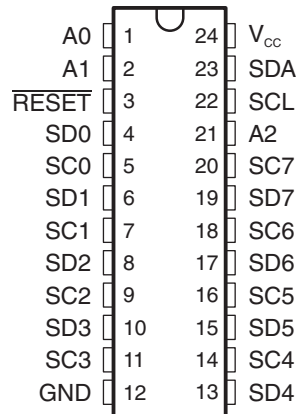


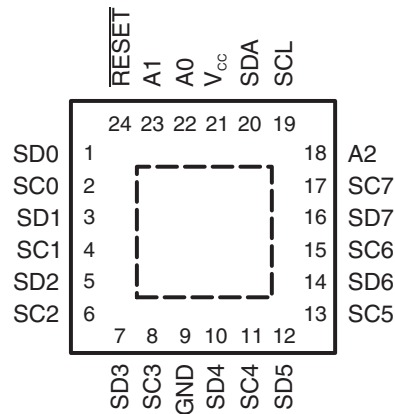
FEATURES

- 1-of-8 Bidirectional Translating Switches
- I²C Bus and SMBus Compatible
- Active-Low Reset Input
- Address by Three Hardware Address Pins for Use of up to Eight Devices
- Channel Selection Via I²C Bus
- Power-Up With All Switch Channels Deselected
- Low R_{ON} Switches
- Allows Voltage-Level Translation Between 2.5-V, 3.3-V, and 5-V Buses
- No Glitch on Power-Up
- Supports Hot Insertion
- Low Standby Current
- Operating Power-Supply Voltage Range of 2.3 V to 5.5 V
- 5-V Tolerant Inputs
- 400-kHz Fast I²C Bus
- 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)

DB, DGV, DW, OR PW PACKAGE
(TOP VIEW)



RGE PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

ORDERING INFORMATION

T _A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	QFN – RGE	Reel of 3000	PCA9548ARGER	PD548A
	SSOP – DB	Reel of 2000	PCA9548ADBR	PD548A
		Reel of 250	PCA9548ADBT	
	TVSOP – DGV	Reel of 2000	PCA9548ADGVR	PD548A
	SOIC – DW	Reel of 2000	PCA9548ADWR	PCA9548A
		Tube of 25	PCA9548ADW	
	TSSOP – PW	Reel of 2000	PCA9548APWR	PD548A
		Tube of 60	PCA9548APW	

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



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.

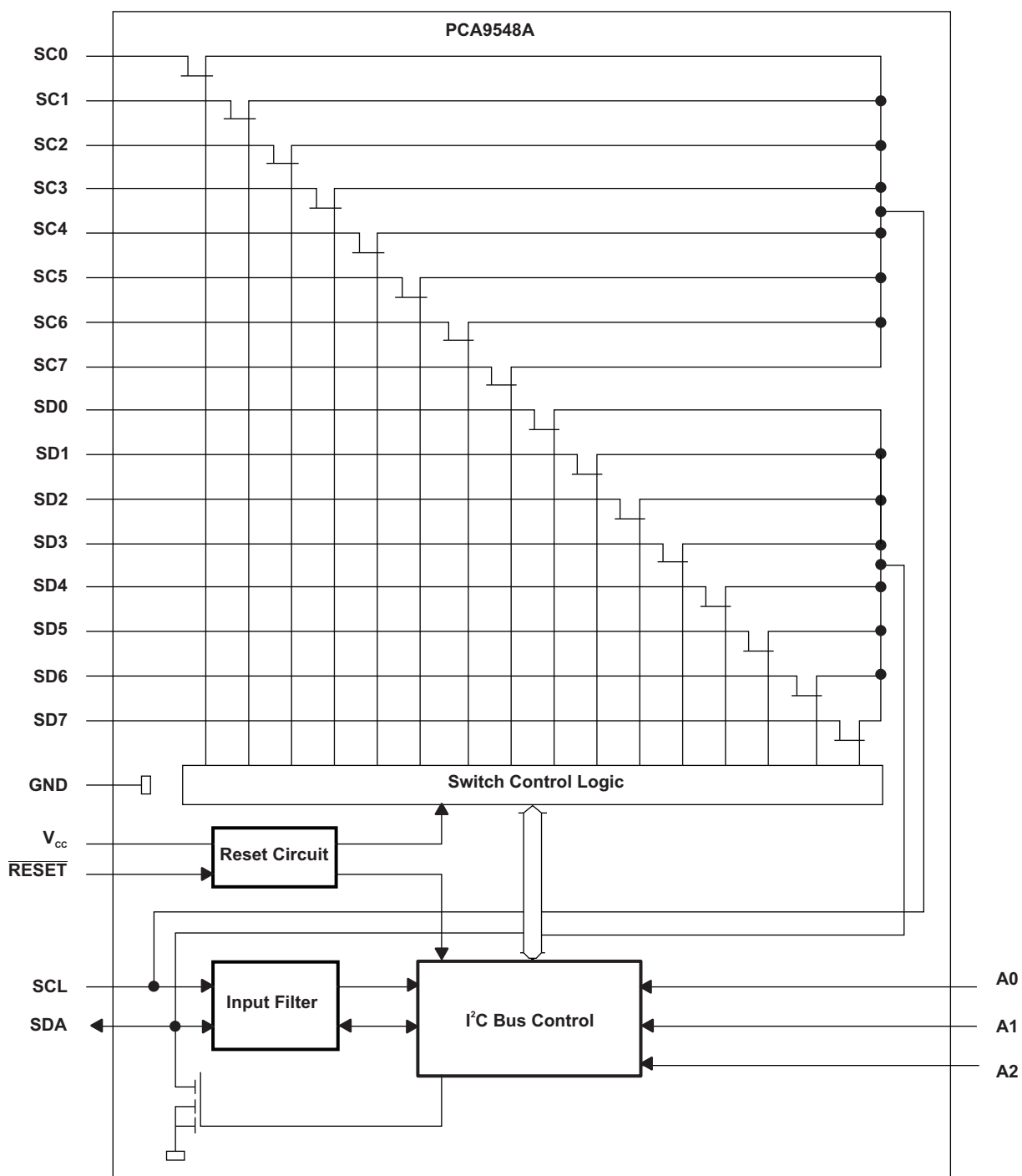
DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The PCA9548A has eight bidirectional translating switches that can be controlled via the I²C bus. The SCL/SDA upstream pair fans out to eight downstream pairs, or channels. Any individual SCx/SDx channel or combination of channels can be selected, determined by the contents of the programmable control register.

The system master can reset the PCA9548A in the event of a timeout or other improper operation by asserting a low in the $\overline{\text{RESET}}$ input. Similarly, the power-on reset deselects all channels and initializes the I²C/SMBus state machine. Asserting RESET causes the same reset/initialization to occur without depowering the part.

The pass gates of the switches are constructed so that the V_{CC} pin can be used to limit the maximum high voltage, which is passed by the PCA9548A. This allows the use of different bus voltages on each pair, so that 2.5-V or 3.3-V parts can communicate with 5-V parts, without any additional protection. External pullup resistors pull the bus up to the desired voltage level for each channel. All I/O pins are 5-V tolerant.

