

TJA1049

High-speed CAN transceiver with Standby mode

Rev. 6 — 15 January 2018

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 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 ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5. 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

2.1 General

- ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5 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 | μ A |
| | | Standby mode: TJA1049T/3, TJA1049TK/3 | - | - | 5 | μ 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 | μ A |
| | | Normal mode; bus recessive | 15 | 80 | 200 | μ A |
| | | Normal mode; bus dominant | - | 350 | 1000 | μ 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 |

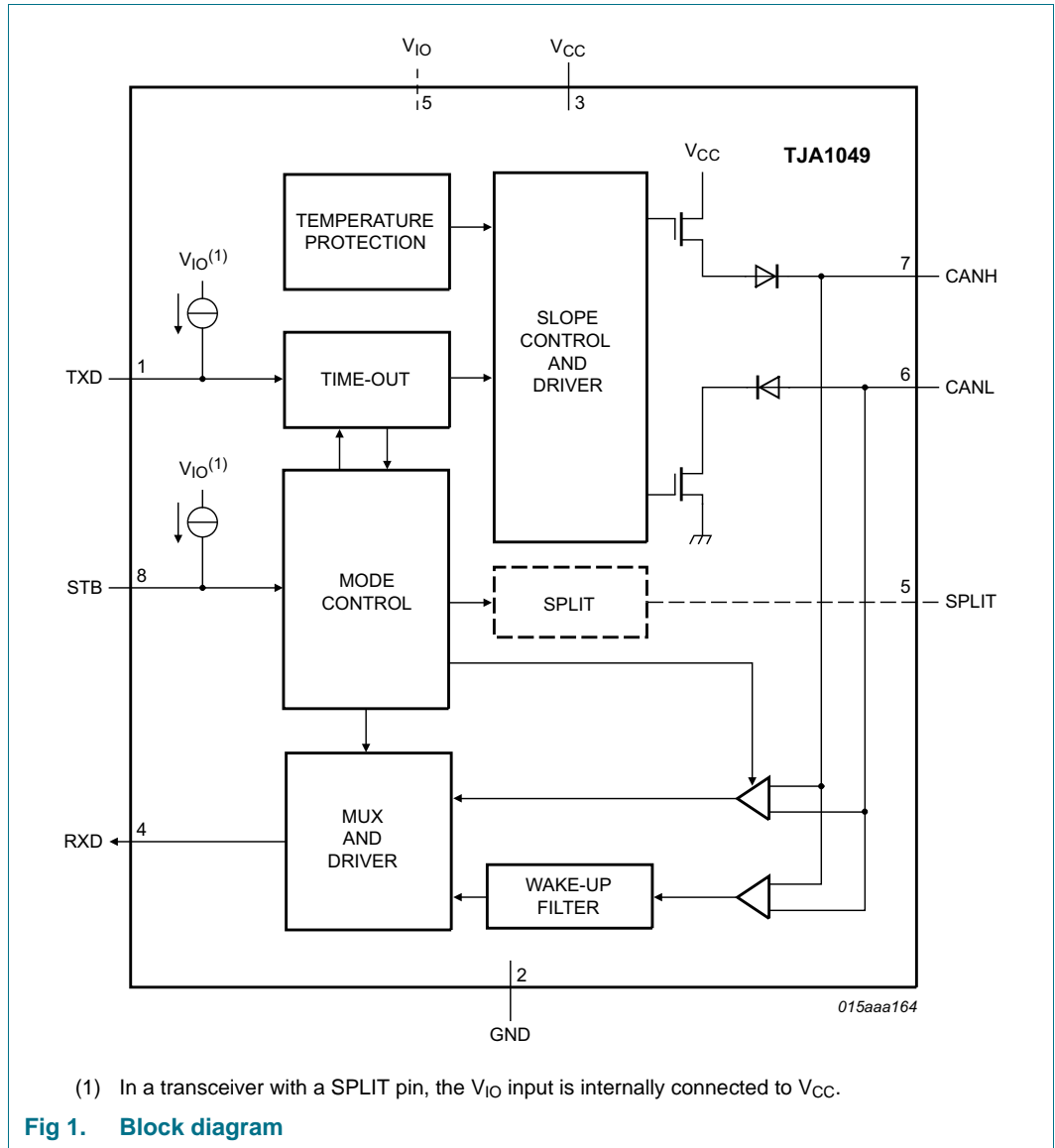
4. Ordering information

Table 2. Ordering information

| Type number ^[1] | 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 |

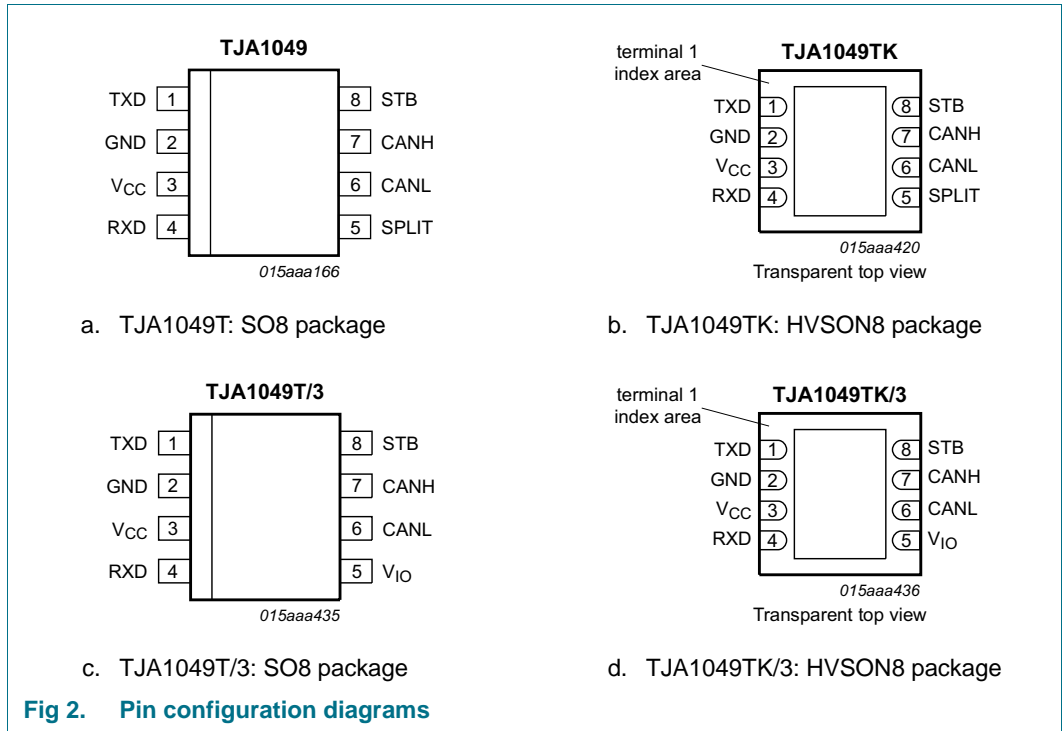
[1] TJA1049T and TJA1049TK with SPLIT pin; TJA1049T/3 and TJA1049TK/3 with V_{IO} pin.

