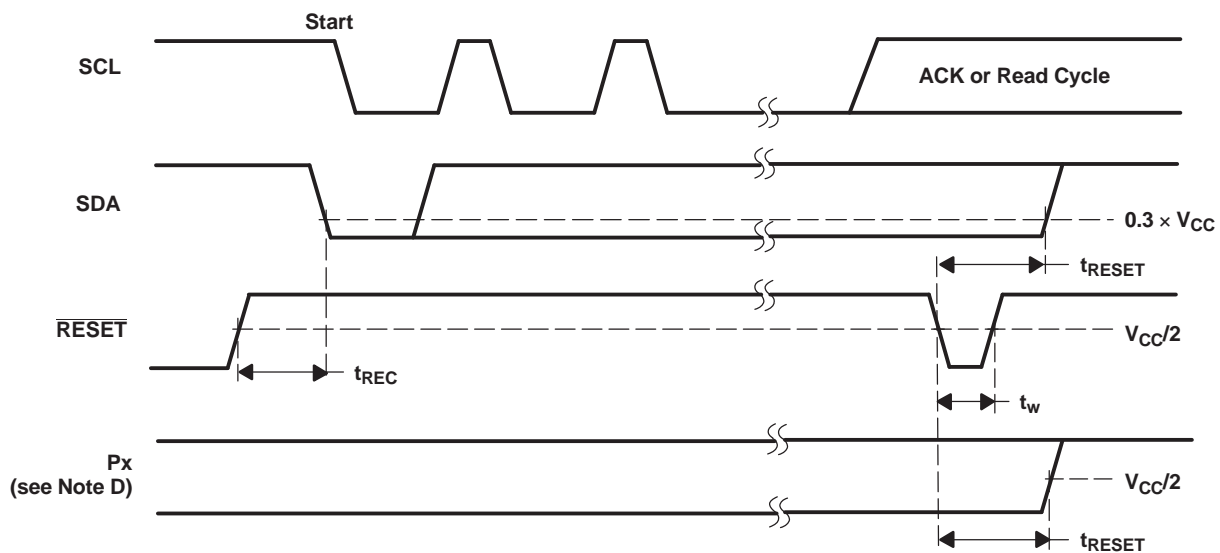
PARAMETER MEASUREMENT INFORMATION (continued)



