



# TJA1044

## High-speed CAN transceiver with Standby mode

Rev. 7 — 16 January 2023

Product data sheet

## 1 General description

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The TJA1044 is part of the Mantis family of high-speed CAN transceivers. It provides an interface between a Controller Area Network (CAN) protocol controller and the physical two-wire CAN bus. The transceiver is designed for high-speed CAN applications in the automotive industry, providing the differential transmit and receive capability to (a microcontroller with) a CAN protocol controller.

The TJA1044 offers a feature set optimized for 12 V automotive applications, with significant improvements over NXP's first- and second-generation CAN transceivers, such as the TJA1040 and TJA1042, and excellent ElectroMagnetic Compatibility (EMC) performance. Additionally, the TJA1044 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
- Excellent EMC performance, even without a common mode choke
- Variants with a  $V_{IO}$  pin can be interfaced directly with microcontrollers with supply voltages from 3.3 V to 5 V

These features make the TJA1044 an excellent choice for all types of HS-CAN, in nodes that require a low-power mode with wake-up capability via the CAN bus.

The TJA1044 implements the CAN physical layer as defined in ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5. The TJA1044T is specified for data rates up to 1 Mbit/s. Additional timing parameters defining loop delay symmetry are specified for the other variants. This implementation enables reliable communication in the CAN FD fast phase at data rates up to 5 Mbit/s. The TJA1044B and TJA1044C feature shorter propagation delay, supporting larger network topologies.

## 2 Features and benefits

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### 2.1 General

- Fully ISO 11898-2:2016, SAE J2284-1 to SAE J2284-5 and SAE J1939-14 compliant
- Very low-current Standby mode with local and bus wake-up capability
- Optimized for use in 12 V automotive systems
- Low Electromagnetic Emission (EME) and high Electromagnetic Immunity (EMI), according to proposed EMC Standards IEC 62228-3 and SAE J2962-2
- AEC-Q100 qualified
- Dark green product (halogen free and Restriction of Hazardous Substances (RoHS) compliant)
- Variants with a  $V_{IO}$  pin allow for direct interfacing with 3.3 V to 5 V microcontrollers. Variants without a  $V_{IO}$  pin can interface with 3.3 V (except TJA1044C) and 5 V-supplied microcontrollers, provided the microcontroller I/Os are 5 V tolerant.



- Shorter propagation delay on the TJA1044B and TJA1044C variants supports larger network topologies (see [Table 8](#))
- Both  $V_{IO}$  and non- $V_{IO}$  variants are available in SO8 and leadless HVSON8 (3.0 mm × 3.0 mm) packages; HVSON8 with improved Automated Optical Inspection (AOI) capability.

## 2.2 Predictable and fail-safe behavior

- Functional behavior predictable under all supply conditions
- Transceiver disengages from the bus (high-ohmic) when the supply voltage drops below the switch-off undervoltage threshold
- Transmit Data (TXD) dominant time-out functions
- Internal biasing of TXD and STB input pins

## 2.3 Low-power management

- Very low-current Standby mode with host and bus wake-up capability
- Variants with  $V_{IO}$  pin: CAN wake-up receiver powered by  $V_{IO}$  allowing  $V_{CC}$  to be shut down
- Variants with  $V_{IO}$  pin and TJA1044C: CAN wake-up pattern filter time of 0.5  $\mu$ s to 1.8  $\mu$ s, meeting Classical CAN and CAN FD requirements

## 2.4 Protection

- High ESD handling capability on the bus pins (8 kV IEC and HBM)
- Bus pins protected against transients in automotive environments
- Undervoltage detection on pins  $V_{CC}$  and  $V_{IO}$
- Thermally protected

