

# DATA SHEET



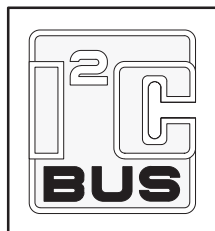
## **PCA9546A** 4-channel I<sup>2</sup>C switch with reset

Objective data sheet  
Supersedes data of 2004 Jul 28

2004 Sep 29

## 4-channel I<sup>2</sup>C switch with reset

## PCA9546A



### FEATURES

- 1-of-4 bi-directional translating switches
- I<sup>2</sup>C interface logic; compatible with SMBus standards
- Active-LOW Reset Input
- 3 address pins allowing up to 8 devices on the I<sup>2</sup>C-bus
- Channel selection via I<sup>2</sup>C-bus, in any combination
- Power up with all switch channels deselected
- Low R<sub>dsON</sub> switches
- Allows voltage level translation between 1.8 V, 2.5 V, 3.3 V and 5 V buses
- No glitch on power-up
- Supports hot insertion
- Low stand-by current
- Operating power supply voltage range of 2.3 V to 5.5 V
- 5 V tolerant Inputs
- 0 kHz to 400 kHz clock frequency
- ESD protection exceeds 2000 V HBM per JESD22-A114, 200 V MM per JESD22-A115 and 1000 V per JESD22-C101
- Latchup testing is done to JESDEC Standard JESD78 which exceeds 100 mA
- Three packages offered: SO16, TSSOP16, and HVQFN16

### DESCRIPTION

The PCA9546A is a quad bi-directional translating switch controlled by the I<sup>2</sup>C-bus. The SCL/SDA upstream pair fans out to four 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.

An active-LOW reset input allows the PCA9546A to recover from a situation where one of the downstream I<sup>2</sup>C-buses is stuck in a LOW state. Pulling the RESET pin LOW resets the I<sup>2</sup>C state machine and causes all the channels to be deselected as does the internal power on reset function.

The pass gates of the switches are constructed such that the V<sub>DD</sub> pin can be used to limit the maximum high voltage which will be passed by the PCA9546A. This allows the use of different bus voltages on each pair, so that 1.8 V, 2.5 V, or 3.3 V parts can communicate with 5 V parts without any additional protection. External pull-up resistors pull the bus up to the desired voltage level for each channel. All I/O pins are 5 V tolerant.

### ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	ORDER CODE	TOPSIDE MARK	DRAWING NUMBER
16-Pin Plastic SO	–40 °C to +85 °C	PCA9546AD	PCA9546AD	SOT109-1
16-Pin Plastic TSSOP	–40 °C to +85 °C	PCA9546APW	PA9546A	SOT403-1
16-Pin Plastic HVQFN	–40 °C to +85 °C	PCA9546ABS	546A	SOT629-1

Standard packing quantities and other packaging data are available at [www.standardproducts.philips.com/packaging](http://www.standardproducts.philips.com/packaging).

4-channel I<sup>2</sup>C switch with reset

PCA9546A

PIN CONFIGURATION — SO, TSSOP

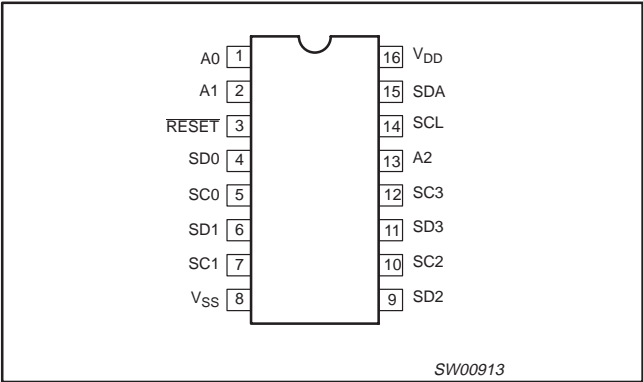


Figure 1. Pin configuration — SO, TSSOP

PIN CONFIGURATION — HVQFN

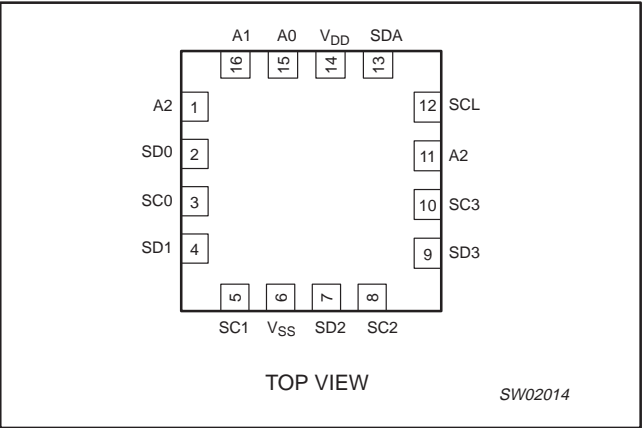


Figure 2. Pin Configuration — HVQFN

PIN DESCRIPTION

SO, TSSOP PIN NUMBER	HVQFN PIN NUMBER	SYMBOL	FUNCTION
1	15	A0	Address input 0
2	16	A1	Address input 1
3	1	RESET	Active-LOW reset input
4	2	SD0	Serial data 0
5	3	SC0	Serial clock 0
6	4	SD1	Serial data 1
7	5	SC1	Serial clock 1
8	6	V <sub>SS</sub>	Supply ground
9	7	SD2	Serial data 2
10	8	SC2	Serial clock 2
11	9	SD3	Serial data 3
12	10	SC3	Serial clock 3
13	11	A2	Address input 2
14	12	SCL	Serial clock line
15	13	SDA	Serial data line
16	14	V <sub>DD</sub>	Supply voltage