SDA LOAD CONFIGURATION



P-PORT LOAD CONFIGURATION

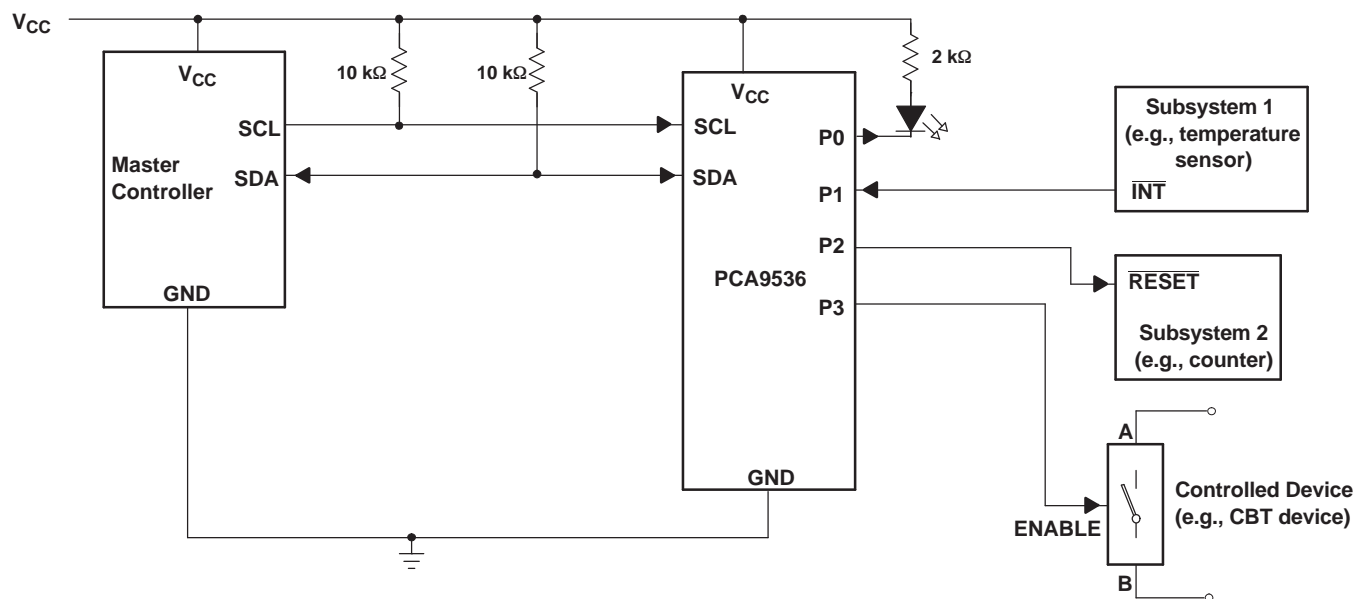


- A. C_L include probe and jig capacitance.
- B. All inputs are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r/t_f ≤ 30 ns.
- C. The outputs are measured one at a time, with one transition per measurement.
- D. I/Os are configured as inputs.
- E. All parameters and waveforms are not applicable to all devices.

Figure 13. Reset Load Circuits and Voltage Waveforms

APPLICATION INFORMATION

Figure 14 shows an application in which the PCA9536 can be used.



- A. Device address is 10000001.
- B. P0, P2, and P3 are configured as outputs.
- C. P1 is configured as an input.

Figure 14. Typical Application

Minimizing I_{CC} When I/Os Control LEDs

When the I/Os are used to control LEDs, they are normally connected to V_{CC} through a resistor as shown in Figure 14. The LED acts as a diode so, when the LED is off, the I/O V_{IN} is about 1.2 V less than V_{CC}. The supply current, I_{CC}, increases as V_{IN} becomes lower than V_{CC} and is specified as ΔI_{CC} in *Electrical Characteristics*.

Designs needing to minimize current consumption, such as battery power applications, should consider maintaining the I/O pins greater than or equal to V_{CC} when the LED is off. Figure 15 shows a high-value resistor in parallel with the LED. Figure 16 shows V_{CC} less than the LED supply voltage by at least 1.2 V. Both of these methods maintain the I/O V_{IN} at or above V_{CC} and prevent additional supply-current consumption when the LED is off.

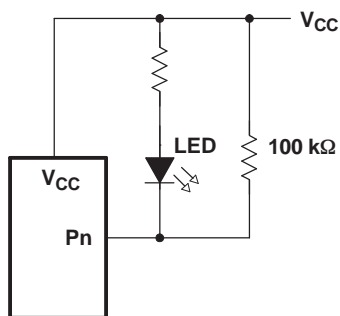


Figure 15. High-Value Resistor in Parallel With the LED

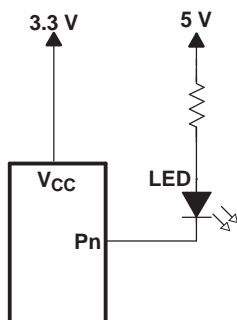


Figure 16. Device Supplied by a Lower Voltage

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| PCA9536D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| PCA9536DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| PCA9536DGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| PCA9536DGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| PCA9536DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| PCA9536DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

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

ACTIVE: Product device recommended for new designs.

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

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

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

OBSOLETE: TI has discontinued the production of the device.