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 ^[1] | 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; TJA1049T and TJA1049TK only |
| V _{IO} | 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, as shown in [Figure 3](#).

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.

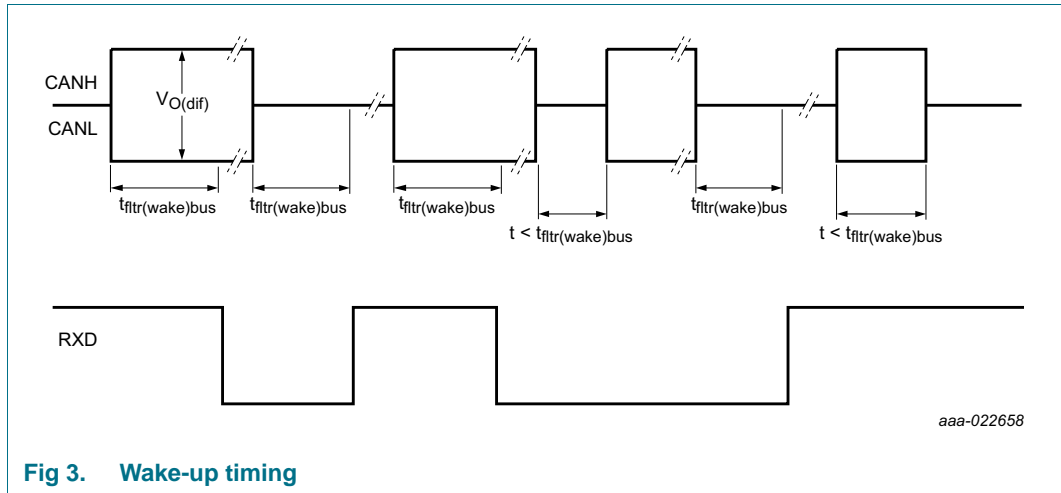


Fig 3. Wake-up timing

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 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_{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.

7.2.4 Undervoltage detection on pins V_{CC} and V_{IO}

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

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 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.

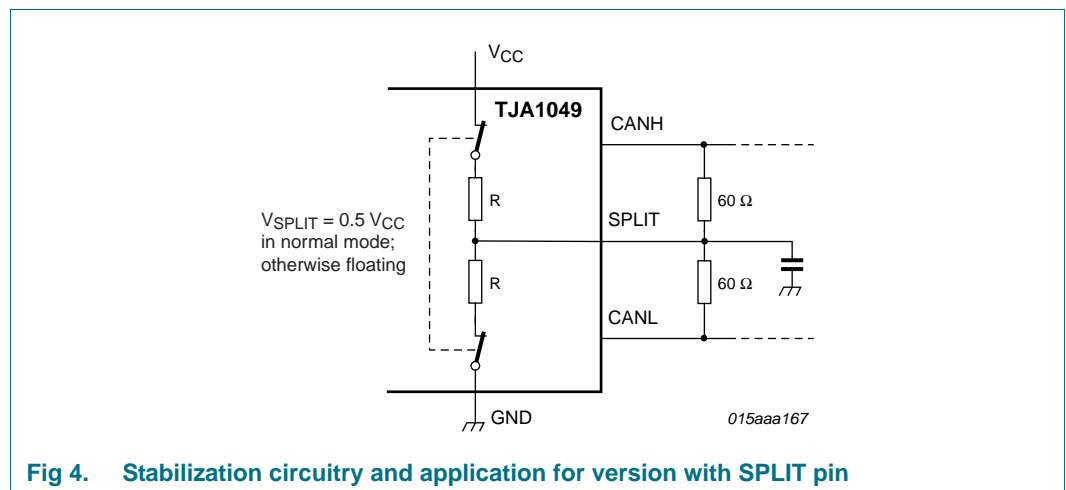


Fig 4. Stabilization circuitry and application for version with SPLIT pin

7.3.2 V_{IO} supply pin

Pin V_{IO} 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_{IO} 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_{CC} .