4-channel I<sup>2</sup>C switch with reset

PCA9546A

## BLOCK DIAGRAM

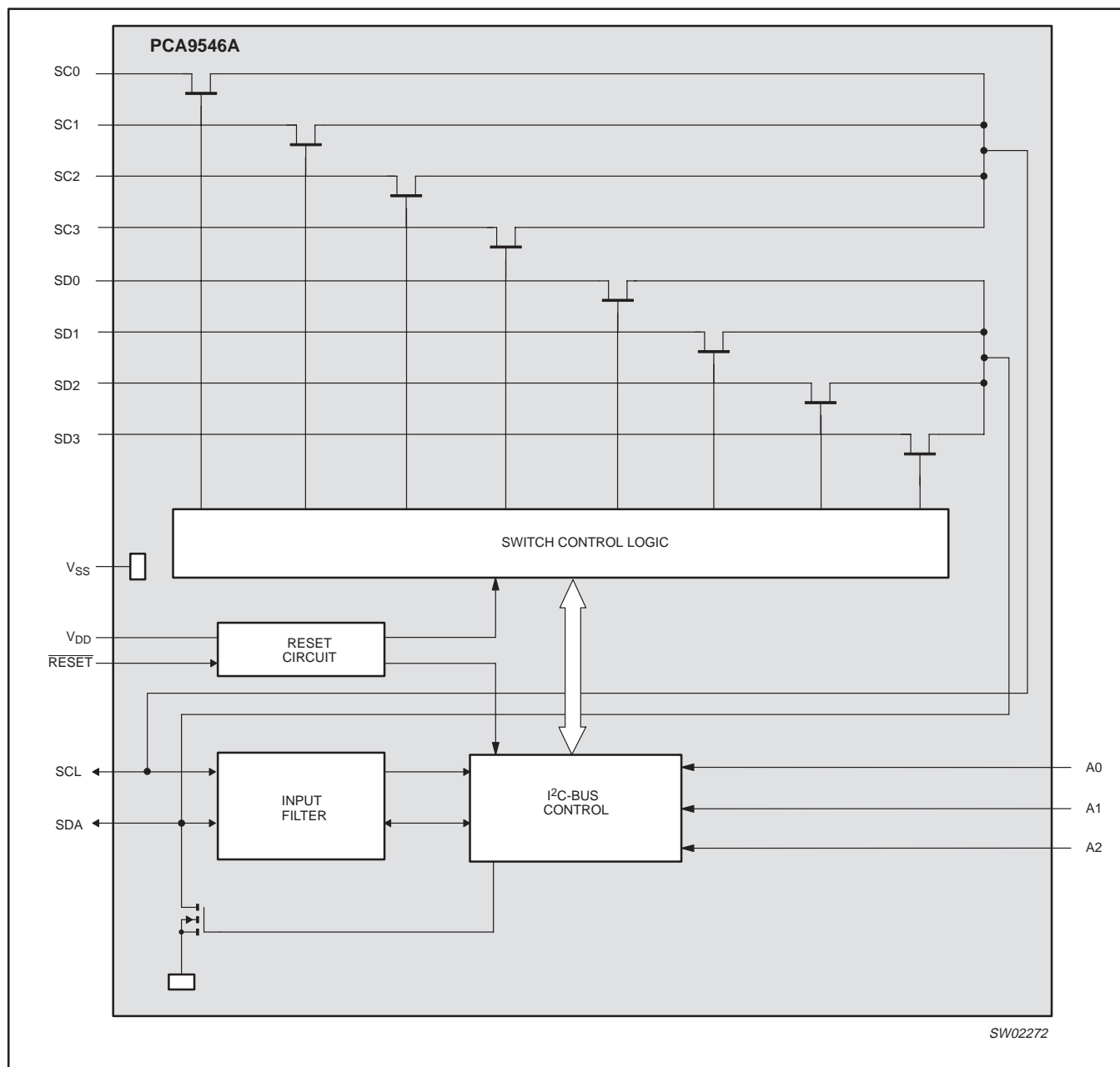


Figure 3. Block diagram

4-channel I<sup>2</sup>C switch with reset

## PCA9546A

## DEVICE ADDRESSING

Following a START condition the bus master must output the address of the slave it is accessing. The address of the PCA9546A is shown in Figure 4. To conserve power, no internal pullup resistors are incorporated on the hardware selectable address pins and they must be pulled HIGH or LOW.

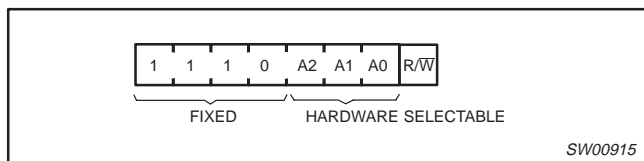


Figure 4. Slave address

The last bit of the slave address defines the operation to be performed. When set to logic 1, a read is selected while a logic 0 selects a write operation.

## CONTROL REGISTER

Following the successful acknowledgement of the slave address, the bus master will send a byte to the PCA9546A, which will be stored in the control register. If multiple bytes are received by the PCA9546A, it will save the last byte received. This register can be written and read via the I<sup>2</sup>C-bus.

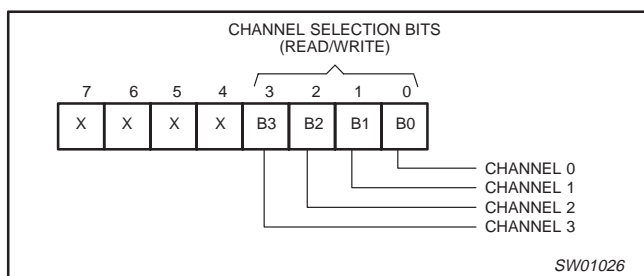


Figure 5. Control register

## CONTROL REGISTER DEFINITION

One or several SCx/SDx downstream pair, or channel, is selected by the contents of the control register. This register is written after the PCA9546A has been addressed. The 2 LSBs of the control byte are used to determine which channel is to be selected. When a channel is selected, the channel will become active after a stop condition has been placed on the I<sup>2</sup>C-bus. This ensures that all SCx/SDx lines will be in a HIGH state when the channel is made active, so that no false conditions are generated at the time of connection.

Table 1. Control Register; Write — Channel Selection/  
Read — Channel Status

D7	D6	D5	D4	B3	B2	B1	B0	COMMAND
X	X	X	X	X	X	X	0	Channel 0 disabled
							1	Channel 0 enabled
X	X	X	X	X	X	X	0	Channel 1 disabled
							1	Channel 1 enabled
X	X	X	X	X	X	X	0	Channel 2 disabled
							1	Channel 2 enabled
X	X	X	X	X	X	X	0	Channel 3 disabled
							1	Channel 3 enabled
0	0	0	0	0	0	0	0	No channel selected; power-up/ reset default state

**NOTE:** Several channels can be enabled at the same time.

Ex: B3 = 0, B2 = 1, B1 = 1, B0 = 0, means that channel 0 and 3 are disabled and channel 1 and 2 are enabled.

Care should be taken not to exceed the maximum bus capacity.

## RESET INPUT

The RESET input is an active-LOW signal which may be used to recover from a bus fault condition. By asserting this signal LOW for a minimum of  $t_{WL}$ , the PCA9546A will reset its registers and I<sup>2</sup>C state machine and will deselect all channels. The RESET input must be connected to V<sub>DD</sub> through a pull-up resistor.

## POWER-ON RESET

When power is applied to V<sub>DD</sub>, an internal Power-On Reset holds the PCA9546A in a reset condition until V<sub>DD</sub> has reached V<sub>POR</sub>. At this point, the reset condition is released and the PCA9546A registers and I<sup>2</sup>C state machine are initialized to their default states, all zeroes causing all the channels to be deselected. Thereafter, V<sub>DD</sub> must be lowered below 0.2 V to reset the device.

