PCA82C251

CAN transceiver for 24 V systems

Rev. 04 — 25 August 2011 Product data sheet

1. General description

The PCA82C251 is the interface between a CAN protocol controller and the physical bus. The device provides differential transmit capability to the bus and differential receive capability to the CAN controller.

2. Features and benefits

- Fully compatible with the *"ISO 11898-24 V"* standard
- Slope control to reduce Radio Frequency Interference (RFI)
- Thermally protected
- Short-circuit proof to battery and ground in 24 V powered systems
- Low-current Standby mode
- An unpowered node does not disturb the bus lines
- At least 110 nodes can be connected
- High speed (up to 1 MBd)
- High immunity against electromagnetic interference.

3. Applications

- High-speed applications (up to 1 MBd) in trucks and busses.

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		4.5	5.5	V
I_{CC}	supply current	Standby mode	-	275	μA
$1/t_{bit}$	maximum transmission speed	non-return-to-zero	1	-	MBd
V_{CAN}	CANH, CANL input/output voltage		−36	+36	V
V_{diff}	differential bus voltage		1.5	3.0	V
t_{PD}	propagation delay	High-speed mode	-	50	ns
T_{amb}	ambient temperature		−40	+125	°C

5. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
PCA82C251T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

6. Block diagram

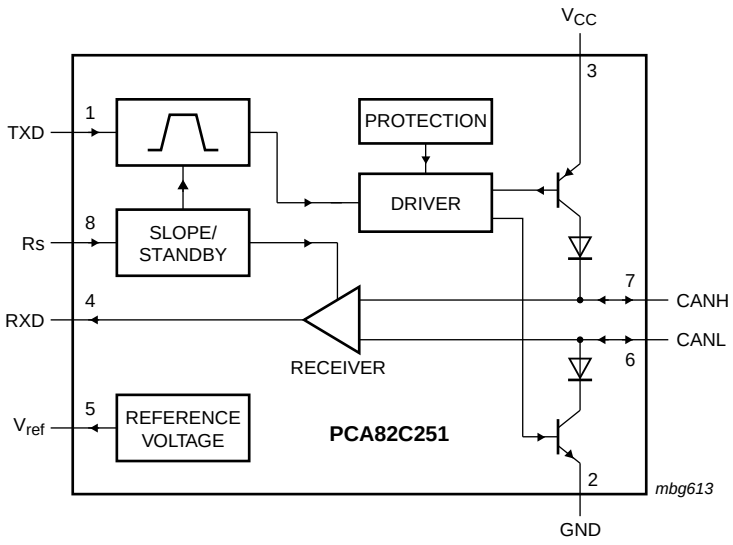


Fig 1. Block diagram

7. Pinning information

7.1 Pinning

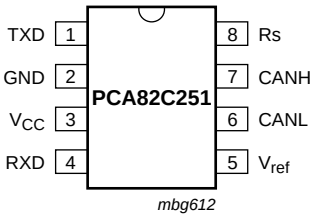


Fig 2. Pin configuration

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7.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
TXD	1	transmit data input
GND	2	ground
V_{CC}	3	supply voltage
RXD	4	receive data output
V_{ref}	5	reference voltage output
CANL	6	LOW-level CAN voltage input/output
CANH	7	HIGH-level CAN voltage input/output
Rs	8	slope resistor input

8. Functional description

The PCA82C251 is the interface between a CAN protocol controller and the physical bus. It is primarily intended for applications up to 1 MBd in trucks and buses. The device provides differential transmit capability to the bus and differential receive capability to the CAN controller. It is fully compatible with the *"ISO 11898-24 V"* standard.

A current-limiting circuit protects the transmitter output stage against short-circuits to positive and negative battery voltage. Although power dissipation will increase as a result of a short circuit fault condition, this feature will prevent destruction of the transmitter output stage.

If the junction temperature exceeds approximately 160 °C, the limiting current of both transmitter outputs is decreased. Because the transmitter is responsible for most of the power dissipated, this will result in reduced power dissipation and hence a lower chip temperature. All other parts of the IC will remain operational. The thermal protection is needed, in particular, when a bus line is short-circuited.

The CANH and CANL lines are also protected against electrical transients which may occur in an automotive environment.

Pin 8 (Rs) allows three different modes of operation to be selected: High-speed, Slope control and Standby.

