

# TJA1049

## High-speed CAN transceiver with Standby mode

Rev. 5 — 23 May 2016

Product data sheet

## 1. General description

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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 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
- TJA1049T/3 and TJA1049TK/3 can be interfaced directly to microcontrollers with supply voltages from 3 V to 5 V

The TJA1049 implements the CAN physical layer as defined in the current ISO11898 standard (ISO11898-2:2003, ISO11898-5:2007 and the pending updated version of ISO 11898-2:2016). Pending the release of ISO11898-2:2016 including CAN FD and SAE J2284-4/5, 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 5 Mbit/s.

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

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### 2.1 General

- Fully ISO 11898-2:2003 and ISO 11898-5:2007 compliant
- Timing guaranteed for data rates up to 5 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 TJA1049T/3 and TJA1049TK/3 allows for direct interfacing with 3 V to 5 V microcontrollers
- SPLIT voltage output on TJA1049T and TJA1049TK for stabilizing recessive bus level
- Both variants available in SO8 and HVSON8 packages
- Leadless HVSON8 package (3.0 mm × 3.0 mm) with improved Automated Optical Inspection (AOI) capability



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

## 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 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		4.75	-	5.25	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	-	4.75	V
$V_{uvd(VIO)}$	undervoltage detection voltage on pin $V_{IO}$		1.3	2.0	2.7	V
$I_{CC}$	supply current	Standby mode: TJA1049T, TJA1049TK	-	10	15	$\mu$ A
		Standby mode: TJA1049T/3, TJA1049TK/3	-	-	5	$\mu$ A
		Normal mode; bus recessive	2.5	5	7.5	mA
		Normal mode; bus dominant	20	45	65	mA
$I_{IO}$	supply current on pin $V_{IO}$	Standby mode	5	-	14	$\mu$ A
		Normal mode; bus recessive	15	80	200	$\mu$ A
		Normal mode; bus dominant	-	350	1000	$\mu$ 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
$V_{SPLIT}$	voltage on pin SPLIT		-58	-	+58	V
$T_{vj}$	virtual junction temperature		-40	-	+150	$^{\circ}$ C

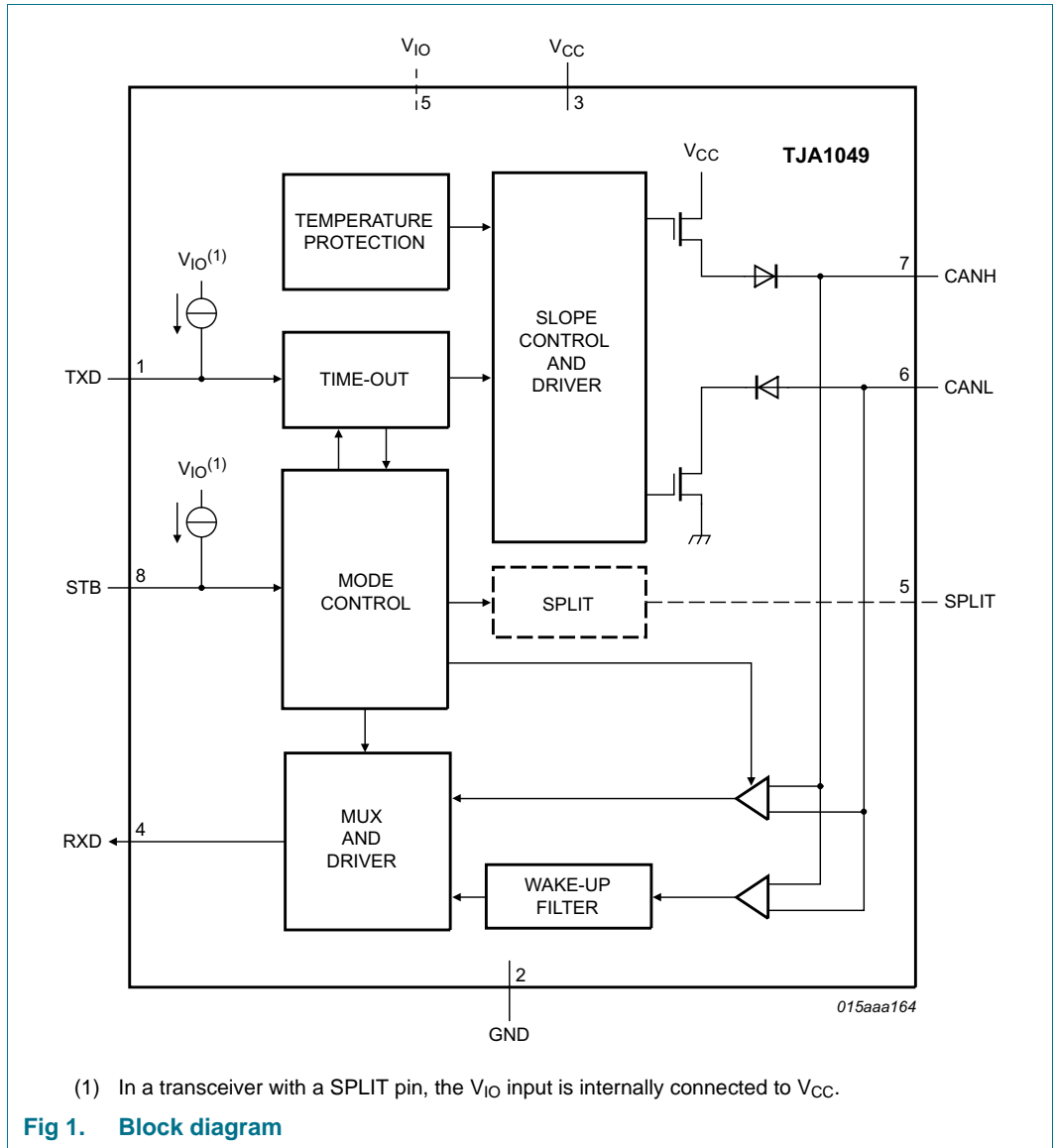
## 4. Ordering information

**Table 2. Ordering information**

Type number <sup>[1]</sup>	Package		
	Name	Description	Version
TJA1049T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TJA1049TK	HVSON8	plastic thermal enhanced very thin small outline package; no leads; 8 terminals; body 3 × 3 × 0.85 mm	SOT782-1
TJA1049T/3	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TJA1049TK/3	HVSON8	plastic thermal enhanced very thin small outline package; no leads; 8 terminals; body 3 × 3 × 0.85 mm	SOT782-1

