

TJA1057

High-speed CAN transceiver

Rev. 1 — 30 May 2013

Preliminary data sheet

1. General description

The TJA1057 is a high-speed CAN transceiver that 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 CAN applications in the automotive industry, providing the differential transmit and receive capability to (a microcontroller with) a CAN protocol controller.

The TJA1057 offers a feature set optimized for 12 V automotive applications, with significant improvements over NXP's first- and second-generation CAN transceivers, such as the TJA1050, and excellent ElectroMagnetic Compatibility (EMC) performance. The TJA1057 also displays ideal passive behavior to the CAN bus when the supply voltage is off.

These features make the TJA1057 an excellent choice for HS-CAN networks that only require basic CAN functionality.

2. Features and benefits

2.1 General

- Fully ISO 11898-2 compliant
- Optimized for use in 12 V automotive systems
- Low ElectroMagnetic Emissions (EME) and high ElectroMagnetic Immunity (EMI)
- Compatible with 5 V and 3V3 microcontrollers

2.2 Predictable and fail-safe behavior

- Functional behavior predictable under all supply conditions
- Transceiver disengages from bus when not powered (zero load) or in Silent mode
- Transmit Data (TXD) dominant time-out function
- Undervoltage detection on pin V_{CC}
- Internal biasing of TXD and S input pins

2.3 Protection

- High ESD handling capability on the bus pins (6 kV IEC and HBM)
- Bus pins protected against transients in automotive environments
- 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
$V_{uvd(VCC)}$	undervoltage detection voltage on pin V_{CC}		3.5	4	4.3	V
I_{CC}	supply current	Silent mode	100	-	800	μ A
		Normal mode; bus recessive	2	5	10	mA
		Normal mode; bus dominant	20	45	70	mA
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2 at pins CANH and CANL	-6	-	+6	kV
V_{CANH}	voltage on pin CANH	no time limit; DC limiting value	-42	-	+42	V
V_{CANL}	voltage on pin CANL	no time limit; DC limiting value	-42	-	+42	V
T_{vj}	virtual junction temperature		-40	-	+150	$^{\circ}$ C

4. Ordering information

Table 2. Ordering information

Type number	Package		Version
	Name	Description	
TJA1057T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

