



# PCA9544A

## 4-channel I<sup>2</sup>C-bus multiplexer with interrupt logic

Rev. 04 — 15 June 2009

Product data sheet

### 1. General description

The PCA9544A is a 1-of-4 bidirectional translating multiplexer, controlled via the I<sup>2</sup>C-bus. The SCL/SDA upstream pair fans out to four SCx/SDx downstream pairs, or channels. Only one SCx/SDx channel is selected at a time, determined by the contents of the programmable control register. Four interrupt inputs,  $\overline{\text{INT0}}$  to  $\overline{\text{INT3}}$ , one for each of the SCx/SDx downstream pairs, are provided. One interrupt output,  $\overline{\text{INT}}$ , which acts as an AND of the four interrupt inputs, is provided.

A power-on reset function puts the registers in their default state and initializes the I<sup>2</sup>C-bus state machine with no channels selected.

The pass gates of the multiplexer 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 PCA9544A. This allows the use of different bus voltages on each SCx/SDx 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.

### 2. Features

- 1-of-4 bidirectional translating multiplexer
- I<sup>2</sup>C-bus interface logic; compatible with SMBus
- 4 active LOW interrupt inputs
- Active LOW interrupt output
- 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
- Power-up with all multiplexer channels deselected
- Low R<sub>on</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 standby current
- Operating power supply voltage range of 2.3 V to 5.5 V
- 5 V tolerant Inputs
- 0 Hz to 400 kHz clock frequency
- ESD protection exceeds 2000 V HBM per JESD22-A114, 200 V MM per JESD22-A115 and 1000 V CDM per JESD22-C101
- Latch-up testing is done to JEDEC Standard JESD78 which exceeds 100 mA
- Three packages offered: SO20, TSSOP20 and HVQFN20

### 3. Ordering information

**Table 1. Ordering information**

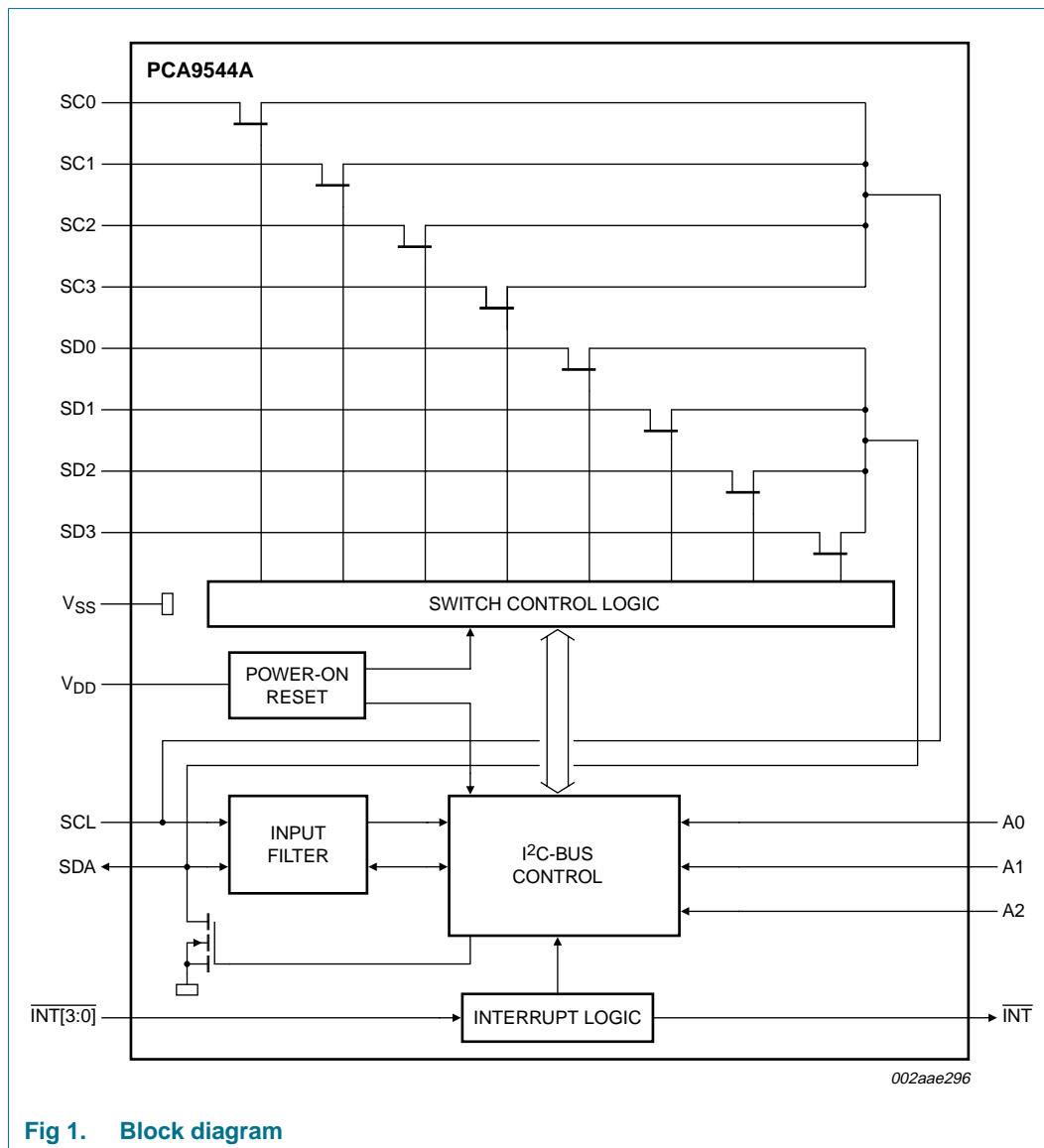
Type number	Package		
	Name	Description	Version
PCA9544AD	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
PCA9544APW	TSSOP20	plastic thin shrink small outline package; 20 leads; body width 4.4 mm	SOT360-1
PCA9544ABS	HVQFN20	plastic thermal enhanced very thin quad flat package; no leads; 20 terminals; body 5 × 5 × 0.85 mm	SOT662-1