For versions of the TJA1049 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 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 _x | voltage on pin x ^[1] | on pins CANH, CANL and SPLIT | -58 | +58 | V |
| | | on any other pin | -0.3 | +7 | V |
| V _(CANH-CANL) | voltage between pin CANH and pin CANL | | -27 | +27 | V |
| V _{trt} | transient voltage | on pins CANH, CANL ^[2] | | | |
| | | pulse 1 | -100 | - | V |
| | | pulse 2a | - | 75 | V |
| | | pulse 3a | -150 | - | V |
| | | pulse 3b | - | 100 | V |
| V _{ESD} | electrostatic discharge voltage | IEC 61000-4-2 (150 pF, 330 Ω) ^[3] | | | |
| | | at pins CANH and CANL | -8 | +8 | kV |
| | | Human Body Model (HBM); 100 pF, 1.5 kΩ ^[4] | | | |
| | | 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 ^[5] | | | |
| | | at any pin | -300 | +300 | V |
| | | Charged Device Model (CDM); field Induced charge; 4 pF ^[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] 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 _{th(j-a)} | 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 V ; $V_{IO} = 2.8\text{ V}$ to 5.5 V [1]; $R_L = 60\ \Omega$ 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 |
|---|---|---|------------------------|------|---------------------------|------|
| Supply; pin V_{CC} | | | | | | |
| V _{CC} | supply voltage | | 4.75 | - | 5.25 | V |
| I _{CC} | supply current | Standby mode | | | | |
| | | TJA1049T or TJA1049TK; includes I _{IO} ; V _{TXD} = V _{IO} [3] | - | 10 | 15 | μA |
| | | TJA1049T/3 or TJA1049TK/3 | - | - | 5 | μA |
| | | Normal mode | | | | |
| | | recessive; V _{TXD} = V _{IO} [3] | 2.5 | 5 | 7.5 | mA |
| | | dominant; V _{TXD} = 0 V | 20 | 45 | 65 | mA |
| V _{uvd(VCC)} | undervoltage detection voltage on pin V _{CC} | dominant; V _{TXD} = 0 V; short circuit on bus lines; -3 V < (V _{CANH} = V _{CANL}) < +18 V | 2.5 | 77.5 | 107.5 | mA |
| | | | 3.5 | - | 4.75 | V |
| | | | | | | |
| I/O level adapter supply; pin V_{IO} [1] | | | | | | |
| V _{IO} | supply voltage on pin V _{IO} | | 2.8 | - | 5.5 | V |
| I _{IO} | supply current on pin V _{IO} | Standby mode; V _{TXD} = V _{IO} [3] | 5 | - | 14 | μA |
| | | Normal mode | | | | |
| | | recessive; V _{TXD} = V _{IO} [3] | 15 | 80 | 200 | μA |
| V _{uvd(VIO)} | undervoltage detection voltage on pin V _{IO} | dominant; V _{TXD} = 0 V | - | 350 | 1000 | μA |
| | | | 1.3 | 2.0 | 2.7 | V |
| Standby mode control input; pin STB | | | | | | |
| V _{IH} | HIGH-level input voltage | [4] | 0.7V _{IO} [3] | - | V _{IO} + 0.3 | V |
| V _{IL} | LOW-level input voltage | | -0.3 | - | 0.3V _{IO} [3] | V |
| I _{IH} | HIGH-level input current | V _{STB} = V _{IO} [3] | -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 | [4] | 0.7V _{IO} [3] | - | V _{IO} [3] + 0.3 | V |
| V _{IL} | LOW-level input voltage | | -0.3 | - | 0.3V _{IO} [3] | V |
| I _{IH} | HIGH-level input current | V _{TXD} = V _{IO} [3] | -5 | - | +5 | μA |
| I _{IL} | LOW-level input current | V _{TXD} = 0 V | -260 | -150 | -30 | μA |
| C _i | input capacitance | [5] | - | 5 | 10 | pF |
| CAN receive data output; pin RXD | | | | | | |
| I _{OH} | HIGH-level output current | TJA1049T or TJA1049TK; V _{RXD} = V _{CC} - 0.4 V | -8 | -3 | -1 | mA |
| | | TJA1049T/3 or TJA1049TK/3; V _{RXD} = V _{IO} - 0.4 V | -9 | -3 | -1 | 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 V ; $V_{IO} = 2.8\text{ V}$ to 5.5 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 |
|--------------------------------------|--|---|-------------------------|--------------|--------------|------------------|
| I_{OL} | LOW-level output current | $V_{RXD} = 0.4\text{ V}$; bus dominant | 1 | - | 12 | mA |
| Bus lines; pins CANH and CANL | | | | | | |
| $V_{O(dom)}$ | 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 | $V_{TXsym} = V_{CANH} + V_{CANL}$; $C_{SPLIT} = 4.7\text{ nF}$; $f_{TXD} = 250\text{ kHz}$, 1 MHz and 2.5 MHz | 0.9 V_{CC} [5] [6] | - | 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 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 | $-12\text{ V} \leq V_{CANL} \leq +12\text{ V}$; $-12\text{ V} \leq V_{CANH} \leq +12\text{ V}$ | | | | |
| | | Normal mode | -4 | - | 0.5 | V |
| | | Standby mode | -4 | - | 0.4 | V |
| $V_{dom(RX)}$ | receiver dominant voltage | $-12\text{ V} \leq V_{CANL} \leq +12\text{ V}$; $-12\text{ V} \leq V_{CANH} \leq +12\text{ V}$ | | | | |
| | | Normal mode | 0.9 | - | 9.0 | V |
| | | Standby mode | 1.15 | - | 9.0 | 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; $V_{CANH} = -15\text{ V}$ to $+40\text{ V}$ | -100 | -70 | -40 | mA |
| | | pin CANL; $V_{CANL} = -15\text{ V}$ 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 $V_{CC} = V_{IO} =$ shorted to GND via $47\text{ k}\Omega$; $V_{CANH} = V_{CANL} = 5\text{ V}$ | -3 | - | +3 | μA |
| R_i | input resistance | $-2\text{ V} \leq V_{CANL} \leq +7\text{ V}$; $-2\text{ V} \leq V_{CANH} \leq +7\text{ V}$ | 9 | 15 | 28 | $\text{k}\Omega$ |

Table 7. Static characteristics ...continued

$T_{vj} = -40\text{ °C to }+150\text{ °C}$; $V_{CC} = 4.75\text{ V to }5.25\text{ V}$; $V_{IO} = 2.8\text{ V to }5.5\text{ V}$ ^[1]; $R_L = 60\ \Omega$ 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 |
|--|--------------------------------|--|------------------|-------------|--------------|--------------------|
| ΔR_i | input resistance deviation | $0\text{ V} \leq V_{CANL} \leq +5\text{ V}$; $0\text{ V} \leq V_{CANH} \leq +5\text{ V}$ | -3 | - | +3 | % |
| $R_{i(dif)}$ | differential input resistance | $-2\text{ V} \leq V_{CANL} \leq +7\text{ V}$; $-2\text{ V} \leq V_{CANH} \leq +7\text{ V}$ | 19 | 30 | 52 | k Ω |
| $C_{i(cm)}$ | common-mode input capacitance | | ^[5] - | - | 20 | pF |
| $C_{i(dif)}$ | differential input capacitance | | ^[5] - | - | 10 | pF |
| Common mode stabilization output, pin SPLIT; only relevant for TJA1049T and TJA1049TK | | | | | | |
| V_O | output voltage | Normal mode; $I_{SPLIT} = -500\ \mu\text{A to }+500\ \mu\text{A}$ | $0.3V_{CC}$ | $0.5V_{CC}$ | $0.7V_{CC}$ | 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 | μA |
| Temperature detection | | | | | | |
| $T_{j(sd)}$ | 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