FUNCTIONAL BLOCK DIAGRAM



PCA9548A

8-CHANNEL I²C SWITCH

WITH RESET

SCPS143B – OCTOBER 2006 – REVISED MARCH 2007

TERMINAL FUNCTIONS

NO.		NAME	DESCRIPTION
SOIC (DW), SSOP (DB), TSSOP (PW), AND TVSOP (DGV)	QFN (RGE)		
1	22	A0	Address input 0. Connect directly to V _{CC} or ground.
2	23	A1	Address input 1. Connect directly to V _{CC} or ground.
3	24	<u>RESET</u>	Active-low reset input. Connect to V _{CC} through a pullup resistor, if not used.
4	1	SD0	Serial data 0. Connect to V _{CC} through a pullup resistor.
5	2	SC0	Serial clock 0. Connect to V _{CC} through a pullup resistor.
6	3	SD1	Serial data 1. Connect to V _{CC} through a pullup resistor.
7	4	SC1	Serial clock 1. Connect to V _{CC} through a pullup resistor.
8	5	SC2	Serial data 2. Connect to V _{CC} through a pullup resistor.
9	6	SC2	Serial clock 2. Connect to V _{CC} through a pullup resistor.
10	7	SD3	Serial data 3. Connect to V _{CC} through a pullup resistor.
11	8	SC3	Serial clock 3. Connect to V _{CC} through a pullup resistor.
12	9	GND	Ground
13	10	SD4	Serial data 4. Connect to V _{CC} through a pullup resistor.
14	11	SC4	Serial clock 4. Connect to V _{CC} through a pullup resistor.
15	12	SD5	Serial data 5. Connect to V _{CC} through a pullup resistor.
16	13	SC5	Serial clock 5. Connect to V _{CC} through a pullup resistor.
17	14	SD6	Serial data 6. Connect to V _{CC} through a pullup resistor.
18	15	SC6	Serial clock 6. Connect to V _{CC} through a pullup resistor.
19	16	SD7	Serial data 7. Connect to V _{CC} through a pullup resistor.
20	17	SC7	Serial clock 7. Connect to V _{CC} through a pullup resistor.
21	18	A2	Address input 2. Connect directly to V _{CC} or ground.
22	19	SCL	Serial clock bus. Connect to V _{CC} through a pullup resistor.
23	20	SDA	Serial data bus. Connect to V _{CC} through a pullup resistor.
24	21	V _{CC}	Supply voltage

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. The address inputs (A0–A2) of the slave device must not be changed between the start and the stop conditions.

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](#)).

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.

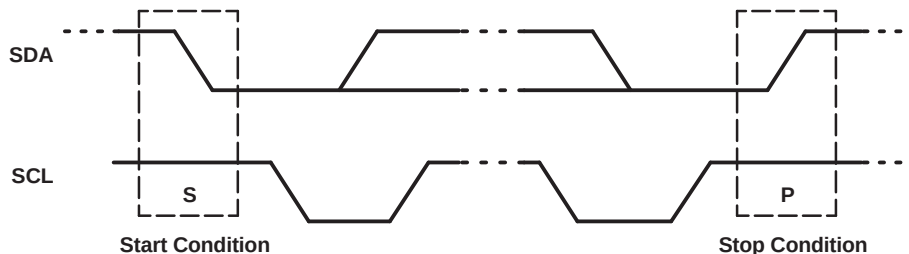


Figure 1. Definition of Start and Stop Conditions

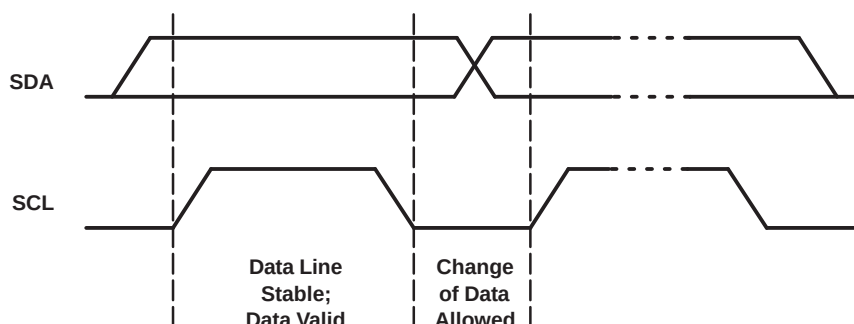


Figure 2. Bit Transfer

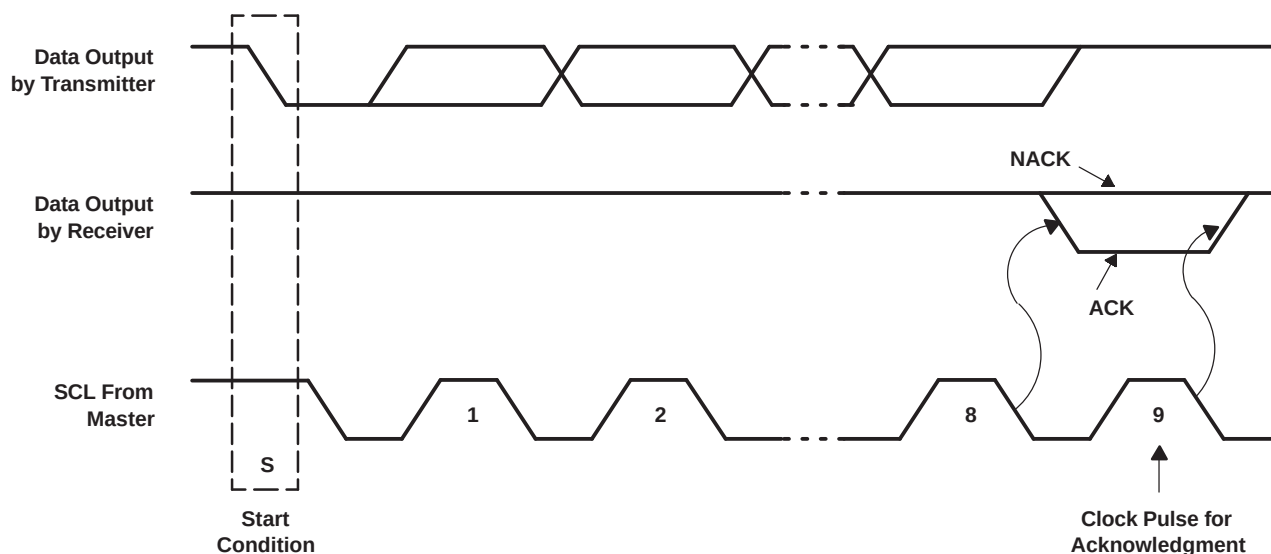


Figure 3. Acknowledgment on I²C Bus

Device Address

Figure 4 shows the address byte of the PCA9548A.

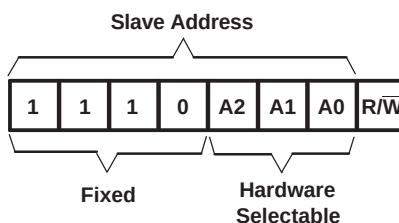


Figure 4. PCA9548A Address

Address Reference

INPUTS			I ² C BUS SLAVE ADDRESS
A2	A1	A0	
L	L	L	112 (decimal), 70 (hexadecimal)
L	L	H	113 (decimal), 71 (hexadecimal)
L	H	L	114 (decimal), 72 (hexadecimal)
L	H	H	115 (decimal), 73 (hexadecimal)
H	L	L	116 (decimal), 74 (hexadecimal)
H	L	H	117 (decimal), 75 (hexadecimal)
H	H	L	118 (decimal), 76 (hexadecimal)
H	H	H	119 (decimal), 77 (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

Following the successful acknowledgment of the address byte, the bus master sends a command byte that is stored in the control register in the PCA9548A (see Figure 5). This register can be written and read via the I²C bus. Each bit in the command byte corresponds to a SCn/SDn channel and a high (or 1) selects this channel. Multiple SCn/SDn channels may be selected at the same time. When a channel is selected, the channel becomes active after a stop condition has been placed on the I²C bus. This ensures that all SCn/SDn lines are in a high state when the channel is made active, so that no false conditions are generated at the time of connection. A stop condition always must occur immediately after the acknowledge cycle. If multiple bytes are received by the PCA9548A, it saves the last byte received.

