PCA82C250

CAN controller interface

Rev. 06 — 25 August 2011 | Product data sheet

1. General description

The PCA82C250 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”* standard
- High speed (up to 1 MBd)
- Bus lines protected against transients in an automotive environment
- Slope control to reduce Radio Frequency Interference (RFI)
- Differential receiver with wide common-mode range for high immunity against ElectroMagnetic Interference (EMI)
- Thermally protected
- Short-circuit proof to battery and ground
- Low-current Standby mode
- An unpowered node does not disturb the bus lines
- At least 110 nodes can be connected

3. Applications

- High-speed automotive applications (up to 1 MBd).

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	-	170	μA
$1/t_{bit}$	maximum transmission speed	non-return-to-zero	1	-	MBd
V_{CAN}	CANH, CANL input/output voltage		–8	+18	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
PCA82C250T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

6. Block diagram

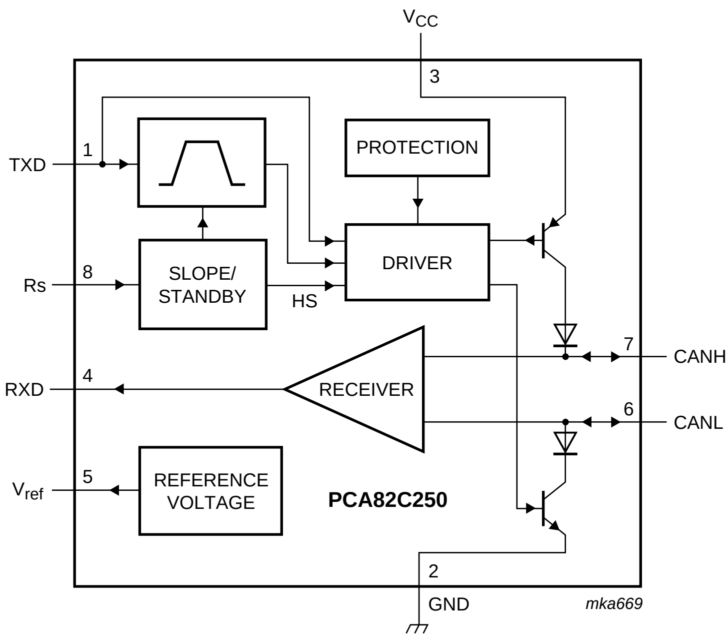


Fig 1. Block diagram

7. Pinning information

7.1 Pinning

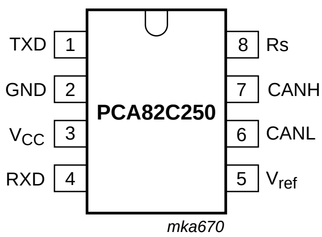


Fig 2. Pin configuration

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 PCA82C250 is the interface between a CAN protocol controller and the physical bus. It is primarily intended for high-speed automotive applications (up to 1 MBd). 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"* standard.

A current limiting circuit protects the transmitter output stage against short-circuit to positive and negative battery voltage. Although the power dissipation is increased during this fault condition, this feature will prevent destruction of the transmitter output stage.

If the junction temperature exceeds a value of approximately 160 °C, the limiting current of both transmitter outputs is decreased. Because the transmitter is responsible for the major part of the power dissipation, this will result in reduced power dissipation and hence a lower chip temperature. All other parts of the PCA82C250 will remain in operation. 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 slope. Use of a shielded cable is recommended to avoid RFI problems. The High-speed mode is selected by connecting pin 8 to ground.

For lower speeds or shorter bus length, an unshielded twisted pair or a parallel pair of wires can be used for the bus. To reduce RFI, the rise and fall slope should be limited. The rise and fall slope 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

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

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
< 2 V (not powered)	X[1]	floating	floating	recessive	X[1]
2 V < V_{CC} < 4.5 V	>0.75V_{CC}	floating	floating	recessive	X[1]
2 V < V_{CC} < 4.5 V	X[1]	floating if V_{Rs} > 0.75V_{CC}	floating if V_{Rs} > 0.75V_{CC}	recessive	X[1]

[1] 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 μA|
−10 μA < I_{Rs} < −200 μA	Slope control	0.4V_{CC} < V_{Rs} < 0.6V_{CC}
V_{Rs} < 0.3V_{CC}	High-speed	I_{Rs} < −500 μA

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	+9.0	V
V_n	DC voltage at pins 1, 4, 5 and 8		−0.3	V_{CC} + 0.3	V
$V_{6,7}$	DC voltage at pins 6 and 7	0 V < V_{CC} < 5.5 V; no time limit	−8.0	+18.0	V
V_{trt}	transient voltage at pins 6 and 7	see Figure 8	−150	+100	V
T_{stg}	storage temperature		−55	+150	°C
T_{amb}	ambient temperature		−40	+125	°C
T_{vj}	virtual junction temperature	[1]	−40	+150	°C
V_{esd}	electrostatic discharge voltage	[2]	−2000	+2000	V
		[3]	−200	+200	V

[1] 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}).