4-channel I<sup>2</sup>C switch with reset

## PCA9546A

**VOLTAGE TRANSLATION**

The pass gate transistors of the PCA9546A are constructed such that the  $V_{DD}$  voltage can be used to limit the maximum voltage that will be passed from one I<sup>2</sup>C-bus to another.

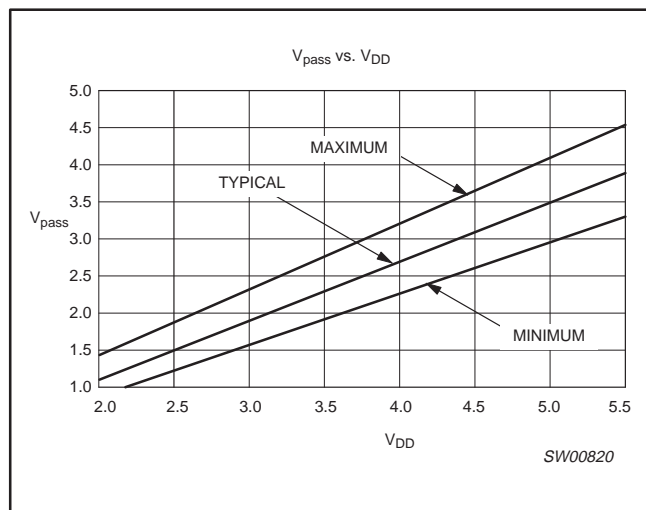


Figure 6.  $V_{pass}$  voltage vs.  $V_{DD}$

Figure 6 shows the voltage characteristics of the pass gate transistors (note that the PCA9546A is only tested at the points specified in the DC Characteristics section of this datasheet). In order for the PCA9546A to act as a voltage translator, the  $V_{pass}$  voltage should be equal to, or lower than the lowest bus voltage. For example, if the main bus was running at 5 V, and the downstream buses were 3.3 V and 2.7 V, then  $V_{pass}$  should be equal to or below 2.7 V to effectively clamp the downstream bus voltages. Looking at Figure 6, we see that  $V_{pass}$  (max.) will be at 2.7 V when the PCA9546A supply voltage is 3.5 V or lower so the PCA9546A supply voltage could be set to 3.3 V. Pull-up resistors can then be used to bring the bus voltages to their appropriate levels (see Figure 13).

More Information can be found in Application Note AN262 *PCA954X family of I<sup>2</sup>C/SMBus multiplexers and switches*.

4-channel I<sup>2</sup>C switch with reset

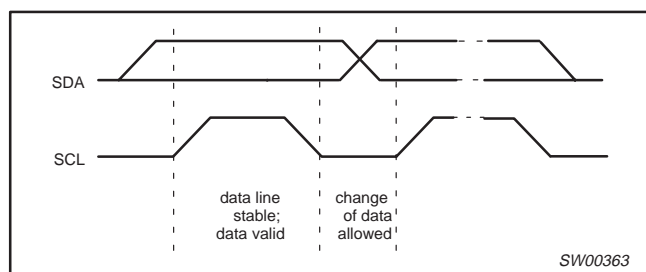
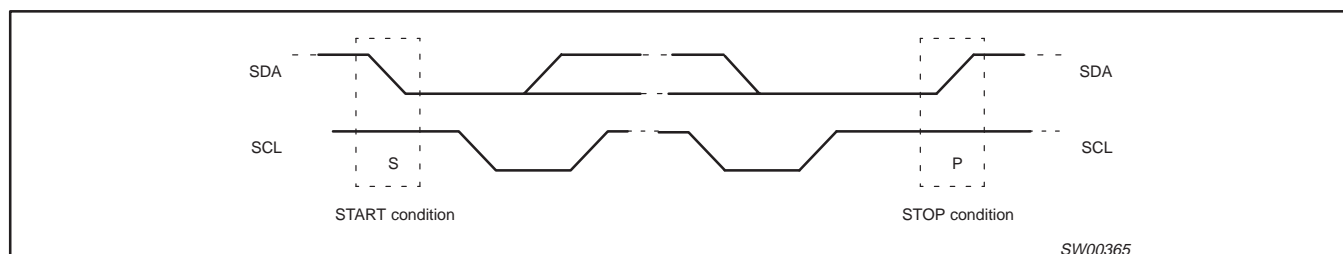
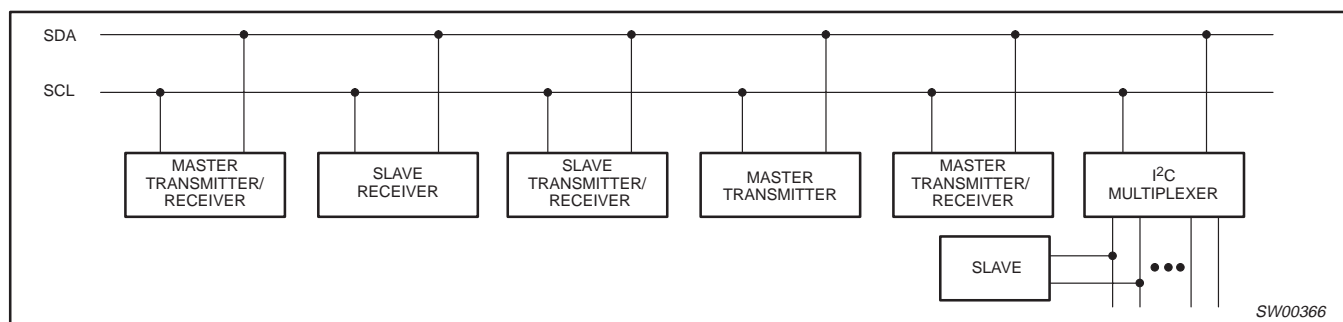
PCA9546A

**CHARACTERISTICS OF THE I<sup>2</sup>C-BUS**

The I<sup>2</sup>C-bus is for 2-way, 2-line communication between different ICs or modules. The two lines are a serial data line (SDA) and a serial clock line (SCL). Both lines must be connected to a positive supply via a pull-up resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

**Bit transfer**

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the HIGH period of the clock pulse as changes in the data line at this time will be interpreted as control signals (see Figure 7).

**Figure 7. Bit transfer****Figure 8. Definition of start and stop conditions****Figure 9. System configuration**

4-channel I<sup>2</sup>C switch with reset

PCA9546A

Acknowledge

The number of data bytes transferred between the start and the stop conditions from transmitter to receiver is not limited. Each byte of eight bits is followed by one acknowledge bit. The acknowledge bit is a HIGH level put on the bus by the transmitter whereas the master generates an extra acknowledge related clock pulse.