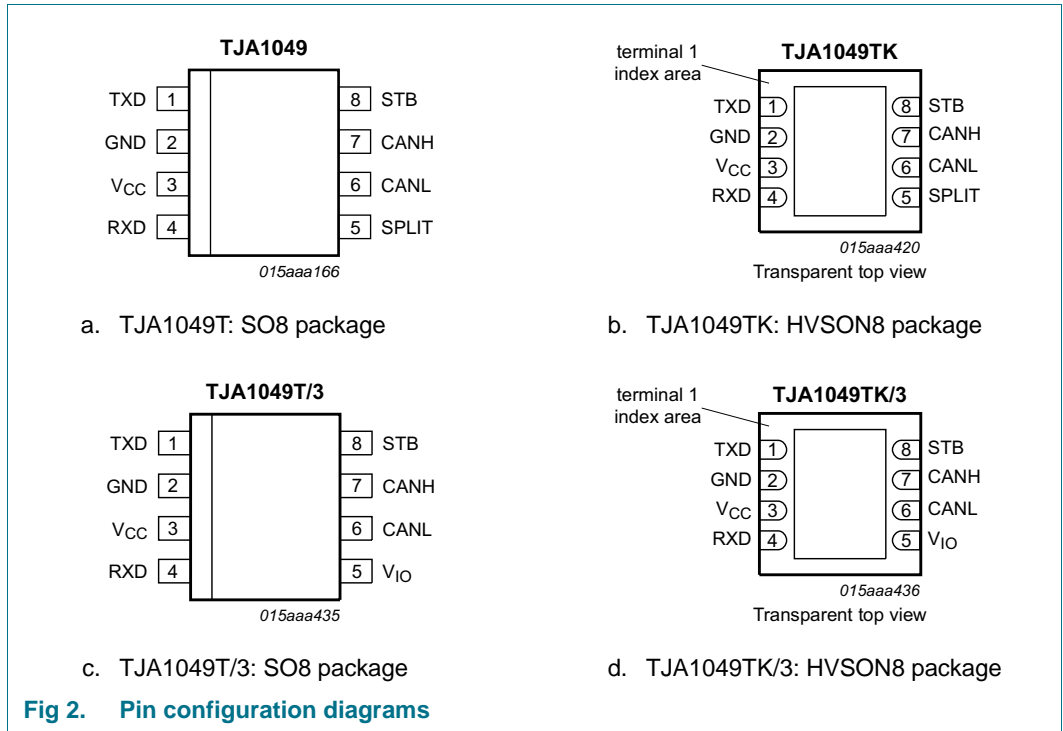
[1] TJA1049T and TJA1049TK with SPLIT pin; TJA1049T/3 and TJA1049TK/3 with V<sub>IO</sub> pin.

5. 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	2 <sup>[1]</sup>	ground supply
V <sub>CC</sub>	3	supply voltage
RXD	4	receive data output; reads out data from the bus lines
SPLIT	5	common-mode stabilization output; TJA1049T and TJA1049TK only
V <sub>IO</sub>	5	supply voltage for I/O level adapter; TJA1049T/3 and TJA1049TK/3 only
CANL	6	LOW-level CAN bus line
CANH	7	HIGH-level CAN bus line
STB	8	Standby mode control input

[1] HVSON8 package die supply ground is connected to both the GND pin and the exposed center pad. The GND pin must be soldered to board ground. For enhanced thermal and electrical performance, it is recommended that the exposed center pad also be soldered to board ground.

## 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 with 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 available in two versions, distinguished only by the function of pin 5:

- The TJA1049T and TJA1049TK are 100 % backwards compatible with the TJA1040 when operating with a 5 V microcontroller, and also cover existing PCA82C250 and PCA82C251 applications
- The TJA1049T/3 and TJA1049TK/3 allow for direct interfacing to microcontrollers with supply voltages down to 3 V

### 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 slopes of the output signals on the bus lines are controlled internally and are 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  $t_{ftr(wake)bus}$  are reflected on pin RXD.

In Standby mode, the bus lines are biased to ground to minimize the system supply current. The low-power receiver is supplied by  $V_{IO}$ , and is capable of detecting CAN bus activity even if  $V_{IO}$  is the only supply voltage available. 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.

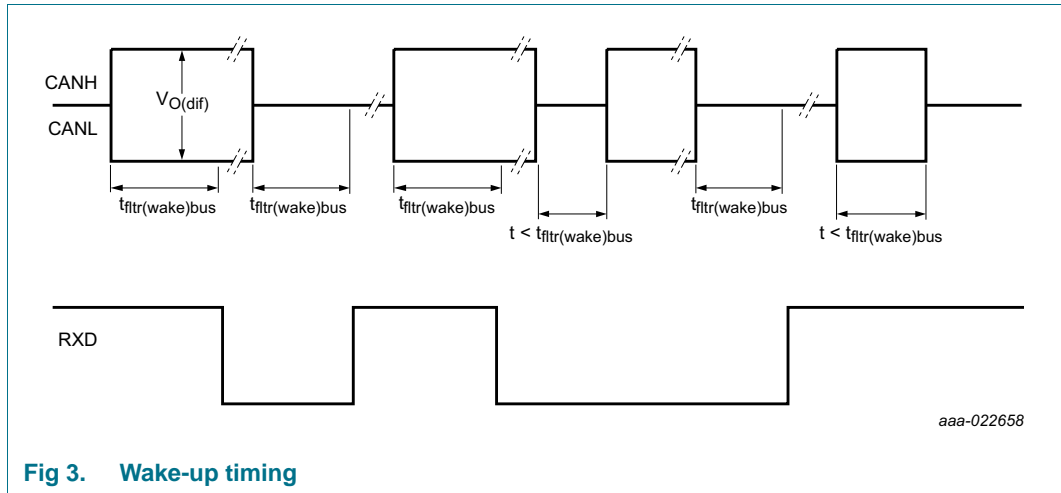


Fig 3. Wake-up timing

## 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 and STB input pins

Pins TXD and STB have internal pull-ups to  $V_{IO}$  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.

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

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

Should  $V_{IO}$  drop below the  $V_{IO}$  undervoltage detection level,  $V_{uvd(VIO)}$ , the transceiver will switch off and disengage from the bus (zero load) until  $V_{IO}$  has 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 oscillation due to temperature drift is avoided.

## 7.3 SPLIT output pin and $V_{IO}$ supply pin

Two versions of the TJA1049 are available, only differing in the function of a single pin. Pin 5 is either a SPLIT output pin or a  $V_{IO}$  supply pin.

7.3.1 SPLIT pin

Using the SPLIT pin on the TJA1049T or TJA1049TK in conjunction with a split termination network (see Figure 4 and Figure 7) 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.