5. Block diagram

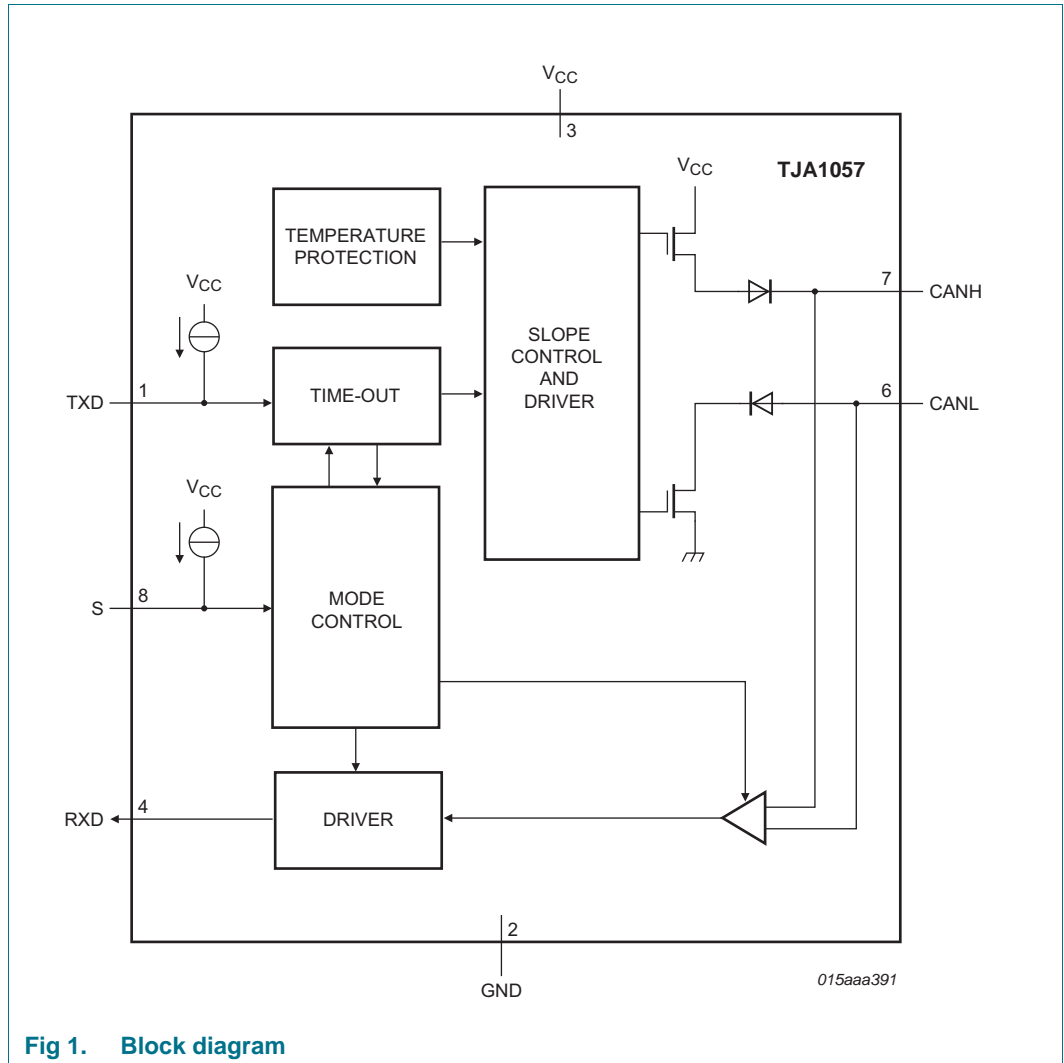


Fig 1. Block diagram

6. Pinning information

6.1 Pinning

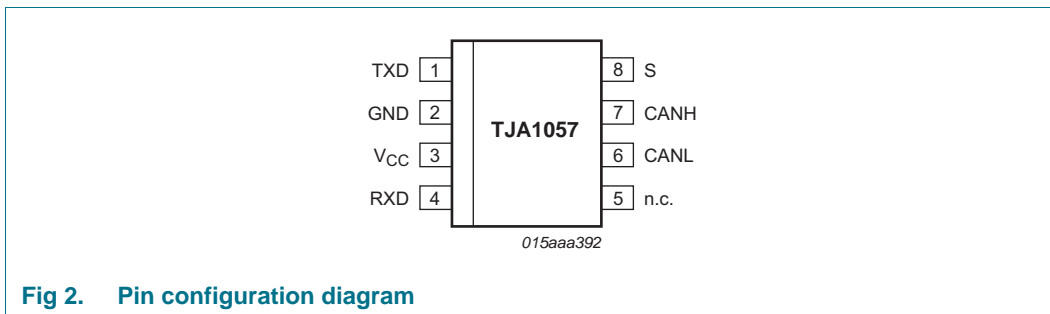


Fig 2. Pin configuration diagram

6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
TXD	1	transmit data input
GND	2	ground
V _{CC}	3	supply voltage
RXD	4	receive data output; reads out data from the bus lines
n.c.	5	not connected
CANL	6	LOW-level CAN bus line
CANH	7	HIGH-level CAN bus line
S	8	Silent mode control input

7. Functional description

7.1 Operating modes

The TJA1057 supports two operating modes, Normal and Silent. The operating mode is selected via pin S. See [Table 4](#) for a description of the operating modes under normal supply conditions.