Channel Selection Bits (Read/Write)

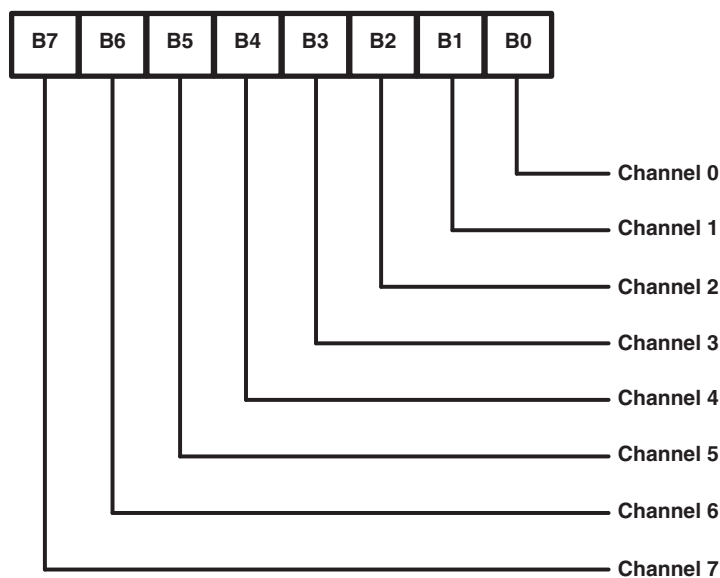


Figure 5. Control Register

Command Byte Definition

CONTROL REGISTER BITS								COMMAND
B7	B6	B5	B4	B3	B2	B1	B0	
X	X	X	X	X	X	X	0	Channel 0 disabled
							1	Channel 0 enabled
X	X	X	X	X	X	0	X	Channel 1 disabled
						1		Channel 1 enabled
X	X	X	X	X	0	X	X	Channel 2 disabled
					1			Channel 2 enabled
X	X	X	X	0	X	X	X	Channel 3 disabled
				1				Channel 3 enabled
X	X	X	0	X	X	X	X	Channel 4 disabled
			1					Channel 4 enabled
X	X	0	X	X	X	X	X	Channel 5 disabled
		1						Channel 5 enabled
X	0	X	X	X	X	X	X	Channel 6 disabled
	1							Channel 6 enabled
0	X	X	X	X	X	X	X	Channel 7 disabled
1								Channel 7 enabled
0	0	0	0	0	0	0	0	No channel selected, power-up/reset default state

RESET Input

The $\overline{\text{RESET}}$ input is an active-low signal that may be used to recover from a bus-fault condition. When this signal is asserted low for a minimum of t_{WL} , the PCA9548A resets its registers and I²C state machine and deselects all channels. The $\overline{\text{RESET}}$ input must be connected to V_{CC} through a pullup resistor.

Power-On Reset

When power (from 0 V) is applied to V_{CC} , an internal power-on reset holds the PCA9548A in a reset condition until V_{CC} has reached V_{POR} . At that point, the reset condition is released and the PCA9548A registers and I²C 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.

Voltage Translation

The pass-gate transistors of the PCA9548A are constructed such that the V_{CC} voltage can be used to limit the maximum voltage that is passed from one I²C bus to another. Figure 6 shows the voltage characteristics of the pass-gate transistors (note that the graph was generated using the data specified in the *Electrical Characteristics* section of this data sheet).

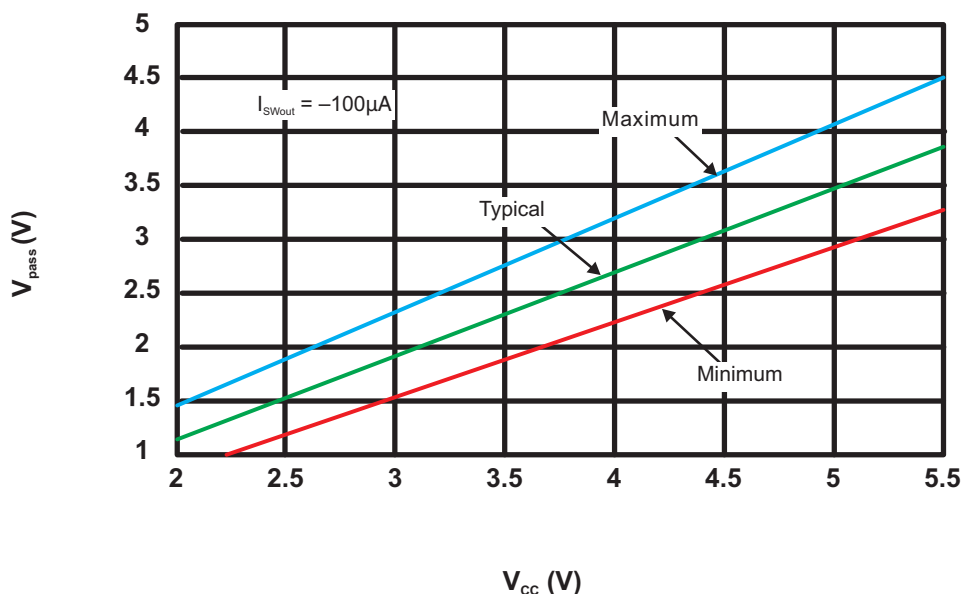


Figure 6. Pass-Gate Voltage vs Supply Voltage at Three Process Points

For the PCA9548A to act as a voltage translator, the $V_{O(SW)}$ voltage must be equal to, or lower than, the lowest bus voltage. For example, if the main bus is running at 5 V and the downstream buses are 3.3 V and 2.7 V, $V_{O(SW)}$ should be equal to or below 2.7 V to effectively clamp the downstream bus voltages. As shown in Figure 6, $V_{O(SW)}(\max)$ is 2.7 V when the PCA9548A supply voltage is 3.5 V or lower, so the PCA9548A supply voltage can be set to 3.3 V. Pullup resistors then can be used to bring the bus voltages to their appropriate levels (see Figure 11).

Bus Transactions

Data is exchanged between the master and PCA9548A through write and read commands.

Writes

Data is transmitted to the PCA9548A 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 SCn/SDn channel receives the data that follows the command byte (see Figure 7). There is no limitation on the number of data bytes sent in one write transmission.

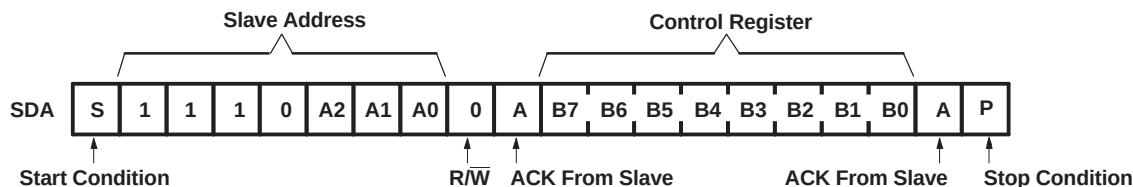


Figure 7. Write to Control Register

Reads

The bus master first must send the PCA9548A address with the LSB set to a logic 1 (see [Figure 4](#) for device address). The command byte is sent after the address and determines which SCn/SDn channel 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 SCn/SDn channel defined by the command byte then is sent by the PCA9548A (see [Figure 8](#)). After a restart, the value of the SCn/SDn channel defined by the command byte matches the SCn/SDn channel being accessed when the restart occurred. Data is clocked into the SCn/SDn channel 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.