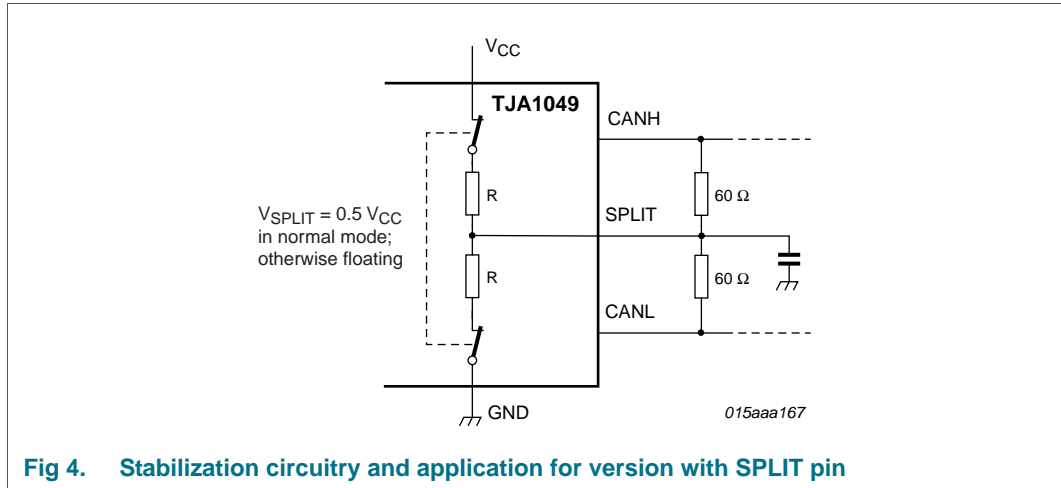


Fig 4. Stabilization circuitry and application for version with SPLIT pin

7.3.2 V<sub>IO</sub> supply pin

Pin V<sub>IO</sub> on the TJA1049T/3 and TJA1049TK/3 should be connected to the microcontroller supply voltage (see Figure 8). This will adjust the signal levels of pins TXD, RXD and STB to the I/O levels of the microcontroller. Pin V<sub>IO</sub> also provides the internal supply voltage for the low-power differential receiver of the transceiver. For applications running in low-power mode, this allows the bus lines to be monitored for activity even if there is no supply voltage on pin V<sub>CC</sub>.

For versions of the TJA1049 without a V<sub>IO</sub> pin, the V<sub>IO</sub> input is internally connected to V<sub>CC</sub>. This sets the signal levels of pins TXD, RXD and STB 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 <sup>[1]</sup>	on pins CANH, CANL and SPLIT	-58	+58	V
		on any other pin	-0.3	+7	V
V <sub>(CANH-CANL)</sub>	voltage between pin CANH and pin CANL		-27	+27	V
V <sub>trt</sub>	transient voltage	on pins CANH, CANL <sup>[2]</sup>			
		pulse 1	-100	-	V
		pulse 2a	-	75	V
		pulse 3a	-150	-	V
		pulse 3b	-	100	V
V <sub>ESD</sub>	electrostatic discharge voltage	IEC 61000-4-2 (150 pF, 330 Ω) <sup>[3]</sup>			
		at pins CANH and CANL	-8	+8	kV
		Human Body Model (HBM); 100 pF, 1.5 kΩ <sup>[4]</sup>			
		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 <sup>[5]</sup>			
		at any pin	-300	+300	V
		Charged Device Model (CDM); field Induced charge; 4 pF <sup>[6]</sup>			
at corner pins	-750	+750	V		
at any pin	-500	+500	V		
T <sub>vj</sub>	virtual junction temperature	<sup>[7]</sup>	-40	+150	°C
T <sub>stg</sub>	storage temperature		-55	+150	°C

- [1] The device can sustain voltages up to the specified values over the product lifetime, provided applied voltages (including transients) never exceed these values.
- [2] According to IEC TS 62228 (2007), Section 4.2.4; parameters for standard pulses defined in ISO7637 part 2: 2004-06.
- [3] According to IEC TS 62228 (2007), Section 4.3; DIN EN 61000-4-2.
- [4] According to AEC-Q100-002.
- [5] According to AEC-Q100-003.
- [6] According to AEC-Q100-011 Rev-C1. The classification level is C4B.
- [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	Typ	Unit
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	SO8 package; in free air	145	K/W
		HVSON8 package; in free air	50	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  $5.25\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$  [1];  $R_L = 60\text{ }\Omega$  unless specified otherwise; All voltages are defined with respect to ground. Positive currents flow into the IC. [2]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply; pin V<sub>CC</sub></b>						
V <sub>CC</sub>	supply voltage		4.75	-	5.25	V
I <sub>CC</sub>	supply current	Standby mode				
		TJA1049T or TJA1049TK; includes I <sub>IO</sub> ; V <sub>TXD</sub> = V <sub>IO</sub> [3]	-	10	15	μA
		TJA1049T/3 or TJA1049TK/3	-	-	5	μA
		Normal mode				
		recessive; V <sub>TXD</sub> = V <sub>IO</sub> [3]	2.5	5	7.5	mA
	dominant; V <sub>TXD</sub> = 0 V	20	45	65	mA	
V <sub>uvd(VCC)</sub>	undervoltage detection voltage on pin V <sub>CC</sub>		3.5	-	4.75	V
<b>I/O level adapter supply; pin V<sub>IO</sub> [1]</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>	Standby mode; V <sub>TXD</sub> = V <sub>IO</sub> [3]	5	-	14	μA
		Normal mode				
		recessive; V <sub>TXD</sub> = V <sub>IO</sub> [3]	15	80	200	μA
		dominant; V <sub>TXD</sub> = 0 V	-	350	1000	μA
V <sub>uvd(VIO)</sub>	undervoltage detection voltage on pin V <sub>IO</sub>		1.3	2.0	2.7	V
<b>Standby mode control input; pin STB</b>						
V <sub>IH</sub>	HIGH-level input voltage		[4] 0.7V <sub>IO</sub> [3]	-	V <sub>IO</sub> + 0.3	V
V <sub>IL</sub>	LOW-level input voltage		-0.3	-	0.3V <sub>IO</sub> [3]	V
I <sub>IH</sub>	HIGH-level input current	V <sub>STB</sub> = V <sub>IO</sub> [3]	-1	-	+1	μA
I <sub>IL</sub>	LOW-level input current	V <sub>STB</sub> = 0 V	-15	-	-1	μA
<b>CAN transmit data input; pin TXD</b>						
V <sub>IH</sub>	HIGH-level input voltage		[4] 0.7V <sub>IO</sub> [3]	-	V <sub>IO</sub> [3] + 0.3	V
V <sub>IL</sub>	LOW-level input voltage		-0.3	-	0.3V <sub>IO</sub> [3]	V
I <sub>IH</sub>	HIGH-level input current	V <sub>TXD</sub> = V <sub>IO</sub> [3]	-5	-	+5	μA
I <sub>IL</sub>	LOW-level input current	V <sub>TXD</sub> = 0 V	-260	-150	-30	μA
C <sub>i</sub>	input capacitance		[5] -	5	10	pF
<b>CAN receive data output; pin RXD</b>						
I <sub>OH</sub>	HIGH-level output current	TJA1049T or TJA1049TK; V <sub>RXD</sub> = V <sub>CC</sub> - 0.4 V	-8	-3	-1	mA
		TJA1049T/3 or TJA1049TK/3; V <sub>RXD</sub> = V <sub>IO</sub> - 0.4 V	-9	-3	-1	mA
I <sub>OL</sub>	LOW-level output current	V <sub>RXD</sub> = 0.4 V; bus dominant	1	-	12	mA

