

# TJA1051

## High-speed CAN transceiver

Rev. 7 — 15 January 2015

Product data sheet

## 1. General description

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The TJA1051 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 differential transmit and receive capability to (a microcontroller with) a CAN protocol controller.

The TJA1051 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 TJA1050. 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
- TJA1051T/3 and TJA1051TK/3 can be interfaced directly to microcontrollers with supply voltages from 3 V to 5 V

The TJA1051 implements the CAN physical layer as defined in the current ISO11898 standard (ISO11898-2:2003). Pending the release of the updated version of ISO11898-2 including CAN FD, additional timing parameters defining loop delay symmetry are specified. This implementation enables reliable communication in the CAN FD fast phase at data rates up to 2 Mbit/s.

These features make the TJA1051 an excellent choice for all types of HS-CAN networks, in nodes that do not require a standby mode with wake-up capability via the bus.

## 2. Features and benefits

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### 2.1 General

- Fully ISO 11898-2:2003 compliant
- Loop delay symmetry timing enables reliable communication at data rates up to 2 Mbit/s in the CAN FD fast phase
- Suitable for 12 V and 24 V systems
- Low ElectroMagnetic Emission (EME) and high ElectroMagnetic Immunity (EMI)
- $V_{IO}$  input on TJA1051T/3 and TJA1051TK/3 allows for direct interfacing with 3 V to 5 V microcontrollers (available in SO8 and very small HVSON8 packages respectively)
- EN input on TJA1051T/E allows the microcontroller to switch the transceiver to a very low-current Off mode
- Available in SO8 package or leadless HVSON8 package (3.0 mm × 3.0 mm) with improved Automated Optical Inspection (AOI) capability



- Dark green product (halogen free and Restriction of Hazardous Substances (RoHS) compliant)
- AEC-Q100 qualified

## 2.2 Low-power management

- Functional behavior predictable under all supply conditions
- Transceiver disengages from the bus when not powered up (zero load)

## 2.3 Protection

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

## 3. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		4.5	-	5.5	V
$V_{IO}$	supply voltage on pin $V_{IO}$		2.8	-	5.5	V
$V_{uvd(VCC)}$	undervoltage detection voltage on pin $V_{CC}$		3.5	-	4.5	V
$V_{uvd(VIO)}$	undervoltage detection voltage on pin $V_{IO}$		1.3	2.0	2.7	V
$I_{CC}$	supply current	Silent mode	0.1	1	2.5	mA
		Normal mode; bus recessive	2.5	5	10	mA
		Normal mode; bus dominant	20	50	70	mA
$I_{IO}$	supply current on pin $V_{IO}$	Normal and Silent modes				
		recessive; $V_{TXD} = V_{IO}$	-	80	250	$\mu$ A
		dominant; $V_{TXD} = 0$ V	-	350	500	$\mu$ A
$V_{ESD}$	electrostatic discharge voltage	IEC 61000-4-2 at pins CANH and CANL	-8	-	+8	kV
$V_{CANH}$	voltage on pin CANH		-58	-	+58	V
$V_{CANL}$	voltage on pin CANL		-58	-	+58	V
$T_{vj}$	virtual junction temperature		-40	-	+150	$^{\circ}$ C