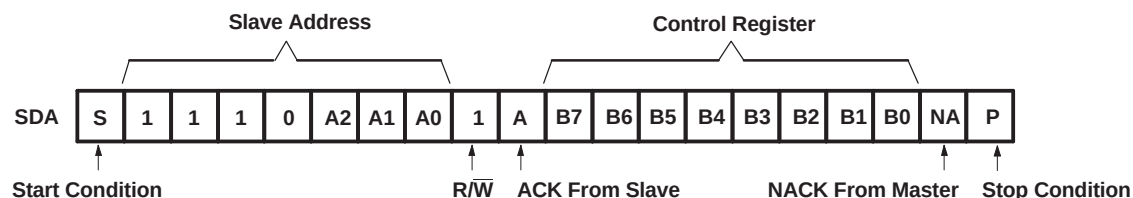


Figure 8. Read From Control Register

PCA9548A

8-CHANNEL I²C SWITCH

WITH RESET

SCPS143B – OCTOBER 2006 – REVISED MARCH 2007

Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V _{CC}	Supply voltage range	–0.5	7	V
V _I	Input voltage range ⁽²⁾	–0.5	7	V
I _I	Input current		±20	mA
I _O	Output current		±25	mA
I _{CC}	Supply current		±100	mA
θ _{JA}	Package thermal impedance, junction to free air ⁽³⁾	DB package	63	°C/W
		DGV package	86	
		DW package	46	
		PW package	88	
		RGE package	45	
θ _{JP}	Package thermal impedance, junction to pad	RGE package	1.5	°C/W
T _{stg}	Storage temperature range	–65	150	°C
T _A	Operating free-air temperature range	–40	85	°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⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Supply voltage	2.3	5.5	V
V _{IH}	High-level input voltage	SCL, SDA	0.7 × V _{CC}	6
		A2–A0, $\overline{\text{RESET}}$	0.7 × V _{CC}	V _{CC} + 0.5
V _{IL}	Low-level input voltage	SCL, SDA	–0.5	0.3 × V _{CC}
		A2–A0, $\overline{\text{RESET}}$	–0.5	0.3 × V _{CC}
T _A	Operating free-air temperature	–40	85	°C

(1) All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

Electrical Characteristics

$V_{CC} = 2.3 \text{ V to } 3.6 \text{ V}$, over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS	V _{CC}	MIN	TYP ⁽¹⁾	MAX	UNIT
V _{POR}	Power-on reset voltage ⁽²⁾		No load, V _I = V _{CC} or GND	V _{POR}	1.6	2.1		V
V _{O(SW)}	Switch output voltage		V _{I(SW)} = V _{CC} , I _{SWout} = −100 μA	5 V	3.6			V
				4.5 V to 5.5 V	2.6	4.5		
				3.3 V	1.9			
				3 V to 3.6 V	1.6	2.8		
				2.5 V	1.5			
				2.3 V to 2.7 V	1.1	2		
I _{OL}	SDA		V _{OL} = 0.4 V	2.3 V to 5.5 V	3	6		mA
			V _{OL} = 0.6 V		6	9		
I _I	SCL, SDA		V _I = V _{CC} or GND	2.3 V to 5.5 V			±1	μA
	SC7–SC0, SD7–SD0						±1	
	A2–A0						±1	
	RESET						±1	
I _{CC}	Operating mode	f _{SCL} = 400 kHz	V _I = V _{CC} or GND, I _O = 0	5.5 V	50	80		μA
				3.6 V	20	35		
				2.7 V	11	20		
		f _{SCL} = 100 kHz	V _I = V _{CC} or GND, I _O = 0	5.5 V	9	30		
				3.6 V	6	15		
				2.7 V	4	8		
	Standby mode	Low inputs	V _I = GND, I _O = 0	5.5 V	0.2	1		
				3.6 V	0.1	1		
				2.7 V	0.1	1		
		High inputs	V _I = V _{CC} , I _O = 0	5.5 V	0.2	1		
				3.6 V	0.1	1		
				2.7 V	0.1	1		
ΔI _{CC}	Supply-current change	SCL, SDA	SCL or SDA input at 0.6 V, Other inputs at V _{CC} or GND	2.3 V to 5.5 V	3	20		μA
			SCL or SDA input at V _{CC} − 0.6 V, Other inputs at V _{CC} or GND		3	20		
C _i	A2–A0		V _I = V _{CC} or GND	2.3 V to 5.5 V	4	5		pF
	RESET				4	5		
	SCL				20	28		
C _{io(off)} ⁽³⁾	SDA		V _I = V _{CC} or GND, Switch OFF	2.3 V to 5.5 V	20	28		pF
	SC7–SC0, SD7–SD0				5.5	7.5		
r _{on}	Switch-on resistance		V _O = 0.4 V, I _O = 15 mA	4.5 V to 5.5 V	4	10	20	Ω
				3 V to 3.6 V	5	12	30	
			V _O = 0.4 V, I _O = 10 mA	2.3 V to 2.7 V	7	15	45	

(1) All typical values are at nominal supply voltage (2.5-V, 3.3-V, or 5-V V_{CC}), $T_A = 25^\circ\text{C}$.

(2) The power-on reset circuit resets the I²C bus logic with $V_{CC} < V_{POR}$. V_{CC} must be lowered to 0.2 V to reset the device.

(3) $C_{i(OFF)}$ depends on internal capacitance and external capacitance added to the SCn lines when channels(s) are ON.

PCA9548A

8-CHANNEL I²C SWITCH

WITH RESET

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I²C Interface Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 9](#))

			STANDARD MODE I ² C BUS		FAST MODE I ² C BUS		UNIT
			MIN	MAX	MIN	MAX	
f_{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 ⁽¹⁾		0 ⁽¹⁾		μs
t_{icr}	I ² C input rise time			1000	$20 + 0.1C_b$ ⁽²⁾	300	ns
t_{icf}	I ² C input fall time			300	$20 + 0.1C_b$ ⁽²⁾	300	ns
t_{ocf}	I ² C output (SDn) fall time (10-pF to 400-pF bus)			300	$20 + 0.1C_b$ ⁽²⁾	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		4.7		0.6		μs
t_{sth}	I ² C start or repeated start condition hold		4		0.6		μs
t_{sps}	I ² C stop condition setup		4		0.6		μs
$t_{vL(Data)}$	Valid-data time (high to low) ⁽³⁾	SCL low to SDA output low valid		1		1	μs
$t_{vH(Data)}$	Valid-data time (low to high) ⁽³⁾	SCL low to SDA output high valid		0.6		0.6	μs
$t_{vd(ack)}$	Valid-data time of ACK condition	ACK signal from SCL low to SDA output low		1		1	μs
C_b	I ² C bus capacitive load			400		400	pF

- (1) A device internally must provide a hold time of at least 300 ns for the SDA signal (referred to the V_{IH} min of the SCL signal), to bridge the undefined region of the falling edge of SCL.
 (2) C_b = total bus capacitance of one bus line in pF
 (3) Data taken using a 1-kΩ pullup resistor and 50-pF load (see [Figure 10](#))

Switching Characteristics

over recommended operating free-air temperature range, $C_L \leq 100$ pF (unless otherwise noted) (see [Figure 9](#))

PARAMETER			FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
t _{pd} ⁽¹⁾	Propagation delay time	R _{ON} = 20 Ω, C _L = 15 pF	SDA or SCL	SDn or SCn	0.3		ns
		R _{ON} = 20 Ω, C _L = 50 pF			1		
t _{rst} ⁽²⁾	RESET time (SDA clear)		RESET	SDA	500		ns

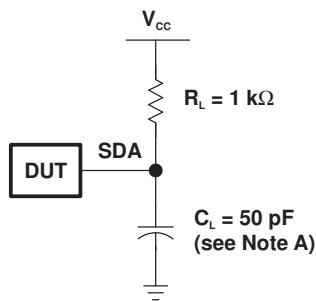
- (1) The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).
 (2) t_{rst} is the propagation delay measured from the time the RESET pin is first asserted low to the time the SDA pin is asserted high, signaling a stop condition. It must be a minimum of t_{WL} .