## 2.5 TJA1044 CAN FD (applicable to all product variants except TJA1044T)

- Timing guaranteed for CAN FD data rates up to 5 Mbit/s

### 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            |
| $I_{CC}$                | supply current  | Standby mode                         |      |     |      |              |
|                         |   | TJA1044T, GT, GTK                    | -    | 10  | 15   | $\mu$ A      |
|                         |   | TJA1044C                             | -    | 10  | 17.5 | $\mu$ A      |
|                         |   | variants with a $V_{IO}$ pin         | -    | 0.1 | 1    | $\mu$ A      |
|                         |   | Normal mode                          |      |     |      |              |
|                         |   | bus recessive                        | 2    | 5   | 10   | mA           |
|                         | bus dominant  | 20                                   | 45   | 60  | mA   |              |
| $V_{uvd(stb)}(V_{CC})$  | standby undervoltage detection voltage on pin $V_{CC}$    |                                      | 3.5  | 4   | 4.3  | V            |
| $V_{uvd(swff)}(V_{CC})$ | switch-off undervoltage detection voltage on pin $V_{CC}$ | TJA1044T, GT, GTK                    | 1.3  | 2.4 | 3.4  | V            |
|                         |   | TJA1044C                             | 2.4  | 2.6 | 2.8  | V            |
| $V_{IO}$                | supply voltage on pin $V_{IO}$                            |                                      | 2.91 | -   | 5.5  | V            |
| $I_{IO}$                | supply current on pin $V_{IO}$                            | Standby mode                         | -    | 10  | 16.5 | $\mu$ A      |
|                         |   | Normal mode; bus recessive           | 10   | 17  | 30   | $\mu$ A      |
|                         |   | Normal mode; bus dominant            | -    | 170 | 300  | $\mu$ A      |
| $V_{uvd(swff)}(V_{IO})$ | switch-off undervoltage detection voltage on pin $V_{IO}$ | variants with a $V_{IO}$ pin         | 2.4  | 2.6 | 2.8  | V            |
| $V_{ESD}$               | electrostatic discharge voltage                           | IEC 61000-4-2 at pins CANH and CANL  | -8   | -   | +8   | kV           |
| $V_{CANH}$              | voltage on pin CANH                                       | limiting value according to IEC60134 | -42  | -   | +42  | V            |
| $V_{CANL}$              | voltage on pin CANL                                       | limiting value according to IEC60134 | -42  | -   | +42  | V            |
| $T_{vj}$                | virtual junction temperature                              |                                      | -40  | -   | +150 | $^{\circ}$ C |