Table 4. Operating modes

Mode	Inputs		Outputs	
	Pin S	Pin TXD	CAN driver	Pin RXD
Normal	LOW	LOW	dominant	LOW
		HIGH	recessive	LOW when bus dominant HIGH when bus recessive
Silent	HIGH	x ^[1]	biased to recessive	follows bus

[1] 'x' = don't care.

7.1.1 Normal mode

A LOW level on pin S 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 Silent mode

A HIGH level on pin S selects Silent mode. The transmitter is disabled in Silent mode, releasing the bus pins to recessive state. All other IC functions, including the receiver, continue to operate as in Normal mode. Silent mode can be used to prevent a faulty CAN controller disrupting all network communications.

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 this pin 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 Internal biasing of TXD and S input pins

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

7.2.3 Undervoltage detection on pins V_{CC}

If V_{CC} drops below the undervoltage detection level, $V_{uvd(VCC)}$, the transceiver switches off.

7.2.4 Overtemperature protection

The output drivers are protected against overtemperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature, $T_{j(sd)}$, both output drivers are disabled. When the virtual junction temperature drops below $T_{j(sd)}$ again, the output drivers recover once TXD has been reset to HIGH. Including the TXD condition prevents output driver oscillation due to small variations in temperature.

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	DC value			
		on pins CANH, CANL	-42	+42	V
		on pin V_{CC}	-0.3	+6	V
		on any other pin	[1] -0.3	$V_{CC} + 0.3$	V
V_{trt}	transient voltage	on pins CANH and CANL	[2] -150	+100	V
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2	[3]		
		at pins CANH and CANL	[4] -6	+6	kV
		HBM	[5]		
		at pins CANH and CANL	-6	+6	kV
		at any other pin	-4	+4	kV
		MM	[6]		
		at any pin	-200	+200	V
T_{vj}	virtual junction temperature	CDM	[7]		
		at corner pins	-750	+750	V
		at any pin	-500	+500	V
T_{stg}	storage temperature		[8] -40	+150	°C
			-55	+150	°C

[1] No time limit.

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

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

[4] ESD performance of pins CANH and CANL according to IEC 61000-4-2 (150 pF, 330 Ω) has been verified by an external test house. The result is equal to or better than ± 6 kV (unaided).

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

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

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

[8] 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	97	K/W

10. Static characteristics

Table 7. Static characteristics

$T_{vj} = -40\text{ }^{\circ}\text{C}$ to $+150\text{ }^{\circ}\text{C}$; $V_{CC} = 4.75\text{ V}$ to 5.25 V ; $R_L = 60\ \Omega$ 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
V _{uvd(VCC)}	undervoltage detection voltage on pin V _{CC}		3.5	4	4.3	V
I _{CC}	supply current	Silent mode; V _{TXD} = V _{CC}	0.1	-	2.5	mA
		Normal mode				
		recessive; V _{TXD} = V _{CC}	2	5	10	mA
		dominant; V _{TXD} = 0 V	20	45	70	mA
Silent mode control input; pin S						
V _{IH}	HIGH-level input voltage		2	-	V _{CC} + 0.3	V
V _{IL}	LOW-level input voltage		-0.3	-	0.8	V
I _{IH}	HIGH-level input current	V _S = V _{CC}	-1	-	+1	μA
I _{IL}	LOW-level input current	V _S = 0 V	-15	-	-1	μA
CAN transmit data input; pin TXD						
V _{IH}	HIGH-level input voltage		2	-	V _{CC} + 0.3	V
V _{IL}	LOW-level input voltage		-0.3	-	0.8	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	-70	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 = 50 Ω to 65 Ω	1.5	-	3	V
		V _{TXD} = V _{CC} ; bus recessive; no load	-50	-	+50	mV
V _{O(rec)}	recessive output voltage	V _{TXD} = V _{CC} ; no load	2	0.5V _{CC}	3	V
V _{th(RX)dif}	differential receiver threshold voltage	V _{cm(CAN)} = -12 V to +12 V; Normal/Silent mode	^[3] 0.5	-	0.9	V
V _{hys(RX)dif}	differential receiver hysteresis voltage	V _{cm(CAN)} = -12 V to +12 V Normal mode	50	-	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