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

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.75\text{ V}$  to  $5.25\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$  [1];  $R_L = 60\text{ }\Omega$  unless specified otherwise; All voltages are defined with respect to ground. Positive currents flow into the IC. [2]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Bus lines; pins CANH and CANL</b>						
$V_{O(dom)}$	dominant output voltage	$V_{TXD} = 0\text{ V}$ ; $t < t_{to(dom)TXD}$				
		pin CANH; $R_L = 50\text{ }\Omega$ to $65\text{ }\Omega$	2.75	3.5	4.5	V
		pin CANL; $R_L = 50\text{ }\Omega$ to $65\text{ }\Omega$	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
$V_{TXsym}$	transmitter voltage symmetry	$V_{TXsym} = V_{CANH} + V_{CANL}$ ; $f_{TXD} = 250\text{ kHz}$ ; $C_{SPLIT} = 4.7\text{ nF}$	[5] [6] 0.9 $V_{CC}$	-	1.1 $V_{CC}$	V
$V_{O(dif)}$	differential output voltage	dominant; Normal mode; $V_{TXD} = 0\text{ V}$ ; $t < t_{to(dom)TXD}$ ; $V_{CC} = 4.75\text{ V}$ to $5.25\text{ V}$				
		$R_L = 45\text{ }\Omega$ to $70\text{ }\Omega$	1.5	-	3	V
		$R_L = 2240\text{ }\Omega$	1.5	-	5	V
		recessive; no load				
		Normal mode: $V_{TXD} = V_{IO}$ [3]	-50	-	+50	mV
		Standby mode	-0.2	-	+0.2	V
$V_{O(rec)}$	recessive output voltage	Normal mode; $V_{TXD} = V_{IO}$ [3]; no load	2	0.5 $V_{CC}$	3	V
		Standby mode; no load	-0.1	-	+0.1	V
$V_{th(RX)dif}$	differential receiver threshold voltage	$-12\text{ V} \leq V_{CANL} \leq +12\text{ V}$ ; $-12\text{ V} \leq V_{CANH} \leq +12\text{ V}$				
		Normal mode	0.5	-	0.9	V
		Standby mode	0.4	-	1.15	V
$V_{rec(RX)}$	receiver recessive voltage	Normal mode; $-12\text{ V} \leq V_{CANL} \leq +12\text{ V}$ ; $-12\text{ V} \leq V_{CANH} \leq +12\text{ V}$	-3	-	0.5	V
$V_{dom(RX)}$	receiver dominant voltage	Normal mode; $-12\text{ V} \leq V_{CANL} \leq +12\text{ V}$ ; $-12\text{ V} \leq V_{CANH} \leq +12\text{ V}$	0.9	-	8.0	V
$V_{hys(RX)dif}$	differential receiver hysteresis voltage	$-12\text{ V} \leq V_{CANL} \leq +12\text{ V}$ ; $-12\text{ V} \leq V_{CANH} \leq +12\text{ V}$ ; Normal mode	100	-	300	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; $V_{CANH} = -3\text{ V}$ to $+40\text{ V}$	-100	-70	-40	mA
		pin CANL; $V_{CANL} = -3\text{ V}$ to $+40\text{ V}$	40	70	100	mA
$I_{O(sc)rec}$	recessive short-circuit output current	Normal mode; $V_{TXD} = V_{IO}$ [3] $V_{CANH} = V_{CANL} = -27\text{ V}$ to $+32\text{ V}$	-5	-	+5	mA
$I_L$	leakage current	$V_{CC} = V_{IO} = 0\text{ V}$ or $V_{CC} = V_{IO} = \text{shorted to GND via } 47\text{ k}\Omega$ ; $V_{CANH} = V_{CANL} = 5\text{ V}$	-3	-	+3	$\mu\text{A}$
$R_i$	input resistance		9	15	28	k $\Omega$
$\Delta R_i$	input resistance deviation	between $V_{CANH}$ and $V_{CANL}$	-3	-	+3	%
$R_{i(dif)}$	differential input resistance		19	30	52	k $\Omega$
$C_{i(cm)}$	common-mode input capacitance		[5] -	-	20	pF

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

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.75\text{ V}$  to  $5.25\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$  [1];  $R_L = 60\text{ }\Omega$  unless specified otherwise; All voltages are defined with respect to ground. Positive currents flow into the IC. [2]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_{i(dif)}$	differential input capacitance	[5]	-	-	10	pF
<b>Common mode stabilization output, pin SPLIT; only relevant for TJA1049T and TJA1049TK</b>						
$V_O$	output voltage	Normal mode; $I_{SPLIT} = -500\text{ }\mu\text{A}$ to $+500\text{ }\mu\text{A}$	$0.3V_{CC}$	$0.5V_{CC}$	$0.7V_{CC}$	V
		Normal mode; $R_L = 1\text{ M}\Omega$	$0.45V_{CC}$	$0.5V_{CC}$	$0.55V_{CC}$	V
$I_L$	leakage current	Standby mode; $V_{SPLIT} = -58\text{ V}$ to $+58\text{ V}$	-5	-	+5	$\mu\text{A}$
<b>Temperature detection</b>						
$T_{j(sd)}$	shutdown junction temperature	[5]	-	190	-	$^{\circ}\text{C}$

- [1] Only TJA1049T/3 and TJA1049TK/3 have a  $V_{IO}$  pin; in TJA1049T and TJA1049TK, 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]  $V_{IO} = V_{CC}$  in non- $V_{IO}$  product variants TJA1049T and TJA1049TK.
- [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] The test circuit used to measure the bus output voltage symmetry (which includes  $C_{SPLIT}$ ) is shown in [Figure 10](#).

## 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  $5.25\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  to  $5.5\text{ V}$  [1];  $R_L = 60\text{ }\Omega$  unless specified otherwise. All voltages are defined with respect to ground. Positive currents flow into the IC. [2]