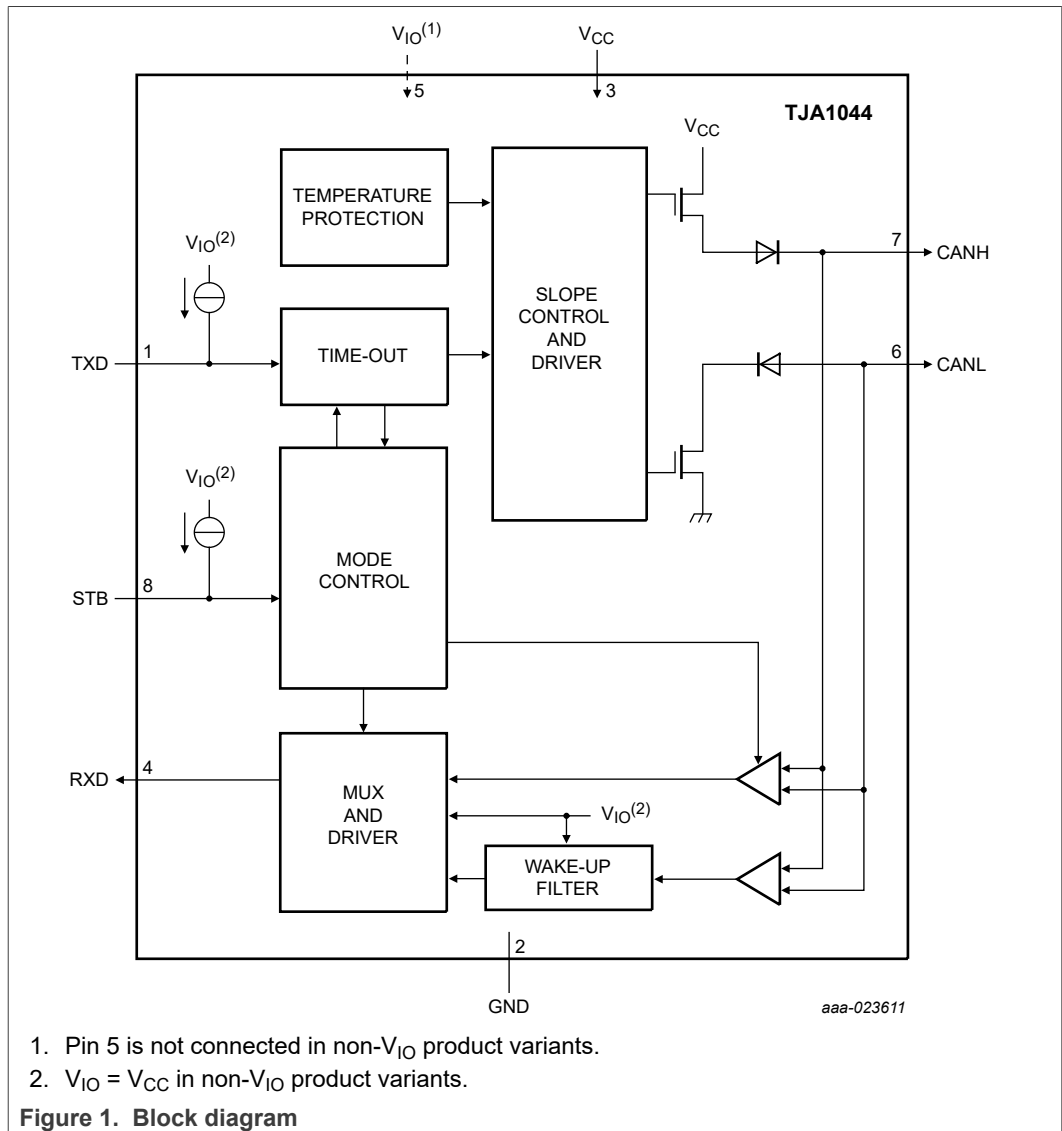
### 4 Ordering information

Table 2. Ordering information

| Type number <sup>[1]</sup>                                     | Package |   |          |
|--|---------|---|----------|
|  | Name    | Description   | Version  |
| TJA1044T<br>TJA1044BT<br>TJA1044CT<br>TJA1044GT<br>TJA1044GT/3 | SO8     | plastic small outline package; 8 leads; body width 3.9 mm   | SOT96-1  |
| TJA1044BTK<br>TJA1044CTK<br>TJA1044GTK<br>TJA1044GTK/3         | HVSON8  | plastic thermal enhanced very thin small outline package; no leads; 8 terminals; body 3 × 3 × 0.85 mm | SOT782-1 |

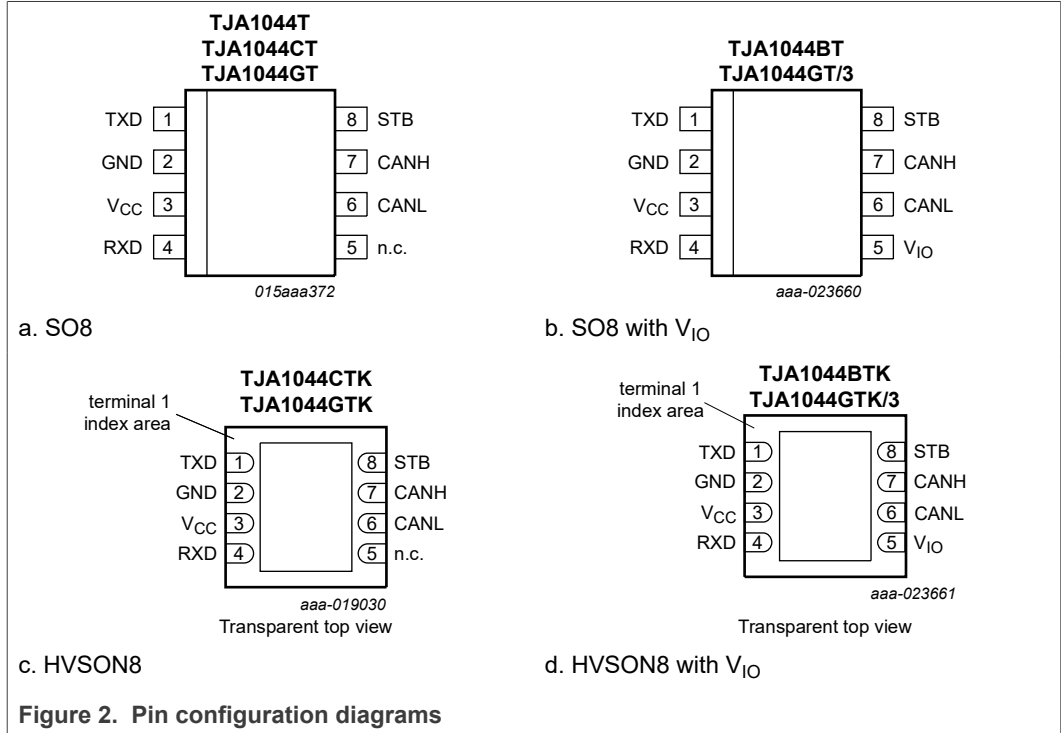
[1] TJA1044BT(K) and TJA1044GT(K)/3 with  $V_{IO}$  pin; all variants other than TJA1044T support CAN FD.