Table 7. Static characteristics ...continued

$T_{vj} = -40\text{ °C}$ to $+150\text{ °C}$; $V_{CC} = 4.75\text{ V}$ to 5.25 V ; $R_L = 60\ \Omega$ 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
$I_{O(rec)}$	recessive output current	Normal mode; $V_{TXD} = V_{CC}$ $V_{CANH} = V_{CANL} = -27\text{ V}$ to $+32\text{ V}$	-5	-	+5	mA
I_L	leakage current	$V_{CC} = 0\text{ V}$; $V_{CANH} = V_{CANL} = 5\text{ V}$	-5	-	+5	μA
R_i	input resistance		9	15	28	k Ω
ΔR_i	input resistance deviation	between V_{CANH} and V_{CANL}	-3	-	+3	%
$R_{i(dif)}$	differential input resistance		19	30	52	k Ω
$C_{i(cm)}$	common-mode input capacitance		[2]	-	20	pF
$C_{i(dif)}$	differential input capacitance		[2]	-	10	pF
Temperature detection						
$T_{j(sd)}$	shutdown junction temperature		[2]	185	-	$^{\circ}\text{C}$

- [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

$T_{vj} = -40\text{ }^{\circ}\text{C}$ to $+150\text{ }^{\circ}\text{C}$; $V_{CC} = 4.75\text{ V}$ to 5.25 V ; $R_L = 60\text{ }\Omega$ 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 3 and Figure 4						
$t_{d(\text{TXD-busdom})}$	delay time from TXD to bus dominant	Normal mode	-	65	-	ns
$t_{d(\text{TXD-busrec})}$	delay time from TXD to bus recessive	Normal mode	-	90	-	ns
$t_{d(\text{busdom-RXD})}$	delay time from bus dominant to RXD	Normal mode	-	60	-	ns
$t_{d(\text{busrec-RXD})}$	delay time from bus recessive to RXD	Normal mode	-	65	-	ns
$t_{PD(\text{TXD-RXD})}$	propagation delay from TXD to RXD	Normal mode	50	-	230	ns
$t_{to(\text{dom})\text{TXD}}$	TXD dominant time-out time	$V_{\text{TXD}} = 0\text{ V}$; Normal mode	0.8	3	16	ms

[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.