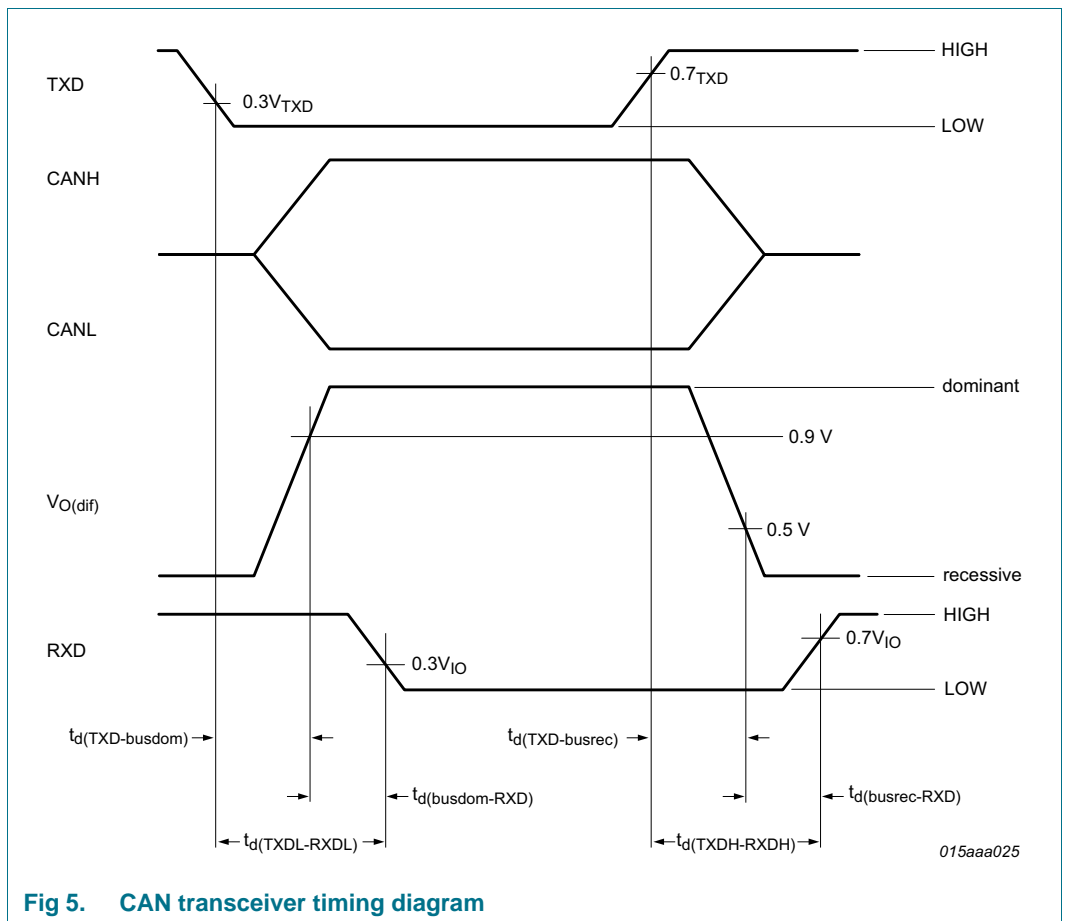
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Transceiver timing; pins CANH, CANL, TXD and RXD; see <a href="#">Figure 9</a> and <a href="#">Figure 5</a></b>							
$t_{d(TXD-busdom)}$	delay time from TXD to bus dominant	Normal mode	-	65	-	ns	
$t_{d(TXD-busrec)}$	delay time from TXD to bus recessive	Normal mode	-	90	-	ns	
$t_{d(busdom-RXD)}$	delay time from bus dominant to RXD	Normal mode	-	60	-	ns	
$t_{d(busrec-RXD)}$	delay time from bus recessive to RXD	Normal mode	-	65	-	ns	
$t_{d(TXDL-RXDL)}$	propagation delay from TXD to RXD	versions with SPLIT pin; Normal mode	60	-	220	ns	
		versions with $V_{IO}$ pin Normal mode	60	-	250	ns	
$t_{d(TXDH-RXDH)}$	propagation delay from TXD to RXD	versions with SPLIT pin; Normal mode	60	-	220	ns	
		versions with $V_{IO}$ pin; Normal mode	60	-	250	ns	
$t_{bit(bus)}$	transmitted recessive bit width	$t_{bit(TXD)} = 500\text{ ns}$	[3]	435	-	530	ns
		$t_{bit(TXD)} = 200\text{ ns}$	[3]	155	-	210	ns
$t_{bit(RXD)}$	bit time on pin RXD	$t_{bit(TXD)} = 500\text{ ns}$	[3]	400	-	550	ns
		$t_{bit(TXD)} = 200\text{ ns}$	[3]	120	-	220	ns

**Table 8. Dynamic characteristics ...continued**

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.75\text{ V}$  to  $5.25\text{ V}$ ;  $V_{IO} = 2.8\text{ V}$  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
$\Delta t_{rec}$	receiver timing symmetry	$t_{bit(TXD)} = 500\text{ ns}$	-65	-	+40	ns
		$t_{bit(TXD)} = 200\text{ ns}$	-45	-	+15	ns
$t_{to(dom)TXD}$	TXD dominant time-out time	$V_{TXD} = 0\text{ V}$ ; Normal mode	0.3	2	5	ms
$t_{fltr(wake)bus}$	bus wake-up filter time	version with SPLIT pin; Standby mode	0.5	1	3	$\mu\text{s}$
		versions with $V_{IO}$ pin; Standby mode	0.5	1.5	5	$\mu\text{s}$
$t_{d(stb-norm)}$	standby to normal mode delay time		7	25	47	$\mu\text{s}$

- [1] Only TJA1049T/3 and TJA1049TK/3 have a  $V_{IO}$  pin; in the TJA1049T and TJA1049TK, 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 6](#).



