TJA1049

High-speed CAN transceiver with Standby mode

Rev. 2 — 23 March 2011 Product data sheet

1. General description

The TJA1049 high-speed CAN transceiver provides an interface between a Controller Area Network (CAN) protocol controller and the physical two-wire CAN bus. The transceiver is designed for high-speed (up to 1 Mbit/s) CAN applications in the automotive industry, supplying the differential transmit and receive capability to (a microcontroller with) a CAN protocol controller.

The TJA1049 belongs to the third generation of high-speed CAN transceivers from NXP Semiconductors, offering significant improvements over first- and second-generation devices such as the TJA1040. It offers improved ElectroMagnetic Compatibility (EMC) and ElectroStatic Discharge (ESD) performance, and also features:

- Ideal passive behavior to the CAN bus when the supply voltage is off
- A very low-current Standby mode with bus wake-up capability

These features make the TJA1049 an excellent choice for all types of HS-CAN networks, in nodes that require a low-power mode with wake-up capability via the CAN bus.

2. Features and benefits

2.1 General

- Fully ISO 11898-2 and ISO 11898-5 compliant
- Suitable for 12 V and 24 V systems
- Low ElectroMagnetic Emission (EME) and high ElectroMagnetic Immunity (EMI)
- SPLIT voltage output for stabilizing the recessive bus level

2.2 Low-power management

- Very low-current Standby mode with host and bus wake-up capability
- Functional behavior predictable under all supply conditions
- Transceiver disengages from the bus when not powered up (zero load)

2.3 Protection

- High ESD handling capability on the bus pins
- Bus pins protected against transients in automotive environments
- Transmit Data (TXD) dominant time-out function
- Bus-dominant time-out function in Standby mode
- Undervoltage detection on pin V_{CC}
- Thermally protected

3. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		4.75	-	5.25	V
I_{CC}	supply current	Standby mode	-	10	15	μA
		Normal mode; bus recessive	2.5	5	7.5	mA
		Normal mode; bus dominant	20	45	65	mA
$V_{uvd(stb)(VCC)}$	standby undervoltage detection voltage on pin V_{CC}		3.5	-	4.75	V
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2 at pins CANH and CANL	−8	-	+8	kV
V_{CANH}	voltage on pin CANH	no time limit; DC limiting value	−58	-	+58	V
V_{CANL}	voltage on pin CANL	no time limit; DC limiting value	−58	-	+58	V
T_{vj}	virtual junction temperature		−40	-	+150	°C

4. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
TJA1049T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