Reset Timing Requirements

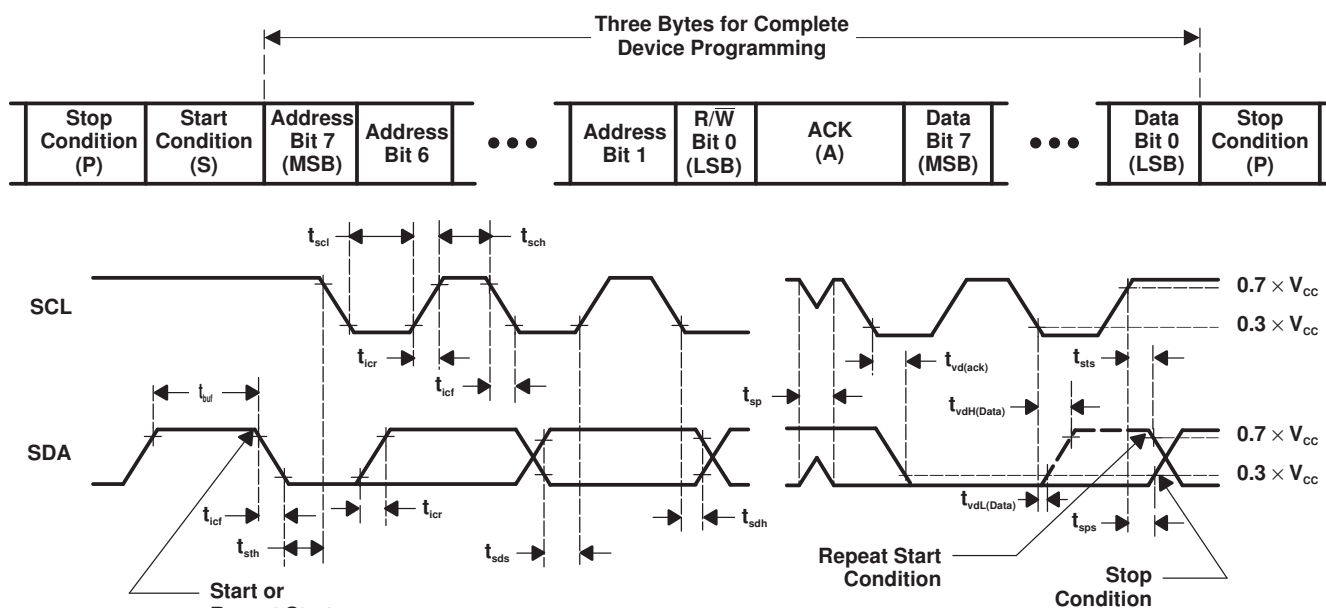
over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			MIN	MAX	UNIT
$t_{W(L)}$	Pulse duration, RESET low		6		ns
$t_{REC(STA)}$	Recovery time from RESET to start		0		ns

PARAMETER MEASUREMENT INFORMATION



SDA LOAD CONFIGURATION



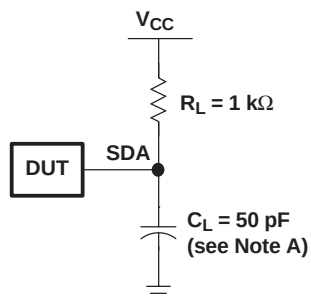
VOLTAGE WAVEFORMS

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

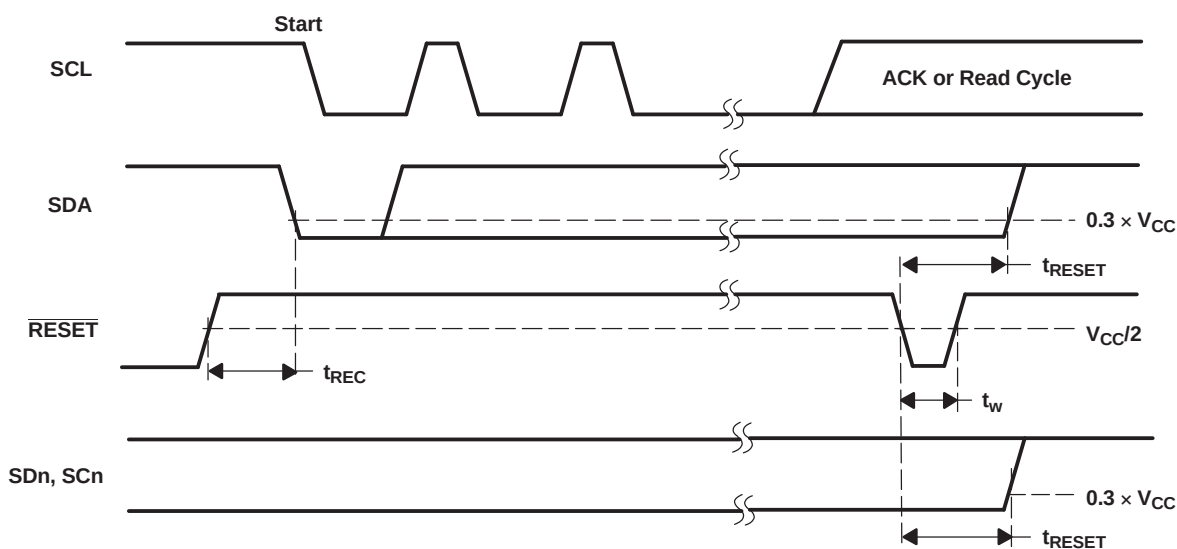
- A. C_L includes probe and jig capacitance.
- B. All inputs are supplied by generators having the following characteristics: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r/t_f \leq 30\text{ ns}$.
- C. Not all parameters and waveforms are applicable to all devices.

Figure 9. I²C Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)