#### 3.1 Ordering options

**Table 2. Ordering options**

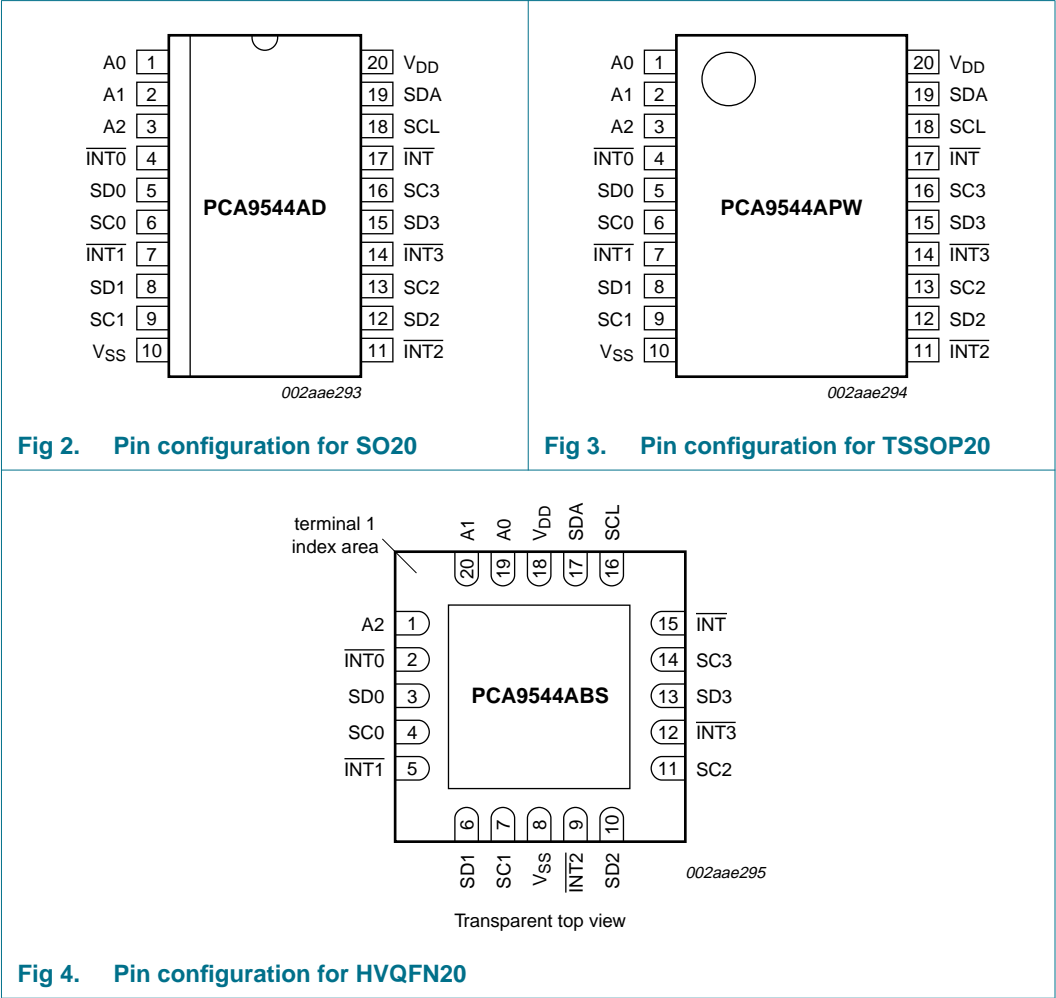
Type number	Topside mark	Temperature range
PCA9544AD	PCA9544AD	−40 °C to +85 °C
PCA9544APW	PA9544A	−40 °C to +85 °C
PCA9544ABS	9544A	−40 °C to +85 °C

## 4. Block diagram



5. Pinning information

5.1 Pinning



## 5.2 Pin description

Table 3. Pin description

Symbol	Pin		Description
	SO20, TSSOP20	HVQFN20	
A0	1	19	address input 0
A1	2	20	address input 1
A2	3	1	address input 2
$\overline{\text{INT0}}$	4	2	active LOW interrupt input 0
SD0	5	3	serial data 0
SC0	6	4	serial clock 0
$\overline{\text{INT1}}$	7	5	active LOW interrupt input 1
SD1	8	6	serial data 1
SC1	9	7	serial clock 1
V <sub>SS</sub>	10	8 <sup>[1]</sup>	supply ground
$\overline{\text{INT2}}$	11	9	active LOW interrupt input 2
SD2	12	10	serial data 2
SC2	13	11	serial clock 2
$\overline{\text{INT3}}$	14	12	active LOW interrupt input 3
SD3	15	13	serial data 3
SC3	16	14	serial clock 3
$\overline{\text{INT}}$	17	15	active LOW interrupt output
SCL	18	16	serial clock line
SDA	19	17	serial data line
V <sub>DD</sub>	20	18	supply voltage

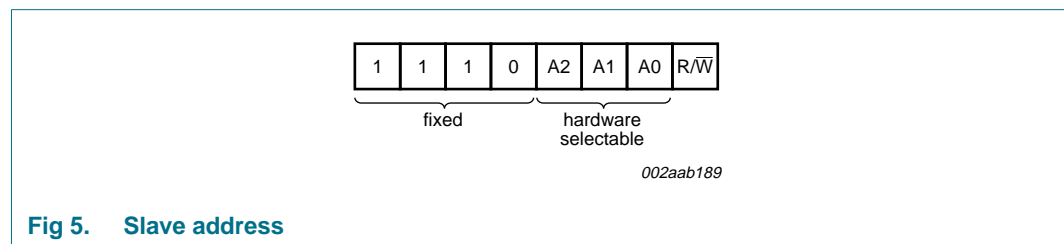
- [1] HVQFN20 package supply ground is connected to both V<sub>SS</sub> pin and exposed center pad. V<sub>SS</sub> pin must be connected to supply ground for proper device operation. For enhanced thermal, electrical, and board level performance, the exposed pad needs to be soldered to the board using a corresponding thermal pad on the board and for proper heat conduction through the board, thermal vias need to be incorporated in the PCB in the thermal pad region.

## 6. Functional description

Refer to [Figure 1 “Block diagram”](#).

### 6.1 Device addressing

Following a START condition the bus master must output the address of the slave it is accessing. The address of the PCA9544A is shown in [Figure 5](#). To conserve power, no internal pull-up resistors are incorporated on the hardware selectable address pins and they must be pulled HIGH or LOW.

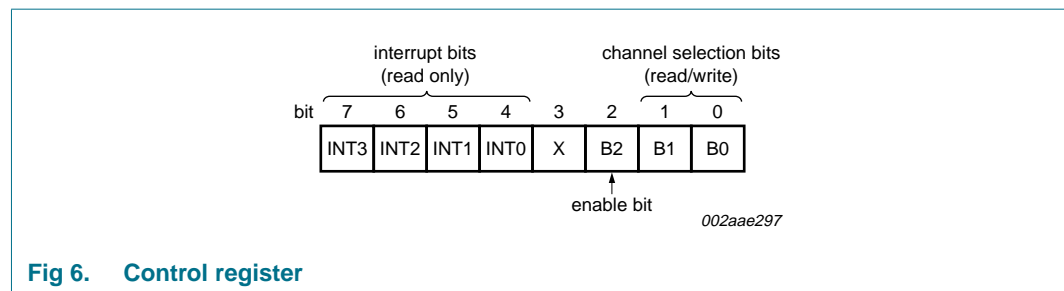


**Fig 5. Slave address**

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.

### 6.2 Control register

Following the successful acknowledgement of the slave address, the bus master will send a byte to the PCA9544A which will be stored in the Control register. If multiple bytes are received by the PCA9544A, it will save the last byte received. This register can be written and read via the I<sup>2</sup>C-bus.



**Fig 6. Control register**

#### 6.2.1 Control register definition

A SCx/SDx downstream pair, or channel, is selected by the contents of the control register. This register is written after the PCA9544A has been addressed. The 3 LSBs of the control byte are used to determine which channel is to be selected. When a channel is selected, it 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 4. Control register: Write—channel selection; Read—channel status**

INT3	INT2	INT1	INT0	D3	B2	B1	B0	Command
X	X	X	X	X	0	X	x	no channel selected
X	X	X	X	X	1	0	0	channel 0 enabled
X	X	X	X	X	1	0	1	channel 1 enabled
X	X	X	X	X	1	1	0	channel 2 enabled
X	X	X	0	X	1	1	1	channel 3 enabled
0	0	0	0	0	0	0	0	no channel selected; power-up default state

### 6.3 Interrupt handling

The PCA9544A provides 4 interrupt inputs, one for each channel and one open-drain interrupt output. When an interrupt is generated by any device, it will be detected by the PCA9544A and the interrupt output will be driven LOW. The channel need not be active for detection of the interrupt. A bit is also set in the control byte. Bits 7:4 of the control byte correspond to channel 3 to channel 0 of the PCA9544A, respectively. Therefore, if an interrupt is generated by any device connected to channel 2, the state of the interrupt inputs is loaded into the control register when a read is accomplished. Likewise, an interrupt on any device connected to channel 0 would cause bit 4 of the control register to be set on the read. The master can then address the PCA9544A and read the contents of the control byte to determine which channel contains the device generating the interrupt. The master can then reconfigure the PCA9544A to select this channel, and locate the device generating the interrupt and clear it. The interrupt clears when the device originating the interrupt clears.

It should be noted that more than one device can be providing an interrupt on a channel, so it is up to the master to ensure that all devices on a channel are interrogated for an interrupt.