$T_{vj} = -40\text{ °C to }+150\text{ °C}$; $V_{CC} = 4.75\text{ V to }5.25\text{ V}$; $V_{IO} = 2.8\text{ V to }5.5\text{ V}$ ^[1]; $R_L = 60\ \Omega$ 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 |
|--|--------------------------------------|---|-----|-----|-----|------|
| Transceiver timing; pins CANH, CANL, TXD and RXD; see Figure 9 and Figure 5 | | | | | | |
| $t_{d(TXD-busdom)}$ | 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 |

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 V ; $V_{IO} = 2.8\text{ V}$ to 5.5 V ^[1]; $R_L = 60\ \Omega$ 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 |
|---|-----------------------------------|--|--------------------|-----|-----|---------------|
| $t_{d(\text{TXDH-RXDH})}$ | 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 |
| $t_{\text{bit}(\text{bus})}$ | transmitted recessive bit width | $t_{\text{bit}(\text{TXD})} = 500\text{ ns}$ | ^[3] 435 | - | 530 | ns |
| | | $t_{\text{bit}(\text{TXD})} = 200\text{ ns}$ | ^[3] 155 | - | 210 | ns |
| $t_{\text{bit}(\text{RXD})}$ | bit time on pin RXD | $t_{\text{bit}(\text{TXD})} = 500\text{ ns}$ | ^[3] 400 | - | 550 | ns |
| | | $t_{\text{bit}(\text{TXD})} = 200\text{ ns}$ | ^[3] 120 | - | 220 | ns |
| Δt_{rec} | receiver timing symmetry | $t_{\text{bit}(\text{TXD})} = 500\text{ ns}$ | -65 | - | +40 | ns |
| | | $t_{\text{bit}(\text{TXD})} = 200\text{ ns}$ | -45 | - | +15 | ns |
| $t_{\text{to}(\text{dom})\text{TXD}}$ | TXD dominant time-out time | $V_{\text{TXD}} = 0\text{ V}$; Normal mode | ^[4] 0.3 | 2 | 5 | ms |
| $t_{\text{to}(\text{dom})\text{bus}}$ | bus dominant time-out time | Standby mode | 0.3 | 2 | 5 | ms |
| $t_{\text{ftr}(\text{wake})\text{bus}}$ | bus wake-up filter time | version with SPLIT pin; Standby mode | 0.5 | 1 | 3 | μs |
| | | versions with V_{IO} pin; Standby mode | 0.5 | 1.5 | 5 | μs |
| $t_{\text{d}(\text{stb-norm})}$ | standby to normal mode delay time | | 7 | 25 | 47 | μs |

- [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](#).
- [4] Minimum value of 0.8 ms required according to SAE J2284; 0.3 ms is allowed according to ISO11898-2:2016 for legacy devices.