For high-speed operation, the transmitter output transistors are simply switched on and off as fast as possible. In this mode, no measures are taken to limit the rise and fall slopes. A shielded cable is recommended to avoid RFI problems. High-speed mode is selected by connecting pin 8 to ground.

Slope control mode allows the use of an unshielded twisted pair or a parallel pair of wires as bus lines. To reduce RFI, the rise and fall slopes should be limited. The rise and fall slopes can be programmed with a resistor connected from pin 8 to ground. The slope is proportional to the current output at pin 8.

If a HIGH level is applied to pin 8, the circuit enters a low-current Standby mode. In this mode, the transmitter is switched off and the receiver is switched to a low current. If dominant bits are detected (differential bus voltage >0.9 V), RXD will be switched to a

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LOW level. The microcontroller should react to this condition by switching the transceiver back to normal operation (via pin 8). Because the receiver is slower in Standby mode, the first message will be lost at higher bit rates.

Table 4. Truth table of the CAN transceiver

Supply	TXD	CANH	CANL	Bus state	RXD
4.5 V to 5.5 V	0	HIGH	LOW	dominant	0
4.5 V to 5.5 V	1 (or floating)	floating	floating	recessive	1[1]
4.5 V < V_{CC} < 5.5 V	X[2]	floating if $V_{Rs} > 0.75V_{CC}$	floating if $V_{Rs} > 0.75V_{CC}$	floating	X[1]
0 V < V_{CC} < 4.5 V	floating	floating	floating	floating	X[2]

[1] If another bus node is transmitting a dominant bit, then RXD is logic 0.

[2] X = don't care.

Table 5. Pin Rs summary

Condition forced at pin Rs	Mode	Resulting voltage or current at pin Rs
$V_{Rs} > 0.75V_{CC}$	Standby	$-I_{Rs} < 10\ \mu A$
$10\ \mu A < -I_{Rs} < 200\ \mu A$	Slope control	$0.4V_{CC} < V_{Rs} < 0.6V_{CC}$
$V_{Rs} < 0.3V_{CC}$	High-speed	$-I_{Rs} < 500\ \mu A$

9. Limiting values

Table 6. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are referenced to pin 2; positive input current.

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage			−0.3	+7.0	V
V_n	DC voltage at pins 1, 4, 5 and 8			−0.3	V_{CC} + 0.3	V
V_6	DC voltage at pin 6 (CANL)	0 V < V_{CC} < 5.5 V; TXD HIGH or floating		−36	+36	V
		0 V < V_{CC} < 5.5 V; no time limit	[1]	−36	+36	V
		0 V < V_{CC} < 5.5 V; no time limit	[2]	−36	+36	V
V_7	DC voltage at pins 7 (CANH)	0 V < V_{CC} < 5.5 V; no time limit		−36	+36	V
V_{trt}	transient voltage at pins 6 and 7	see Figure 8		−200	+200	V
T_{stg}	storage temperature			−55	+150	°C
T_{amb}	ambient temperature			−40	+125	°C
T_{vj}	virtual junction temperature		[3]	−40	+150	°C
V_{ESD}	electrostatic discharge voltage		[4]	−2500	+2500	V
			[5]	−250	+250	V

[1] TXD is LOW. Short-circuit protection provided for slew rates up to 5 V/µs for voltages above +30 V.

[2] Short-circuit applied when TXD is HIGH, followed by TXD switched to LOW.

[3] In accordance with *"IEC 60747-1"*. An alternative definition of virtual junction temperature is: $T_{vj} = T_{amb} + P_d \times R_{th(vj-a)}$, where $R_{th(j-a)}$ is a fixed value to be used for the calculation of T_{vj}. The rating for T_{vj} limits the allowable combinations of power dissipation (P_d) and ambient temperature (T_{amb}).

[4] Classification A: human body model; C = 100 pF; R = 1500 Ω; V = ±2000 V.

[5] Classification B: machine model; C = 200 pF; R = 25 Ω; V = ±200 V.