5 Block diagram



## 6 Pinning information

### 6.1 Pinning



### 6.2 Pin description

Table 3. Pin description

| Symbol             | Pin | Type <sup>[1]</sup> | Description  |
|--------------------|-----|---------------------|--|
| TXD                | 1   | I                   | transmit data input  |
| GND <sup>[2]</sup> | 2   | G                   | ground supply  |
| V <sub>CC</sub>    | 3   | P                   | supply voltage   |
| RXD                | 4   | O                   | receive data output; reads out data from the bus lines                         |
| n.c.               | 5   | -                   | not connected; TJA1044T, TJA1044CT(K) and TJA1044GT(K) variants                |
| V <sub>IO</sub>    | 5   | P                   | supply voltage for I/O level adapter; TJA1044BT(K) and TJA1044GT(K)/3 variants |
| CANL               | 6   | AIO                 | LOW-level CAN bus line   |
| CANH               | 7   | AIO                 | HIGH-level CAN bus line  |
| STB                | 8   | I                   | Standby mode control input   |

[1] I: digital input; O: digital output; AIO: analog input/output; P: power supply; G: ground.

[2] 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

### 7.1 Operating modes

The TJA1044 supports two operating modes, Normal and Standby. The operating mode is selected via pin STB. See [Table 4](#) for a description of the operating modes under normal supply conditions.

Table 4. Operating modes

| Mode    | Inputs  |                  | Outputs          |  |
|---------|---------|------------------|------------------|--|
|         | Pin STB | Pin TXD          | CAN driver       | Pin RXD  |
| Normal  | LOW     | LOW              | dominant         | LOW  |
|         |         | HIGH             | recessive        | LOW when bus dominant<br>HIGH when bus recessive                   |
| Standby | HIGH    | x <sup>[1]</sup> | biased to ground | follows BUS when wake-up detected<br>HIGH when no wake-up detected |

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

#### 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.

In Standby mode, the bus lines are biased to ground to minimize system supply current. The low-power receiver is supplied from V<sub>IO</sub> (V<sub>CC</sub> in non-V<sub>IO</sub> variants) and can detect CAN bus activity even if V<sub>IO</sub> is the only available supply voltage. Pin RXD follows the bus after a wake-up request has been detected. A transition to Normal mode is triggered when STB is forced LOW.

### 7.2 Remote wake-up (via the CAN bus)

The TJA1044 wakes up from Standby mode when a dedicated wake-up pattern (specified in ISO 11898-2:2016) is detected on the bus. This filtering helps avoid spurious wake-up events. A spurious wake-up sequence could be triggered by, for example, a dominant clamped bus or by dominant phases due to noise or spikes on the bus.

The wake-up pattern consists of:

- a dominant phase of at least t<sub>wake(busdom)</sub> followed by

- a recessive phase of at least  $t_{wake(busrec)}$  followed by
- a dominant phase of at least  $t_{wake(busdom)}$

Dominant or recessive bits between the above mentioned phases that are shorter than  $t_{wake(busdom)}$  and  $t_{wake(busrec)}$  respectively are ignored.