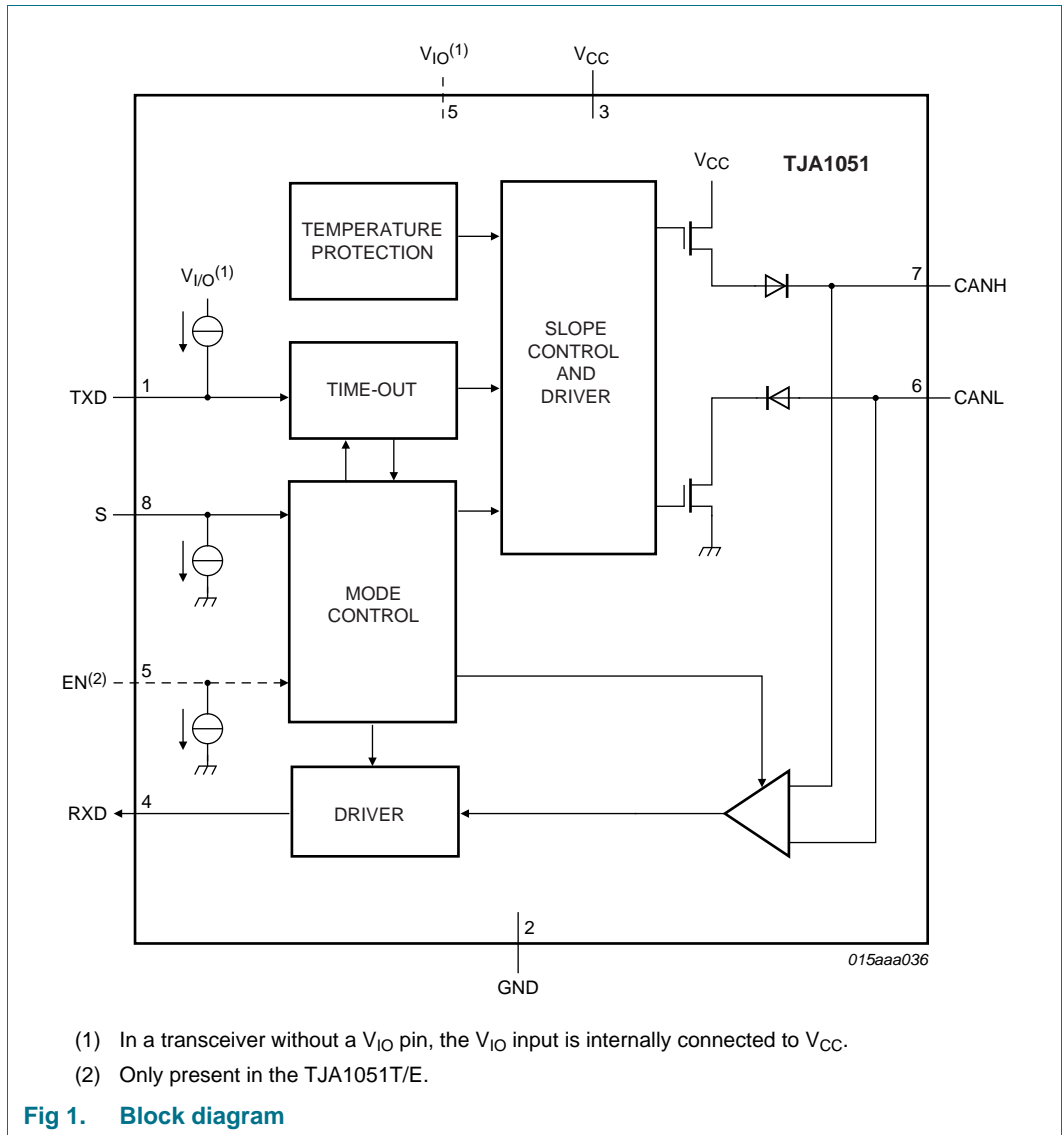
### 4. Ordering information

Table 2. Ordering information

Type number	Package		Version
	Name	Description	
TJA1051T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TJA1051T/3 <sup>[1]</sup>	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TJA1051T/E <sup>[1]</sup>	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TJA1051TK/3 <sup>[1]</sup>	HVSON8	plastic thermal enhanced very thin small outline package; no leads; 8 terminals; body 3 × 3 × 0.85 mm	SOT782-1

[1] TJA1051T/3 and TJA1051TK/3 with V<sub>IO</sub> pin; TJA1051T/E with EN pin.

### 5. Block diagram

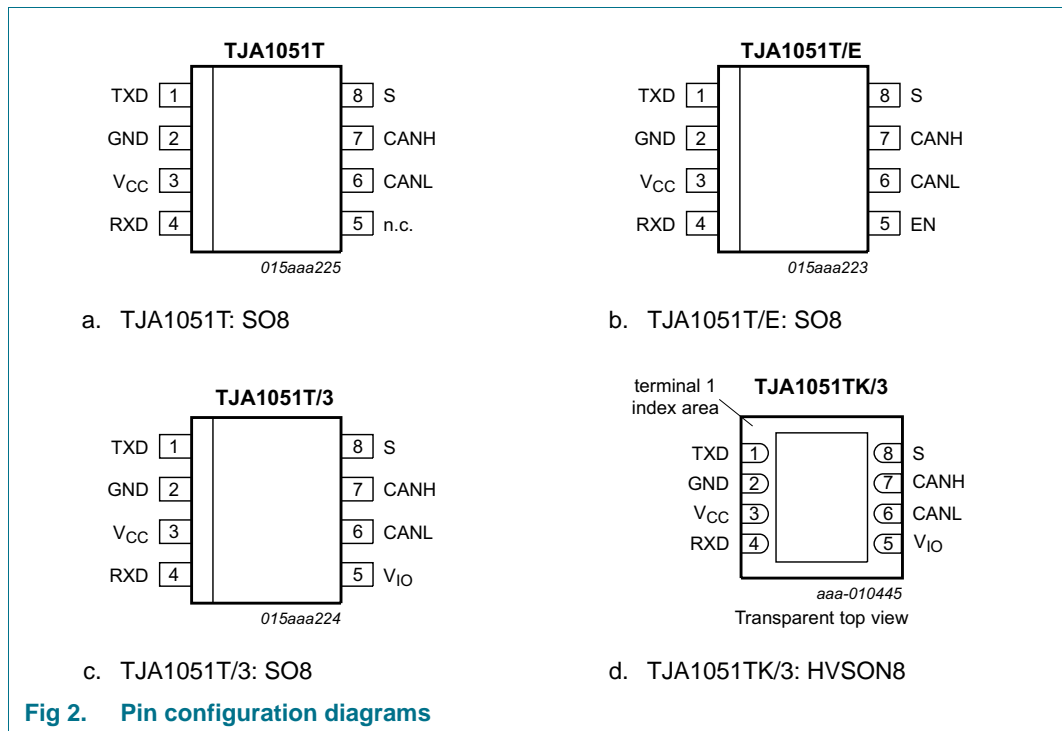


- (1) In a transceiver without a V<sub>IO</sub> pin, the V<sub>IO</sub> input is internally connected to V<sub>CC</sub>.
- (2) Only present in the TJA1051T/E.

Fig 1. Block diagram

## 6. Pinning information

### 6.1 Pinning



### 6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
TXD	1	transmit data input
GND <sup>[1]</sup>	2	ground
V <sub>CC</sub>	3	supply voltage
RXD	4	receive data output; reads out data from the bus lines
n.c.	5	not connected; in TJA1051T version
EN	5	enable control input; TJA1051T/E only
V <sub>IO</sub>	5	supply voltage for I/O level adapter; TJA1051T/3 and TJA1051TK/3 only
CANL	6	LOW-level CAN bus line
CANH	7	HIGH-level CAN bus line
S	8	Silent mode control input

[1] For enhanced thermal and electrical performance, the exposed center pad of the HVSON8 package should be soldered to board ground.

## 7. Functional description

The TJA1051 is a high-speed CAN stand-alone transceiver with Silent mode. It combines the functionality of the TJA1050 transceiver with improved EMC and ESD handling capability. Improved slope control and high DC handling capability on the bus pins provides additional application flexibility.

The TJA1051 is available in three versions, distinguished only by the function of pin 5:

- The TJA1051T is backwards compatible with the TJA1050
- The TJA1051T/3 and TJA1051TK/3 allow for direct interfacing to microcontrollers with supply voltages down to 3 V
- The TJA1051T/E allows the transceiver to be switched to a very low-current Off mode.

### 7.1 Operating modes

The TJA1051 supports two operating modes, Normal and Silent, which are selected via pin S. An additional Off mode is supported in the TJA1051T/E via pin EN. See [Table 4](#) for a description of the operating modes under normal supply conditions.

**Table 4. Operating modes**

Mode	Inputs			Outputs	
	Pin EN <sup>[1]</sup>	Pin S	Pin TXD	CAN driver	Pin RXD
Normal	HIGH	LOW	LOW	dominant	active <sup>[2]</sup>
	HIGH	LOW	HIGH	recessive	active <sup>[2]</sup>
Silent	HIGH	HIGH	X <sup>[3]</sup>	recessive	active <sup>[2]</sup>
Off <sup>[1]</sup>	LOW	X <sup>[3]</sup>	X <sup>[3]</sup>	floating	floating

[1] Only available on the TJA1051T/E.