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

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

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 to 5.5 V; T_{amb} = −40 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		-	-	70	mA
		recessive; V_1 = 4 V; R_8 = 47 kΩ		-	-	14	mA
		recessive; V_1 = 4 V; V_8 = 1 V		-	-	18	mA
		Standby; T_{amb} < 90 °C	[1]	-	100	170	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	-	+1	mA
		−5 V < (V_6,V_7) < 18 V		−5	-	+12	mA
V_7	CANH output voltage	V_1 = 1 V		2.75	-	4.5	V
V_6	CANL output voltage	V_1 = 1 V		0.5	-	2.25	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; V_{CC} ≥ 4.9 V		1.5	-	-	V
		V_1 = 4 V; no load		−500	-	+50	mV
I_{sc7}	short-circuit CANH current	V_7 = −5 V; V_{CC} ≤ 5 V		-	-	−105	mA
		V_7 = −5 V; V_{CC} = 5.5 V		-	-	−120	mA
I_{sc6}	short-circuit CANL current	V_6 = 18 V		-	-	160	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)			−1.0	-	+0.5	V
		−7 V < (V_6, V_7) < 12 V; not Standby mode		−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
$V_{diff(hys)}$	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

Table 8. Characteristics *...continued*

V_{CC} = 4.5 to 5.5 V; T_{amb} = −40 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_{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
C_i	input capacitance	CANH, CANL	-	-	20	pF
C_{diff}	differential input capacitance		-	-	10	pF
Reference output						
V_{ref}	reference output voltage	V_8 = 1 V; −50 μA < I_5 < 50 μA	$0.45V_{CC}$	-	$0.55V_{CC}$	V
		V_8 = 4 V; −5 μA < I_5 < 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; V_{CC} < 5.1 V; T_{amb} < +85 °C	-	82	150	ns
		R_{ext} = 0 Ω; V_{CC} < 5.1 V; T_{amb} < +125 °C	-	82	170	ns
		R_{ext} = 0 Ω; V_{CC} < 5.5 V; T_{amb} < +85 °C	-	90	170	ns
		R_{ext} = 0 Ω; V_{CC} < 5.5 V; T_{amb} < +125 °C	-	90	190	ns
t_{onRXD}	delay TXD to receiver active	R_{ext} = 47 kΩ	-	390	520	ns
		R_{ext} = 24 kΩ	-	260	320	ns
t_{offRXD}	delay TXD to receiver inactive	R_{ext} = 47 kΩ	-	260	450	ns
		R_{ext} = 24 kΩ	-	210	320	ns
|SR|	differential output voltage slew rate	R_{ext} = 47 kΩ	-	14	-	V/μs
t_{WAKE}	wake-up time from Standby	via pin 8	-	-	20	μs
t_{dRXDL}	bus dominant to RXD LOW	V_8 = 4 V; Standby mode	-	-	3	μs
Standby/Slope Control (pin 8)						
V_8	input voltage for high-speed		-	-	$0.3V_{CC}$	V
I_8	input current for high-speed	V_8 = 0 V	-	-	−500	μA
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}; $V_8 = V_{CC}$.

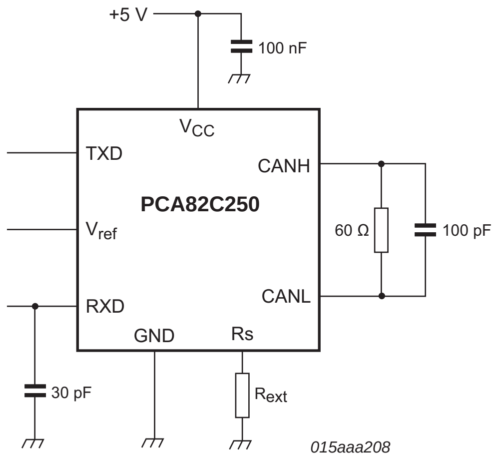


Fig 3. Test circuit for dynamic characteristics.