5. Block diagram

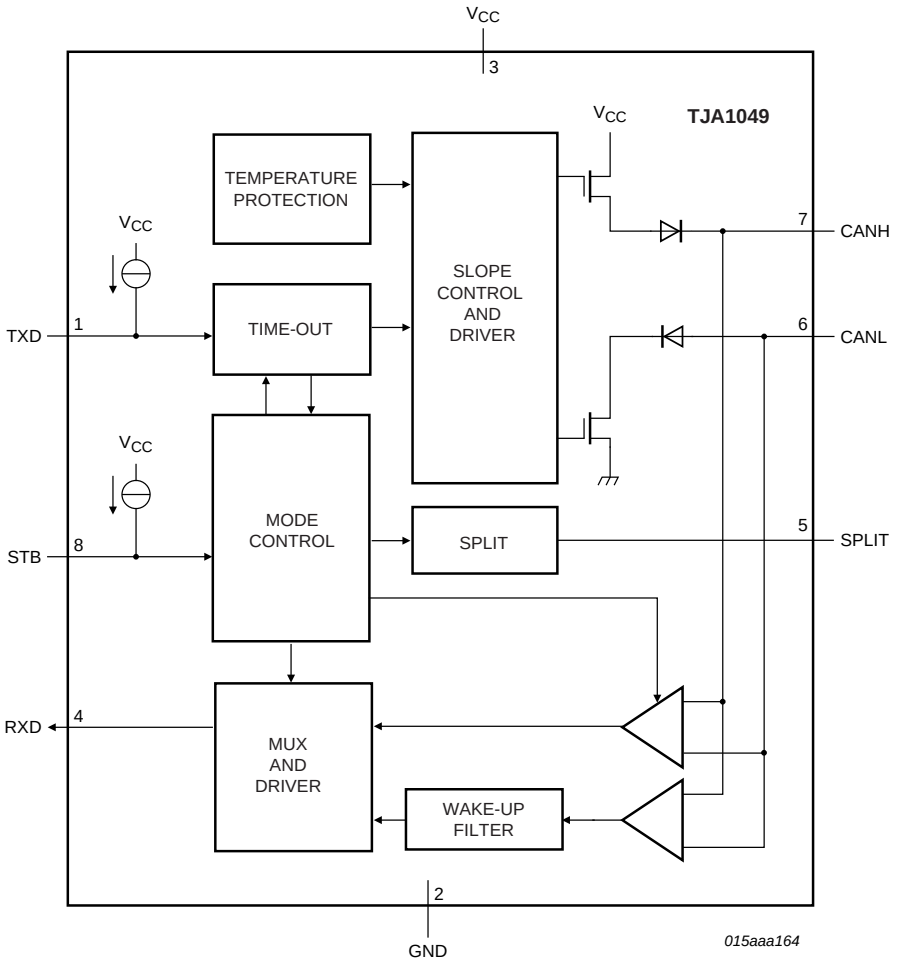


Fig 1. Block diagram

6. Pinning information

6.1 Pinning

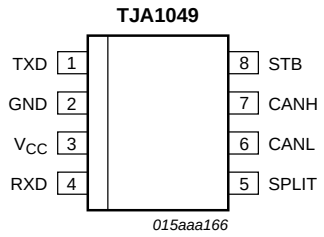


Fig 2. Pin configuration diagram

6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
TXD	1	transmit data input
GND	2	ground supply
V_{CC}	3	supply voltage
RXD	4	receive data output; reads out data from the bus lines
SPLIT	5	common-mode stabilization output
CANL	6	LOW-level CAN bus line
CANH	7	HIGH-level CAN bus line
STB	8	Standby mode control input

7. Functional description

The TJA1049 is a HS-CAN stand-alone transceiver with Standby mode. It combines the functionality of the PCA82C250, PCA82C251 and TJA1040 transceivers and offers improved EMC and ESD handling capability and quiescent current performance. Improved slope control and high DC handling capability on the bus pins provide additional application flexibility.

The TJA1049 is 100 % backwards-compatible with the TJA1040, and can be used in existing PCA82C250 and PCA82C251 applications.

7.1 Operating modes

The TJA1049 supports two operating modes, Normal and Standby, which are selectable via pin STB. See Table 4 for a description of the operating modes under normal supply conditions.

Table 4. Operating modes

Mode	Pin STB	Pin RXD	
		LOW	HIGH
Normal	LOW	bus dominant	bus recessive
Standby	HIGH	wake-up request detected	no wake-up request detected

7.1.1 Normal mode

A LOW level on pin STB selects Normal mode. In this mode, the transceiver can transmit and receive data via the bus lines CANH and CANL (see Figure 1 for the block diagram). The differential receiver converts the analog data on the bus lines into digital data which is output on pin RXD. The slope of the output signals on the bus lines is controlled and optimized in a way that guarantees the lowest possible EME.

7.1.2 Standby mode

A HIGH level on pin STB selects Standby mode. In Standby mode, the transceiver is not able to transmit or correctly receive data via the bus lines. The transmitter and Normal-mode receiver blocks are switched off to reduce supply current, and only a low-power differential receiver monitors the bus lines for activity. The wake-up filter on the output of the low-power receiver does not latch bus dominant states, but ensures that only bus dominant and bus recessive states that persist longer than $t_{fltr(wake)bus}$ are reflected on pin RXD.