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10. Thermal characteristics

Table 7. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	160	K/W

11. Characteristics

Table 8. Characteristics

V_{CC} = 4.5 V to 5.5 V; T_{amb} = −40 °C to +125 °C; R_L = 60 Ω; I_8 > −10 μA; unless otherwise specified; all voltages referenced to ground (pin 2); positive input current; all parameters are guaranteed over the ambient temperature range by design, but only 100 % tested at +25 °C.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Supply							
I_3	supply current	dominant; V_1 = 1 V; V_{CC} = 5.1 V		-	-	78	mA
		dominant; V_1 = 1 V; V_{CC} = 5.25 V		-	-	80	mA
		dominant; V_1 = 1 V; V_{CC} = 5.5 V		-	-	85	mA
		recessive; V_1 = 4 V; R_8 = 47 kΩ		-	-	10	mA
		Standby	[1]	-	-	275	μA
DC bus transmitter							
V_{IH}	HIGH-level input voltage	output recessive		0.7V_{CC}	-	V_{CC} + 0.3	V
V_{IL}	LOW-level input voltage	output dominant		−0.3	-	0.3V_{CC}	V
I_{IH}	HIGH-level input current	V_1 = 4 V		−200	-	+30	μA
I_{IL}	LOW-level input current	V_1 = 1 V		−100	-	−600	μA
$V_{6,7}$	recessive bus voltage	V_1 = 4 V; no load		2.0	-	3.0	V
I_{LO}	off-state output leakage current	−2 V < (V_6, V_7) < 7 V		−2	-	+2	mA
		−5 V < (V_6, V_7) < 36 V		−10	-	+10	mA
V_7	CANH output voltage	V_1 = 1 V; V_{CC} = 4.75 V to 5.5 V		3.0	-	4.5	V
		V_1 = 1 V; V_{CC} = 4.5 V to 4.75 V		2.75		4.5	
V_6	CANL output voltage	V_1 = 1 V		0.5	-	2.0	V
$\Delta V_{6,7}$	difference between output voltage at pins 6 and 7	V_1 = 1 V		1.5	-	3.0	V
		V_1 = 1 V; R_L = 45 Ω		1.5	-	-	V
		V_1 = 4 V; no load		−500	-	+50	mV
I_{sc7}	short-circuit CANH current	V_7 = −5 V		-	-	−200	mA
		V_7 = −36 V		-	−100	-	mA
I_{sc6}	short-circuit CANL current	V_6 = 36 V		-	-	200	mA
DC bus receiver: V_1 = 4 V; pins 6 and 7 externally driven; −2 V < (V_6, V_7) < 7 V; unless otherwise specified							
$V_{diff(r)}$	differential input voltage (recessive)		[2]	−1.0	-	+0.5	V
		−7 V < (V_6, V_7) < 12 V	[2]	−1.0	-	+0.4	V
$V_{diff(d)}$	differential input voltage (dominant)			0.9	-	5.0	V
		−7 V < (V_6, V_7) < 12 V; not Standby mode		1.0	-	5.0	V
		Standby mode		0.97	-	5.0	V
		Standby mode; V_{CC} = 4.5 V to 5.10 V		0.91	-	5.0	V

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Table 8. Characteristics *...continued*

V_{CC} = 4.5 V to 5.5 V; T_{amb} = −40 °C to +125 °C; R_L = 60 Ω; I_8 > −10 μA; unless otherwise specified; all voltages referenced to ground (pin 2); positive input current; all parameters are guaranteed over the ambient temperature range by design, but only 100 % tested at +25 °C.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{diff(hys)}$	differential input hysteresis	see Figure 5	-	150	-	mV
V_{OH}	HIGH-level output voltage	pin 4; I_4 = −100 μA	$0.8V_{CC}$	-	V_{CC}	V
V_{OL}	LOW-level output voltage	pin 4; I_4 = 1 mA	0	-	$0.2V_{CC}$	V
		I_4 = 10 mA	0	-	1.5	V
R_i	input resistance	CANH, CANL	5	-	25	kΩ
R_{diff}	differential input resistance		20	-	100	kΩ
Reference output						
V_{ref}	reference output voltage	V_8 = 1 V; $\lvert I_5 \rvert$ < 50 μA	$0.45V_{CC}$	-	$0.55V_{CC}$	V
		V_8 = 4 V; $\lvert I_5 \rvert$ < 5 μA	$0.4V_{CC}$	-	$0.6V_{CC}$	V
Timing (C_L = 100 pF; see Figure 3, Figure 4, Figure 6 and Figure 7)						
t_{bit}	minimum bit time	R_{ext} = 0 Ω	-	-	1	μs
t_{onTXD}	delay TXD to bus active	R_{ext} = 0 Ω	-	-	50	ns
t_{offTXD}	delay TXD to bus inactive	R_{ext} = 0 Ω	-	40	80	ns
t_{onRXD}	delay TXD to receiver active	R_{ext} = 0 Ω	-	55	120	ns
t_{offRXD}	delay TXD to receiver inactive	R_{ext} = 0 Ω; T_{amb} < +85 °C; V_{CC} = 4.5 V to 5.1 V	-	80	150	ns
		R_{ext} = 0 Ω; V_{CC} = 4.5 V to 5.1 V	-	80	170	ns
		R_{ext} = 0 Ω; T_{amb} < +85 °C	-	90	170	ns
		R_{ext} = 0 kΩ	-	90	190	ns
		R_{ext} = 47 kΩ	-	290	400	ns
t_{onRXD}	delay TXD to receiver active	R_{ext} = 47 kΩ	-	440	550	ns
$\lvert SR \rvert$	CANH, CANL slew rate	R_{ext} = 47 kΩ	-	7	-	V/μs
t_{WAKE}	wake-up time from Standby (via pin 8)	see Figure 6	-	-	20	μs
t_{dRXDL}	bus dominant to RXD LOW	V_8 = 4 V; see Figure 7	-	-	3	μs
Standby/Slope control (pin 8)						
V_{stb}	input voltage for Standby mode		$0.75V_{CC}$	-	-	V
I_{slope}	Slope control mode current		−10	-	−200	μA
V_{slope}	Slope control mode voltage		$0.4V_{CC}$	-	$0.6V_{CC}$	V