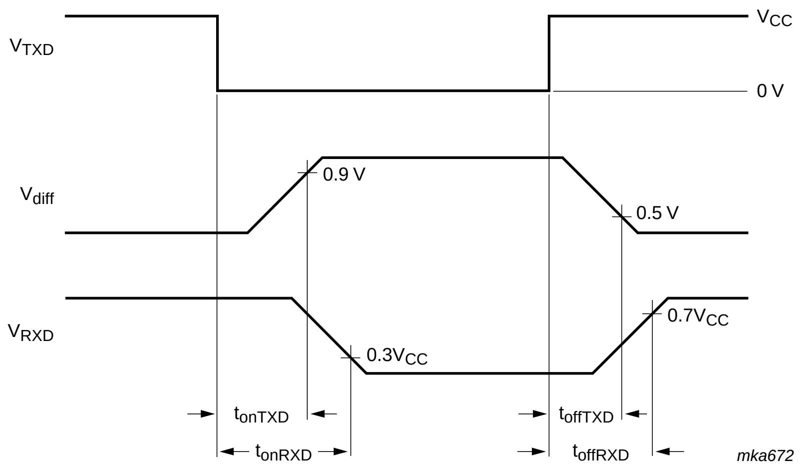


Fig 4. Timing diagram for dynamic characteristics.

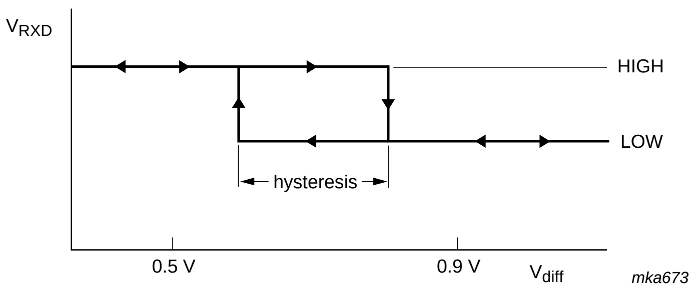
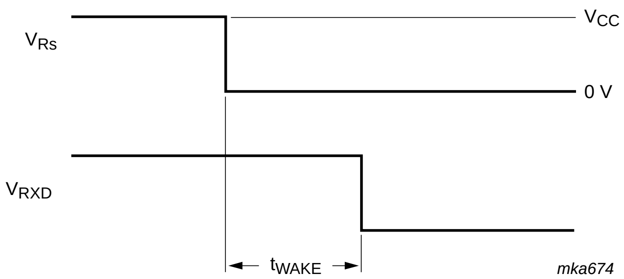
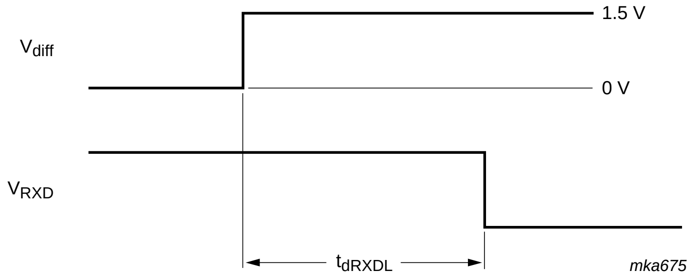


Fig 5. Hysteresis.



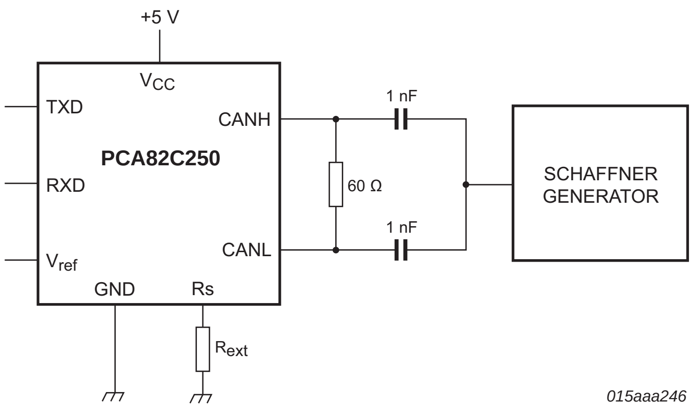
V_1 = 1 V.

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



V_1 = 4 V; V_8 = 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.