[2] LOW if the CAN bus is dominant, HIGH if the CAN bus is recessive.

[3] 'X' = don't care.

#### 7.1.1 Normal mode

A LOW level on pin S selects Normal mode. In this mode, the transceiver is able to 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 to pin RXD. The slopes of the output signals on the bus lines are controlled internally and are optimized in a way that guarantees the lowest possible ElectroMagnetic Emission (EME).

#### 7.1.2 Silent mode

A HIGH level on pin S selects Silent mode. In Silent mode the transmitter is disabled, 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 from disrupting all network communications.

### 7.1.3 Off mode

A LOW level on pin EN of TJA1051T/E selects Off mode. In Off mode the entire transceiver is disabled, allowing the microcontroller to save power when CAN communication is not required. The bus pins are floating in Off mode, making the transceiver invisible to the rest of the network.

## 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 Internal biasing of TXD, S and EN input pins

Pin TXD has an internal pull-up to  $V_{IO}$  and pins S and EN (TJA1051T/E) have internal pull-downs to GND. This ensures a safe, defined state in case one or more of these pins is left floating.

### 7.2.3 Undervoltage detection on pins $V_{CC}$ and $V_{IO}$

Should  $V_{CC}$  or  $V_{IO}$  drop below their respective undervoltage detection levels ( $V_{uvd(VCC)}$  and  $V_{uvd(VIO)}$ ; see [Table 7](#)), the transceiver will switch off and disengage from the bus (zero load) until  $V_{CC}$  and  $V_{IO}$  have recovered.

### 7.2.4 Overtemperature protection

The output drivers are protected against overtemperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature,  $T_{j(sd)}$ , 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 oscillations due to temperature drift are avoided.

## 7.3 $V_{IO}$ supply pin

There are three versions of the TJA1051 available, only differing in the function of a single pin. Pin 5 is either an enable control input (EN), a  $V_{IO}$  supply pin or is not connected.

Pin  $V_{IO}$  on the TJA1051T/3 and TJA1051TK/3 should be connected to the microcontroller supply voltage (see [Figure 6](#)). This will adjust the signal levels of pins TXD, RXD and S to the I/O levels of the microcontroller. For versions of the TJA1051 without a  $V_{IO}$  pin, the  $V_{IO}$  input is internally connected to  $V_{CC}$ . This sets the signal levels of pins TXD, RXD and S to levels compatible with 5 V microcontrollers.

## 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 <sub>x</sub>	voltage on pin x	on pins CANH, CANL and SPLIT	-58	+58	V
		on any other pin	-0.3	+7	V
V <sub>trt</sub>	transient voltage	on pins CANH and CANL [1]	-150	+100	V
V <sub>ESD</sub>	electrostatic discharge voltage	IEC 61000-4-2 (150 pF, 330 Ω) [2]			
		at pins CANH and CANL	-8	+8	kV
		Human Body Model (HBM); 100 pF, 1.5 kΩ [3]			
		at pins CANH and CANL	-8	+8	kV
		at any other pin	-4	+4	kV
		Machine Model (MM); 200 pF, 0.75 μH, 10 Ω [4]			
		at any pin	-300	+300	V
		Charged Device Model (CDM); field Induced charge; 4 pF [5]			
	at corner pins	-750	+750	V	
	at any pin	-500	+500	V	
T <sub>vj</sub>	virtual junction temperature	[6]	-40	+150	°C
T <sub>stg</sub>	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] According to IEC TS 62228 (2007), Section 4.3; DIN EN 61000-4-2.
- [3] According to AEC-Q100-002.
- [4] According to AEC-Q100-003.
- [5] AEC-Q100-011 Rev-C1. The classification level is C4B.
- [6] 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 <sub>th(vj-a)</sub>	thermal resistance from virtual junction to ambient	SO8 package; in free air	155	K/W
		HVSON8 package; in free air	55	K/W

## 10. Static characteristics

**Table 7. Static characteristics**

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$ <sup>[1]</sup>;  $R_L = 60\text{ }\Omega$  unless specified otherwise; All voltages are defined with respect to ground; Positive currents flow into the IC<sup>[2]</sup>.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply; pin V<sub>CC</sub></b>						
V <sub>CC</sub>	supply voltage		4.5	-	5.5	V
I <sub>CC</sub>	supply current	Off mode (TJA1051T/E)	1	5	8	$\mu\text{A}$
		Silent mode	0.1	1	2.5	mA
		Normal mode				
		recessive; $V_{TXD} = V_{IO}$	-	5	10	mA
	dominant; $V_{TXD} = 0\text{ V}$	-	50	70	mA	
V <sub>uvd(VCC)</sub>	undervoltage detection voltage on pin V <sub>CC</sub>		3.5	-	4.5	V
<b>I/O level adapter supply; pin V<sub>IO</sub><sup>[1]</sup></b>						
V <sub>IO</sub>	supply voltage on pin V <sub>IO</sub>		2.8	-	5.5	V
I <sub>IO</sub>	supply current on pin V <sub>IO</sub>	Normal and Silent modes				
		recessive; $V_{TXD} = V_{IO}$	-	80	250	$\mu\text{A}$
		dominant; $V_{TXD} = 0\text{ V}$	-	350	500	$\mu\text{A}$
V <sub>uvd(VIO)</sub>	undervoltage detection voltage on pin V <sub>IO</sub>		1.3	2.0	2.7	V
<b>Mode control inputs; pins S and EN<sup>[3]</sup></b>						
V <sub>IH</sub>	HIGH-level input voltage		<sup>[4]</sup> 0.7V <sub>IO</sub>	-	V <sub>IO</sub> + 0.3	V
V <sub>IL</sub>	LOW-level input voltage		-0.3	-	0.3V <sub>IO</sub>	V
I <sub>IH</sub>	HIGH-level input current	V <sub>S</sub> = V <sub>IO</sub> ; V <sub>EN</sub> = V <sub>IO</sub>	1	4	10	$\mu\text{A}$
I <sub>IL</sub>	LOW-level input current	V <sub>S</sub> = 0 V; V <sub>EN</sub> = 0 V	-1	0	+1	$\mu\text{A}$
<b>CAN transmit data input; pin TXD</b>						
V <sub>IH</sub>	HIGH-level input voltage		<sup>[4]</sup> 0.7V <sub>IO</sub>	-	V <sub>IO</sub> + 0.3	V
V <sub>IL</sub>	LOW-level input voltage		-0.3	-	+0.3V <sub>IO</sub>	V
I <sub>IH</sub>	HIGH-level input current	V <sub>TXD</sub> = V <sub>IO</sub>	-5	0	+5	$\mu\text{A}$
I <sub>IL</sub>	LOW-level input current	Normal mode; V <sub>TXD</sub> = 0 V	-260	-150	-30	$\mu\text{A}$
C <sub>i</sub>	input capacitance		<sup>[5]</sup> -	5	10	pF
<b>CAN receive data output; pin RXD</b>						
I <sub>OH</sub>	HIGH-level output current	V <sub>RXD</sub> = V <sub>IO</sub> - 0.4 V; V <sub>IO</sub> = V <sub>CC</sub>	-8	-3	-1	mA
I <sub>OL</sub>	LOW-level output current	V <sub>RXD</sub> = 0.4 V; bus dominant	2	5	12	mA
<b>Bus lines; pins CANH and CANL</b>						
V <sub>O(dom)</sub>	dominant output voltage	V <sub>TXD</sub> = 0 V; t < t <sub>to(dom)TXD</sub>				
		pin CANH	2.75	3.5	4.5	V
		pin CANL	0.5	1.5	2.25	V
V <sub>dom(TX)sym</sub>	transmitter dominant voltage symmetry	V <sub>dom(TX)sym</sub> = V <sub>CC</sub> - V <sub>CANH</sub> - V <sub>CANL</sub>	-400	0	+400	mV