In Standby mode, the bus lines are biased to ground to minimize the system supply current. When pin RXD goes LOW to signal a wake-up request, a transition to Normal mode will not be triggered until STB is forced LOW.

7.2 Fail-safe features

7.2.1 TXD dominant time-out function

A ‘TXD dominant time-out’ timer is started when pin TXD is set LOW. If the LOW state on pin TXD persists for longer than $t_{to(dom)TXD}$, the transmitter is disabled, releasing the bus lines to recessive state. This function prevents a hardware and/or software application

failure from driving the bus lines to a permanent dominant state (blocking all network communications). The TXD dominant time-out timer is reset when pin TXD is set HIGH. The TXD dominant time-out time also defines the minimum possible bit rate of 40 kbit/s.

7.2.2 Bus dominant time-out function

In Standby mode, a 'bus dominant time-out' timer is started when the CAN bus changes from recessive to dominant state. If the dominant state on the bus persists for longer than $t_{to(dom)bus}$, the RXD pin is forced HIGH. This prevents a clamped dominant bus (due to a bus short-circuit or a failure in one of the other nodes on the network) generating a permanent wake-up request. The bus dominant time-out timer is reset when the CAN bus changes from dominant to recessive state.

7.2.3 Internal biasing of TXD and STB input pins

Pins TXD and STB have internal pull-ups to V_{CC} to ensure a safe, defined state in case one (or both) of these pins is left floating. Pull-up currents flow in these pins in all states; both pins should be held HIGH in Standby mode to minimize standby current.

7.2.4 Undervoltage detection on pin V_{CC}

Should V_{CC} drop below the standby undervoltage detection level, $V_{uvd(stb)(VCC)}$, the transceiver will switch to Standby mode. The logic state of pin STB will be ignored until V_{CC} has recovered ($V_{CC} > V_{uvd(stb)(VCC)}$).

Should V_{CC} drop below the switch-off undervoltage detection level, $V_{uvd(swoff)(VCC)}$, the transceiver will switch off and disengage from the bus (zero load) until V_{CC} has recovered ($V_{CC} > V_{uvd(swoff)(VCC)}$).

7.2.5 Overtemperature protection

The output drivers are protected against overtemperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature, $T_{j(sd)}$, the output drivers will be disabled until the virtual junction temperature falls below $T_{j(sd)}$ and TXD becomes recessive again. Including the TXD condition ensures that output driver oscillation due to temperature drift is avoided.

7.3 SPLIT pin

Using the SPLIT pin in conjunction with a split termination network (see Figure 3 and Figure 6) can help to stabilize the recessive voltage level on the bus. This will reduce EME in networks with DC leakage to ground (e.g. from deactivated nodes with poor bus leakage performance). In Normal mode, pin SPLIT delivers a DC output voltage of $0.5V_{CC}$. In Standby mode or when V_{CC} is off, pin SPLIT is floating.

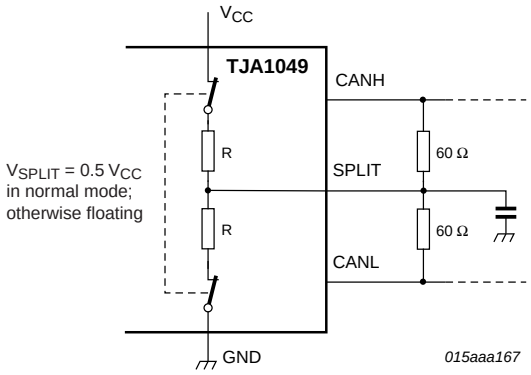


Fig 3. Stabilization circuitry

8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are referenced to GND.