SDA LOAD CONFIGURATION

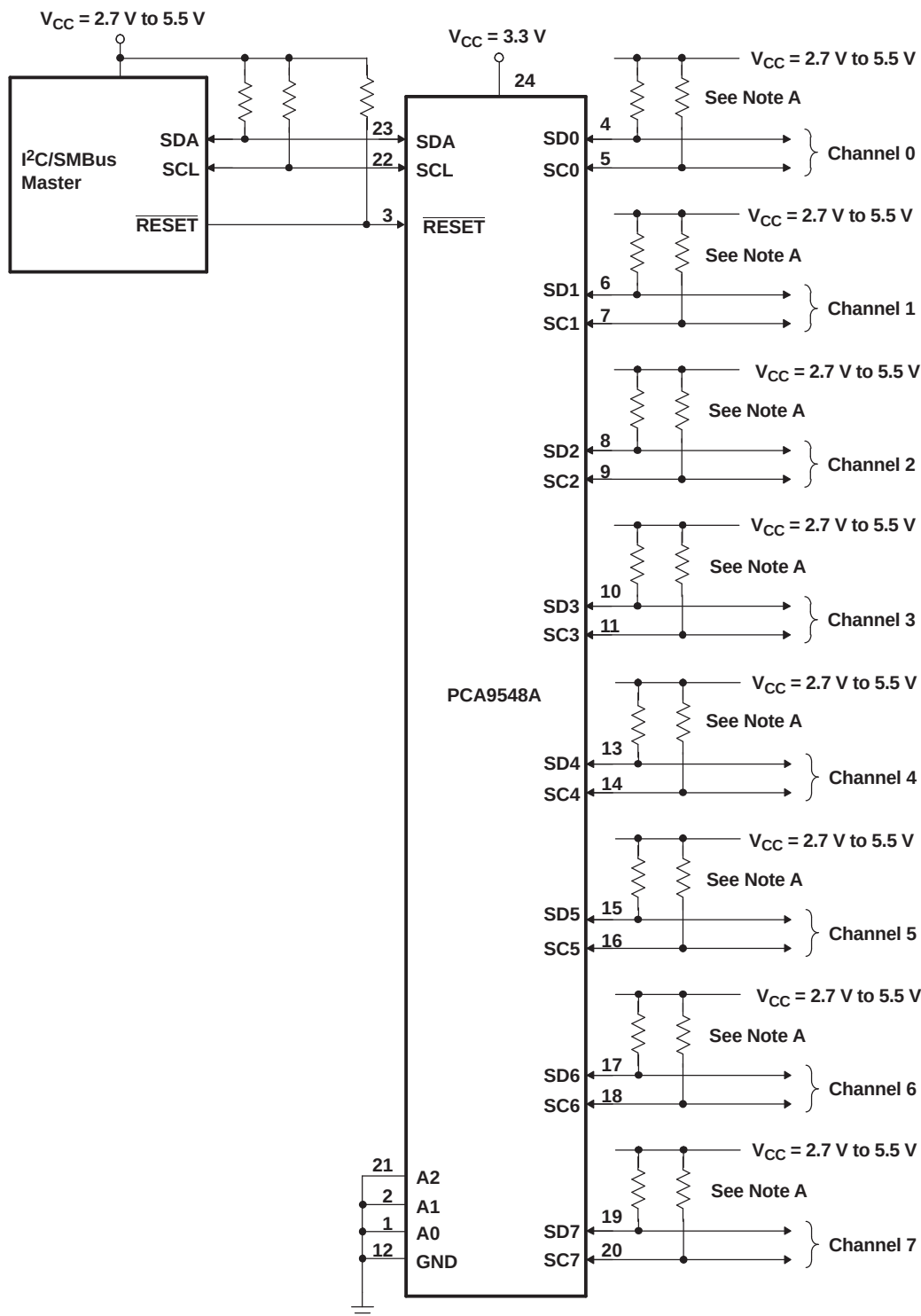


- A. C_L includes probe and jig capacitance.
- B. All inputs are supplied by generators having the following characteristics: $PRR \leq 10\text{ MHz}$, $Z_O = 50\text{ }\Omega$, $t_r/t_f \leq 30\text{ ns}$.
- C. I/Os are configured as inputs.
- D. Not all parameters and waveforms are applicable to all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

Figure 10. Reset Load Circuit and Voltage Waveforms

APPLICATION INFORMATION

Figure 11 shows an application in which the PCA9548A can be used.



A. Pin numbers shown are for the DB, DW, PW, and DGV packages.

Figure 11. Typical Application

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
PCA9548ADB	ACTIVE	SSOP	DB	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548ADBR	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548ADGVR	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548ADW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548ADWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548APW	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548APWR	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
PCA9548ARGER	ACTIVE	QFN	RGE	24	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1YEAR

⁽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.

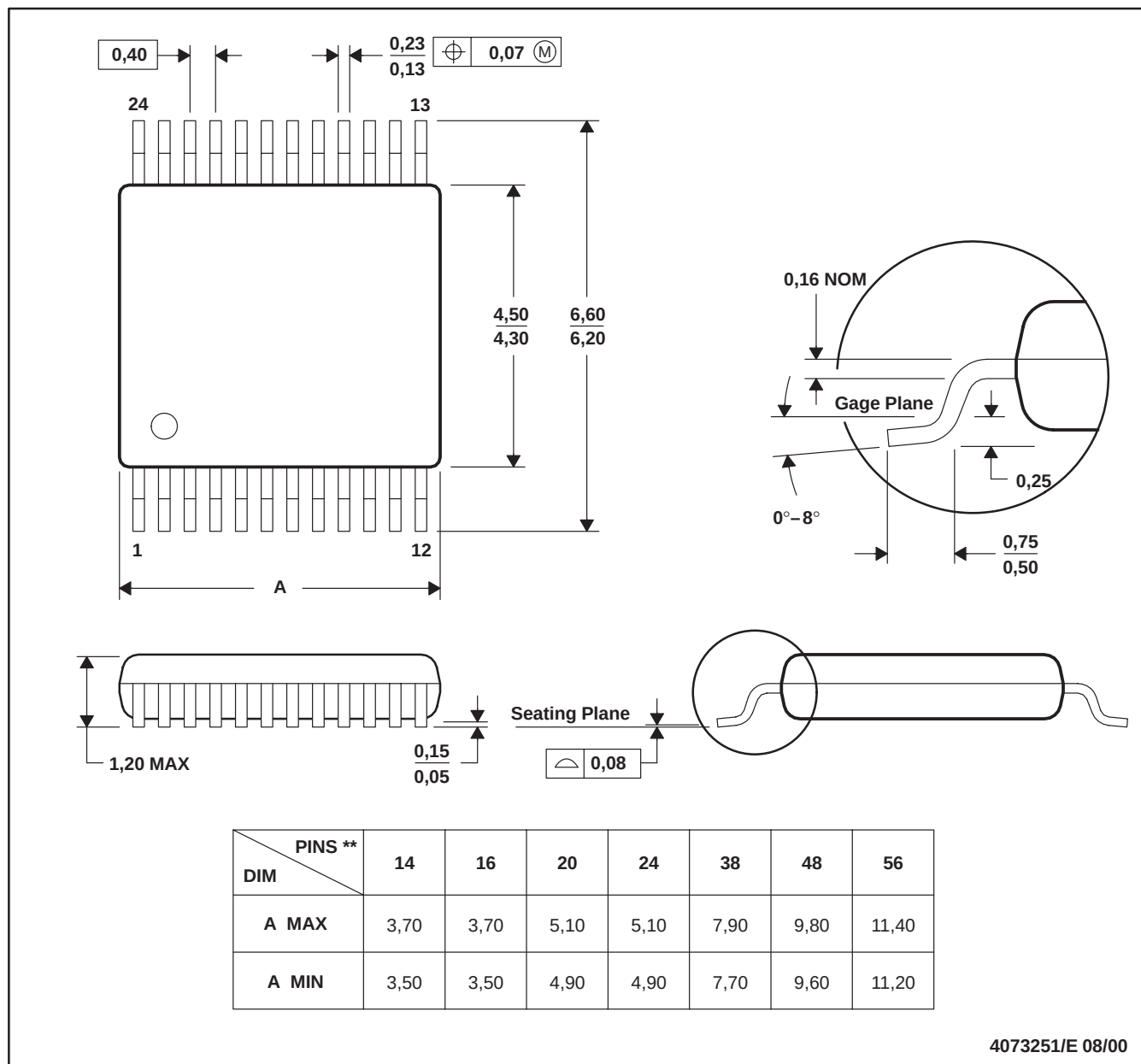
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DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