The interrupt inputs may be used as general purpose inputs if the interrupt function is not required.

If unused, interrupt input(s) must be connected to V<sub>DD</sub> through a pull-up resistor.

**Table 5. Control register read — interrupt**

INT3	INT2	INT1	INT0	D3	B2	B1	B0	Command
X	X	X	0	X	X	X	X	no interrupt on channel 0
			1					interrupt on channel 0
X	X	0	X	X	X	X	X	no interrupt on channel 1
		1						interrupt on channel 1
X	0	X	X	X	X	X	X	no interrupt on channel 2
	1							interrupt on channel 2
0	X	X	X	X	X	X	X	no interrupt on channel 3
1								interrupt on channel 3

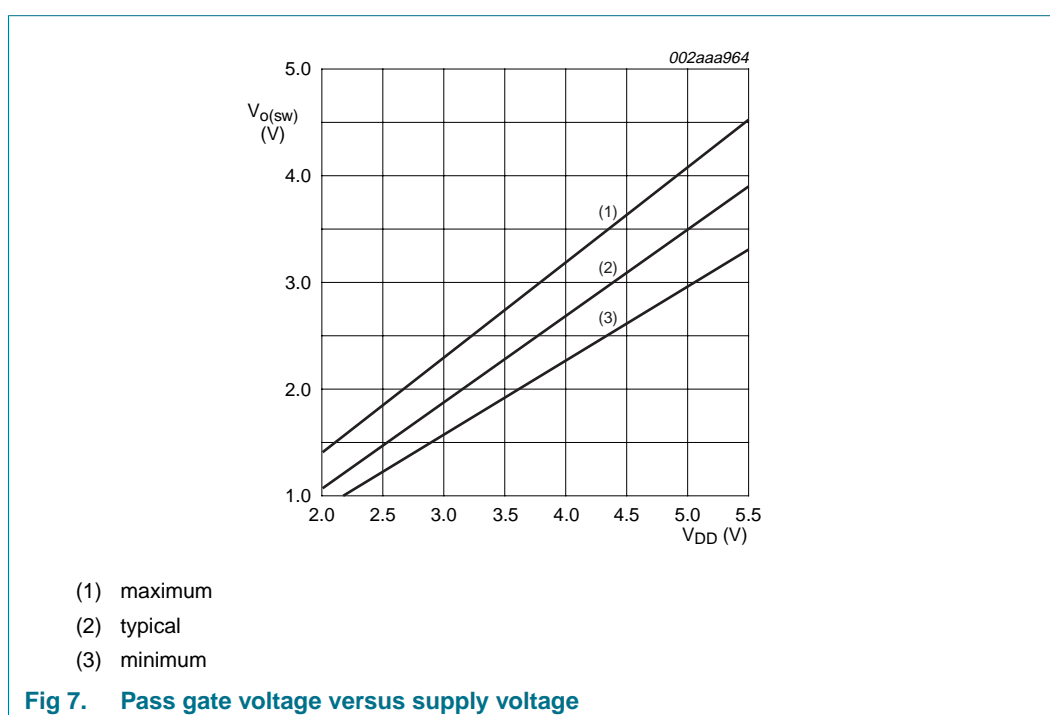
**Remark:** Several interrupts can be active at the same time. For example: INT3 = 0, INT2 = 1, INT1 = 1, INT0 = 0, means that there is no interrupt on channel 0 and channel 3, and there is an interrupt on channel 1 and on channel 2.

## 6.4 Power-on reset

When power is applied to  $V_{DD}$ , an internal Power-On Reset (POR) holds the PCA9544A in a reset condition until  $V_{DD}$  has reached  $V_{POR}$ . At this point, the reset condition is released and the PCA9544A registers and I<sup>2</sup>C-bus state machine are initialized to their default states (all zeroes), causing all the channels to be deselected. Thereafter,  $V_{DD}$  must be lowered below 0.2 V to reset the device.

## 6.5 Voltage translation

The pass gate transistors of the PCA9544A 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.



**Fig 7. Pass gate voltage versus supply voltage**

[Figure 7](#) shows the voltage characteristics of the pass gate transistors (note that the graph was generated using the data specified in [Section 11 “Dynamic characteristics”](#) of this data sheet). In order for the PCA9544A to act as a voltage translator, the  $V_{O(sw)}$  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  $V_{O(sw)}$  should be equal to or below 2.7 V to effectively clamp the downstream bus voltages. Looking at [Figure 7](#), we see that  $V_{O(sw)(max)}$  will be at 2.7 V when the PCA9544A supply voltage is 3.5 V or lower so the PCA9544A 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 14](#)).

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



## 7. 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.

### 7.1 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 8](#)).

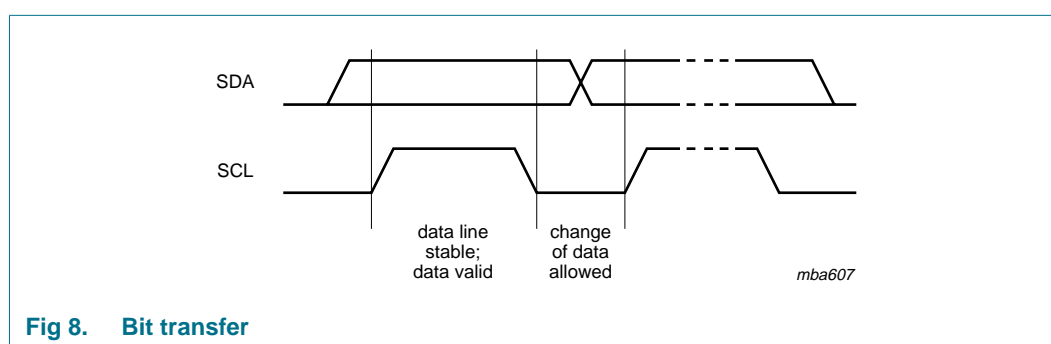


Fig 8. Bit transfer

### 7.2 START and STOP conditions

Both data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line while the clock is HIGH is defined as the START condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the STOP condition (P) (see [Figure 9](#)).

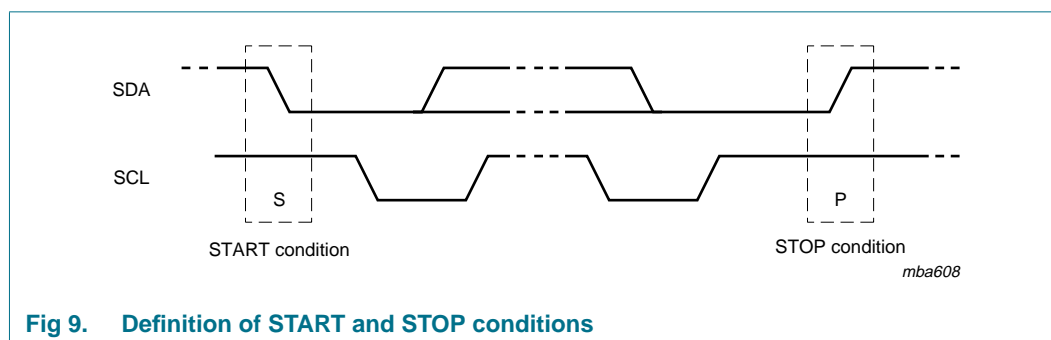


Fig 9. Definition of START and STOP conditions

### 7.3 System configuration

A device generating a message is a 'transmitter', a device receiving is the 'receiver'. The device that controls the message is the 'master' and the devices which are controlled by the master are the 'slaves' (see [Figure 10](#)).