**Table 7. Static characteristics ...continued**

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$ <sup>[1]</sup>;  $R_L = 60\text{ }\Omega$  unless specified otherwise; All voltages are defined with respect to ground; Positive currents flow into the IC<sup>[2]</sup>.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{O(dif)bus}$	bus differential output voltage	$V_{TXD} = 0\text{ V}$ ; $t < t_{to(dom)TXD}$ $V_{CC} = 4.75\text{ V}$ to $5.25\text{ V}$ $R_L = 45\text{ }\Omega$ to $65\text{ }\Omega$	1.5	-	3	V
		$V_{TXD} = V_{IO}$ ; recessive; no load	-50	-	+50	mV
$V_{O(rec)}$	recessive output voltage	Normal and Silent modes; $V_{TXD} = V_{IO}$ ; no load	2	$0.5V_{CC}$	3	V
$V_{th(RX)dif}$	differential receiver threshold voltage	Normal and Silent modes $V_{cm(CAN)}^{[6]} = -30\text{ V}$ to $+30\text{ V}$	0.5	0.7	0.9	V
$V_{hys(RX)dif}$	differential receiver hysteresis voltage	Normal and Silent modes $V_{cm(CAN)} = -30\text{ V}$ to $+30\text{ V}$	50	120	200	mV
$I_{O(sc)dom}$	dominant short-circuit output current	$V_{TXD} = 0\text{ V}$ ; $t < t_{to(dom)TXD}$ ; $V_{CC} = 5\text{ V}$ pin CANH; $V_{CANH} = 0\text{ V}$	-100	-70	-40	mA
		pin CANL; $V_{CANL} = 5\text{ V} / 40\text{ V}$	40	70	100	mA
$I_{O(sc)rec}$	recessive short-circuit output current	Normal and Silent modes; $V_{TXD} = V_{IO}$ ; $V_{CANH} = V_{CANL} = -27\text{ V}$ to $+32\text{ V}$	-5	-	+5	mA
$I_L$	leakage current	$V_{CC} = V_{IO} = 0\text{ V}$ ; $V_{CANH} = V_{CANL} = 5\text{ V}$	-5	0	+5	$\mu\text{A}$
$R_i$	input resistance		9	15	28	$\text{k}\Omega$
$\Delta R_i$	input resistance deviation	between $V_{CANH}$ and $V_{CANL}$	-1	0	+1	%
$R_{i(dif)}$	differential input resistance		19	30	52	$\text{k}\Omega$
$C_{i(cm)}$	common-mode input capacitance		<sup>[5]</sup> -	-	20	pF
$C_{i(dif)}$	differential input capacitance		<sup>[5]</sup> -	-	10	pF
<b>Temperature protection</b>						
$T_{j(sd)}$	shutdown junction temperature		<sup>[5]</sup> -	190	-	$^{\circ}\text{C}$

- [1] Only TJA1051T/3 and TJA1051TK/3 have a  $V_{IO}$  pin. In transceivers without a  $V_{IO}$  pin, the  $V_{IO}$  input is internally connected to  $V_{CC}$ .
- [2] 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.
- [3] Only TJA1051T/E has an EN pin.
- [4] Maximum value assumes  $V_{CC} < V_{IO}$ ; if  $V_{CC} > V_{IO}$ , the maximum value will be  $V_{CC} + 0.3\text{ V}$ .
- [5] Not tested in production; guaranteed by design.
- [6]  $V_{cm(CAN)}$  is the common mode voltage of CANH and CANL.

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

$T_{vj} = -40\text{ °C}$  to  $+150\text{ °C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$ <sup>[1]</sup>;  $R_L = 60\ \Omega$  unless specified otherwise. All voltages are defined with respect to ground. Positive currents flow into the IC.<sup>[2]</sup>

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Transceiver timing; pins CANH, CANL, TXD and RXD; see <a href="#">Figure 7</a> and <a href="#">Figure 3</a></b>						
$t_{d(TXD-busdom)}$	delay time from TXD to bus dominant	Normal mode	-	65	-	ns
$t_{d(TXD-busrec)}$	delay time from TXD to bus recessive	Normal mode	-	90	-	ns
$t_{d(busdom-RXD)}$	delay time from bus dominant to RXD	Normal and Silent modes	-	60	-	ns
$t_{d(busrec-RXD)}$	delay time from bus recessive to RXD	Normal and Silent modes	-	65	-	ns
$t_{PD(TXD-RXD)}$	propagation delay from TXD to RXD	Normal mode; versions with $V_{IO}$ pin	40	-	250	ns
		Normal mode; all other versions	40	-	220	ns
$t_{bit(RXD)}$	bit time on pin RXD	$t_{bit(TXD)} = 500\text{ ns}$ <sup>[3]</sup>	400	-	550	ns
$t_{to(dom)TXD}$	TXD dominant time-out time	$V_{TXD} = 0\text{ V}$ ; Normal mode	0.3	1	5	ms

- [1] Only TJA1051T/3 and TJA1051TK/3 have a  $V_{IO}$  pin. In transceivers without a  $V_{IO}$  pin, the  $V_{IO}$  input is internally connected to  $V_{CC}$ .
- [2] 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.
- [3] See [Figure 4](#).