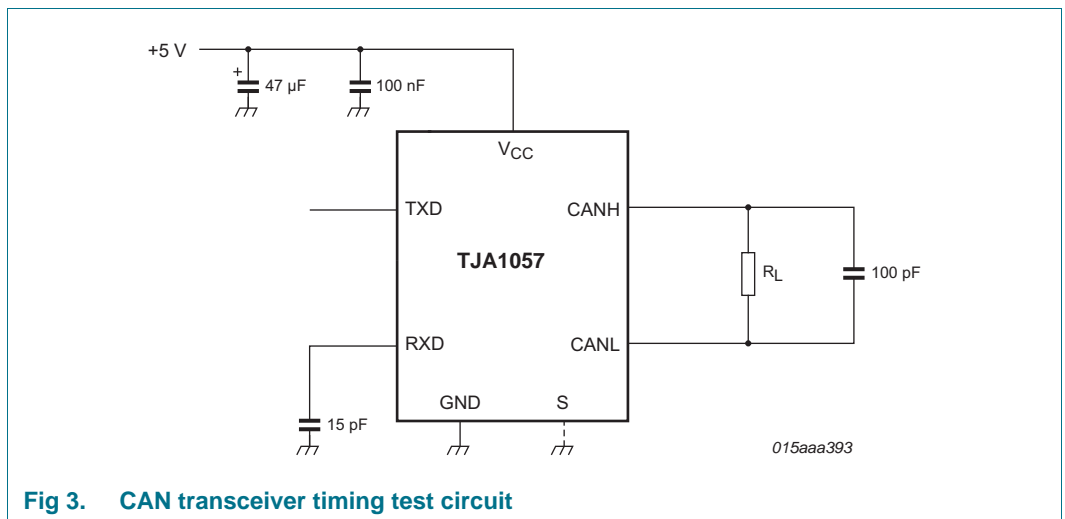


Fig 3. CAN transceiver timing test circuit

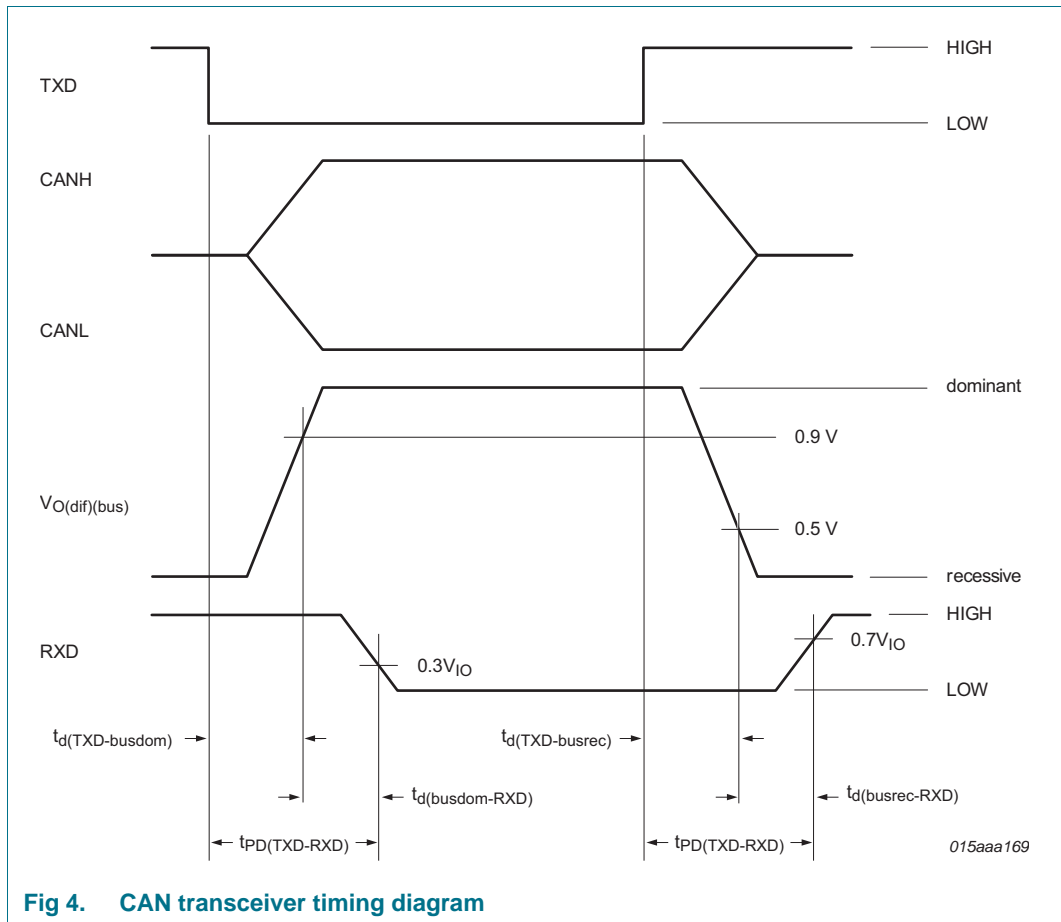


Fig 4. CAN transceiver timing diagram

12. Application information

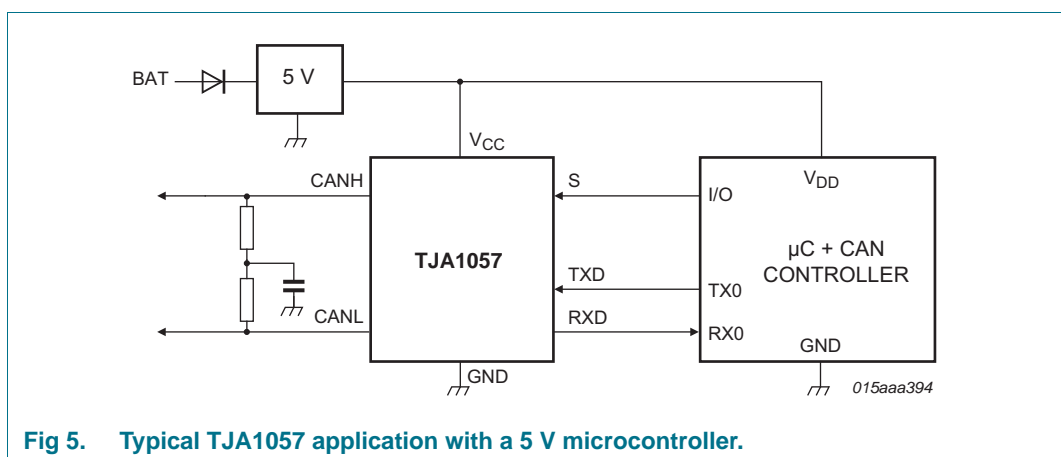


Fig 5. Typical TJA1057 application with a 5 V microcontroller.

13. Test information

13.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard *Q100 - Failure mechanism based stress test qualification for integrated circuits*, 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