Symbol	Parameter	Conditions		Min	Max	Unit
V_x	voltage on pin x	no time limit; DC value				
		on pins CANH, CANL and SPLIT		−58	+58	V
		on any other pin		−0.3	+7	V
V_{trt}	transient voltage	on pins CANH and CANL	[1]	−150	+100	V
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2	[2]			
		at pins CANH and CANL	[3]	−8	+8	kV
		HBM	[4]			
		at pins CANH and CANL		−8	+8	kV
		at any other pin		−4	+4	kV
		MM	[5]			
		at any pin		−300	+300	V
		CDM	[6]			
		at corner pins		−750	+750	V
		at any pin		−500	+500	V
T_{vj}	virtual junction temperature		[7]	−40	+150	°C
T_{stg}	storage temperature			−55	+150	°C

[1] Verified by an external test house to ensure pins CANH and CANL can withstand ISO 7637 part 3 automotive transient test pulses 1, 2a, 3a and 3b.

[2] IEC 61000-4-2 (150 pF, 330 Ω); direct coupling.

[3] ESD performance of pins CANH and CANL according to IEC 61000-4-2 (150 pF, 330 Ω) has been be verified by an external test house. The result is equal to or better than ±8 kV (unaided).

[4] Human Body Model (HBM): according to AEC-Q100-002 (100 pF, 1.5 kΩ).

[5] Machine Model (MM): according to AEC-Q100-003 (200 pF, 0.75 μH, 10 Ω).

[6] Charged Device Model (CDM): according to AEC-Q100-011 (field Induced charge; 4 pF); grade C3B.

[7] In accordance with IEC 60747-1. An alternative definition of virtual junction temperature is: $T_{vj} = T_{amb} + P \times R_{th(vj-a)}$, where $R_{th(vj-a)}$ 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) and ambient temperature (T_{amb}).

9. Thermal characteristics

Table 6. Thermal characteristics

According to IEC 60747-1.

Symbol	Parameter	Conditions	Value	Unit
$R_{th(vj-a)}$	thermal resistance from virtual junction to ambient	SO8 package; in free air	145	K/W

10. Static characteristics

Table 7. Static characteristics

T_{vj} = −40 °C to +150 °C; V_{CC} = 4.75 V to 5.25 V; R_L = 60 Ω unless specified otherwise; All voltages are defined with respect to ground. Positive currents flow into the IC.[1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply; pin V_{CC}						
V_{CC}	supply voltage		4.75	-	5.25	V
I_{CC}	supply current	Standby mode; $V_{TXD} = V_{CC}$	-	10	15	µA
		Normal mode				
		recessive; $V_{TXD} = V_{CC}$	2.5	5	7.5	mA
		dominant; V_{TXD} = 0 V	20	45	65	mA
$V_{uvd(stb)(VCC)}$	standby undervoltage detection voltage on pin V_{CC}		3.5	-	4.75	V
$V_{uvd(swoff)(VCC)}$	switch-off undervoltage detection voltage on pin V_{CC}		1.3	2	2.7	V
Standby mode control input; pin STB						
V_{IH}	HIGH-level input voltage		0.7V_{CC}	-	V_{CC} + 0.3	V
V_{IL}	LOW-level input voltage		−0.3	-	0.3V_{CC}	V
I_{IH}	HIGH-level input current	$V_{STB} = V_{CC}$	−1	-	+1	µA
I_{IL}	LOW-level input current	V_{STB} = 0 V	−15	-	−1	µA
CAN transmit data input; pin TXD						
V_{IH}	HIGH-level input voltage		0.7V_{CC}	-	V_{CC} + 0.3	V
V_{IL}	LOW-level input voltage		−0.3	-	0.3V_{CC}	V
I_{IH}	HIGH-level input current	$V_{TXD} = V_{CC}$	−5	-	+5	µA
I_{IL}	LOW-level input current	V_{TXD} = 0 V	−260	−150	−30	µA
C_i	input capacitance	[2]	-	5	10	pF
CAN receive data output; pin RXD						
I_{OH}	HIGH-level output current	$V_{RXD} = V_{CC}$ − 0.4 V	−8	−3	−1	mA
I_{OL}	LOW-level output current	V_{RXD} = 0.4 V; bus dominant	1	-	12	mA
Bus lines; pins CANH and CANL						
$V_{O(dom)}$	dominant output voltage	V_{TXD} = 0 V; $t < t_{to(dom)TXD}$				
		pin CANH	2.75	3.5	4.5	V
		pin CANL	0.5	1.5	2.25	V
$V_{dom(TX)sym}$	transmitter dominant voltage symmetry	$V_{dom(TX)sym} = V_{CC} - V_{CANH} - V_{CANL}$	−400	-	+400	mV
$V_{O(dif)bus}$	bus differential output voltage	V_{TXD} = 0 V; $t < t_{to(dom)TXD}$ R_L = 45 Ω to 65 Ω	1.5	-	3	V
		$V_{TXD} = V_{CC}$ recessive; no load	−50	-	+50	mV
$V_{O(rec)}$	recessive output voltage	Normal mode; $V_{TXD} = V_{CC}$; no load	2	0.5V_{CC}	3	V
		Standby mode; no load	−0.1	-	+0.1	V