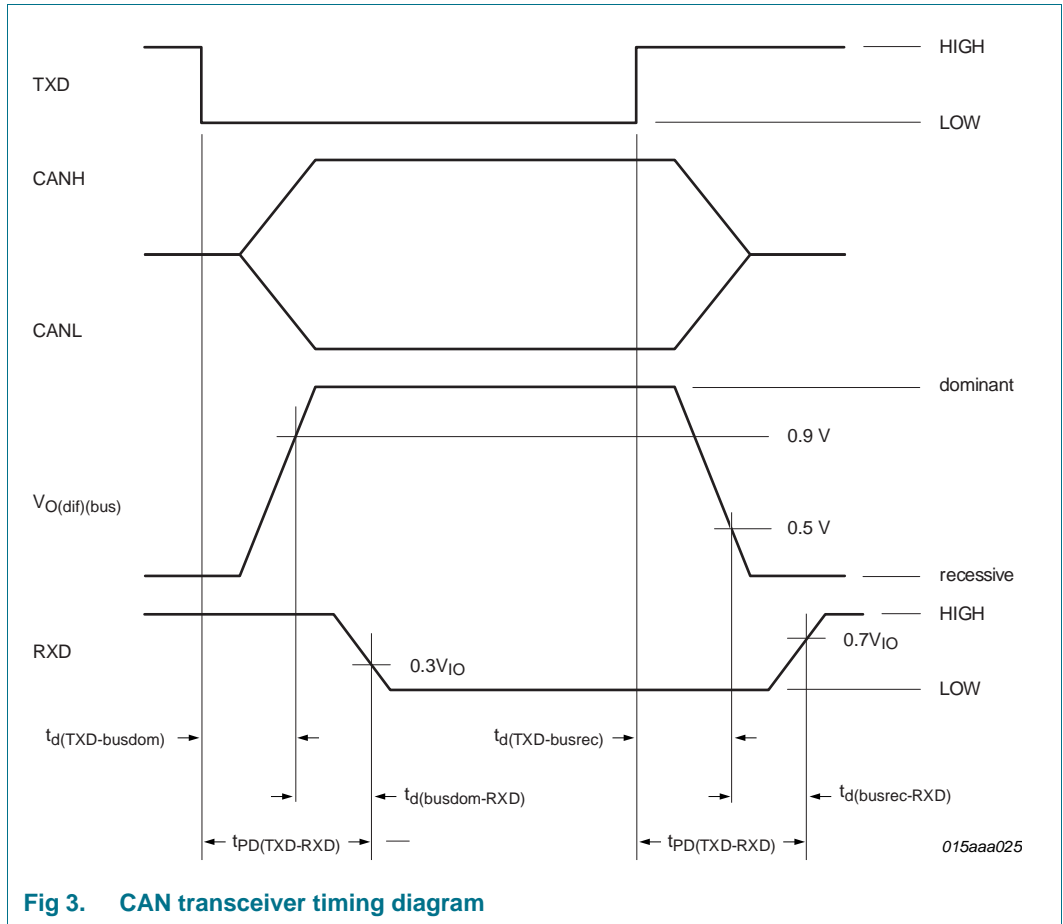


Fig 3. CAN transceiver timing diagram

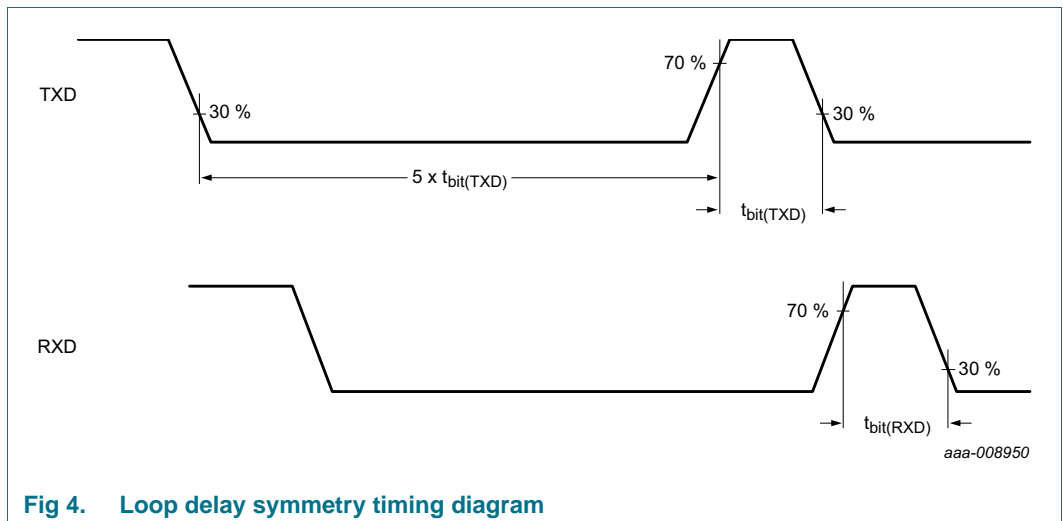


Fig 4. Loop delay symmetry timing diagram

## 12. Application information

### 12.1 Application diagrams

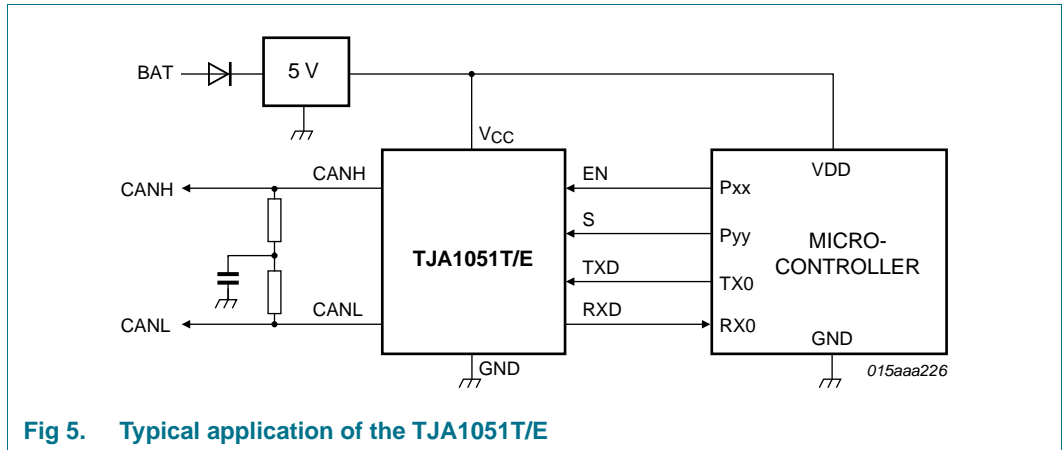


Fig 5. Typical application of the TJA1051T/E

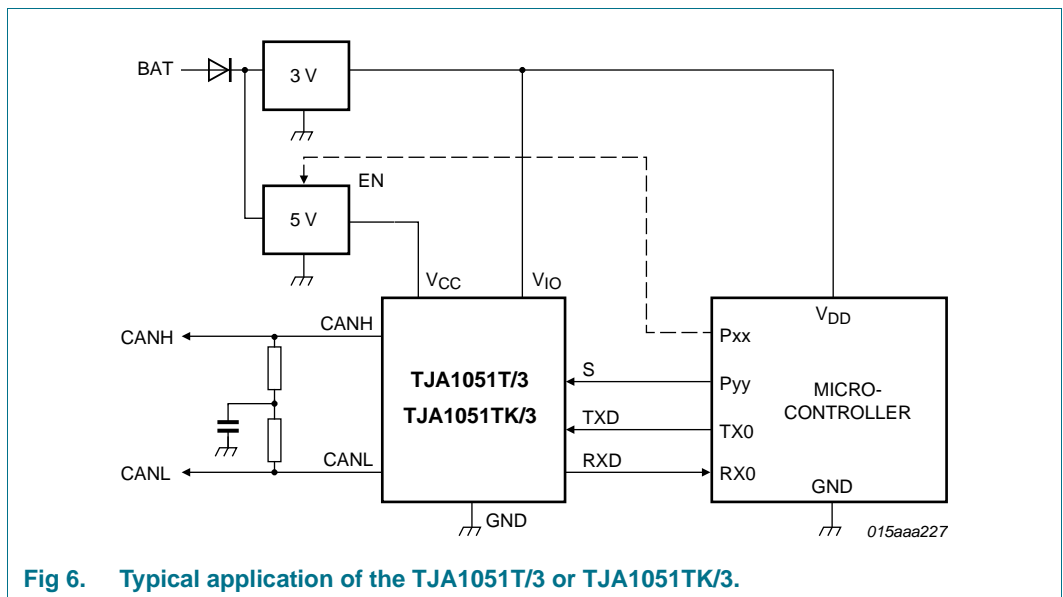