The complete dominant-recessive-dominant pattern must be received within  $t_{to(wake)bus}$  to be recognized as a valid wake-up pattern (see Figure 3). Otherwise, the internal wake-up logic is reset. The complete wake-up pattern will then need to be retransmitted to trigger a wake-up event. Pin RXD remains HIGH until the wake-up event has been triggered.

After a wake-up sequence has been detected, the TJA1044 will remain in Standby mode with the bus signals reflected on RXD. Note that dominant or recessive phases lasting less than  $t_{fltr(wake)bus}$  will not be detected by the low-power differential receiver and will not be reflected on RXD in Standby mode.

A wake-up event is not flagged on RXD if any of the following events occurs while a valid wake-up pattern is being received:

- The TJA1044 switches to Normal mode
- The complete wake-up pattern was not received within  $t_{to(wake)bus}$
- A  $V_{CC}$  or  $V_{IO}$  undervoltage is detected ( $V_{CC} < V_{uvd(swoff)}(V_{CC})$  or  $V_{IO} < V_{uvd(swoff)}(V_{IO})$ ; see Section 7.3.3)

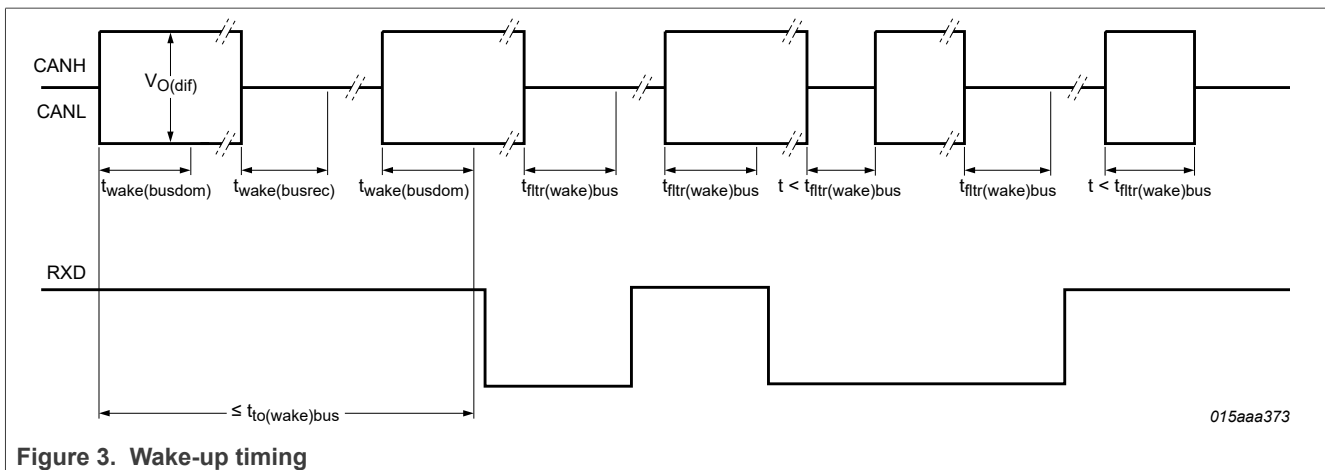


Figure 3. Wake-up timing

## 7.3 Fail-safe features

### 7.3.1 TXD dominant time-out function

A 'TXD dominant time-out' timer is started when pin TXD is set LOW. If the LOW state on this pin persists for longer than  $t_{to(dom)TXD}$ , the transmitter is disabled, releasing the bus lines to recessive state. This function prevents a hardware and/or software application failure from driving the bus lines to a permanent dominant state (blocking all network communications). The TXD dominant time-out timer is reset when pin TXD is set HIGH.

### 7.3.2 Internal biasing of TXD and STB input pins

Pins TXD and STB have internal pull-ups to  $V_{CC}$  ( $V_{IO}$  for variants with a  $V_{IO}$  pin) to ensure a safe, defined state in case one or both of these pins are left floating. Pull-up

currents flow in these pins in all states; both pins should be held HIGH in Standby mode to minimize supply current.