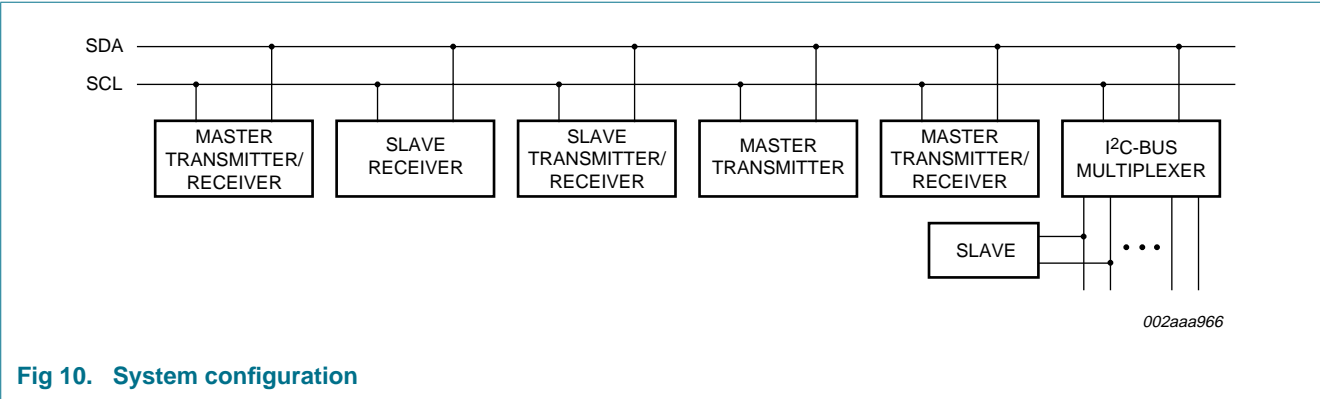


Fig 10. System configuration

7.4 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.

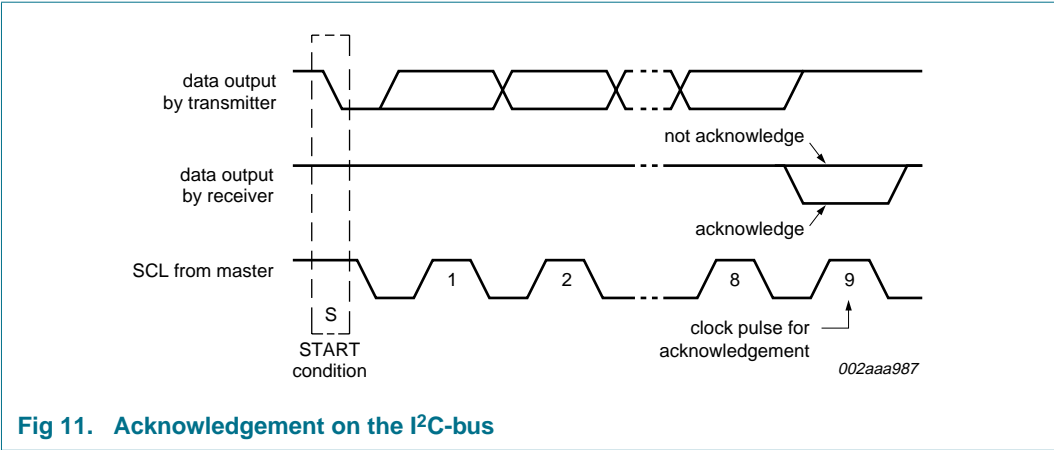


Fig 11. Acknowledgement on the I<sup>2</sup>C-bus

7.5 Bus transactions

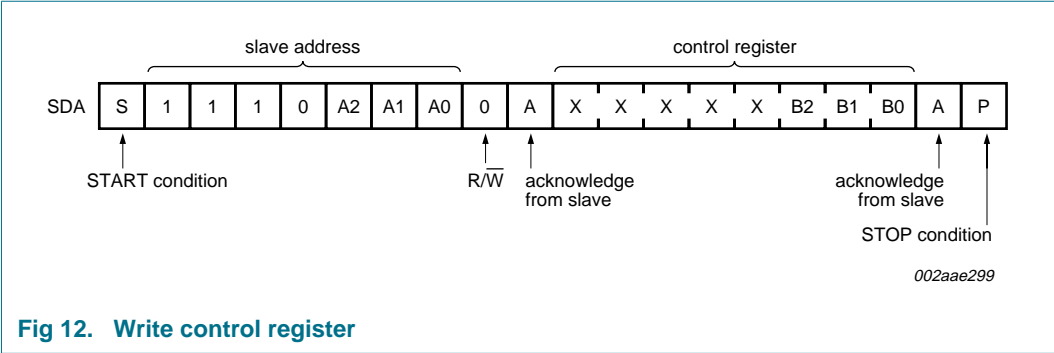


Fig 12. Write control register

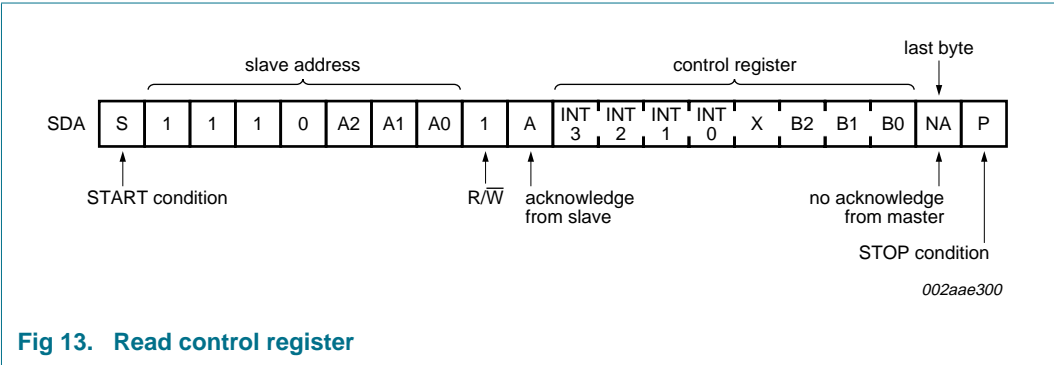
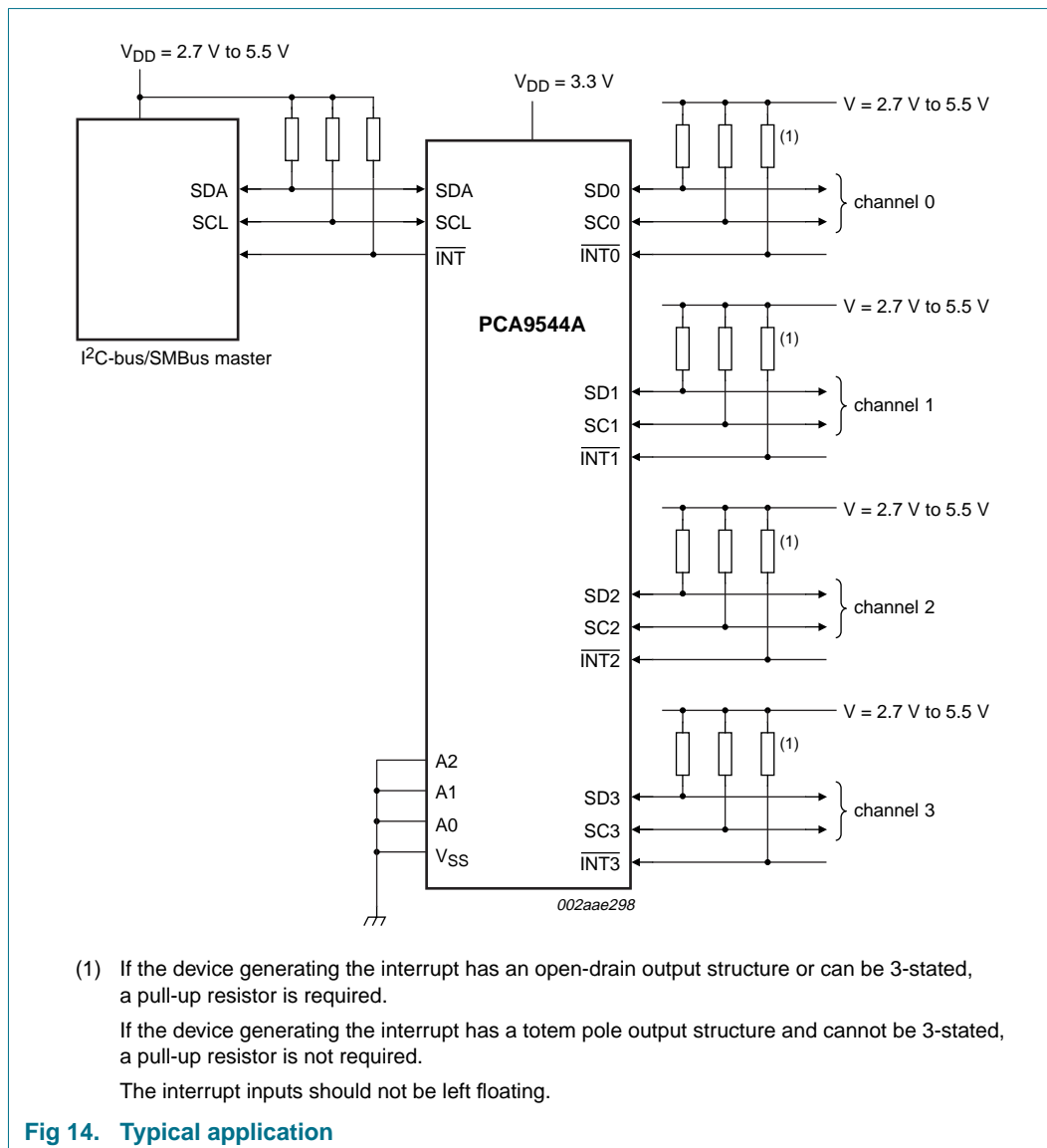