[1] $I_1 = I_4 = I_5$ = 0 mA; 0 V < V_6 < V_{CC}; 0 V < V_7 < V_{CC}; $V_8 = V_{CC}$; T_{amb} < 90 °C.

[2] This is valid for the receiver in all modes: High-speed, Slope control and Standby.

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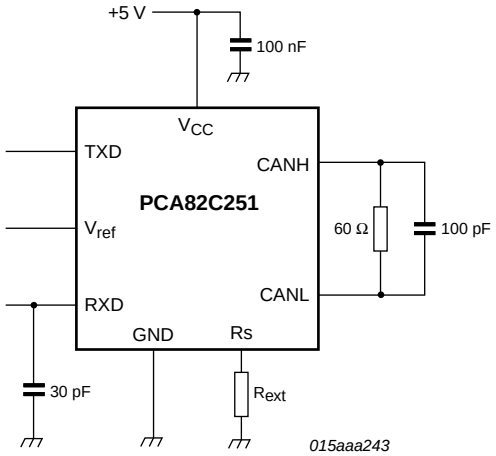


Fig 3. Test circuit for dynamic characteristics.

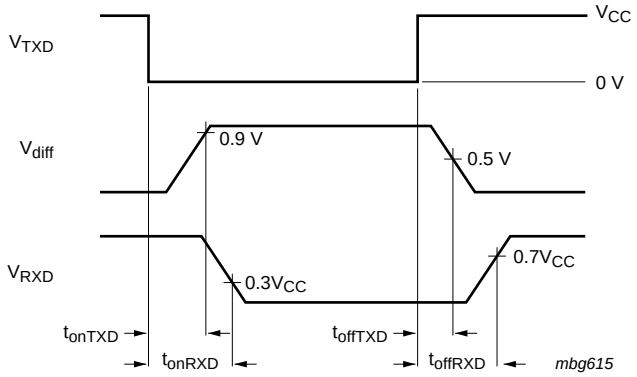


Fig 4. Timing diagram for dynamic characteristics.

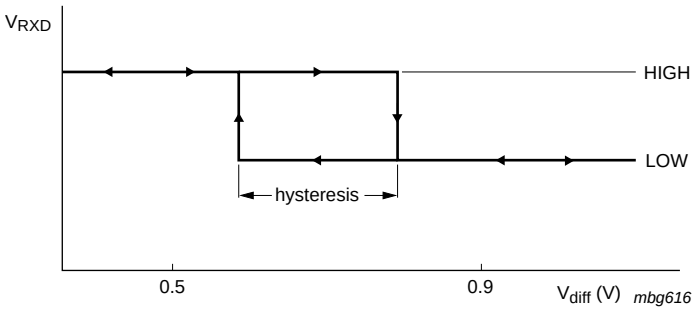
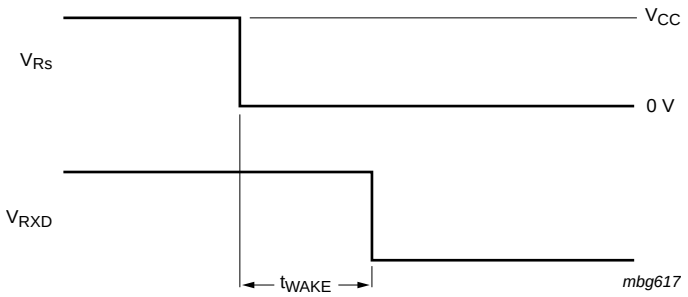


Fig 5. Hysteresis.