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

If  $V_{CC}$  drops below the standby undervoltage detection level,  $V_{uvd(stb)(VCC)}$ , the transceiver switches to Standby mode. The logic state of pin STB is ignored until  $V_{CC}$  has recovered.

In versions with a  $V_{IO}$  pin, if  $V_{IO}$  drops below the switch-off undervoltage detection level ( $V_{uvd(swoff)(VIO)}$ ), the transceiver switches off and disengages from the bus (zero load) until  $V_{IO}$  has recovered.

In versions without a  $V_{IO}$  pin, if  $V_{CC}$  drops below the switch-off undervoltage detection level ( $V_{uvd(swoff)(VCC)}$ ), the transceiver switches off and disengages from the bus (zero load) until  $V_{CC}$  has recovered.

### 7.3.4 Overtemperature protection

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

## 7.4 $V_{IO}$ supply pin (TJA1044GT(K)/3 and TJA1044BT(K) variants)

Pin  $V_{IO}$  should be connected to the microcontroller supply voltage (see [Figure 7](#)). 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 in 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 variants of the TJA1044 without a  $V_{IO}$  pin, all circuitry is connected to  $V_{CC}$  (pin 5 is not bonded). The signal levels of pins TXD, RXD and STB are then compatible with 5 V microcontrollers. This allows the device to interface with both 3.3 V (except TJA1044C) and 5 V-supplied microcontrollers, provided the microcontroller I/Os are 5 V tolerant.



## 8 Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134); all voltages are referenced to ground.

| Symbol                   | Parameter                             | Conditions   | Min  | Max                                  | Unit |
|--------------------------|---------------------------------------|--|------|--------------------------------------|------|
| V <sub>x</sub>           | voltage on pin x <sup>[1]</sup>       | on pins CANH, CANL   | -42  | +42                                  | V    |
|                          |                                       | on pin V <sub>CC</sub> , V <sub>IO</sub>                       | -0.3 | +7                                   | V    |
|                          |                                       | on any other pin <sup>[2]</sup>                                | -0.3 | V <sub>IO</sub> + 0.3 <sup>[3]</sup> | 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 and CANL <sup>[4]</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 discharge circuit) <sup>[5]</sup> |      |                                      |      |
|                          |                                       | on pins CANH and CANL  | -8   | +8                                   | kV   |
|                          |                                       | Human Body Model (HBM)   |      |                                      |      |
|                          |                                       | on any pin <sup>[6]</sup>                                      | -4   | +4                                   | kV   |
|                          |                                       | on pins CANH and CANL <sup>[7]</sup>                           | -8   | +8                                   | kV   |
|                          |                                       | Machine Model (MM); 200 pF, 0.75 μH, 10 Ω <sup>[8]</sup>       |      |                                      |      |
|                          |                                       | on any pin   | -200 | +200                                 | V    |
|                          |                                       | Charged Device Model (CDM) <sup>[9]</sup>                      |      |                                      |      |
|                          |                                       | on corner pins   | -750 | +750                                 | V    |
| on any other pin         | -500                                  | +500   | V    |                                      |      |
| T <sub>vj</sub>          | virtual junction temperature          | <sup>[10]</sup>  | -40  | +150                                 | °C   |
| T <sub>stg</sub>         | storage temperature                   | <sup>[11]</sup>  | -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] Maximum voltage should never exceed 7 V.

[3] V<sub>CC</sub> + 0.3 in the non-V<sub>IO</sub> product variants.

[4] Verified by an external test house according to IEC TS 62228, Section 4.2.4; parameters for standard pulses defined in ISO 7637.

[5] Verified by an external test house according to IEC TS 62228, Section 4.3.

[6] According to AEC-Q100-002.

[7] Pins stressed to reference group containing all ground and supply pins, emulating the application circuits ([Figure 6](#) and [Figure 7](#)). HBM pulse as specified in AEC-Q100-002 used.

[8] According to AEC-Q100-003.

[9] According to AEC-Q100-011.

[10] 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 ( $T_{amb}$ ).

[11]  $T_{stg}$  in application according to IEC61360-4. For component transport and storage conditions, see instead IEC61760-2.