**Fig 5. CAN transceiver timing diagram**

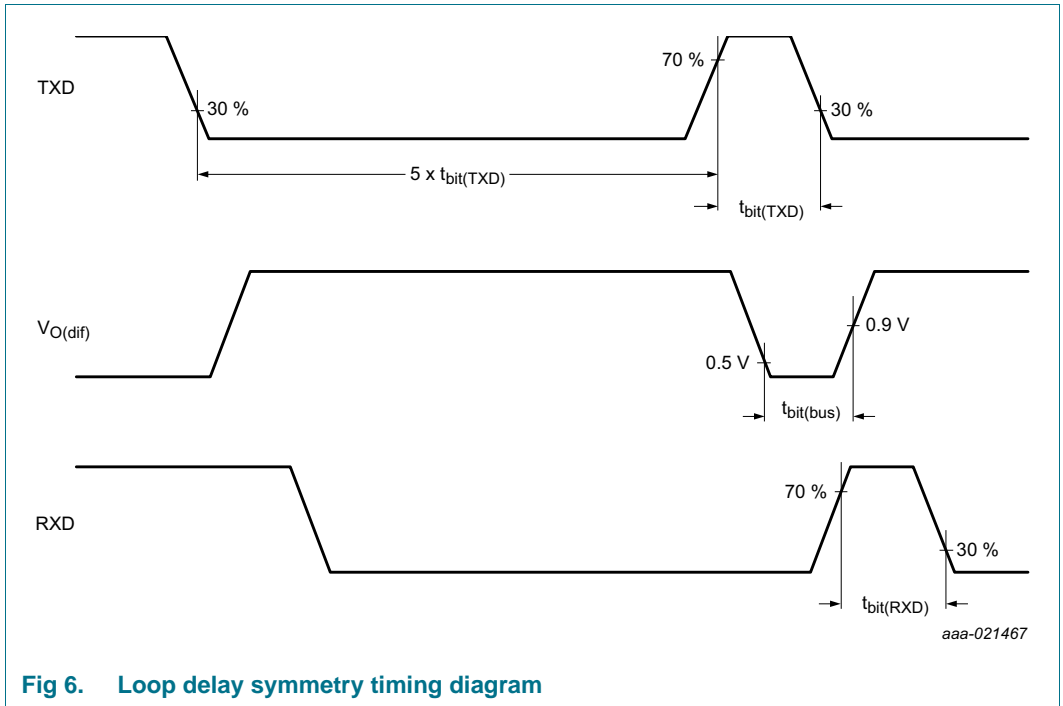


Fig 6. Loop delay symmetry timing diagram

## 12. Application information

### 12.1 Application diagrams

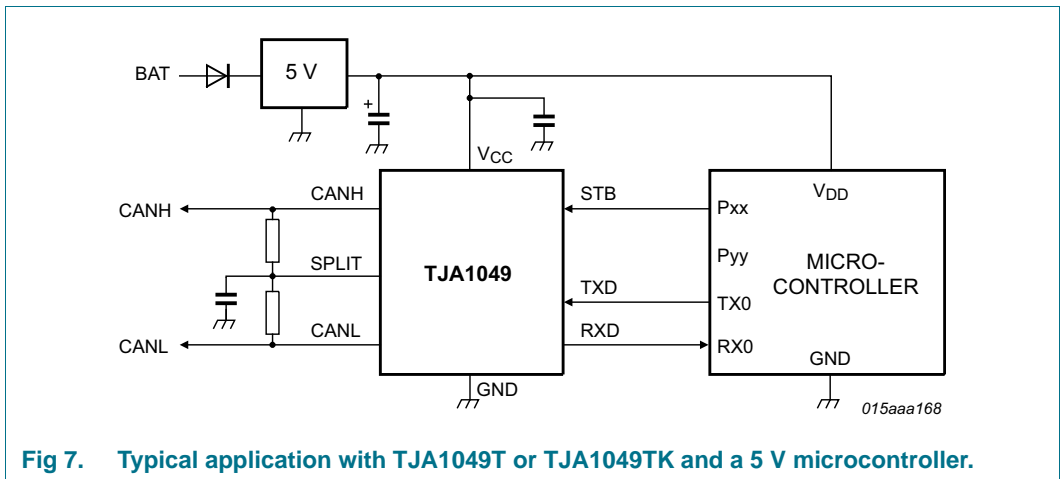
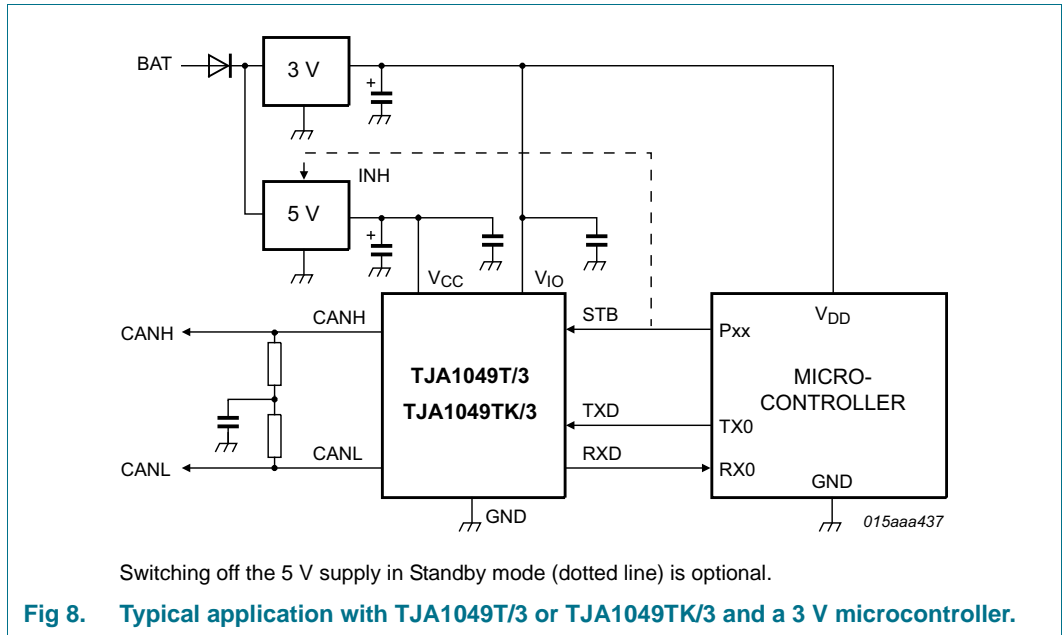


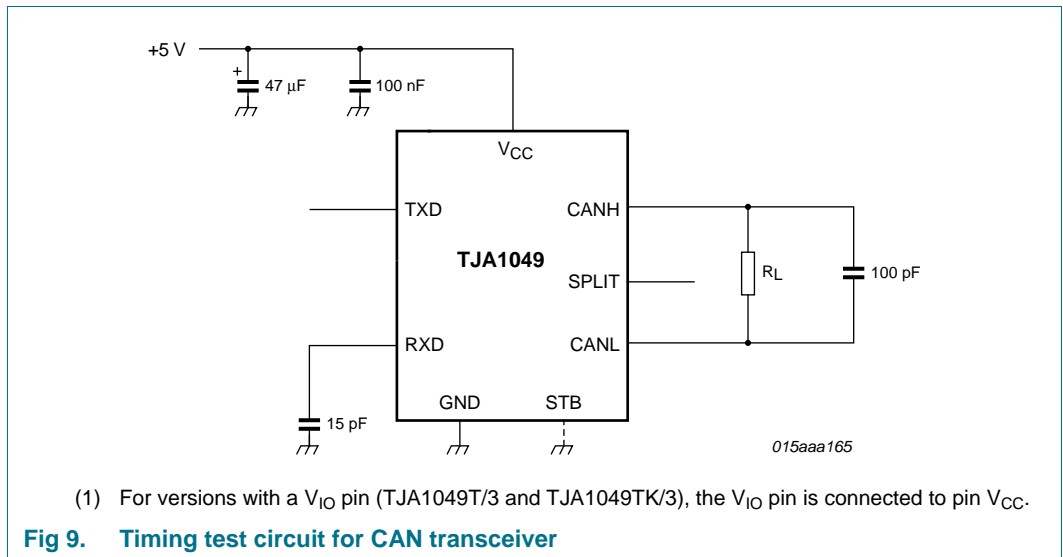
Fig 7. Typical application with TJA1049T or TJA1049TK and a 5 V microcontroller.



### 12.2 Application hints

Further information on the application of the TJA1049 can be found in NXP application hints *AH1021 Application Hints - High-speed CAN transceiver TJA1049*.