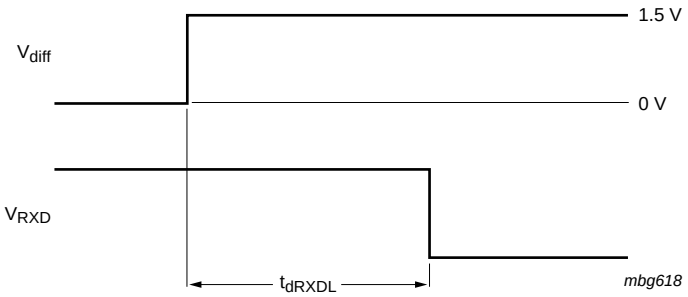
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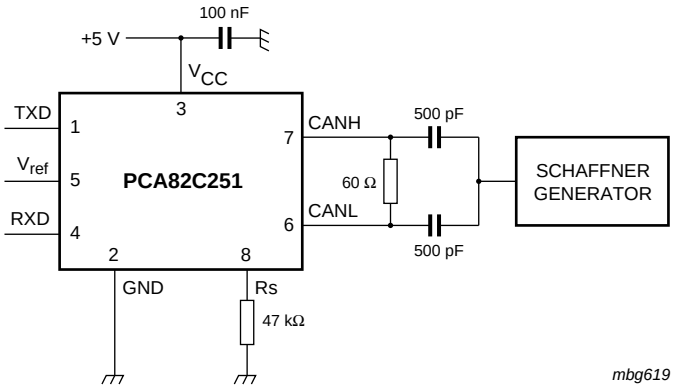
V_{TXD} = 1 V.

Fig 6. Timing diagram for wake-up from Standby.



V_{Rs} = 4 V; V_{TXD} = 4 V.

Fig 7. Timing diagram for bus dominant to RXD LOW.



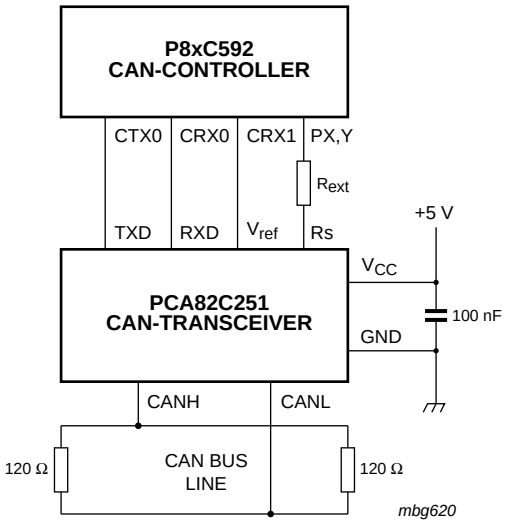
The waveforms of the applied transients shall be in accordance with *"ISO 7637 part 1"*, test pulses 1, 2, 3a and 3b.

Fig 8. Test circuit for automotive transients.

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12. Application information



(1) The output control register of the P8xC592 should be programmed to 1AH (push-pull operation, dominant = LOW).

(2) If no slope control is desired: R_{ext} = 0.