Fig 13. Read control register

## 8. Application design-in information



## 9. Limiting values

**Table 6. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

*Voltages are referenced to ground ( $V_{SS} = 0$  V).*<sup>[1]</sup>

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DD}$	supply voltage		−0.5	+7.0	V
$V_I$	input voltage		−0.5	+7.0	V
$I_I$	input current		-	±20	mA
$I_O$	output current		-	±25	mA
$I_{DD}$	supply current		-	±100	mA
$I_{SS}$	ground supply current		-	±100	mA
$P_{tot}$	total power dissipation		-	400	mW
$T_{stg}$	storage temperature		−60	+150	°C
$T_{amb}$	ambient temperature	operating	−40	+85	°C

- [1] 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 125 °C.

## 10. Static characteristics

**Table 7. Static characteristics at  $V_{DD} = 2.3\text{ V}$  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 [Table 8](#) for  $V_{DD} = 4.5\text{ V}$  to  $5.5\text{ V}$ .<sup>[1]</sup>

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply</b>						
$V_{DD}$	supply voltage		2.3	-	3.6	V
$I_{DD}$	supply current	operating mode; $V_{DD} = 3.6\text{ V}$ ; no load; $V_I = V_{DD}$ or $V_{SS}$ ; $f_{SCL} = 100\text{ kHz}$	-	10	30	$\mu\text{A}$
$I_{stb}$	standby current	standby mode; $V_{DD} = 3.6\text{ V}$ ; no load; $V_I = V_{DD}$ or $V_{SS}$ ; $f_{SCL} = 0\text{ kHz}$	-	0.1	1	$\mu\text{A}$
$V_{POR}$	power-on reset voltage	no load; $V_I = V_{DD}$ or $V_{SS}$	<sup>[2]</sup> -	1.5	2.1	V
<b>Input SCL; input/output SDA</b>						
$V_{IL}$	LOW-level input voltage		-0.5	-	+0.3 $V_{DD}$	V
$V_{IH}$	HIGH-level input voltage		0.7 $V_{DD}$	-	6	V
$I_{OL}$	LOW-level output current	$V_{OL} = 0.4\text{ V}$	3	7	-	mA
		$V_{OL} = 0.6\text{ V}$	6	10	-	mA
$I_L$	leakage current	$V_I = V_{DD}$ or $V_{SS}$	-1	-	+1	$\mu\text{A}$
$C_i$	input capacitance	$V_I = V_{SS}$	-	10	13	pF
<b>Select inputs A0 to A2, <math>\overline{\text{INT0}}</math> to <math>\overline{\text{INT3}}</math></b>						
$V_{IL}$	LOW-level input voltage		-0.5	-	+0.3 $V_{DD}$	V
$V_{IH}$	HIGH-level input voltage		0.7 $V_{DD}$	-	$V_{DD} + 0.5$	V
$I_{LI}$	input leakage current	$V_I = V_{DD}$ or $V_{SS}$	-1	-	+1	$\mu\text{A}$
$C_i$	input capacitance	$V_I = V_{SS}$	-	1.6	3	pF
<b>Pass gate</b>						
$R_{on}$	ON-state resistance	$V_{DD} = 3.0\text{ V}$ to $3.6\text{ V}$ ; $V_O = 0.4\text{ V}$ ; $I_O = 15\text{ mA}$	5	11	30	$\Omega$
		$V_{DD} = 2.3\text{ V}$ to $2.7\text{ V}$ ; $V_O = 0.4\text{ V}$ ; $I_O = 10\text{ mA}$	7	16	55	$\Omega$
$V_{o(sw)}$	switch output voltage	$V_{i(sw)} = V_{DD} = 3.3\text{ V}$ ; $I_{o(sw)} = -100\text{ }\mu\text{A}$	-	1.9	-	V
		$V_{i(sw)} = V_{DD} = 3.0\text{ V}$ to $3.6\text{ V}$ ; $I_{o(sw)} = -100\text{ }\mu\text{A}$	1.6	-	2.8	V
		$V_{i(sw)} = V_{DD} = 2.5\text{ V}$ ; $I_{o(sw)} = -100\text{ }\mu\text{A}$	-	1.5	-	V
		$V_{i(sw)} = V_{DD} = 2.3\text{ V}$ to $2.7\text{ V}$ ; $I_{o(sw)} = -100\text{ }\mu\text{A}$	1.1	-	2.0	V
$I_L$	leakage current	$V_I = V_{DD}$ or $V_{SS}$	-1	-	+1	$\mu\text{A}$
$C_{io}$	input/output capacitance	$V_I = V_{SS}$	-	3	5	pF
<b><math>\overline{\text{INT}}</math> output</b>						
$I_{OL}$	LOW-level output current	$V_{OL} = 0.4\text{ V}$	3	7	-	mA
$I_{OH}$	HIGH-level output current		-	-	+10	$\mu\text{A}$

[1] For operation between published voltage ranges, refer to worst case parameter in both ranges.