A slave receiver which is addressed must generate an acknowledge after the reception of each byte. Also a master must generate an acknowledge after the reception of each byte that has been clocked out of the slave transmitter. The device that acknowledges has to pull down the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during the HIGH period of the acknowledge related clock pulse, set-up and hold times must be taken into account.

A master receiver must signal an end of data to the transmitter by not generating an acknowledge on the last byte that has been clocked out of the slave. In this event, the transmitter must leave the data line HIGH to enable the master to generate a stop condition.

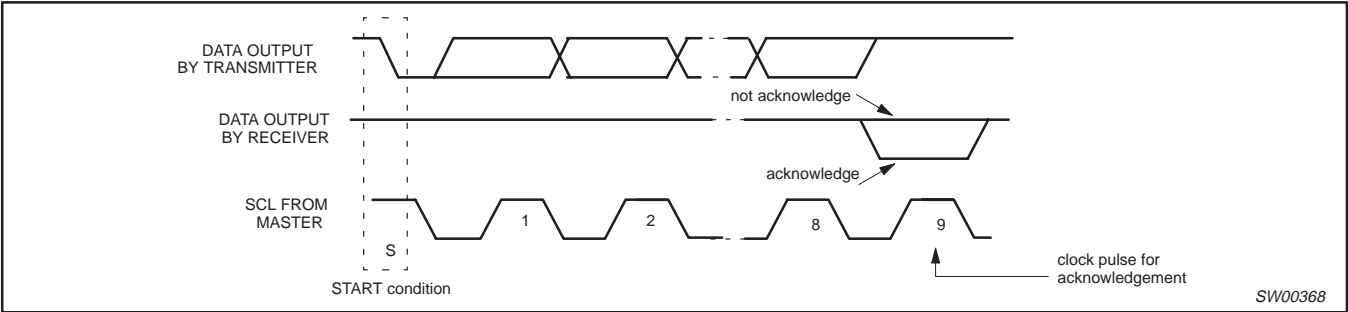


Figure 10. Acknowledgement on the I<sup>2</sup>C-bus

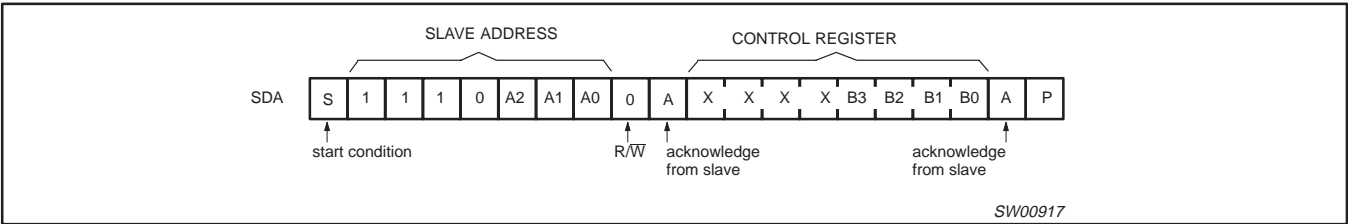


Figure 11. WRITE control register

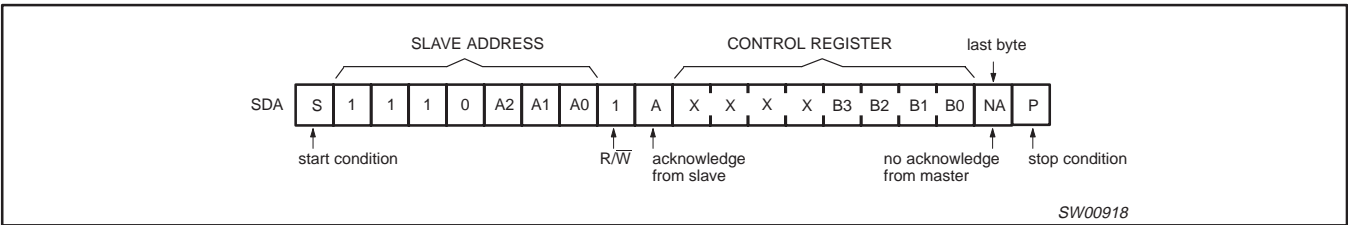


Figure 12. READ control register



4-channel I<sup>2</sup>C switch with reset

PCA9546A

## TYPICAL APPLICATION

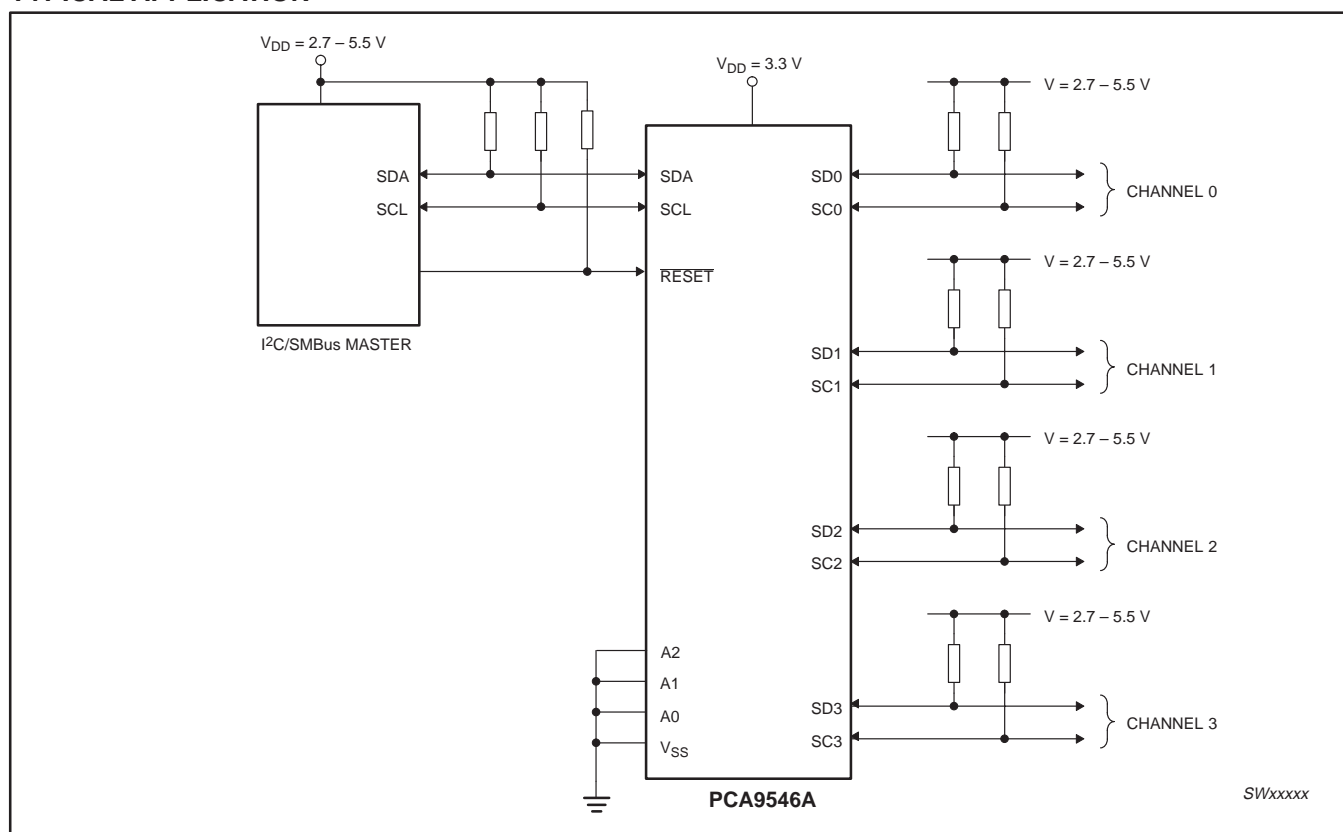


Figure 13. Typical application

ABSOLUTE MAXIMUM RATINGS<sup>1, 2</sup>

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V <sub>DD</sub>	DC supply voltage		-0.5 to +7.0	V
V <sub>I</sub>	DC input voltage		-0.5 to +7.0	V
I <sub>I</sub>	DC input current		±20	mA
I <sub>O</sub>	DC output current		±25	mA
I <sub>DD</sub>	Supply current		±100	mA
I <sub>SS</sub>	Supply current		±100	mA
P <sub>tot</sub>	total power dissipation		400	mW
T <sub>stg</sub>	Storage temperature range		-60 to +150	°C
T <sub>amb</sub>	Operating ambient temperature		-40 to +85	°C

## NOTES:

- Stresses beyond those listed 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.
- The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150 °C.

4-channel I<sup>2</sup>C switch with reset

PCA9546A

## DC CHARACTERISTICS

 $V_{DD} = 2.3 \text{ V to } 3.6 \text{ V}$ ;  $V_{SS} = 0 \text{ V}$ ;  $T_{amb} = -40 \text{ }^{\circ}\text{C to } +85 \text{ }^{\circ}\text{C}$ ; unless otherwise specified. (See page 11 for  $V_{DD} = 3.6 \text{ V to } 5.5 \text{ V}$ )

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Supply						