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

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

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

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

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

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

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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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| PCA9536DGKR | MSOP | DGK | 8 | 2500 | 330.0 | 13.0 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| PCA9536DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| PCA9536DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

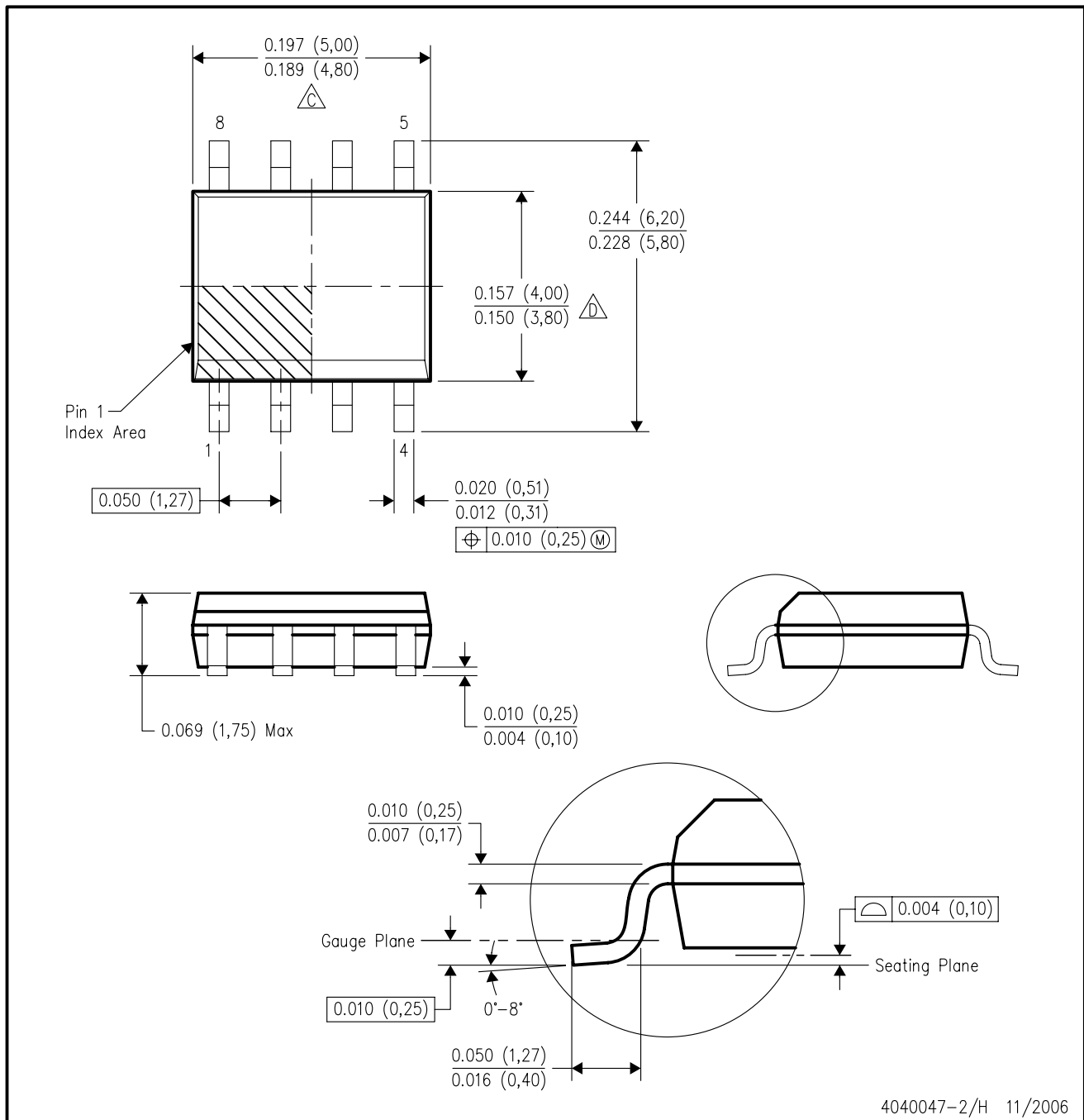


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| PCA9536DGKR | MSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| PCA9536DR | SOIC | D | 8 | 2500 | 342.9 | 338.1 | 20.6 |
| PCA9536DR | SOIC | D | 8 | 2500 | 346.0 | 346.0 | 29.0 |

D (R-PDSO-G8)