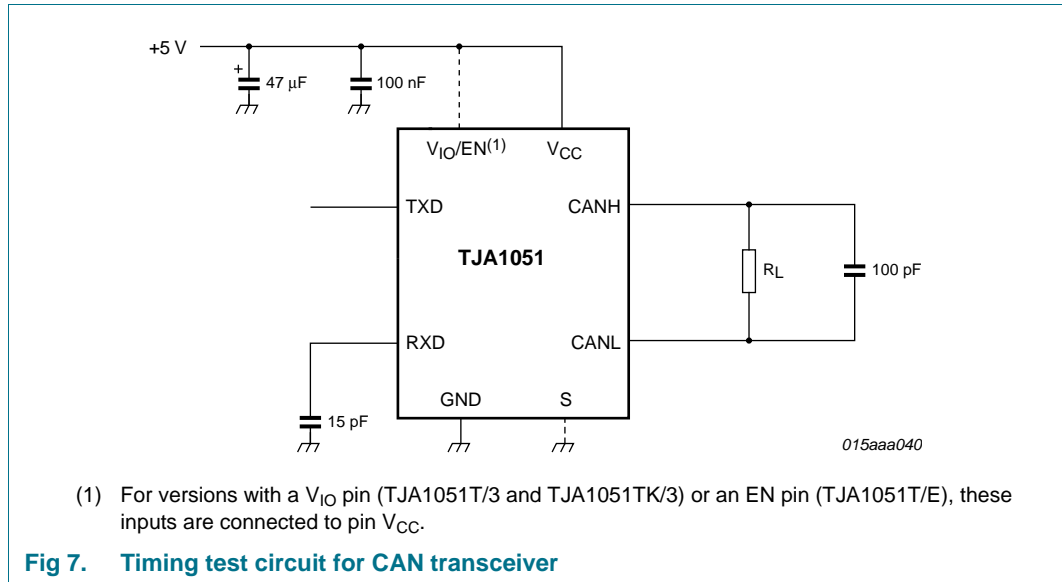


Fig 6. Typical application of the TJA1051T/3 or TJA1051TK/3.

### 12.2 Application hints

Further information on the application of the TJA1051 can be found in NXP application hints *AH1014 Application Hints - Standalone high speed CAN transceiver TJA1042/TJA1043/TJA1048/TJA1051*.