Table 7. Static characteristics *…continued*

T_{vj} = −40 °C to +150 °C; V_{CC} = 4.75 V to 5.25 V; R_L = 60 Ω unless specified otherwise; All voltages are defined with respect to ground. Positive currents flow into the IC.[1]

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{th(RX)dif}$	differential receiver threshold voltage	$V_{cm(CAN)}$ = −12 V to +12 V	[3]				
		Normal mode		0.5	-	0.9	V
		Standby mode		0.4	-	1.15	V
$V_{hys(RX)dif}$	differential receiver hysteresis voltage	$V_{cm(CAN)}$ = −12 V to +12 V Normal mode		100	-	300	mV
$I_{O(dom)}$	dominant output current	V_{TXD} = 0 V; t < $t_{to(dom)TXD}$; V_{CC} = 5 V					
		pin CANH; V_{CANH} = 0 V		−100	−70	−40	mA
		pin CANL; V_{CANL} = 5 V / 40 V		40	70	100	mA
$I_{O(rec)}$	recessive output current	Normal mode; V_{TXD} = V_{CC} V_{CANH} = V_{CANL} = −27 V to +32 V		−5	-	+5	mA
I_L	leakage current	V_{CC} = 0 V; V_{CANH} = V_{CANL} = 5 V		−3	-	+3	µA
R_i	input resistance			9	15	28	kΩ
ΔR_i	input resistance deviation	between V_{CANH} and V_{CANL}		−3	-	+3	%
$R_{i(dif)}$	differential input resistance			19	30	52	kΩ
$C_{i(cm)}$	common-mode input capacitance		[2]	-	-	20	pF
$C_{i(dif)}$	differential input capacitance		[2]	-	-	10	pF
Common mode stabilization output; pin SPLIT							
V_O	output voltage	Normal mode I_{SPLIT} = −500 µA to +500 µA		$0.3V_{CC}$	$0.5V_{CC}$	$0.7V_{CC}$	V
		Normal mode; R_L = 1 MΩ		$0.45V_{CC}$	$0.5V_{CC}$	$0.55V_{CC}$	V
I_L	leakage current	Standby mode V_{SPLIT} = −58 V to +58 V		−5	-	+5	µA
Temperature detection							
$T_{j(sd)}$	shutdown junction temperature		[2]	-	190	-	°C

[1] All parameters are guaranteed over the virtual junction temperature range by design. Factory testing uses correlated test conditions to cover the specified temperature and power supply voltage range.

[2] Not tested in production; guaranteed by design.

[3] $V_{cm(CAN)}$ is the common mode voltage of CANH and CANL.