12. Application information

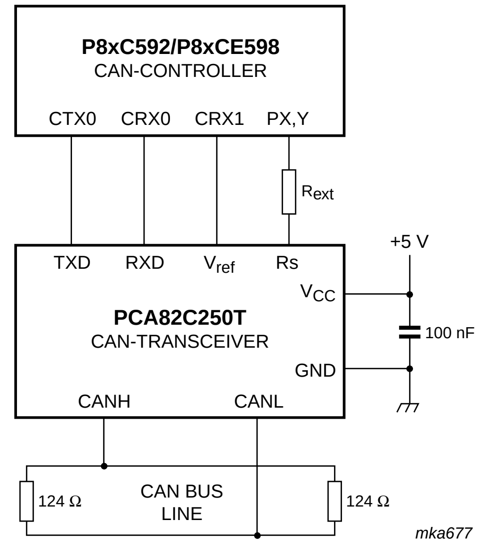


Fig 9. Application of the CAN transceiver.

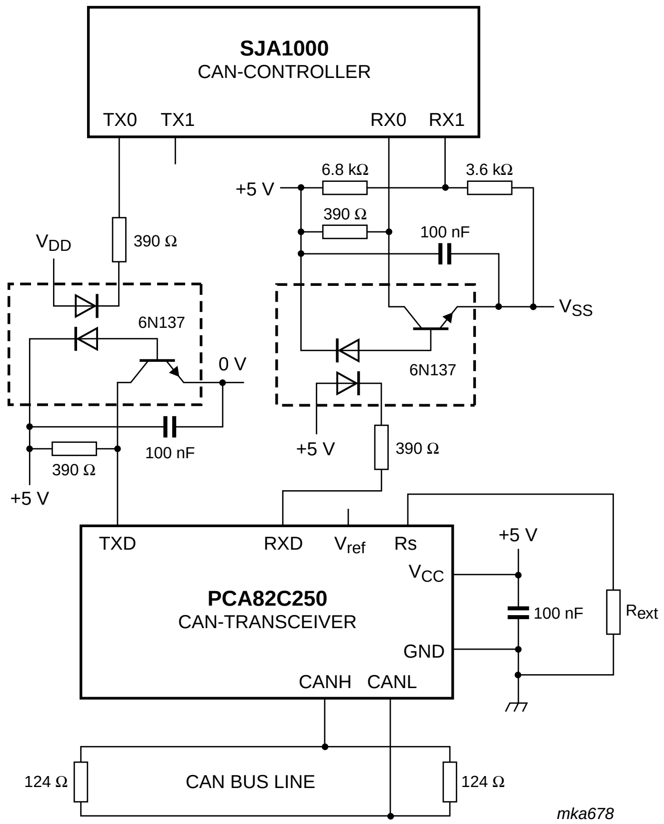


Fig 10. Application with galvanic isolation.