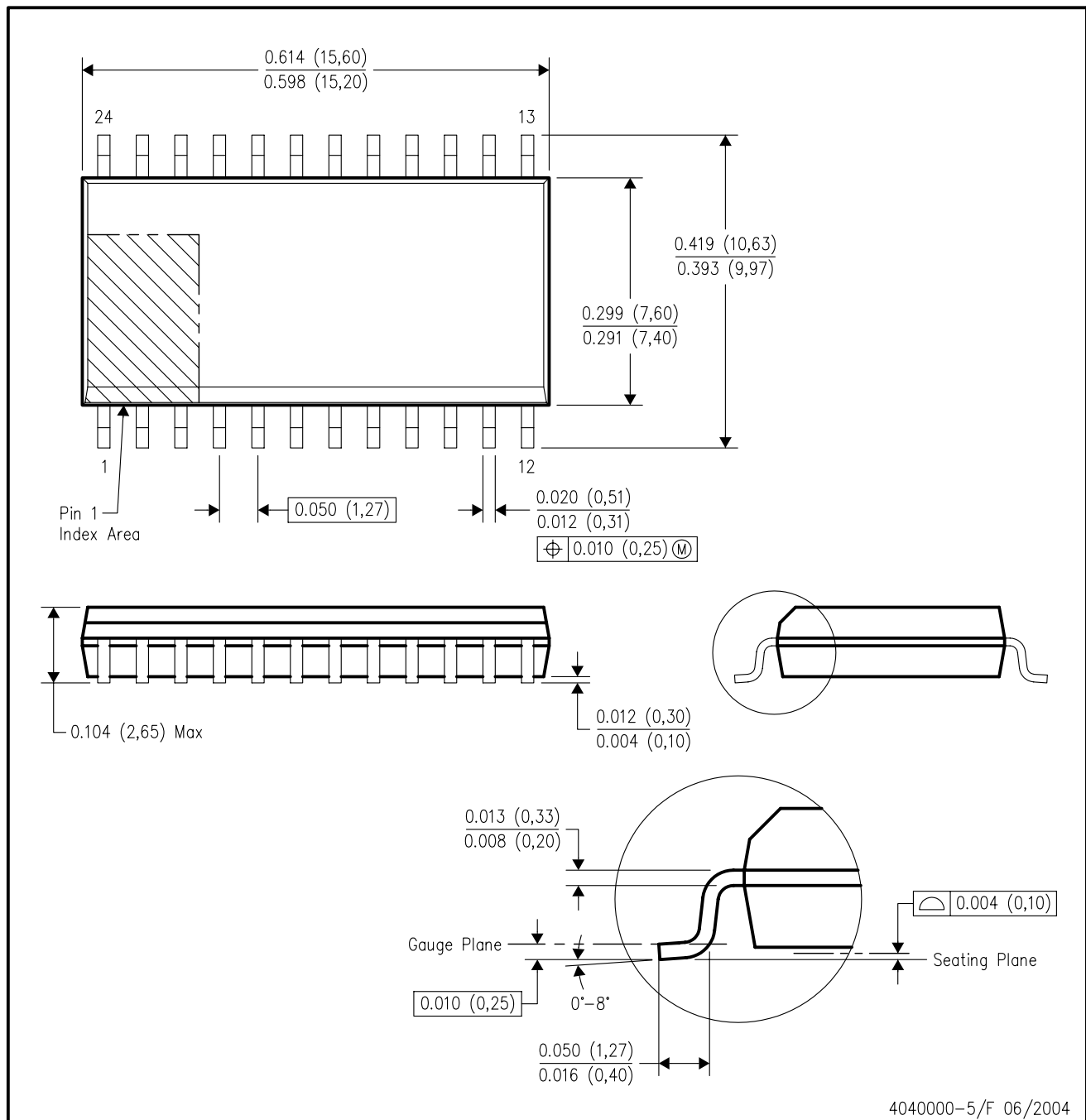
24 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

DW (R-PDSO-G24)

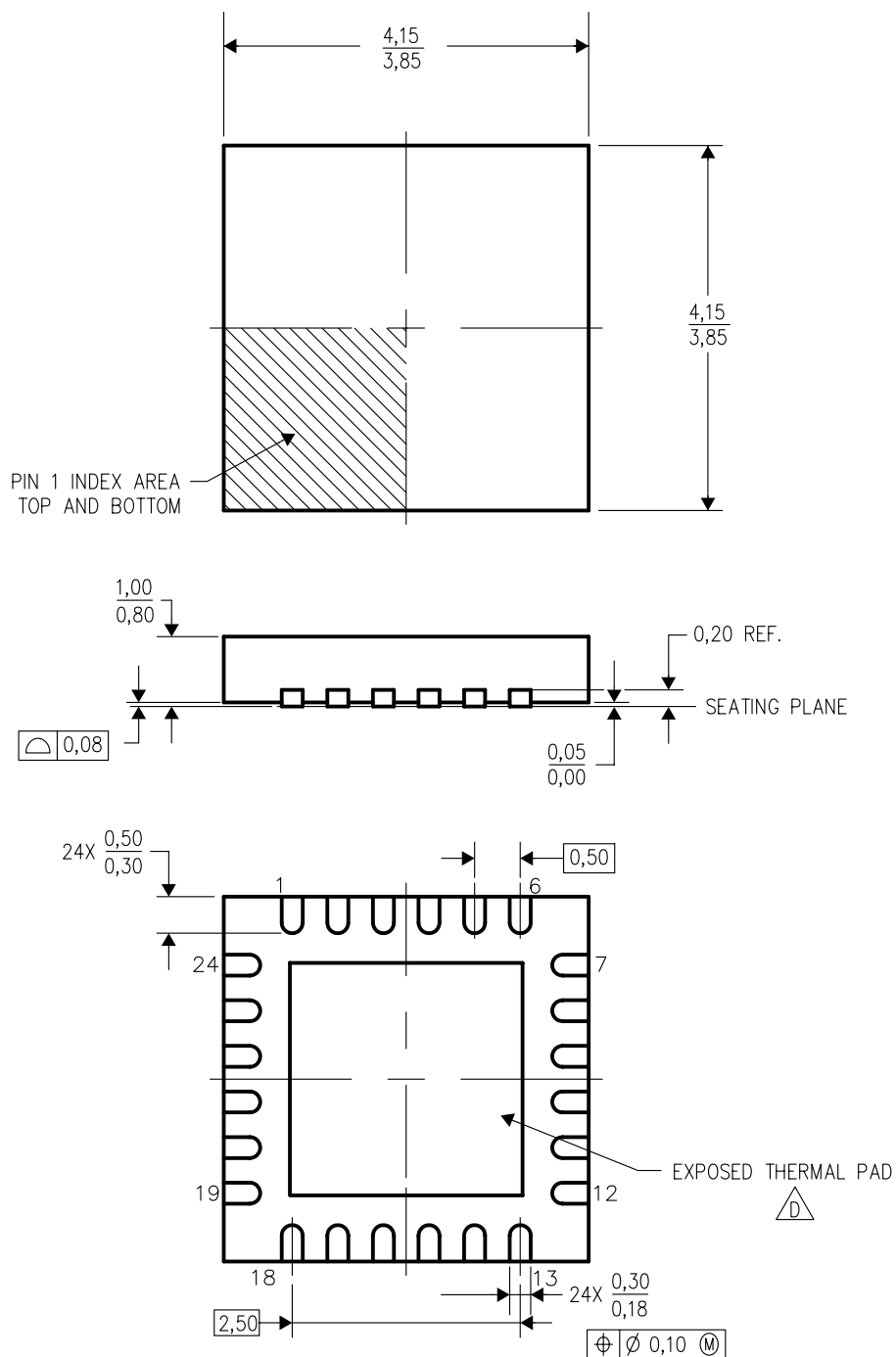
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
 - 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 AD.

RGE (S-PQFP-N24)

PLASTIC QUAD FLATPACK



4204104/C 11/04

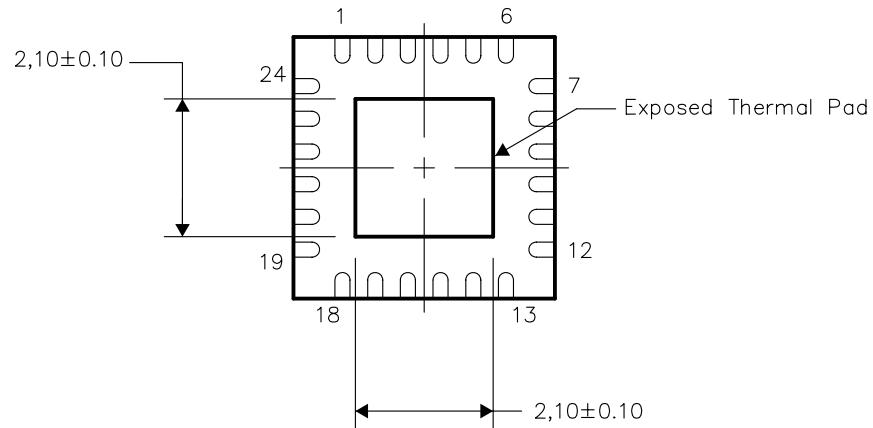
- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Quad Flatpack, No-Leads (QFN) package configuration.
 - D. The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
 - E. Falls within JEDEC MO-220.