## 13. Test information



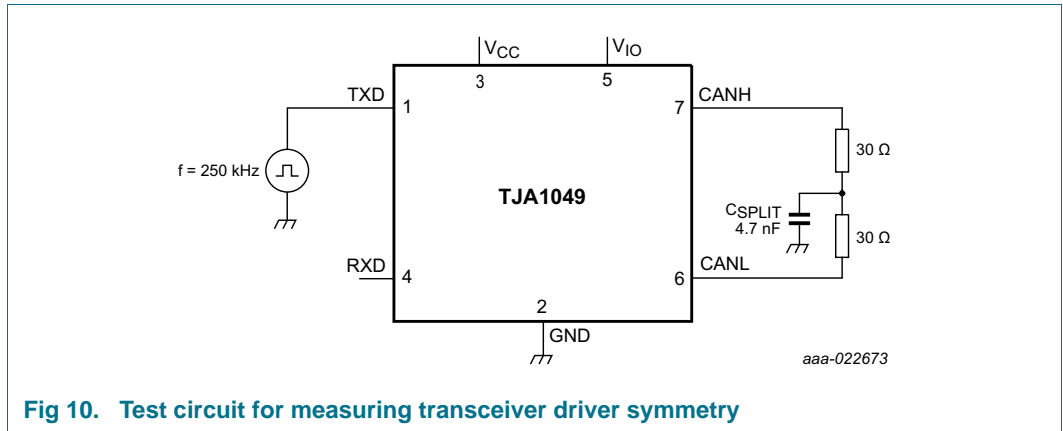


Fig 10. Test circuit for measuring transceiver driver symmetry

### 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

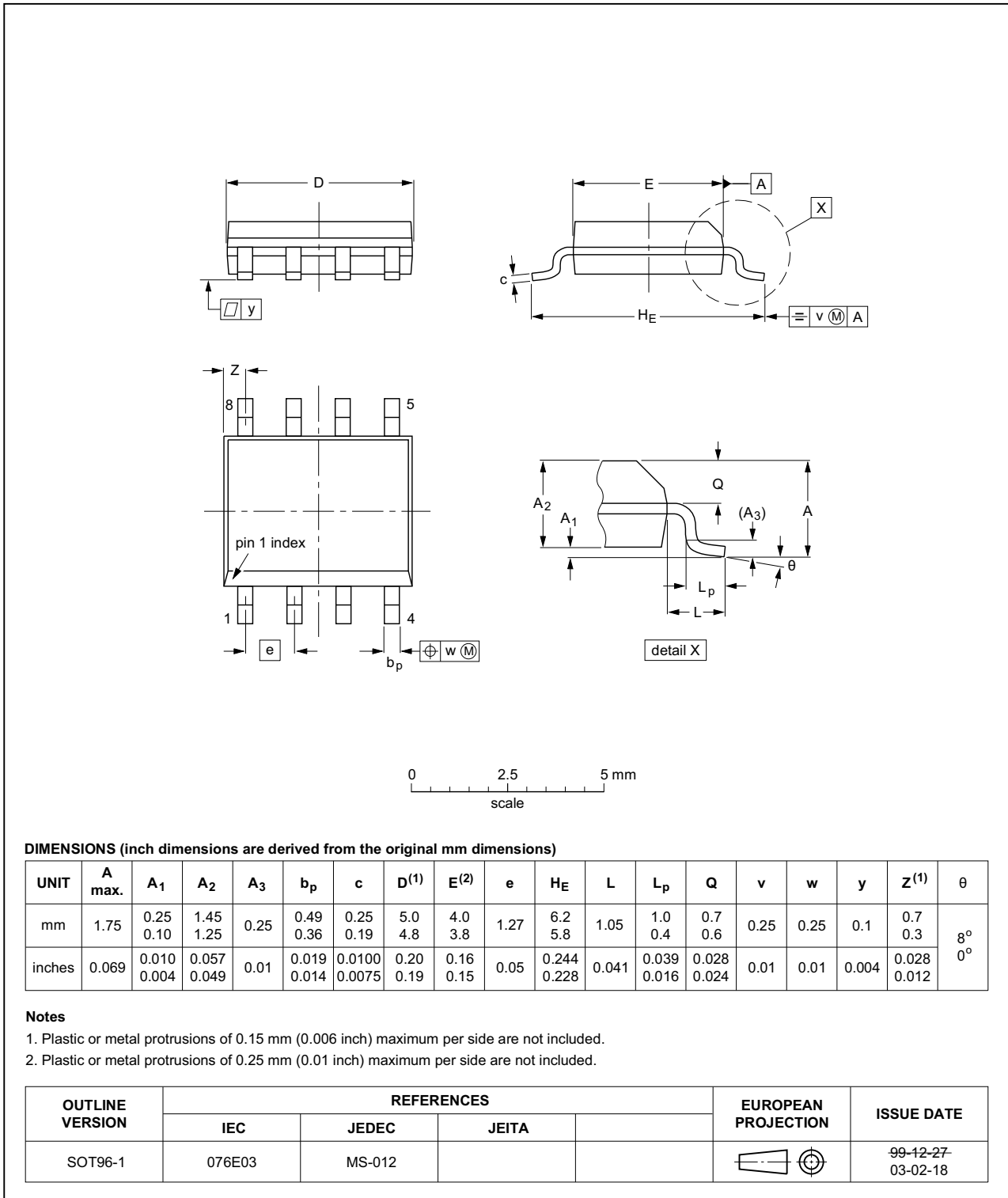


Fig 11. Package outline SOT96-1 (SO8)

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

SOT782-1



Fig 12. 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 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-020D)**

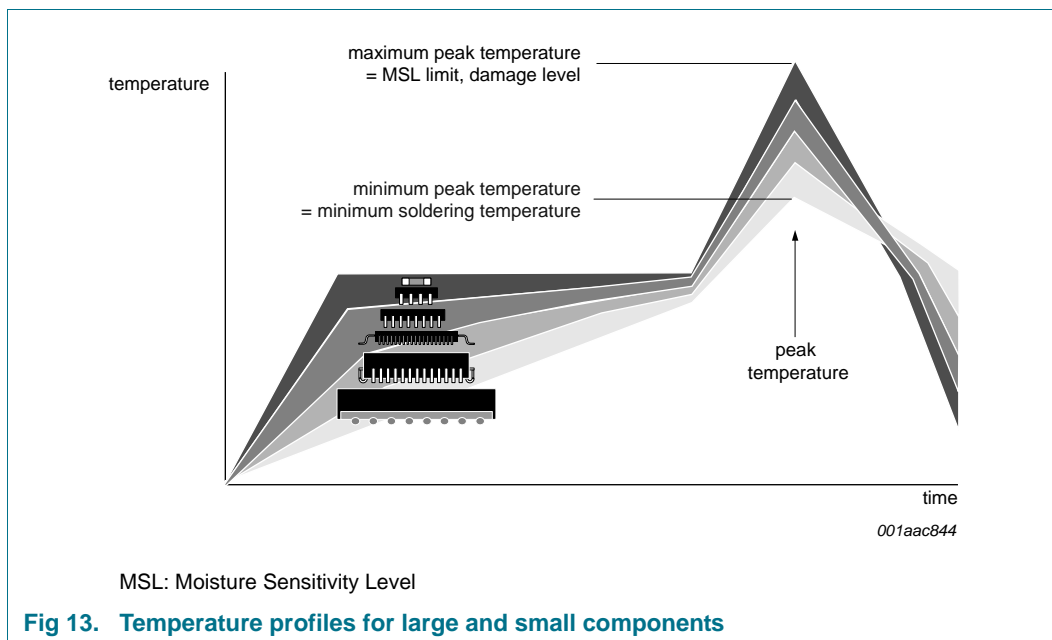
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm <sup>3</sup> )	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

**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 13](#).



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. Appendix: ISO 11898-2:2016 parameter cross-reference list