V <sub>DD</sub>	Supply voltage		2.3	—	3.6	V
I <sub>DD</sub>	Supply current	Operating mode; V <sub>DD</sub> = 3.6 V; no load; V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub> ; f <sub>SCL</sub> = 100 kHz	—	16	50	μA
I <sub>stb</sub>	Standby current	Standby mode; V <sub>DD</sub> = 3.6 V; no load; V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	—	0.1	1	μA
V <sub>POR</sub>	Power-on reset voltage (Note 1)	no load; V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	—	1.6	2.1	V
Input SCL; input/output SDA						
V <sub>IL</sub>	LOW-level input voltage		−0.5	—	0.3 V <sub>DD</sub>	V
V <sub>IH</sub>	HIGH-level input voltage		0.7 V <sub>DD</sub>	—	6	V
I <sub>OL</sub>	LOW-level output current	V <sub>OL</sub> = 0.4 V	3	—	—	mA
		V <sub>OL</sub> = 0.6 V	6	—	—	
I <sub>L</sub>	Leakage current	V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	−1	—	+1	μA
C <sub>i</sub>	Input capacitance	V <sub>I</sub> = V <sub>SS</sub>	—	12	13	pF
Select inputs A0 to A2 / RESET						
V <sub>IL</sub>	LOW-level input voltage		−0.5	—	+0.3 V <sub>DD</sub>	V
V <sub>IH</sub>	HIGH-level input voltage		0.7 V <sub>DD</sub>	—	V <sub>DD</sub> + 0.5	V
I <sub>LI</sub>	Input leakage current	pin at V <sub>DD</sub> or V <sub>SS</sub>	−1	—	+1	μA
C <sub>i</sub>	Input capacitance	V <sub>I</sub> = V <sub>SS</sub>	—	1.6	3	pF
Pass Gate						
R <sub>ON</sub>	Switch resistance	V <sub>CC</sub> = 3.67 V; V <sub>O</sub> = 0.4 V; I <sub>O</sub> = 15 mA	5	11	30	Ω
		V <sub>CC</sub> = 2.3 V to 2.7 V; V <sub>O</sub> = 0.4 V; I <sub>O</sub> = 10 mA	7	16	55	
V <sub>Pass</sub>	Switch output voltage	V <sub>swin</sub> = V <sub>DD</sub> = 3.3 V; I <sub>swout</sub> = −100 μA	—	1.9	—	V
		V <sub>swin</sub> = V <sub>DD</sub> = 3.0 V to 3.6 V; I <sub>swout</sub> = −100 μA	1.6	—	2.8	
		V <sub>swin</sub> = V <sub>DD</sub> = 2.5 V; I <sub>swout</sub> = −100 μA	—	1.5	—	
		V <sub>swin</sub> = V <sub>DD</sub> = 2.3 to 2.7 V; I <sub>swout</sub> = −100 μA	1.1	—	2.0	
I <sub>L</sub>	Leakage current	V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	−1	—	+1	μA
C <sub>iO</sub>	Input/output capacitance	V <sub>I</sub> = V <sub>SS</sub>	—	3	5	pF

## NOTE:

1.  $V_{DD}$  must be lowered to 0.2 V in order to reset part.