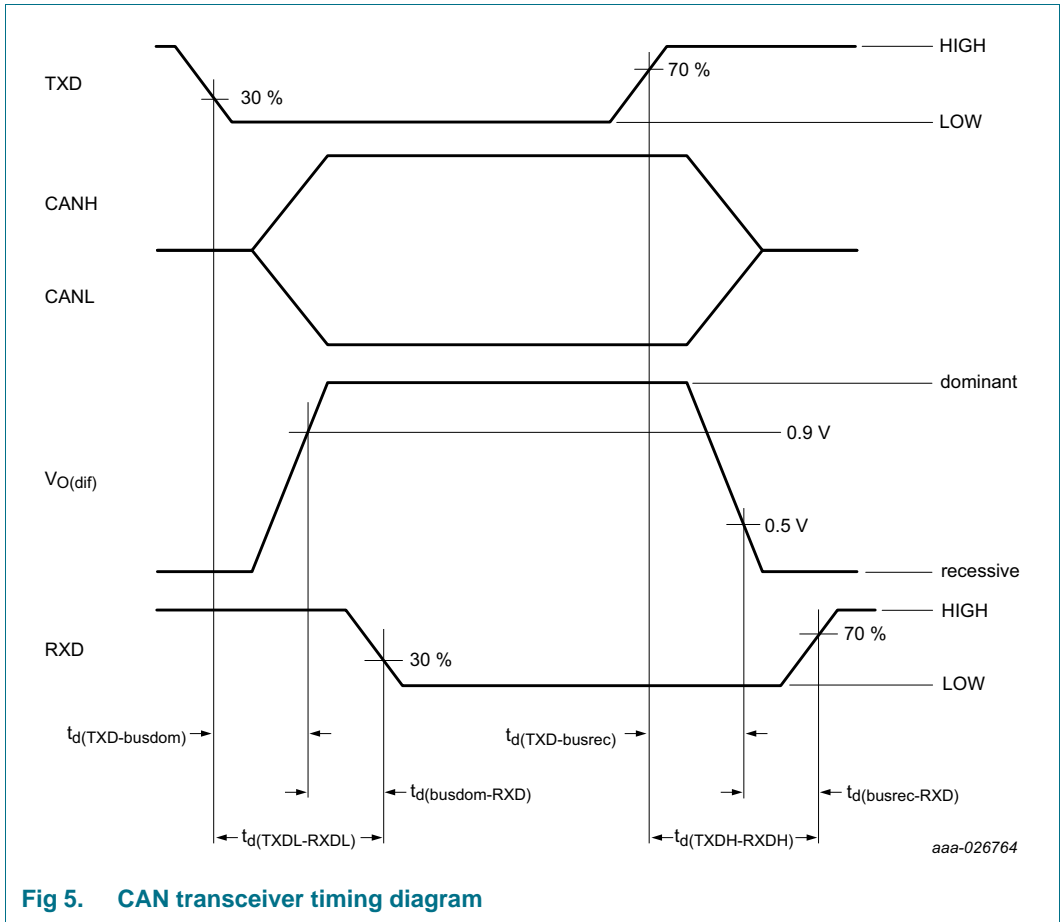


Fig 5. CAN transceiver timing diagram

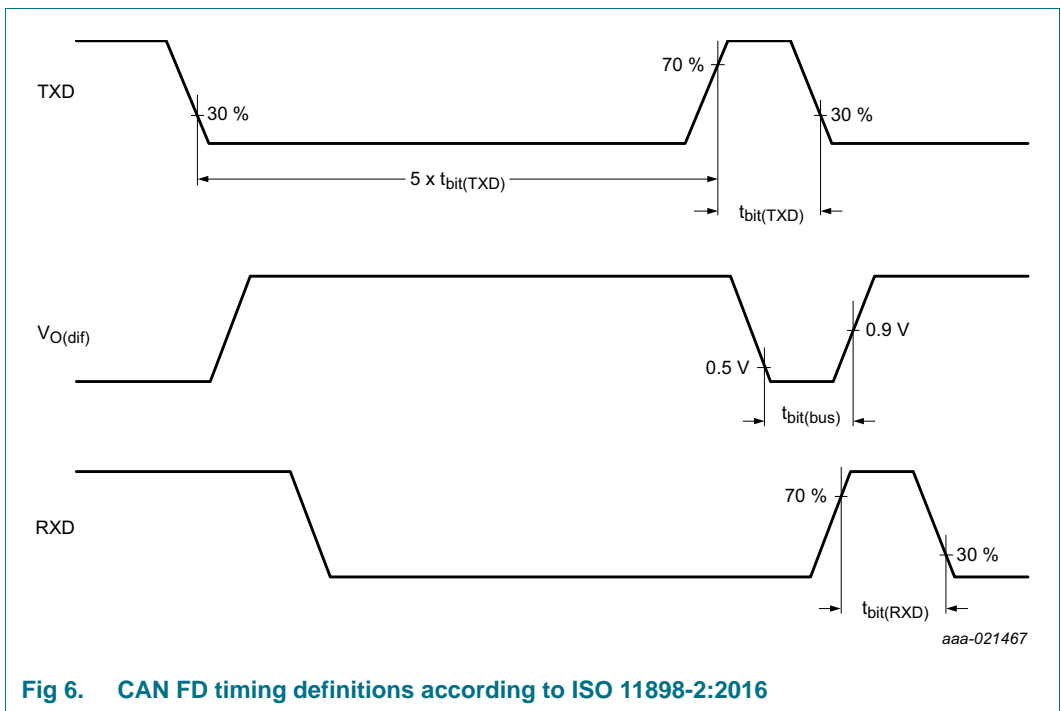
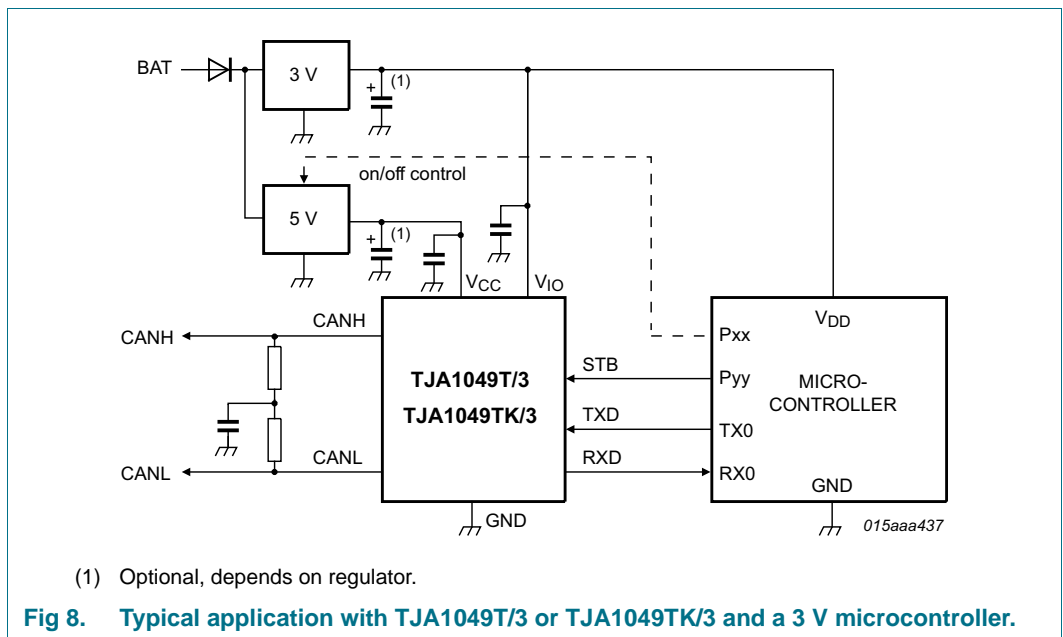
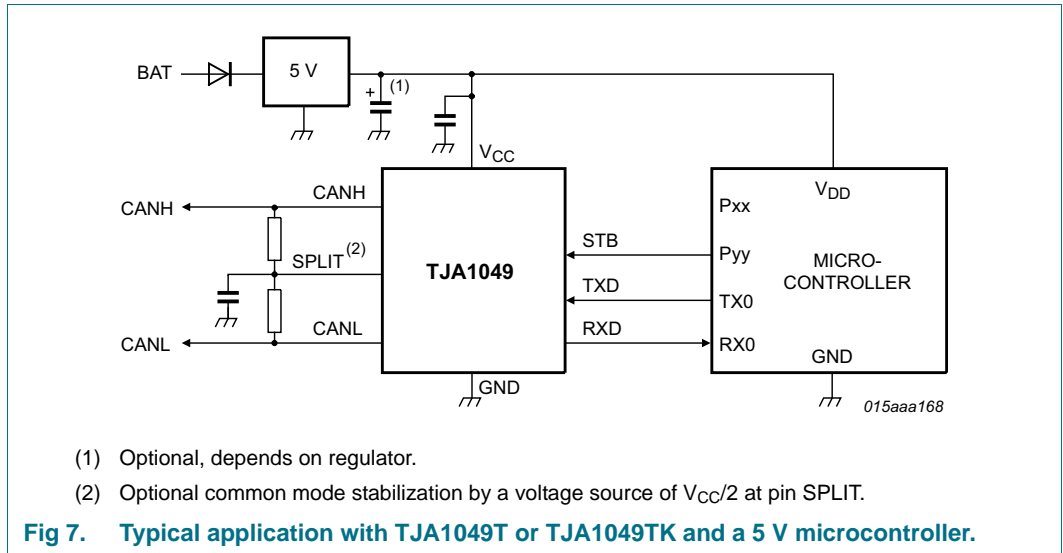