11. Dynamic characteristics

Table 8. Dynamic characteristics

T_{vj} = −40 °C to +150 °C; V_{CC} = 4.75 V to 5.25 V; R_L = 60 Ω unless specified otherwise. All voltages are defined with respect to ground. Positive currents flow into the IC.[1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Transceiver timing; pins CANH, CANL, TXD and RXD; see Figure 4 and Figure 5						
$t_{d(TXD-busdom)}$	delay time from TXD to bus dominant	Normal mode	-	65	140	ns
$t_{d(TXD-busrec)}$	delay time from TXD to bus recessive	Normal mode	-	90	140	ns
$t_{d(busdom-RXD)}$	delay time from bus dominant to RXD	Normal mode	-	60	140	ns
$t_{d(busrec-RXD)}$	delay time from bus recessive to RXD	Normal mode	-	65	140	ns
$t_{PD(TXD-RXD)}$	propagation delay from TXD to RXD	Normal mode	60	-	220	ns
$t_{to(dom)TXD}$	TXD dominant time-out time	V_{TXD} = 0 V; Normal mode	0.3	1.7	5	ms
$t_{to(dom)bus}$	bus dominant time-out time	Standby mode	0.3	1.7	5	ms
$t_{fltr(wake)bus}$	bus wake-up filter time	Standby mode	0.5	-	5	µs
$t_{d(stb-norm)}$	standby to normal mode delay time		7	25	47	µs

[1] All parameters are guaranteed over the virtual junction temperature range by design. Factory testing uses correlated test conditions to cover the specified temperature and power supply voltage range.