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 a ground or power plane (whichever is applicable), or alternatively, a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

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

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



Bottom View

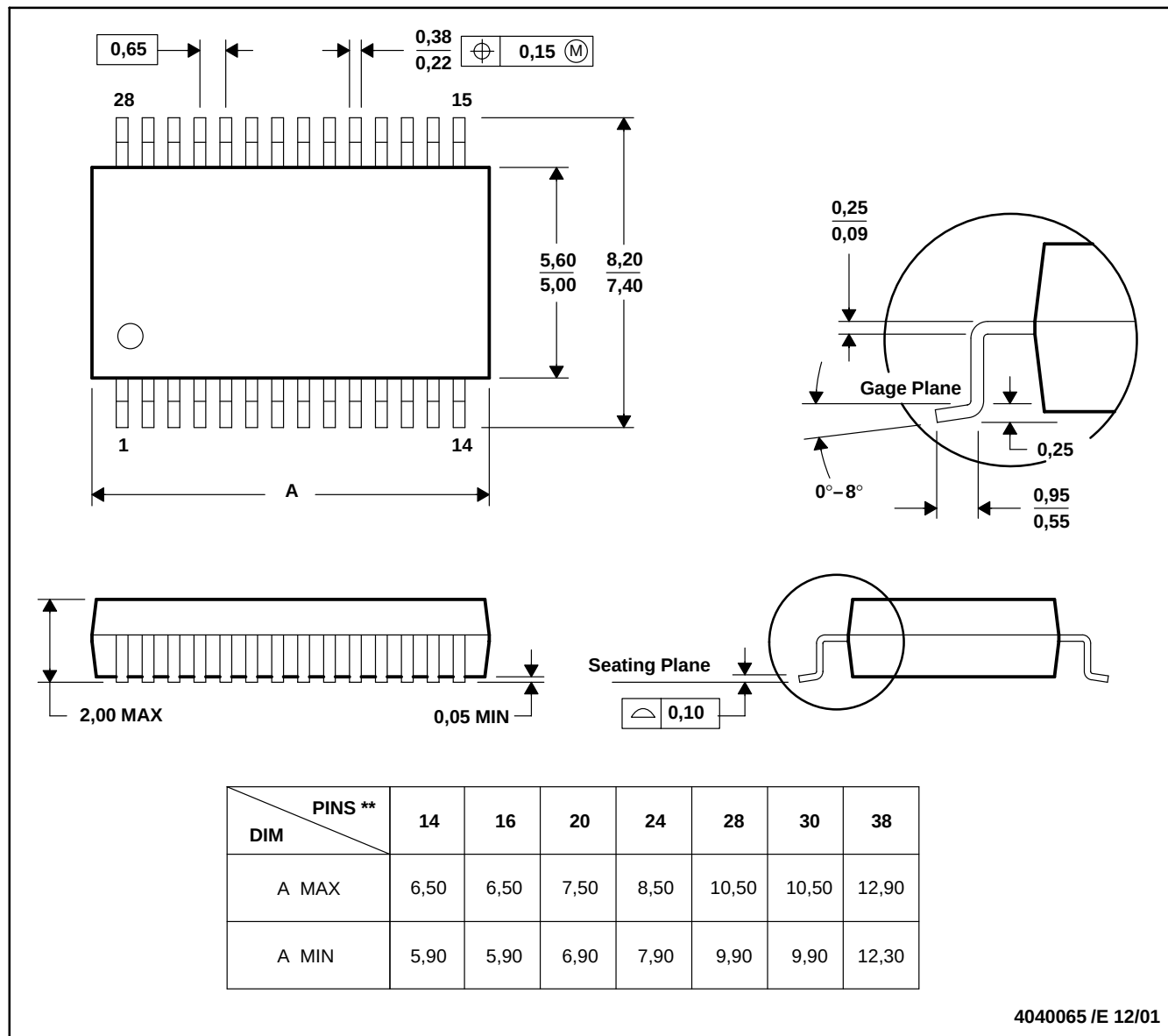
NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN

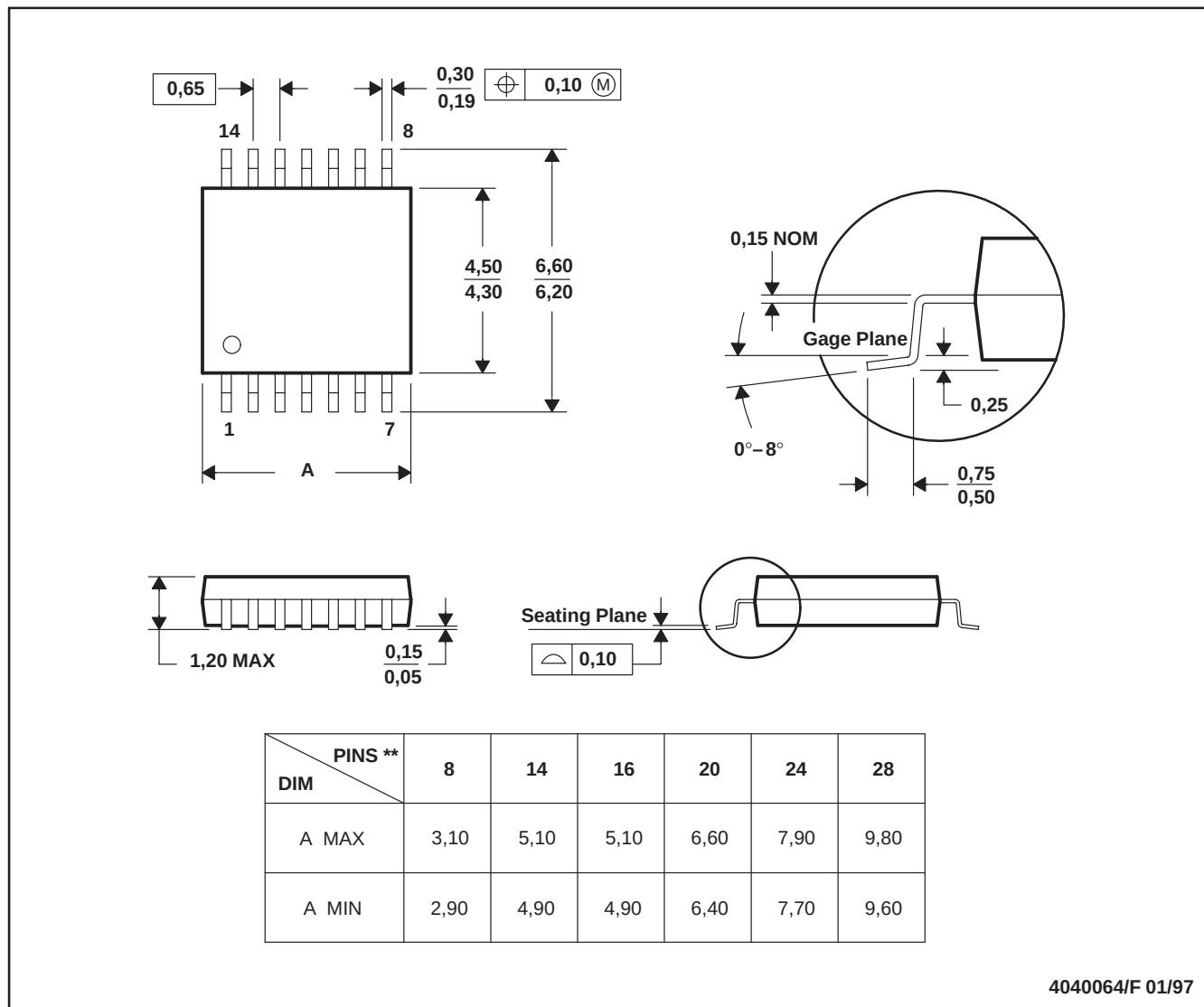


- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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