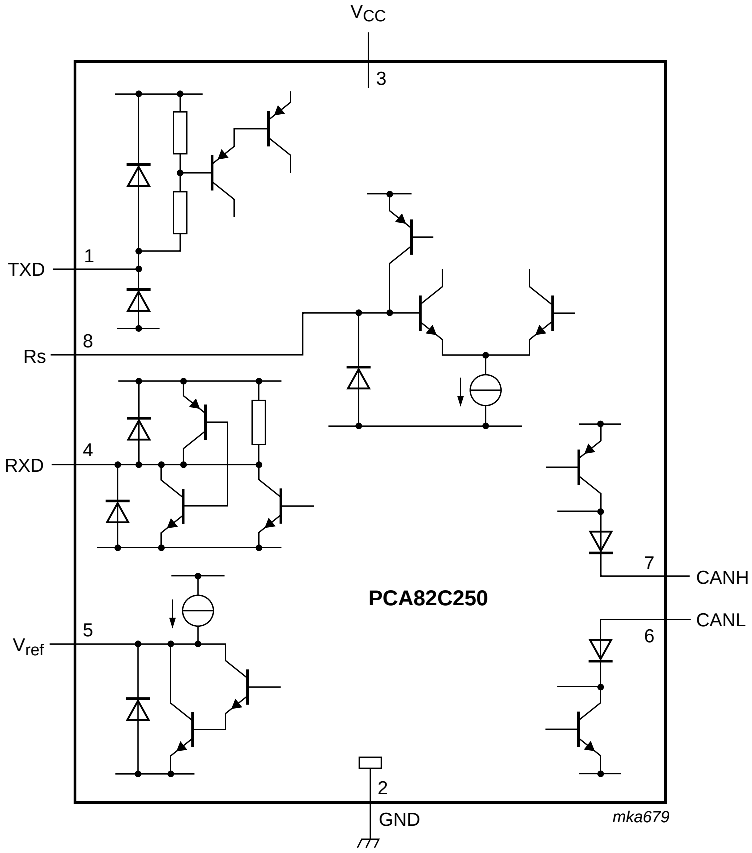
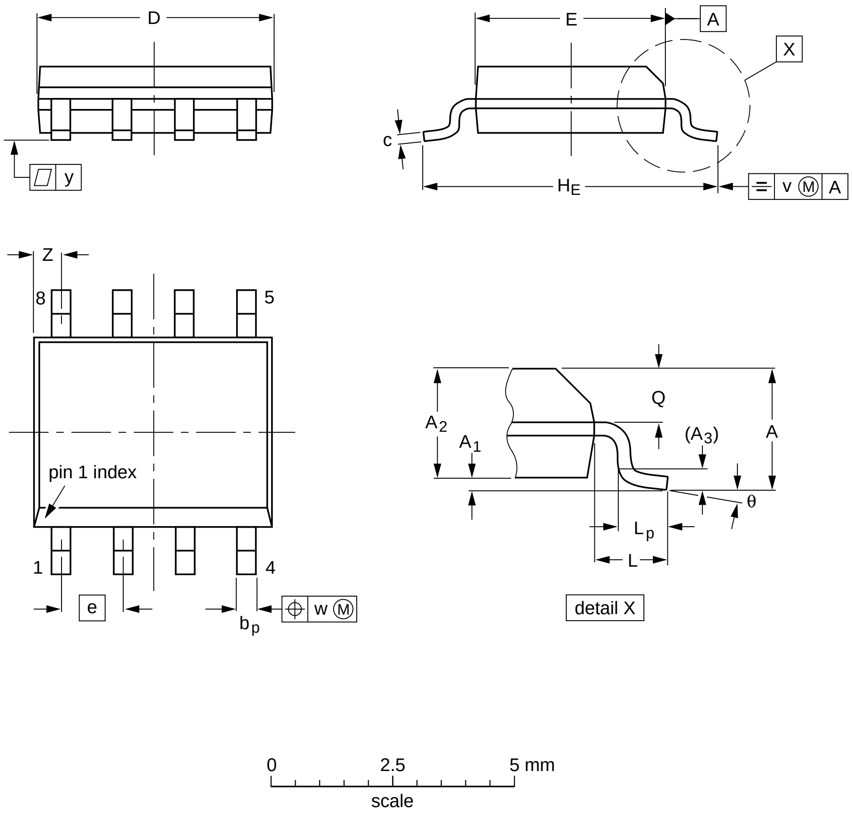


Fig 11. Internal pin configuration.

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 12. Package outline SOT96-1 (SO8)

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

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 13) 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)

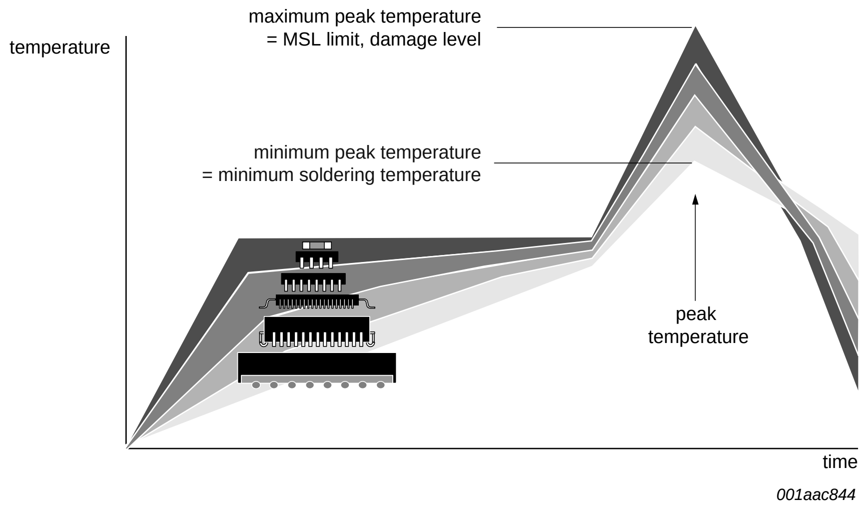
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm^3)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

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 13.



MSL: Moisture Sensitivity Level

Fig 13. Temperature profiles for large and small components

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

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCA82C250_6	20110825	Product data sheet	-	PCA82C250_5
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. • Typing errors corrected in Table 8, Figure 3 and Figure 8.			
PCA82C250 v.5	20000113	Product specification	-	PCA82C250 v.3
PCA82C250 v.3	19971021	Preliminary specification		PCA82C250 v.2
PCA82C250 v.2	19940915	-		PCA82C250 v.1
PCA82C250 v.1	19940408	-		-

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.

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18. Contents

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