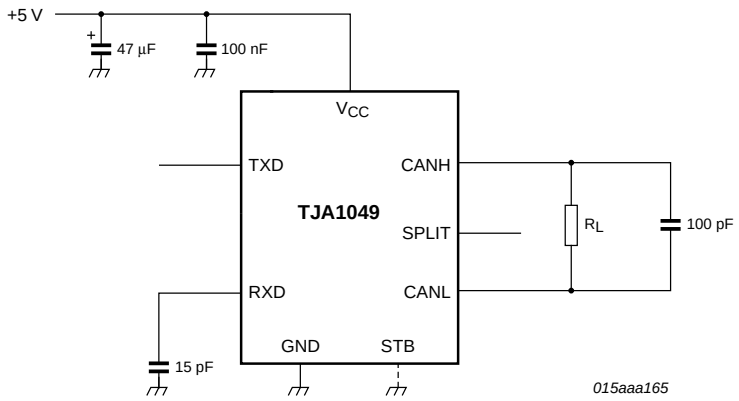


Fig 4. Timing test circuit for CAN transceiver

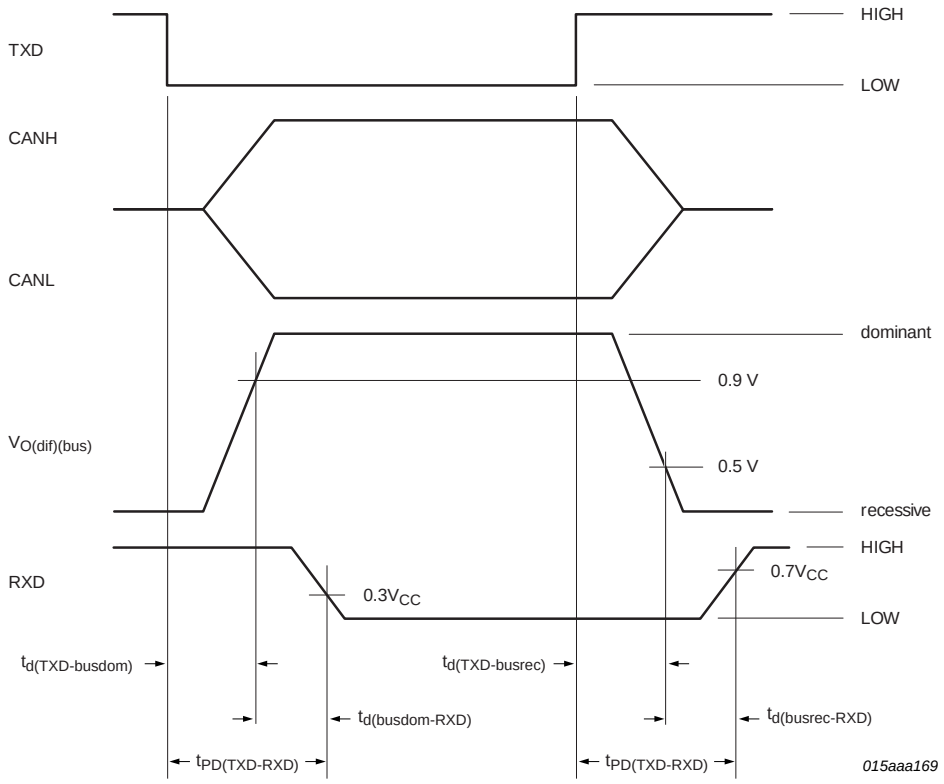


Fig 5. CAN transceiver timing diagram

12. Application information

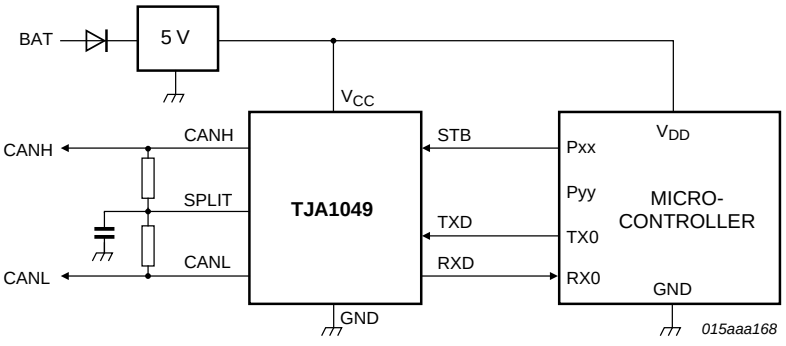


Fig 6. Typical application with TJA1049 and a 5 V microcontroller.