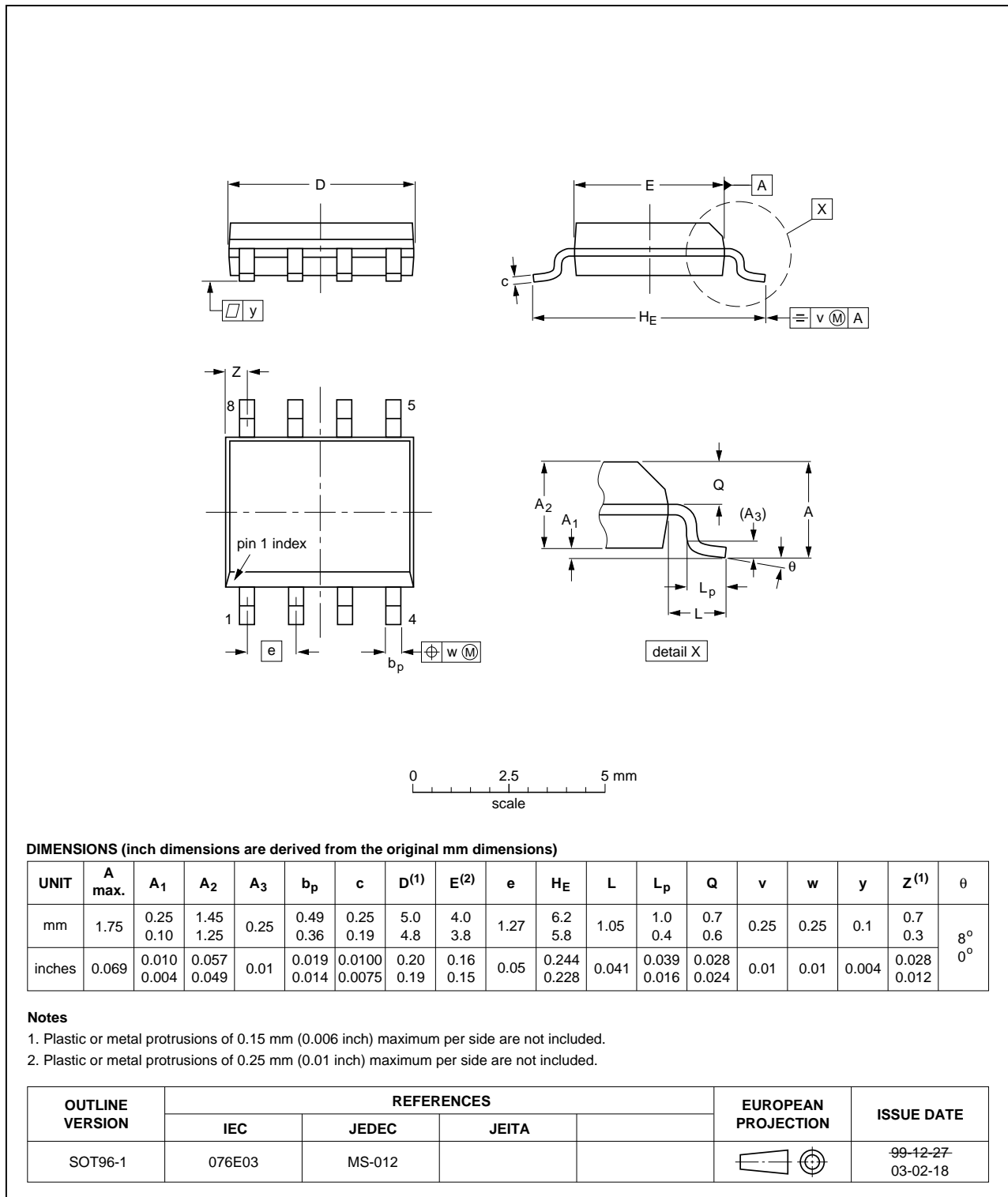


Fig 6. Package outline SOT96-1 (SO8)

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 7](#)) 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-020D)

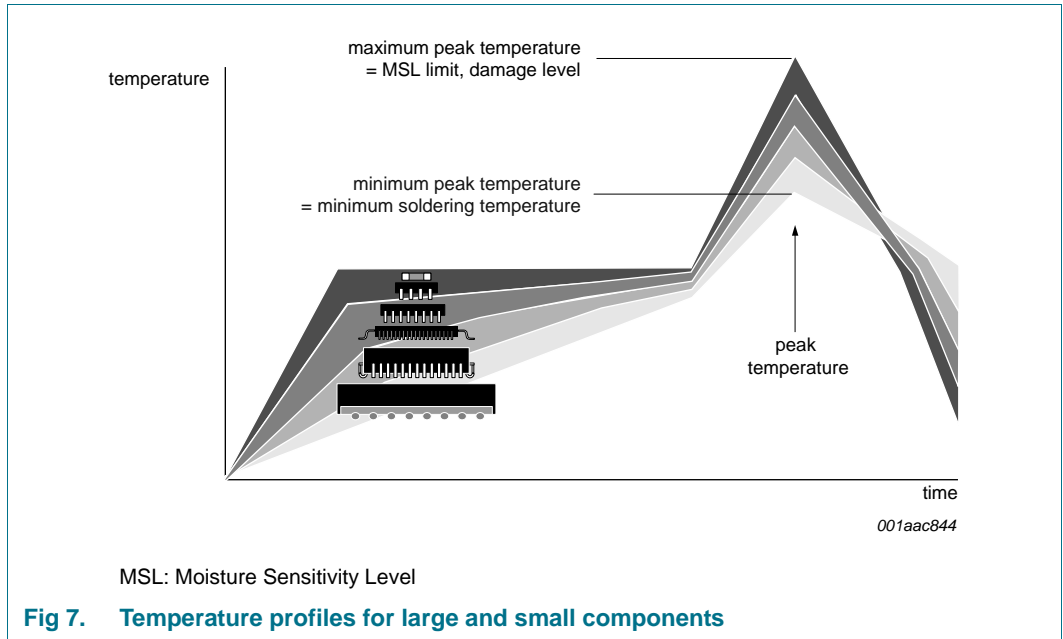
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm ³)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

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

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 7](#).



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
TJA1057 v.1	20130530	Preliminary 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".

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