Fig 6. CAN FD timing definitions according to ISO 11898-2:2016

12. Application information

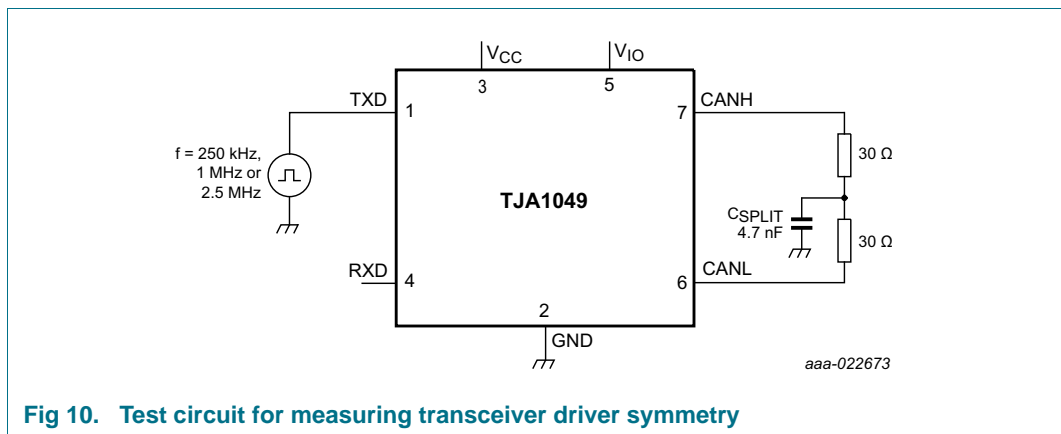
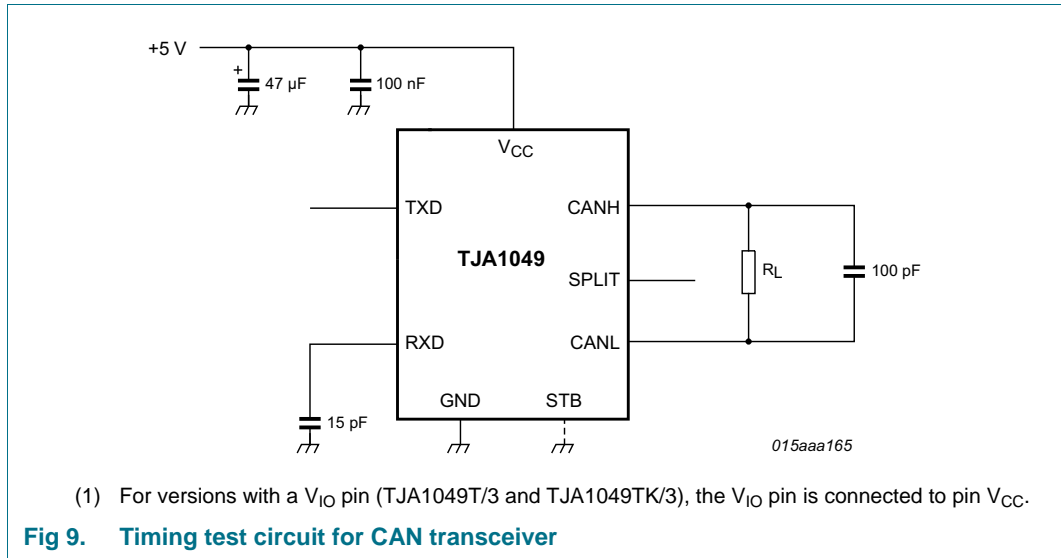
12.1 Application diagrams