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

**Table 8. Static characteristics at  $V_{DD} = 4.5\text{ V}$  to  $5.5\text{ V}$**  $V_{SS} = 0\text{ V}$ ;  $T_{amb} = -40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ ; unless otherwise specified. See [Table 7](#) for  $V_{DD} = 2.3\text{ V}$  to  $3.6\text{ V}$  <sup>[1]</sup>

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply</b>						
$V_{DD}$	supply voltage		4.5	-	5.5	V
$I_{DD}$	supply current	operating mode; $V_{DD} = 5.5\text{ V}$ ; no load; $V_I = V_{DD}$ or $V_{SS}$ ; $f_{SCL} = 100\text{ kHz}$	-	25	100	$\mu\text{A}$
$I_{stb}$	standby current	standby mode; $V_{DD} = 5.5\text{ V}$ ; no load; $V_I = V_{DD}$ or $V_{SS}$ ; $f_{SCL} = 0\text{ kHz}$	-	0.3	1	$\mu\text{A}$
$V_{POR}$	power-on reset voltage	no load; $V_I = V_{DD}$ or $V_{SS}$	<sup>[2]</sup> -	1.7	2.1	V
<b>Input SCL; input/output SDA</b>						
$V_{IL}$	LOW-level input voltage		-0.5	-	+0.3 $V_{DD}$	V
$V_{IH}$	HIGH-level input voltage		0.7 $V_{DD}$	-	6	V
$I_{OL}$	LOW-level output current	$V_{OL} = 0.4\text{ V}$	3	-	-	mA
		$V_{OL} = 0.6\text{ V}$	6	-	-	mA
$I_L$	leakage current	$V_I = V_{DD}$ or $V_{SS}$	-1	-	+1	$\mu\text{A}$
$C_i$	input capacitance	$V_I = V_{SS}$	-	12	13	pF
<b>Select inputs A0 to A2, INT0 to INT3</b>						
$V_{IL}$	LOW-level input voltage		-0.5	-	+0.3 $V_{DD}$	V
$V_{IH}$	HIGH-level input voltage		0.7 $V_{DD}$	-	$V_{DD} + 0.5$	V
$I_{LI}$	input leakage current	pin at $V_{DD}$ or $V_{SS}$	-1	-	+1	$\mu\text{A}$
$C_i$	input capacitance	$V_I = V_{SS}$	-	2	5	pF
<b>Pass gate</b>						
$R_{on}$	ON-state resistance	$V_{DD} = 4.5\text{ V}$ to $5.5\text{ V}$ ; $V_O = 0.4\text{ V}$ ; $I_O = 15\text{ mA}$	4	9	24	$\Omega$
$V_{o(sw)}$	switch output voltage	$V_{i(sw)} = V_{DD} = 5.0\text{ V}$ ; $I_{o(sw)} = -100\text{ }\mu\text{A}$	-	3.6	-	V
		$V_{i(sw)} = V_{DD} = 4.5\text{ V}$ to $5.5\text{ V}$ ; $I_{o(sw)} = -100\text{ }\mu\text{A}$	2.6	-	4.5	V
$I_L$	leakage current	$V_I = V_{DD}$ or $V_{SS}$	-1	-	+1	$\mu\text{A}$
$C_{io}$	input/output capacitance	$V_I = V_{SS}$	-	3	5	pF
<b>INT output</b>						
$I_{OL}$	LOW-level output current	$V_{OL} = 0.4\text{ V}$	3	-	-	mA
$I_{OH}$	HIGH-level output current		-	-	+10	$\mu\text{A}$

[1] For operation between published voltage ranges, refer to worst case parameter in both ranges.

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

## 11. Dynamic characteristics

**Table 9. Dynamic characteristics**

Symbol	Parameter	Conditions	Standard-mode I <sup>2</sup> C-bus		Fast-mode I <sup>2</sup> C-bus		Unit
			Min	Max	Min	Max	
t <sub>PD</sub>	propagation delay	from SDA to SDx, or SCL to SCx	-	0.3 <sup>[1]</sup>	-	0.3 <sup>[1]</sup>	ns
f <sub>SCL</sub>	SCL clock frequency		0	100	0	400	kHz
t <sub>BUF</sub>	bus free time between a STOP and START condition		4.7	-	1.3	-	μs
t <sub>HD;STA</sub>	hold time (repeated) START condition	<sup>[2]</sup>	4.0	-	0.6	-	μs
t <sub>LOW</sub>	LOW period of the SCL clock		4.7	-	1.3	-	μs
t <sub>HIGH</sub>	HIGH period of the SCL clock		4.0	-	0.6	-	μs
t <sub>SU;STA</sub>	set-up time for a repeated START condition		4.7	-	0.6	-	μs
t <sub>SU;STO</sub>	set-up time for STOP condition		4.0	-	0.6	-	μs
t <sub>HD;DAT</sub>	data hold time		0 <sup>[3]</sup>	3.45	0 <sup>[3]</sup>	0.9	μs
t <sub>SU;DAT</sub>	data set-up time		250	-	100	-	ns
t <sub>r</sub>	rise time of both SDA and SCL signals		-	1000	20 + 0.1C <sub>b</sub> <sup>[4]</sup>	300	ns
t <sub>f</sub>	fall time of both SDA and SCL signals		-	300	20 + 0.1C <sub>b</sub> <sup>[4]</sup>	300	ns
C <sub>b</sub>	capacitive load for each bus line		-	400	-	400	pF
t <sub>SP</sub>	pulse width of spikes that must be suppressed by the input filter		-	50	-	50	ns
t <sub>VD;DAT</sub>	data valid time	HIGH-to-LOW	<sup>[5]</sup>	-	1	-	1 μs
		LOW-to-HIGH	<sup>[5]</sup>	-	0.6	-	0.6 μs
t <sub>VD;ACK</sub>	data valid acknowledge time		-	1	-	1	μs
<b>INT</b>							
t <sub>V(INTnN-INTN)</sub>	valid time from $\overline{\text{INTn}}$ to $\overline{\text{INT}}$ signal	<sup>[5]</sup>	-	4	-	4	μs
t <sub>d(INTnN-INTN)</sub>	delay time from $\overline{\text{INTn}}$ to $\overline{\text{INT}}$ inactive	<sup>[5]</sup>	-	2	-	2	μs
t <sub>w(rej)L</sub>	LOW-level rejection time	$\overline{\text{INTn}}$ inputs	<sup>[5]</sup>	1	-	1	μs
t <sub>w(rej)H</sub>	HIGH-level rejection time	$\overline{\text{INTn}}$ inputs	<sup>[5]</sup>	0.5	-	0.5	μs

[1] Pass gate propagation delay is calculated from the 20 Ω typical R<sub>on</sub> and the 15 pF load capacitance.

[2] After this period, the first clock pulse is generated.

[3] A device must internally provide a hold time of at least 300 ns for the SDA signal (referred to the V<sub>IH(min)</sub> of the SCL signal) in order to bridge the undefined region of the falling edge of SCL.

[4] C<sub>b</sub> = total capacitance of one bus line in pF.

[5] Measurements taken with 1 kΩ pull-up resistor and 50 pF load.