Table 11. ISO 11898-2:2016 to NXP data sheet parameter conversion

ISO 11898-2:2016		NXP data sheet	
Parameter	Notation	Symbol	Parameter
<b>HS-PMA dominant output characteristics</b>			
Single ended voltage on CAN_H	$V_{CAN\_H}$	$V_{O(dom)}$	dominant output voltage
Single ended voltage on CAN_L	$V_{CAN\_L}$		
Differential voltage on normal bus load	$V_{Diff}$	$V_{O(dif)}$	differential output voltage
Differential voltage on effective resistance during arbitration			
Optional: Differential voltage on extended bus load range			
<b>HS-PMA driver symmetry</b>			
Driver symmetry	$V_{SYM}$	$V_{TXsym}$	transmitter voltage symmetry
<b>Maximum HS-PMA driver output current</b>			
Absolute current on CAN_H	$I_{CAN\_H}$	$I_{O(sc)dom}$	dominant short-circuit output current
Absolute current on CAN_L	$I_{CAN\_L}$		
<b>HS-PMA recessive output characteristics, bus biasing active/inactive</b>			
Single ended output voltage on CAN_H	$V_{CAN\_H}$	$V_{O(rec)}$	recessive output voltage
Single ended output voltage on CAN_L	$V_{CAN\_L}$		
Differential output voltage	$V_{Diff}$	$V_{O(dif)}$	differential output voltage
<b>Optional HS-PMA transmit dominant timeout</b>			
Transmit dominant timeout, long	$t_{dom}$	$t_{to(dom)TXD}$	TXD dominant time-out time
Transmit dominant timeout, short			
<b>HS-PMA static receiver input characteristics, bus biasing active/inactive</b>			
Recessive state differential input voltage range	$V_{Diff}$	$V_{th(RX)dif}$	differential receiver threshold voltage
Dominant state differential input voltage range		$V_{rec(RX)}$	receiver recessive voltage
		$V_{dom(RX)}$	receiver dominant voltage
<b>HS-PMA receiver input resistance (matching)</b>			
Differential internal resistance	$R_{Diff}$	$R_{i(dif)}$	differential input resistance
Single ended internal resistance	$R_{CAN\_H}$ $R_{CAN\_L}$	$R_i$	input resistance
Matching of internal resistance	MR	$\Delta R_i$	input resistance deviation
<b>HS-PMA implementation loop delay requirement</b>			
Loop delay	$t_{Loop}$	$t_{d(TXDH-RXDH)}$	delay time from TXD HIGH to RXD HIGH
		$t_{d(TXDL-RXDL)}$	delay time from TXD LOW to RXD LOW
<b>Optional HS-PMA implementation data signal timing requirements for use with bit rates above 1 Mbit/s up to 2 Mbit/s and above 2 Mbit/s up to 5 Mbit/s</b>			
Transmitted recessive bit width @ 2 Mbit/s / @ 5 Mbit/s, intended	$t_{Bit(Bus)}$	$t_{bit(bus)}$	transmitted recessive bit width
Received recessive bit width @ 2 Mbit/s / @ 5 Mbit/s	$t_{Bit(RXD)}$	$t_{bit(RXD)}$	bit time on pin RXD
Receiver timing symmetry @ 2 Mbit/s / @ 5 Mbit/s	$\Delta t_{Rec}$	$\Delta t_{rec}$	receiver timing symmetry

Table 11. ISO 11898-2:2016 to NXP data sheet parameter conversion

ISO 11898-2:2016		NXP data sheet	
Parameter	Notation	Symbol	Parameter
<b>HS-PMA maximum ratings of V<sub>CAN_H</sub>, V<sub>CAN_L</sub> and V<sub>Diff</sub></b>			
Maximum rating V <sub>Diff</sub>	V <sub>Diff</sub>	V <sub>(CANH-CANL)</sub>	voltage between pin CANH and pin CANL
General maximum rating V <sub>CAN_H</sub> and V <sub>CAN_L</sub>	V <sub>CAN_H</sub>	V <sub>x</sub>	voltage on pin x
Optional: Extended maximum rating V <sub>CAN_H</sub> and V <sub>CAN_L</sub>	V <sub>CAN_L</sub>		
<b>HS-PMA maximum leakage currents on CAN_H and CAN_L, unpowered</b>			
Leakage current on CAN_H, CAN_L	I <sub>CAN_H</sub> I <sub>CAN_L</sub>	I <sub>L</sub>	leakage current
<b>HS-PMA bus biasing control timings</b>			
CAN activity filter time, long	t <sub>Filter</sub>	t <sub>wake(busdom)</sub> <sup>[1]</sup>	bus dominant wake-up time
CAN activity filter time, short		t <sub>wake(busrec)</sub> <sup>[1]</sup>	bus recessive wake-up time
Wake-up timeout, short	t <sub>Wake</sub>	t <sub>to(wake)bus</sub>	bus wake-up time-out time
Wake-up timeout, long			
Timeout for bus inactivity	t <sub>Silence</sub>	t <sub>to(silence)</sub>	bus silence time-out time
Bus Bias reaction time	t <sub>Bias</sub>	t <sub>d(busact-bias)</sub>	delay time from bus active to bias

[1] t<sub>filtr(wake)bus</sub> - bus wake-up filter time, in devices with basic wake-up functionality

## 19. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TJA1049 v.5.01	20160523	Product data sheet	-	TJA1049 v.4
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Table 3: Table note 1</a>: text revised</li> <li>• <a href="#">Figure 3</a> added</li> <li>• Redundant parameter <math>t_{to(dom)bus}</math> deleted (from <a href="#">Table 8</a>; Section 7.2.2 deleted)</li> <li>• <a href="#">Table 5: Table note 1</a> added; <a href="#">Table note 2</a> amended; parameter <math>V_{tt}</math> revised</li> <li>• <a href="#">Table 7</a>: Table note 6 deleted; <a href="#">Table note 3</a> added</li> <li>• <a href="#">Figure 7</a> and <a href="#">Figure 8</a> amended; <a href="#">Figure 10</a> added</li> <li>• ISO 11898-2:2016 compliance: <ul style="list-style-type: none"> <li>– <a href="#">Section 1</a>: text amended (2nd last paragraph)</li> <li>– <a href="#">Section 2.1</a>: text amended (2nd feature)</li> <li>– <a href="#">Table 5</a>: parameter <math>V_{(CANH-CANL)}</math> added</li> <li>– <a href="#">Table 7</a>: <ul style="list-style-type: none"> <li>- measurement conditions changed for parameters <math>V_{O(dom)}</math>, <math>V_{O(dif)}</math>, <math>I_L</math>, <math>I_{O(sc)dom}</math>, <math>V_{hys(RX)dif}</math> and <math>V_{th(RX)dif}</math> (associated table note removed)</li> <li>- added parameters <math>V_{TXsym}</math> (and associated table note), <math>V_{rec(RX)}</math> and <math>V_{dom(RX)}</math></li> <li>- symbol <math>V_{O(dif)bus}</math> renamed as <math>V_{O(dif)}</math></li> <li>- additional measurements included for parameter <math>V_{O(dif)}</math></li> </ul> </li> <li>– <a href="#">Table 8</a>: <ul style="list-style-type: none"> <li>- added parameters <math>t_{bit(bus)}</math> and <math>\Delta t_{rec}</math></li> <li>- parameter <math>t_{PD(TXD-RXD)}</math> replaced with parameters <math>t_{d(TXDL-RXDL)}</math> and <math>t_{d(TXDH-RXDH)}</math></li> <li>- additional measurement included for parameter <math>t_{bit(RXD)}</math></li> </ul> </li> <li>– <a href="#">Figure 5</a> and <a href="#">Figure 6</a> amended</li> <li>– <a href="#">Section 18</a> added</li> </ul> </li> </ul>			
TJA1049 v.4	20150115	Product data sheet	-	TJA1049 v.3
TJA1049 v3	20130916	Product data sheet	-	TJA1049 v.2
TJA1049 v.2	20110323	Product data sheet	-	TJA1049 v.1
TJA1049 v.1	20100924	Product data sheet	-	-



## 20. Legal information

### 20.1 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.

[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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