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



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

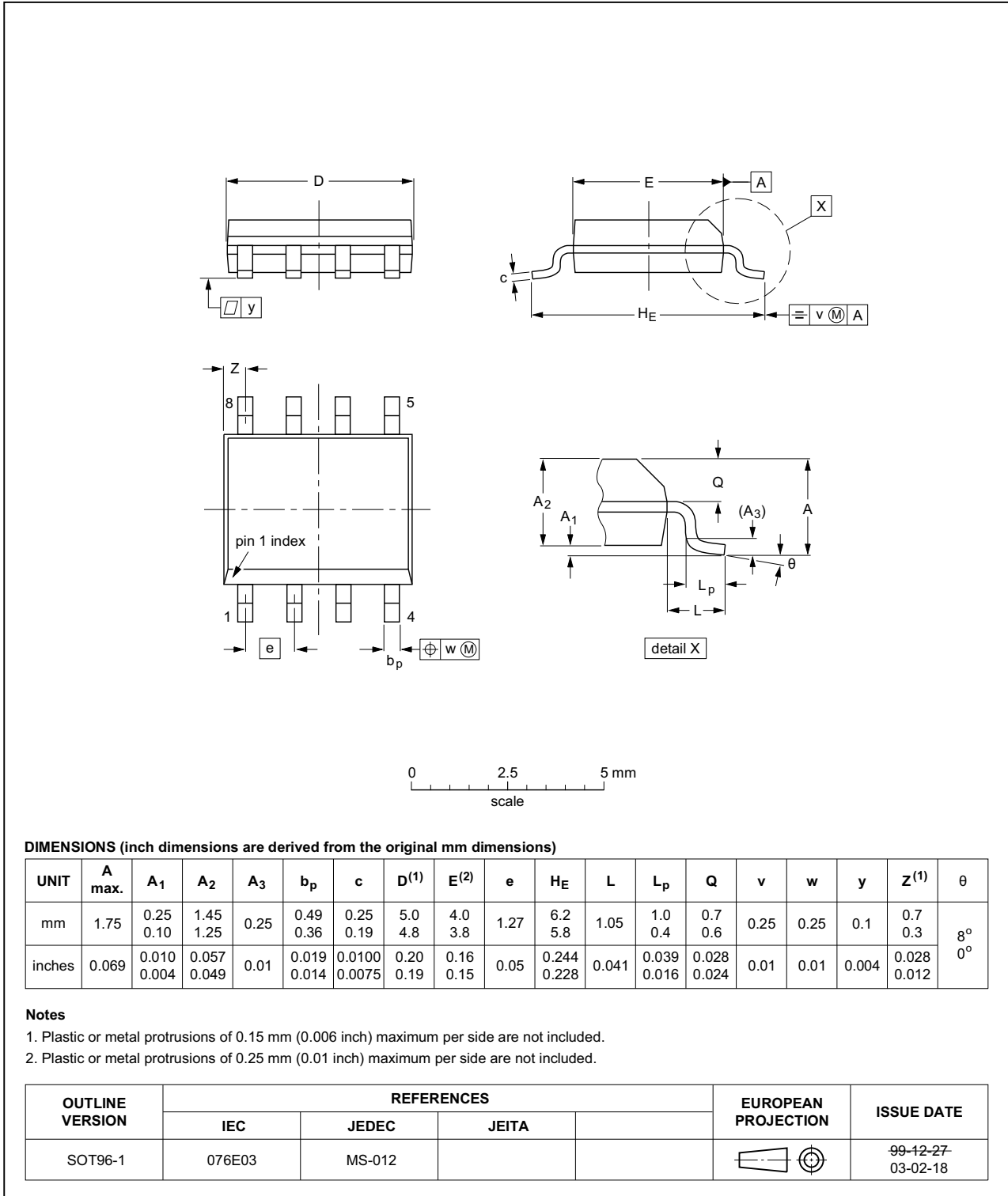


Fig 11. Package outline SOT96-1 (SO8)

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

SOT782-1

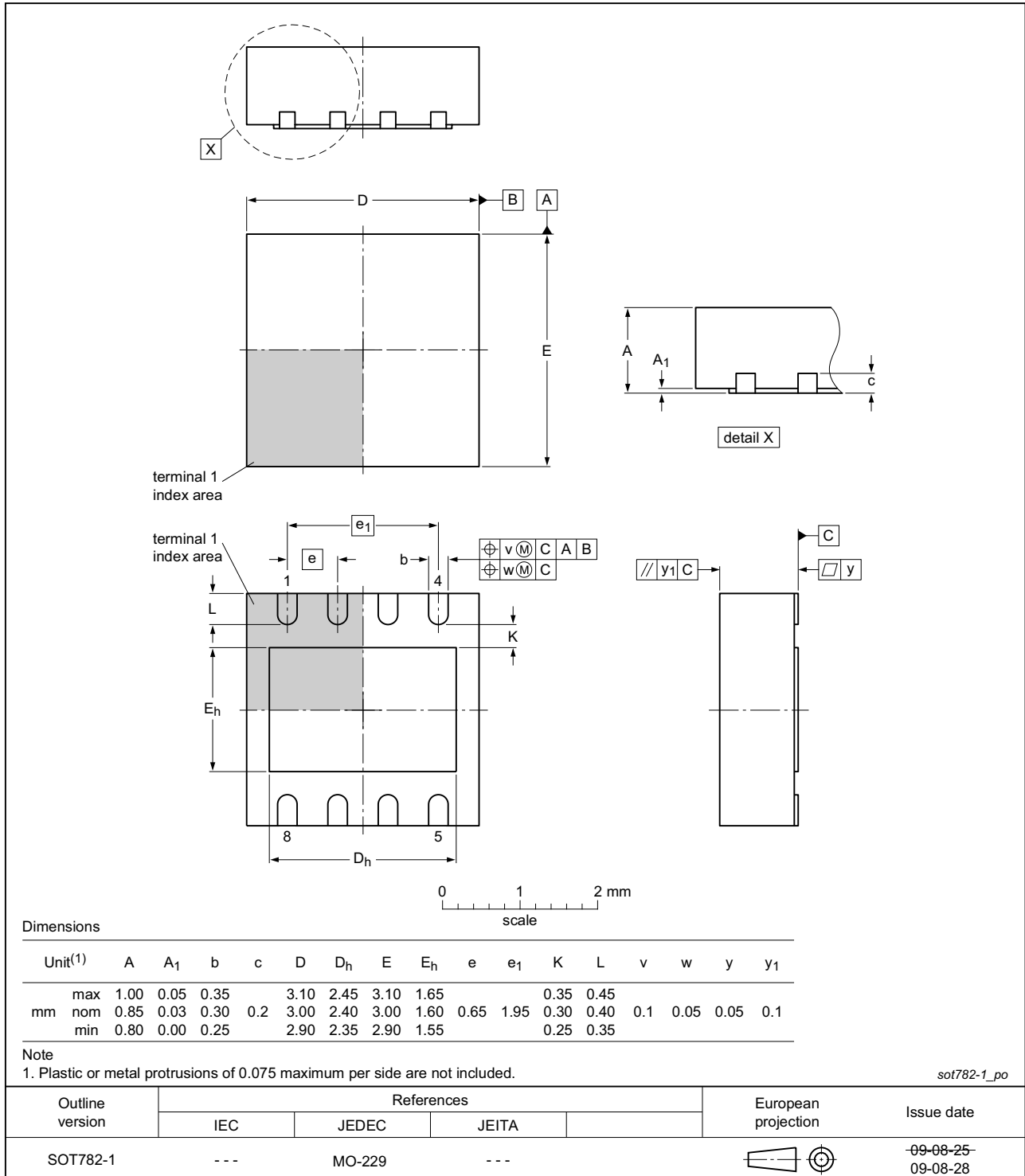


Fig 12. Package outline SOT782-1 (HVSON8)