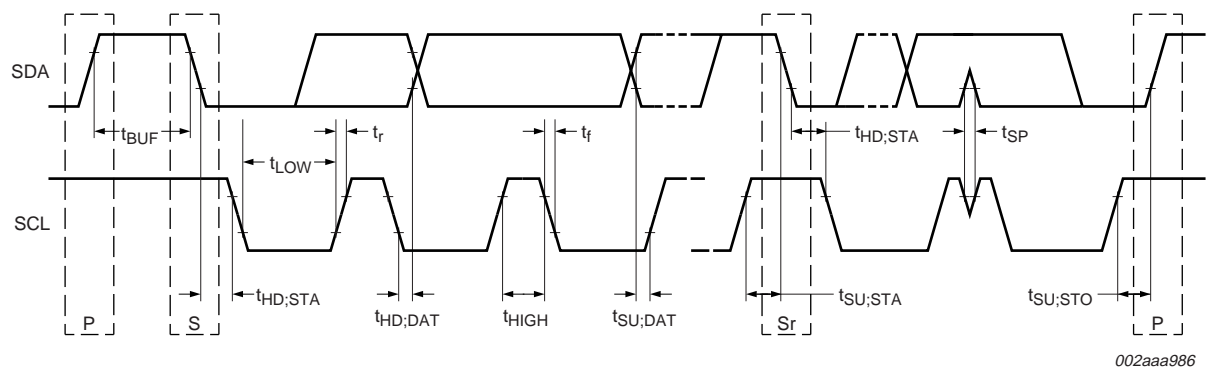


Fig 15. Definition of timing on the I<sup>2</sup>C-bus

12. Package outline

SO20: plastic small outline package; 20 leads; body width 7.5 mm SOT163-1

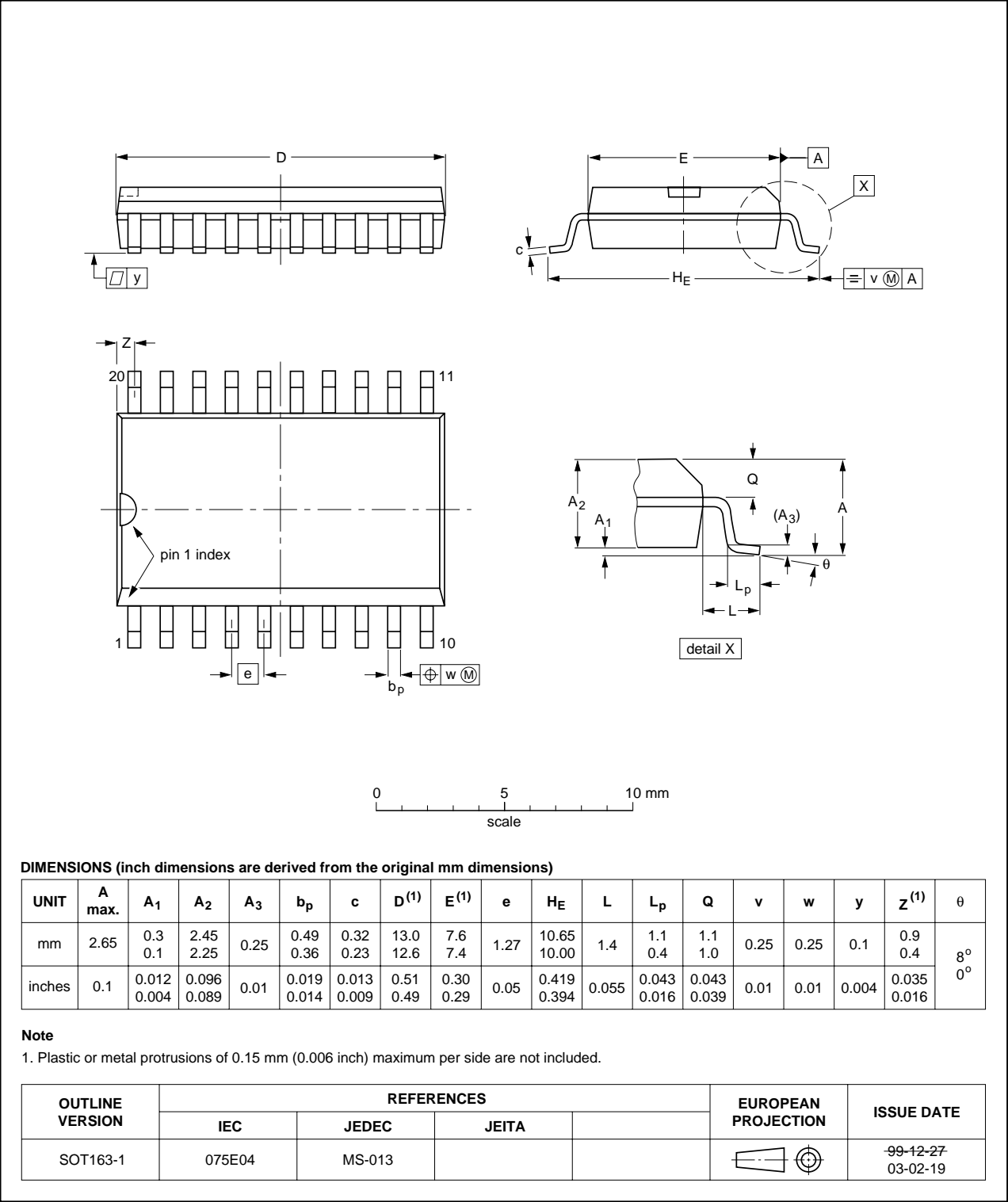


Fig 16. Package outline SOT163-1 (SO20)

TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm

SOT360-1

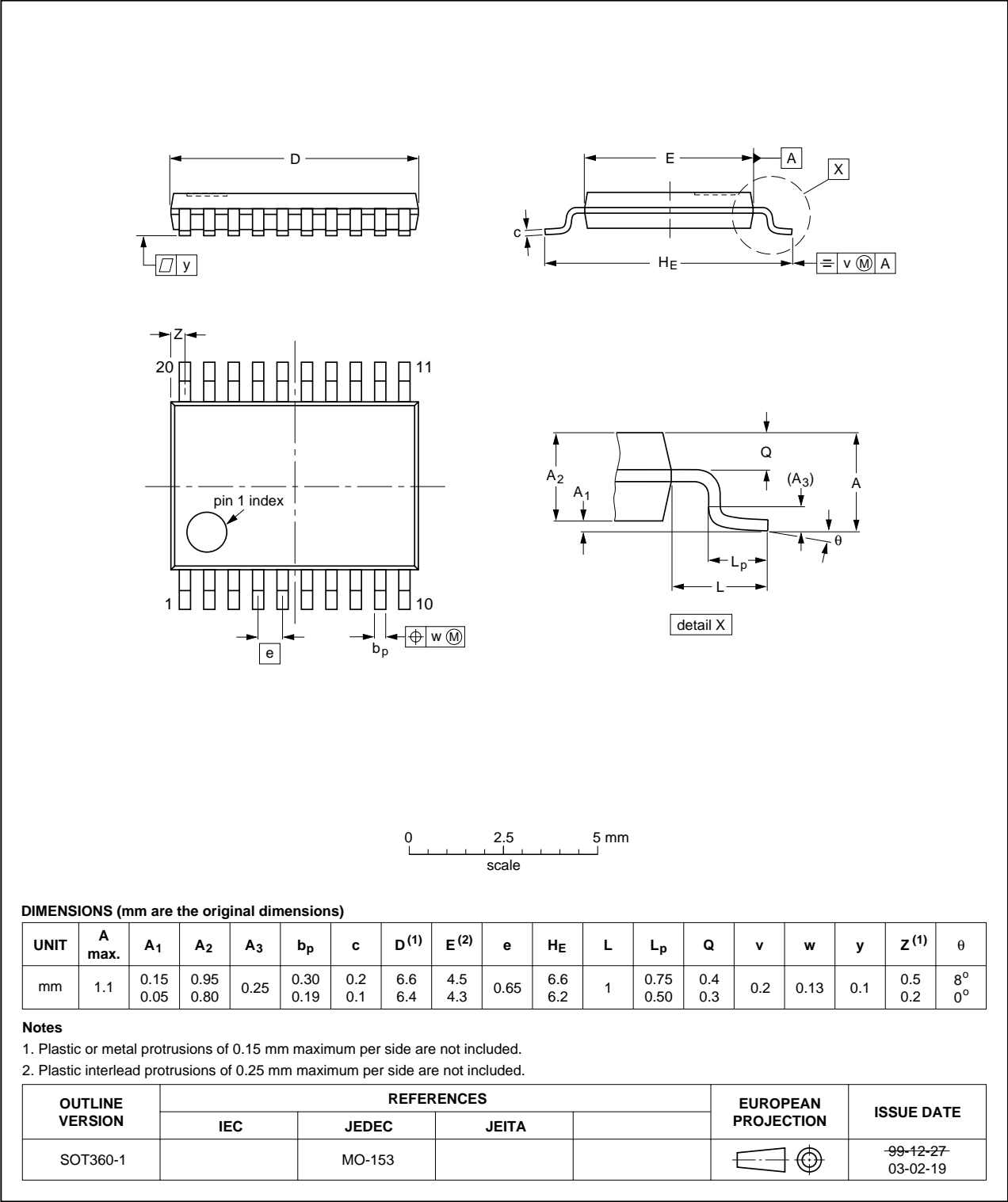


Fig 17. Package outline SOT360-1 (TSSOP20)