### 13. Test information



#### 13.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q100 Rev-G - *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

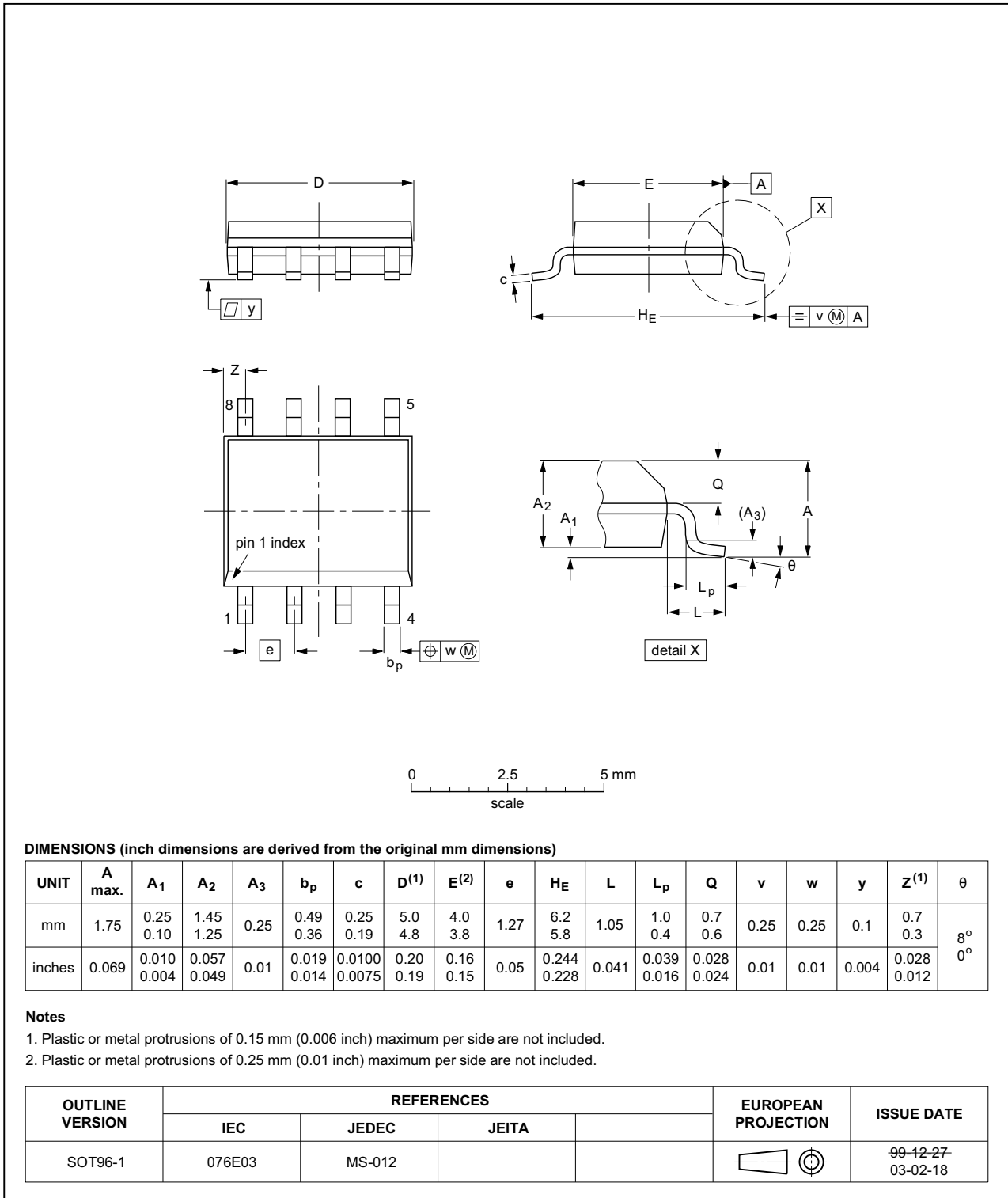


Fig 8. Package outline SOT96-1 (SO8)

HVSON8: plastic thermal enhanced very thin small outline package; no leads;  
8 terminals; body 3 x 3 x 0.85 mm