4-channel I<sup>2</sup>C switch with reset

PCA9546A

## DC CHARACTERISTICS

V<sub>DD</sub> = 3.6 V to 5.5 V; V<sub>SS</sub> = 0 V; T<sub>amb</sub> = -40 °C to +85 °C; unless otherwise specified. (See page 10 for V<sub>DD</sub> = 2.3 V to 3.6 V)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Supply						
V <sub>DD</sub>	Supply voltage		3.6	—	5.5	V
I <sub>DD</sub>	Supply current	Operating mode; V <sub>DD</sub> = 5.5 V; no load; V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub> ; f <sub>SCL</sub> = 100 kHz	—	65	100	μA
I <sub>stb</sub>	Standby current	Standby mode; V <sub>DD</sub> = 5.5 V; no load; V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	—	0.3	1	μA
V <sub>POR</sub>	Power-on reset voltage (Note 1)	no load; V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	—	1.7	2.1	V
Input SCL; input/output SDA						
V <sub>IL</sub>	LOW-level input voltage		−0.5	—	0.3 V <sub>DD</sub>	V
V <sub>IH</sub>	HIGH-level input voltage		0.7 V <sub>DD</sub>	—	6	V
I <sub>OL</sub>	LOW-level output current	V <sub>OL</sub> = 0.4 V	3	—	—	mA
		V <sub>OL</sub> = 0.6 V	6	—	—	mA
I <sub>IL</sub>	LOW-level input current	V <sub>I</sub> = V <sub>SS</sub>	1	—	1	μA
I <sub>IH</sub>	HIGH-level input current	V <sub>I</sub> = V <sub>DD</sub>	1	—	1	μA
C <sub>i</sub>	Input capacitance	V <sub>I</sub> = V <sub>SS</sub>	—	12	13	pF
Select inputs A0 to A2 / RESET						
V <sub>IL</sub>	LOW-level input voltage		−0.5	—	+0.3 V <sub>DD</sub>	V
V <sub>IH</sub>	HIGH-level input voltage		0.7 V <sub>DD</sub>	—	V <sub>DD</sub> + 0.5	V
I <sub>LI</sub>	Input leakage current	pin at V <sub>DD</sub> or V <sub>SS</sub>	−1	—	+50	μA
C <sub>i</sub>	Input capacitance	V <sub>I</sub> = V <sub>SS</sub>	—	2	3	pF
Pass Gate						
R <sub>ON</sub>	Switch resistance	V <sub>CC</sub> = 4.5 to 5.5 V, V <sub>O</sub> = 0.4 V, I <sub>O</sub> = 15 mA	4	9	24	Ω
V <sub>Pass</sub>	Switch output voltage	V <sub>swin</sub> = V <sub>DD</sub> = 5.0 V; I <sub>swout</sub> = −100 μA	—	3.6	—	V
		V <sub>swin</sub> = V <sub>DD</sub> = 4.5 V to 5.5 V; I <sub>swout</sub> = −100 μA	2.6	—	4.5	V
I <sub>L</sub>	Leakage current	V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>	−10	—	+100	μA
C <sub>io</sub>	Input/output capacitance	V <sub>I</sub> = V <sub>SS</sub>	—	3	5	pF

## NOTE:

1. V<sub>DD</sub> must be lowered to 0.2 V in order to reset part.

4-channel I<sup>2</sup>C switch with reset

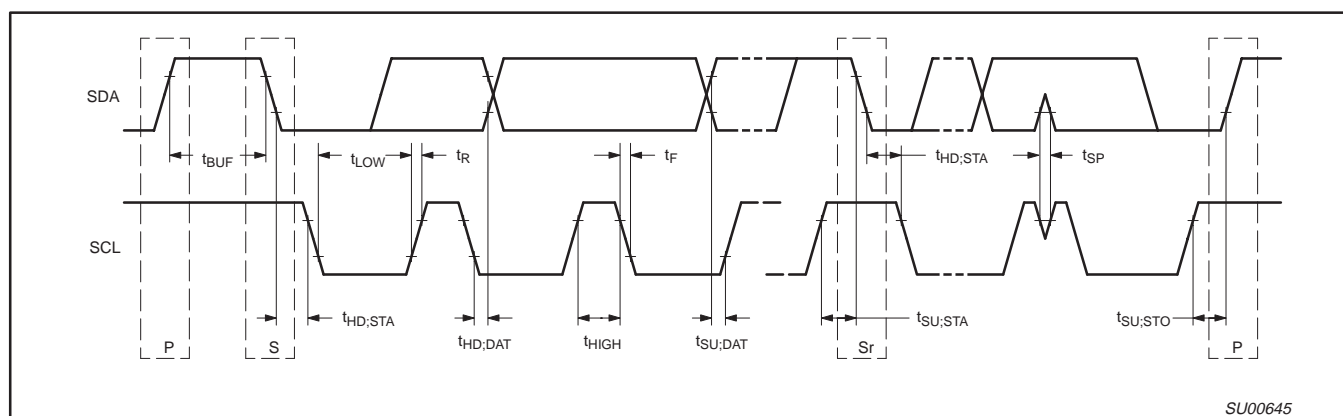
PCA9546A

## AC CHARACTERISTICS

SYMBOL	PARAMETER	STANDARD-MODE I <sup>2</sup> C-bus		FAST-MODE I <sup>2</sup> C-bus		UNIT
		MIN	MAX	MIN	MAX	
$t_{pd}$	Propagation delay from SDA to SD <sub>n</sub> or SCL to SC <sub>n</sub>	—	0.3 <sup>1</sup>	—	0.3 <sup>1</sup>	ns
$f_{SCL}$	SCL clock frequency	0	100	0	400	kHz
$t_{BUF}$	Bus free time between a STOP and START condition	4.7	—	1.3	—	μs
$t_{HD;STA}$	Hold time (repeated) START condition After this period, the first clock pulse is generated	4.0	—	0.6	—	μs
$t_{LOW}$	LOW period of the SCL clock	4.7	—	1.3	—	μs
$t_{HIGH}$	HIGH period of the SCL clock	4.0	—	0.6	—	μs
$t_{SU;STA}$	Set-up time for a repeated START condition	4.7	—	0.6	—	μs
$t_{SU;STO}$	Set-up time for STOP condition	4.0	—	0.6	—	μs
$t_{HD;DAT}$	Data hold time	0 <sup>2</sup>	3.45	0 <sup>2</sup>	0.9	μs
$t_{SU;DAT}$	Data set-up time	250	—	100	—	ns
$t_R$	Rise time of both SDA and SCL signals	—	1000	$20 + 0.1C_b^3$	300	ns
$t_F$	Fall time of both SDA and SCL signals	—	300	$20 + 0.1C_b^3$	300	μs
$C_b$	Capacitive load for each bus line	—	400	—	400	μs
$t_{SP}$	Pulse width of spikes which must be suppressed by the input filter	—	50	—	50	ns
$t_{VD;DATL}$	Data valid (HL) <sup>4</sup>	—	1	—	1	μs
$t_{VD;DATH}$	Data valid (LH) <sup>4</sup>	—	0.6	—	0.6	μs
$t_{VD;ACK}$	Data valid Acknowledge	—	1	—	1	μs
<b>RESET</b>						
$t_{WL(rst)}$	Pulse width LOW reset	4	—	4	—	ns
$t_{rst}$	Reset time (SDA clear)	500	—	500	—	ns
$t_{REC;STA}$	Recovery to Start	0	—	0	—	ns

## NOTES:

1. Pass gate propagation delay is calculated from the 20 Ω typical R<sub>ON</sub> and the 15 pF load capacitance.
2. A device must internally provide a hold time of at least 300 ns for the SDA signal (referred to the V<sub>IHmin</sub> of the SCL signal) in order to bridge the undefined region of the falling edge of SCL.
3. C<sub>b</sub> = total capacitance of one bus line in pF.
4. Measurements taken with 1 kΩ pull-up resistor and 50 pF load.