HVQFN20: plastic thermal enhanced very thin quad flat package; no leads;  
20 terminals; body 5 x 5 x 0.85 mm

SOT662-1

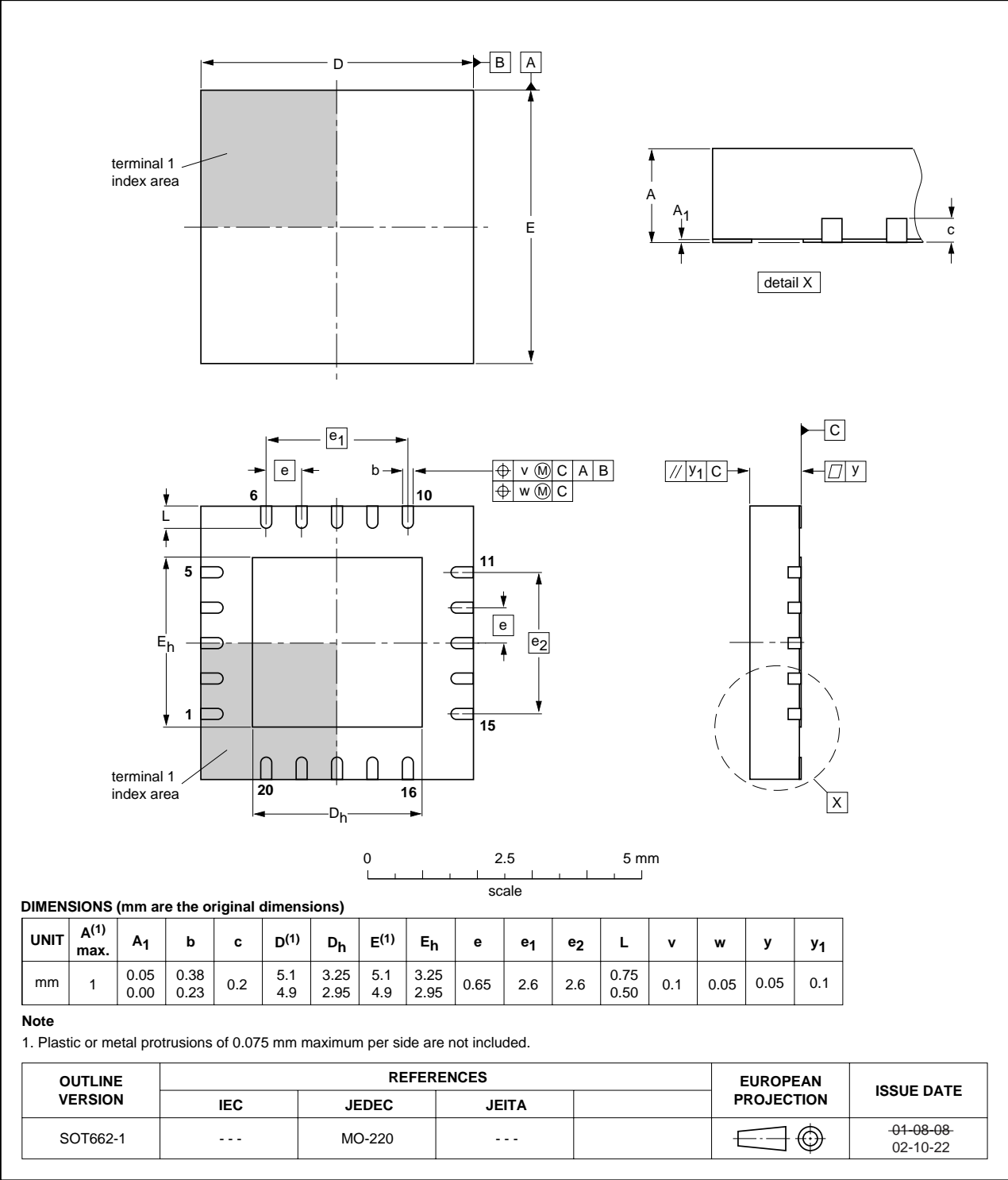


Fig 18. Package outline SOT662-1 (HVQFN20)

## 13. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 13.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 13.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leadless or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leadless SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leadless packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 13.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

### 13.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 19](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 10](#) and [11](#)

**Table 10. SnPb eutectic process (from J-STD-020C)**

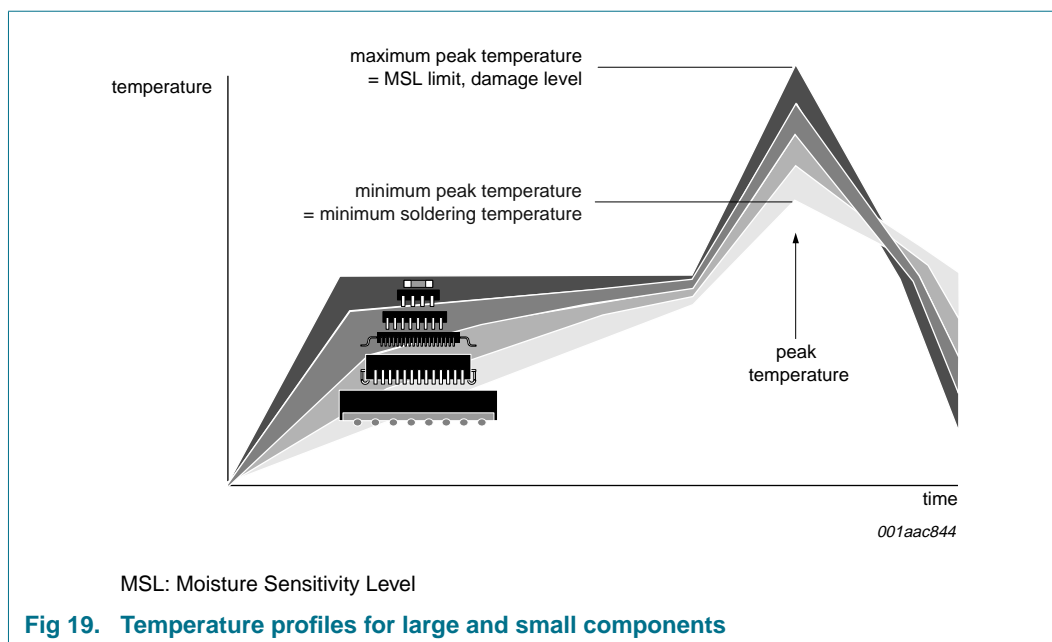
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm <sup>3</sup> )	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

**Table 11. Lead-free process (from J-STD-020C)**

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm <sup>3</sup> )		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 19](#).



For further information on temperature profiles, refer to Application Note *AN10365* "Surface mount reflow soldering description".

## 14. Abbreviations

**Table 12. Abbreviations**

Acronym	Description
CDM	Charged-Device Model
ESD	ElectroStatic Discharge
HBM	Human Body Model
I/O	Input/Output
I <sup>2</sup> C-bus	Inter-Integrated Circuit bus
LSB	Least Significant Bit
MM	Machine Model
PCB	Printed-Circuit Board
POR	Power-On Reset
SMBus	System Management Bus

## 15. Revision history

**Table 13. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCA9544A_4	20090615	Product data sheet	-	PCA9544A_3
Modifications:	<ul style="list-style-type: none"><li>• <a href="#">Table 9 "Dynamic characteristics"</a>:<ul style="list-style-type: none"><li>– Symbol <math>t_f</math>: changed Unit from "μs" to "ns"</li><li>– Symbol <math>C_b</math>: changed Unit from "μs" to "pF"</li></ul></li></ul>			
PCA9544A_3	20081124	Product data sheet	-	PCA9544A_2
PCA9544A_2 (9397 750 13931)	20040929	Product data sheet	-	PCA9544A_1
PCA9544A_1 (9397 750 13301)	20040728	Objective data sheet	-	-



## 16. Legal information

### 16.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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