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)

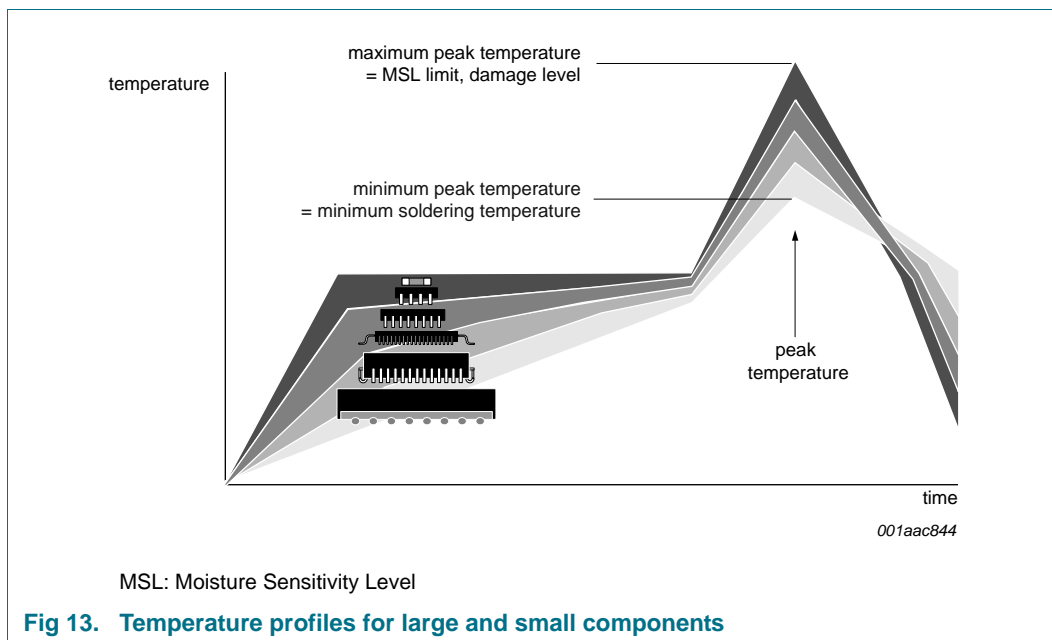
| Package thickness (mm) | Package reflow temperature (°C) | |
|------------------------|---------------------------------|-------|
| | Volume (mm ³) | |
| | < 350 | ≥ 350 |
| < 2.5 | 235 | 220 |
| ≥ 2.5 | 220 | 220 |

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 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 |
| HS-PMA dominant output characteristics | | | |
| 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 | | | |
| HS-PMA driver symmetry | | | |
| Driver symmetry | V_{SYM} | V_{TXsym} | transmitter voltage symmetry |
| Maximum HS-PMA driver output current | | | |
| 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} | | |
| HS-PMA recessive output characteristics, bus biasing active/inactive | | | |
| 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 |
| Optional HS-PMA transmit dominant timeout | | | |
| Transmit dominant timeout, long | t_{dom} | $t_{to(dom)TXD}$ | TXD dominant time-out time |
| Transmit dominant timeout, short | | | |
| HS-PMA static receiver input characteristics, bus biasing active/inactive | | | |
| 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 |
| HS-PMA receiver input resistance (matching) | | | |
| 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 | ΔR_i | input resistance deviation |
| HS-PMA implementation loop delay requirement | | | |
| 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 |
| 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 | | | |
| 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 | Δt_{Rec} | Δt_{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 |
| HS-PMA maximum ratings of V_{CAN_H}, V_{CAN_L} and V_{Diff} | | | |
| Maximum rating V_{Diff} | V_{Diff} | $V_{(CANH-CANL)}$ | voltage between pin CANH and pin CANL |
| General maximum rating V_{CAN_H} and V_{CAN_L} | V_{CAN_H} | V_x | voltage on pin x |
| Optional: Extended maximum rating V_{CAN_H} and V_{CAN_L} | V_{CAN_L} | | |
| HS-PMA maximum leakage currents on CAN_H and CAN_L, unpowered | | | |
| Leakage current on CAN_H, CAN_L | I_{CAN_H} I_{CAN_L} | I_L | leakage current |
| HS-PMA bus biasing control timings | | | |
| CAN activity filter time, long | t_{Filter} | $t_{wake(busdom)}$ ^[1] | bus dominant wake-up time |
| CAN activity filter time, short | | $t_{wake(busrec)}$ ^[1] | bus recessive wake-up time |
| Wake-up timeout, short | t_{Wake} | $t_{to(wake)bus}$ | bus wake-up time-out time |
| Wake-up timeout, long | | | |
| Timeout for bus inactivity | $t_{Silence}$ | $t_{to(silence)}$ | bus silence time-out time |
| Bus Bias reaction time | t_{Bias} | $t_{d(busact-bias)}$ | delay time from bus active to bias |

[1] $t_{filtr(wake)bus}$ - 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.6 | 20170115 | Product data sheet | - | TJA1049 v.5.01 |
| Modifications: | <ul style="list-style-type: none"> • Updated to comply with ISO 11898-2:2016 and SAE J22884-1 through SAE J2284-5 specifications: <ul style="list-style-type: none"> – Section 1: text amended (2nd last paragraph) – Section 2.1: text amended (1st entry) – Section 7.1.2: text amended (1st paragraph) – Table 7: values/conditions changed for parameters I_{CC}, V_{TXsym}, $V_{rec(RX)}$, $V_{dom(RX)}$, $I_{O(sc)dom}$; measurement conditions added to parameters R_i, ΔR_i and $R_{i(dif)}$; – Table 7: additional measurements taken at $f_{TXD} = 1$ MHz and 2.5 MHz for parameter V_{TXsym}; see Figure 10 – Table 8: Table note 4 added – Figure 6: title changed • Section 7.2.2 added • Table 8: parameter $t_{to(dom)bus}$ added • Amended Figure 5, Figure 7, Figure 8 and Figure 10 | | | |
| TJA1049 v.5.01 | 20160523 | Product data sheet | - | TJA1049 v.4 |
| 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 ^{[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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