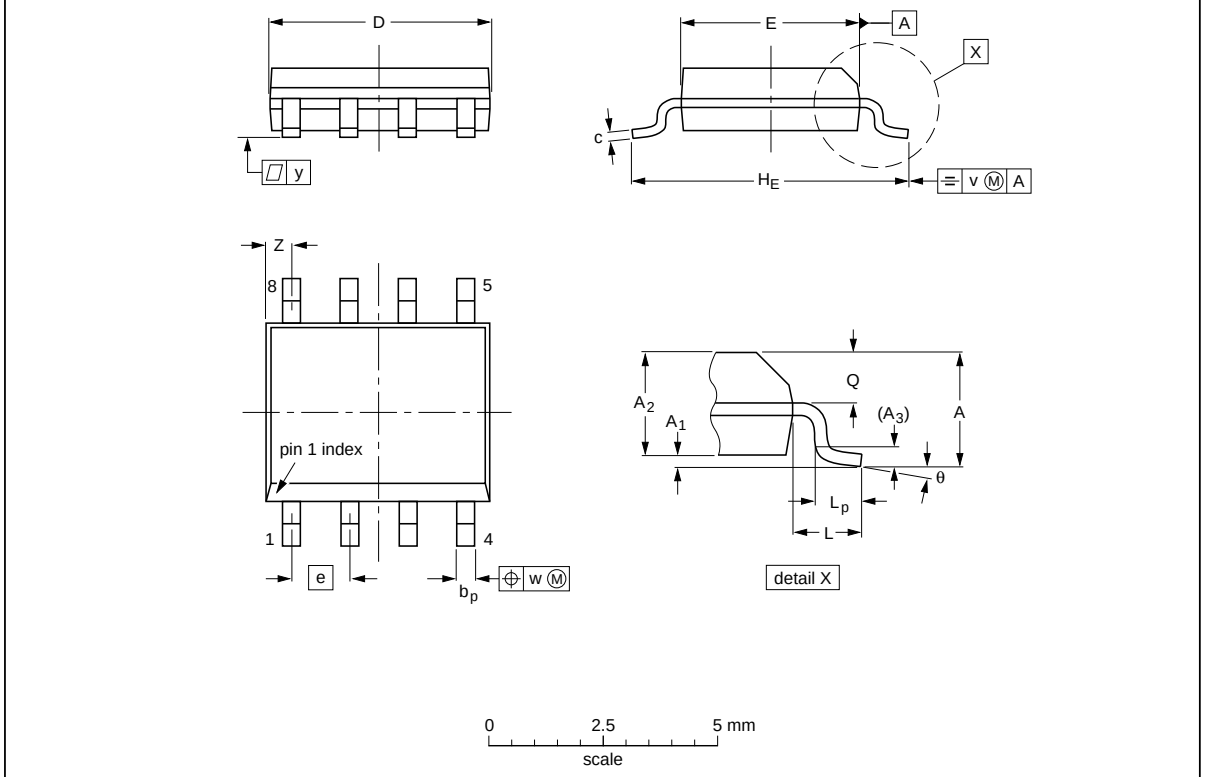
13. Test information

13.1 Quality information

This product has been qualified to the appropriate Automotive Electronics Council (AEC) standard Q100 or Q101 and is suitable for use in automotive applications.

14. 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 7. Package outline SOT96-1 (SO8)

15. Handling information

All input and output pins are protected against ElectroStatic Discharge (ESD) under normal handling. When handling ensure that the appropriate precautions are taken as described in *JESD625-A* or equivalent standards.

16. 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"*.

16.1 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.

16.2 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

16.3 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

16.4 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 8) 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)

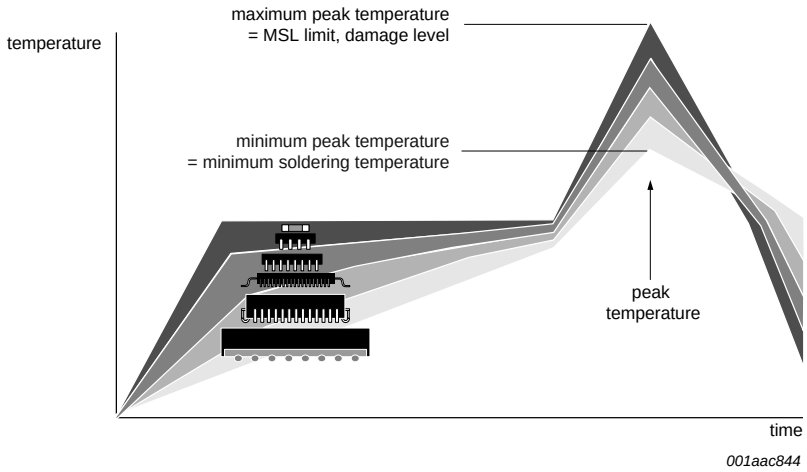
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm^3)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

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 8.



MSL: Moisture Sensitivity Level

Fig 8. Temperature profiles for large and small components

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

17. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TJA1049 v.2	20110323	Product data sheet	-	TJA1049 v.1
Modifications	• Section 1: text revised • Table 1: added along with 'Quick reference data' disclaimer in Section 18.3 • Section 7.2.3: text revised • Table 5: parameter T_{amb} deleted • Table 7: measuring conditions for parameters I_{CC} and I_{IL} (for pin TXD) revised • Section 15: added			
TJA1049 v.1	20100924	Product data sheet	-	-

18. Legal information

18.1 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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19. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

20. Contents

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