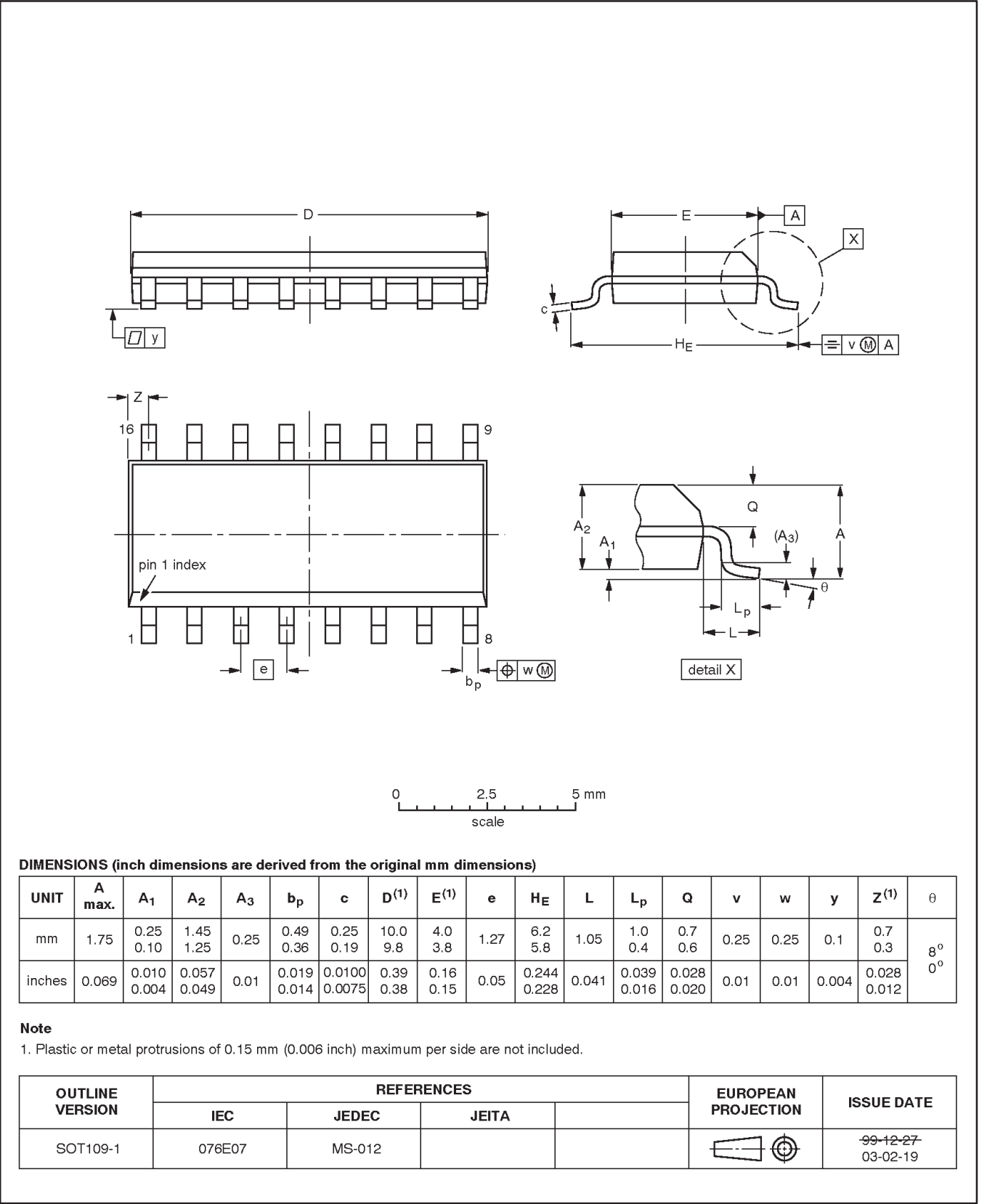
Figure 14. Definition of timing on the I<sup>2</sup>C-bus