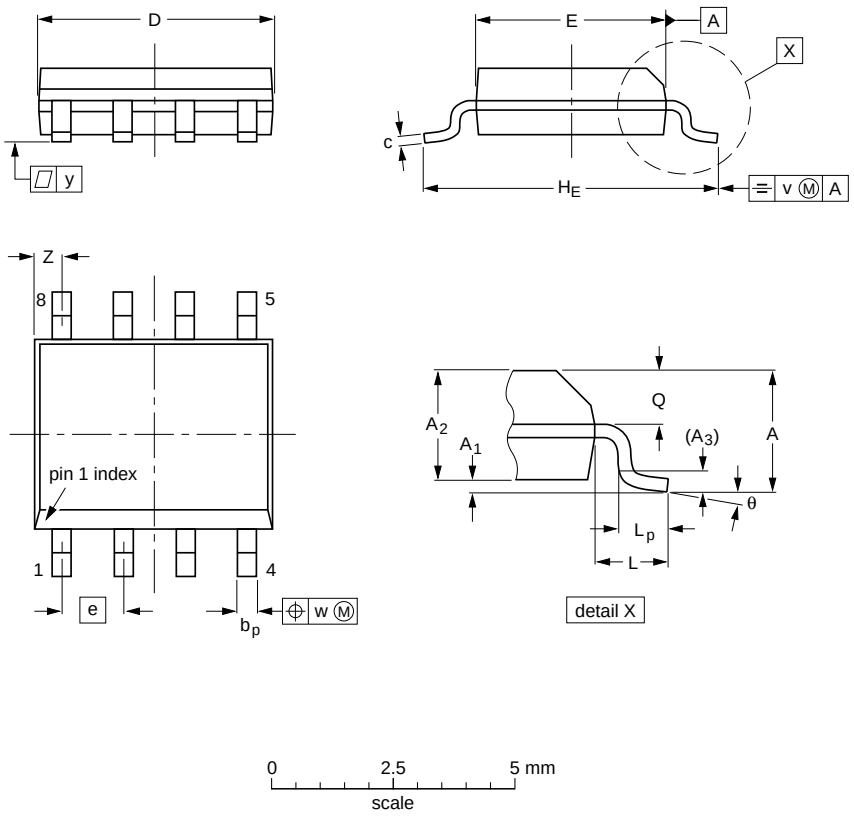
Fig 9. PCA82C251 CAN transceiver application diagram

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13. Package outline

SO8: plastic small outline package; 8 leads; body width 3.9 mm **SOT96-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT96-1	076E03	MS-012				~~99-12-27~~ 03-02-18

Fig 10. Package outline SOT96-1 (SO8)

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14. 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”*.

14.1 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.

14.2 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
- Leaded 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, leaded 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. Leaded 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

14.3 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

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14.4 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 11) 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 9 and 10

Table 9. SnPb eutectic process (from J-STD-020C)

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

Table 10. Lead-free process (from J-STD-020C)

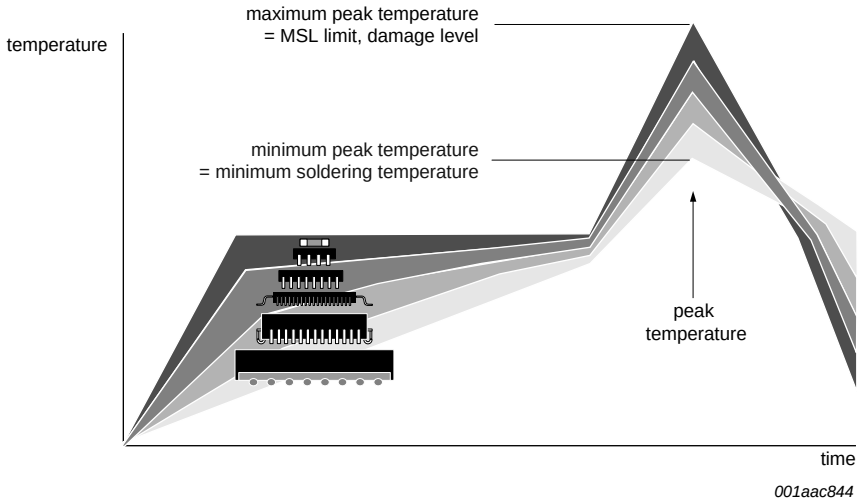
Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm^3)		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

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 11.

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MSL: Moisture Sensitivity Level

Fig 11. Temperature profiles for large and small components

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

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15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCA82C251_4	20110825	Product data sheet	-	PCA82C251_3
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • DIP8 package discontinued; bare die no longer available. • Section 4 “Quick reference data” t_{PD} propagation delay added. • Typing errors corrected in Table 8 and Figure 3.			
PCA82C251_3	20000113	Product data sheet	-	PCA82C251_2
PCA82C251_2	19970314	Product data sheet	-	PCA82C251_1
PCA82C251_1	-	Product data sheet	-	-

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16. Legal information

16.1 Data sheet status

Document status[1][2]	Product status[3]	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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

16.2 Definitions

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