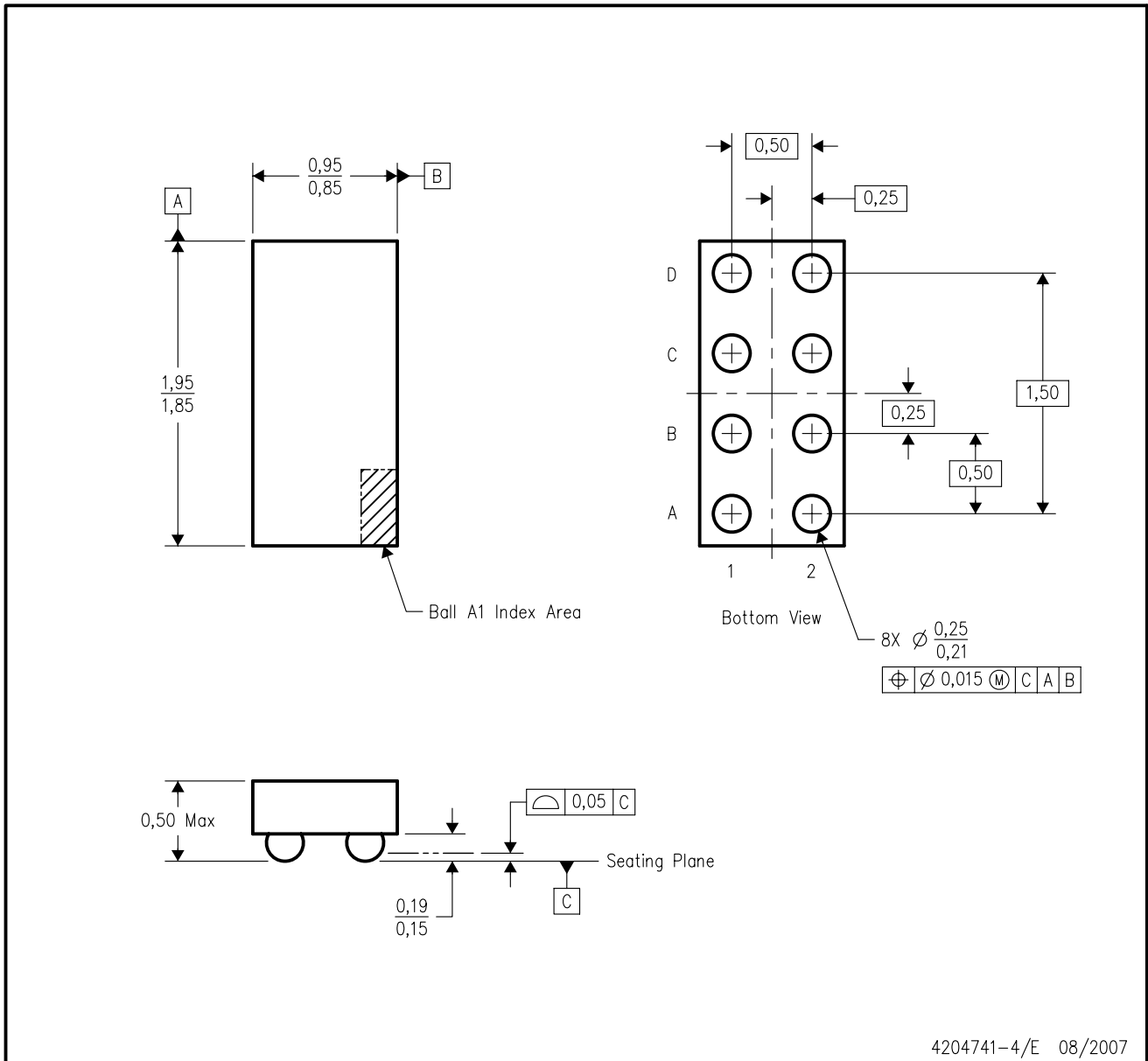
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (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 .006 (0,15) per end.
 - (D) Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AA.

YZP (R-XBGA-N8)

DIE-SIZE BALL GRID ARRAY



- 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. NanoFree™ package configuration.
 - D. This package is lead-free. Refer to the 8 YEP package (drawing 4204725) for tin-lead (SnPb).

NanoFree is a trademark of Texas Instruments.

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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