4-channel I<sup>2</sup>C switch with reset

PCA9546A

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

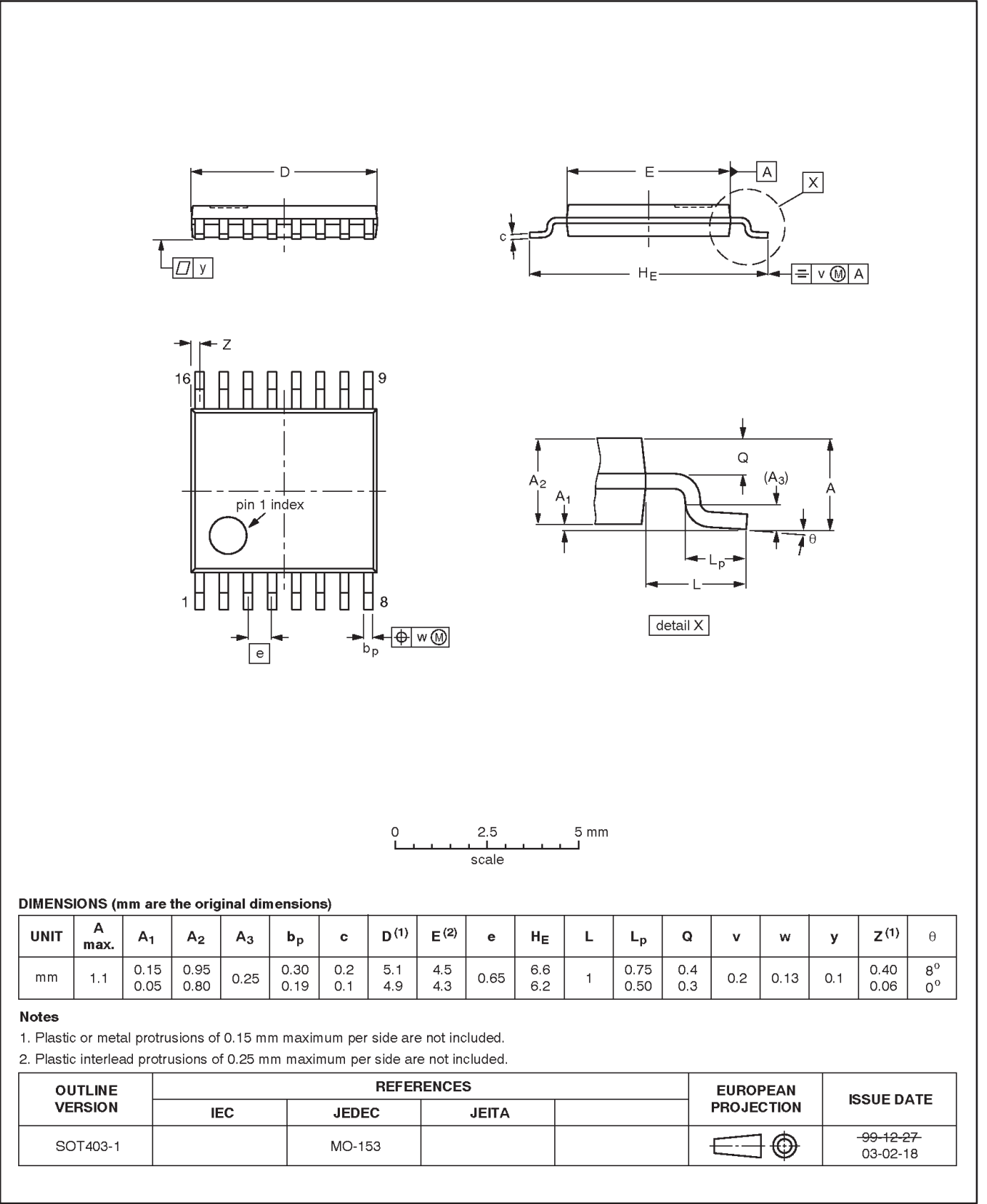


4-channel I<sup>2</sup>C switch with reset

PCA9546A

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

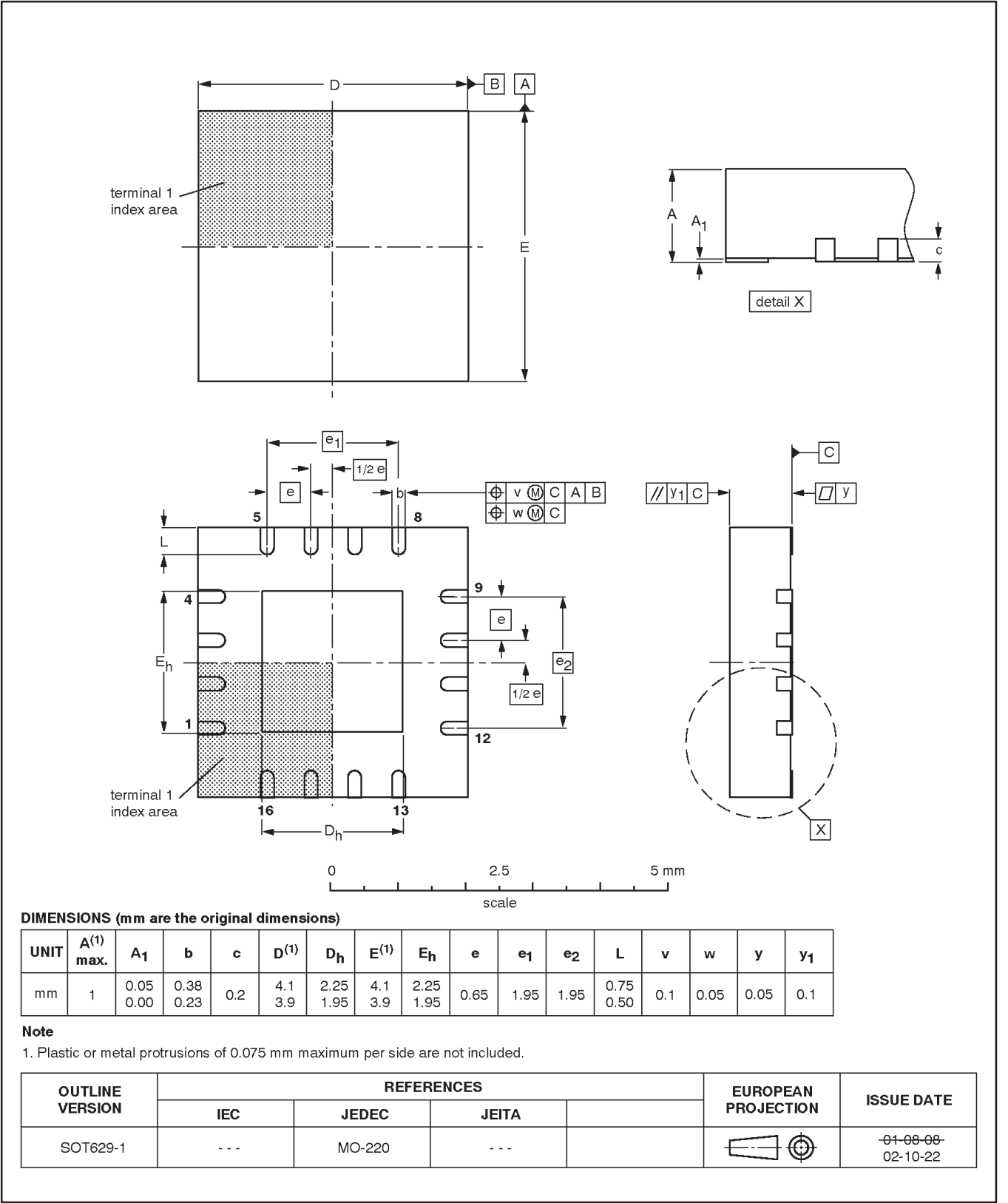


4-channel I<sup>2</sup>C switch with reset

PCA9546A

HVQFN16: plastic thermal enhanced very thin quad flat package; no leads; 16 terminals;  
body 4 x 4 x 0.85 mm

SOT629-1



4-channel I<sup>2</sup>C switch with reset

PCA9546A

## REVISION HISTORY

Rev	Date	Description
_2	20040929	<b>Objective data sheet (9397 750 13991). Supersedes data of 28 Jul 2004 (9397 750 13308).</b> Modifications: <ul style="list-style-type: none"><li>• Table 1. "Control Register; Write — Channel Selection/Read — Channel Status" on page 5: add 'No channel selected; power-up/reset default state' row to bottom of table.</li><li>• AC characterists table on page 12: Add Note 4 and references to it at parameters t<sub>VD;DATL</sub> and t<sub>VD;DATH</sub>.</li></ul>
_1	20040728	<b>Objective data sheet (9397 750 13308).</b>



4-channel I<sup>2</sup>C switch with reset

PCA9546A



Purchase of Philips I<sup>2</sup>C components conveys a license under the Philips' I<sup>2</sup>C patent to use the components in the I<sup>2</sup>C system provided the system conforms to the I<sup>2</sup>C specifications defined by Philips. This specification can be ordered using the code 9398 393 40011.

## Data sheet status

Level	Data sheet status <sup>[1]</sup>	Product status <sup>[2] [3]</sup>	Definitions
I	Objective data sheet	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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## Contact information

For additional information please visit  
<http://www.semiconductors.philips.com>. Fax: +31 40 27 24825

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For sales offices addresses send e-mail to:  
[sales.addresses@www.semiconductors.philips.com](mailto:sales.addresses@www.semiconductors.philips.com)

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9397 750 13991

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