SOT782-1

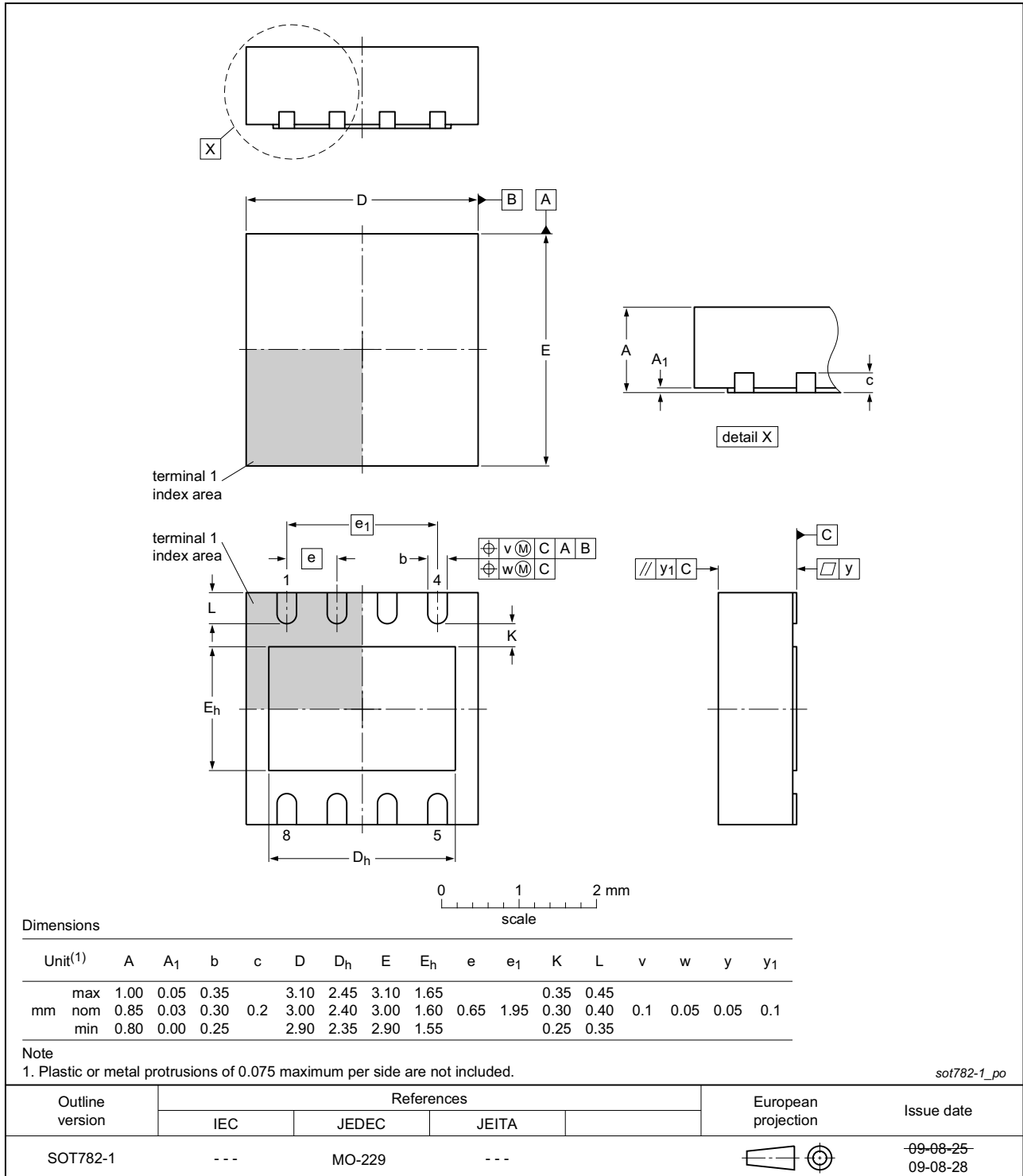


Fig 9. Package outline SOT782-1 (HVSON8)

## 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 10](#)) 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)**

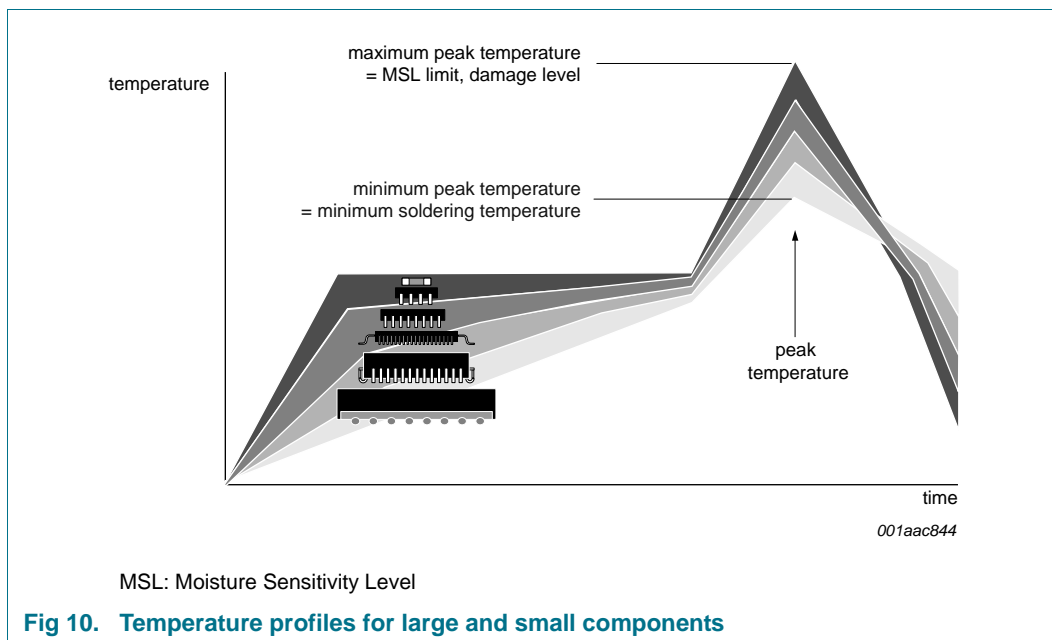
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm <sup>3</sup> )	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

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

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm <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 10](#).



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

## 17. Soldering of HVSON packages

[Section 16](#) contains a brief introduction to the techniques most commonly used to solder Surface Mounted Devices (SMD). A more detailed discussion on soldering HVSON leadless package ICs can be found in the following application notes:

- *AN10365* “*Surface mount reflow soldering description*”
- *AN10366* “*HVQFN application information*”

## 18. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TJA1051 v.7	20150115	Product data sheet	-	TJA1051 v.6
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Section 1</a>: text revised (1st paragraph); paragraph added</li> <li>• <a href="#">Section 2.1</a>: minor amendments to text; features added</li> <li>• <a href="#">Table 1</a>: added parameters <math>V_{IO}</math>, <math>V_{uvd(VIO)}</math> and <math>I_{IO}</math>; measurements conditions changed: <math>V_{CANH}</math>, <math>V_{CANL}</math></li> <li>• <a href="#">Figure 2</a>: pin diagrams updated</li> <li>• <a href="#">Table 3</a>: <a href="#">Table note 1</a> added</li> <li>• <a href="#">Section 7</a>, <a href="#">Section 7.1.1</a>: minor changes to text</li> <li>• <a href="#">Table 5</a>: measurements conditions changed: <math>V_x</math>, <math>V_{ESD}</math>; table note section revised</li> <li>• <a href="#">Table 7</a>: parameter values changed: <math>V_{uvd(VIO)}</math>; parameters renamed: <math>I_{O(sc)dom}</math> and <math>I_{O(sc)rec}</math></li> <li>• <a href="#">Table 8</a>: parameter <math>t_{bit(RXD)}</math> added; <a href="#">Table note 3</a> and <a href="#">Figure 4</a> added</li> <li>• <a href="#">Section 12.2 "Application hints"</a>: added</li> <li>• <a href="#">Figure 7</a> moved to <a href="#">Section 13</a></li> <li>• <a href="#">Section 13.1</a>: text updated</li> <li>• <a href="#">Section 19.3</a>: 'Translations' disclaimer added</li> </ul>			
TJA1051 v.6	20110325	Product data sheet	-	TJA1051 v.5
TJA1051 v.5	20101229	Product data sheet	-	TJA1051 v.4
TJA1051 v.4	20091020	Product data sheet	-	TJA1051 v.3
TJA1051 v.3	20090825	Product data sheet	-	TJA1051 v.2
TJA1051 v.2	20090701	Product data sheet	-	TJA1051 v.1
TJA1051 v.1	20090309	Product data sheet	-	-

## 19. Legal information

### 19.1 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.

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