## 9 Thermal characteristics

**Table 6. Thermal characteristics**

Value determined for free convection conditions on a JEDEC 2S2P board.

| Symbol               | Parameter  | Conditions <sup>[1]</sup>   | Typ | Unit |
|----------------------|--|-----------------------------|-----|------|
| R <sub>th(j-a)</sub> | thermal resistance from junction to ambient                        | SO8 package; in free air    | 94  | K/W  |
|                      |  | HVSON8 package; in free air | 54  | K/W  |
| R <sub>th(j-c)</sub> | thermal resistance from junction to case                           | HVSON8 package; in free air | 16  | K/W  |
| Ψ <sub>j-top</sub>   | thermal characterization parameter from junction to top of package | SO8 package; in free air    | 13  | K/W  |
|                      |  | HVSON8 package; in free air | 6   | K/W  |

[1] According to JEDEC JESD51-2, JESD51-5 and JESD51-7 at natural convection on 2s2p board. Board with two inner copper layers (thickness: 35 μm) and thermal via array under the exposed pad connected to the first inner copper layer (thickness: 70 μm).

## 10 Static characteristics

**Table 7. Static characteristics**

T<sub>vj</sub> = -40 °C to +150 °C; V<sub>CC</sub> = 4.5 V to 5.5 V; V<sub>IO</sub> = 2.91 V to 5.5 V<sup>[1]</sup>; R<sub>L</sub> = 60 Ω; C<sub>L</sub> = 100 pF unless otherwise specified; 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    |
| V <sub>uvd(stb)(VCC)</sub>  | standby undervoltage detection voltage on pin V <sub>CC</sub>    | <sup>[3]</sup>  | 3.5                | 4   | 4.3  | V    |
| V <sub>uvd(swoff)(VCC)</sub>  | switch-off undervoltage detection voltage on pin V <sub>CC</sub> | TJA1044T, GT, GTK   | <sup>[3]</sup> 1.3 | 2.4 | 3.4  | V    |
|   |  | TJA1044C  | <sup>[3]</sup> 2.4 | 2.6 | 2.8  | V    |
| I <sub>CC</sub>   | supply current   | Standby mode  |                    |     |      |      |
|   |  | TJA1044T, GT, GTK; V <sub>TXD</sub> = V <sub>CC</sub>                   | -                  | 10  | 15   | μA   |
|   |  | TJA1044C; V <sub>TXD</sub> = V <sub>CC</sub>                            | -                  | 10  | 17.5 | μA   |
|   |  | variants with a V <sub>IO</sub> pin; V <sub>TXD</sub> = V <sub>IO</sub> | -                  | 0.1 | 1    | μA   |
|   |  | Normal mode   |                    |     |      |      |
|   |  | recessive; V <sub>TXD</sub> = V <sub>IO</sub> <sup>[4]</sup>            | 2                  | 5   | 10   | mA   |
|   |  | dominant; V <sub>TXD</sub> = 0 V  | 20                 | 45  | 60   | mA   |
| dominant; V <sub>TXD</sub> = 0 V; short circuit on bus lines; -3 V < (V <sub>CANH</sub> = V <sub>CANL</sub> ) < +18 V | 2  | 80  | 110                | mA  |      |      |
| <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>                            |   | 2.91               | -   | 5.5  | V    |

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  $5.5\text{ V}$ ;  $V_{IO} = 2.91\text{ V}$  to  $5.5\text{ V}$ <sup>[1]</sup>;  $R_L = 60\text{ }\Omega$ ;  $C_L = 100\text{ pF}$  unless otherwise specified; all voltages are defined with respect to ground; positive currents flow into the IC.<sup>[2]</sup>

| Symbol                                     | Parameter   | Conditions   | Min         | Typ  | Max            | Unit          |
|--|---|--|-------------|------|----------------|---------------|
| $I_{IO}$                                   | supply current on pin $V_{IO}$                            | Standby mode; $V_{TXD} = V_{IO}$ <sup>[4]</sup>          | -           | 10   | 16.5           | $\mu\text{A}$ |
|  |   | Normal mode  |             |      |                |               |
|  |   | recessive; $V_{TXD} = V_{IO}$ <sup>[4]</sup>             | 10          | 17   | 30             | $\mu\text{A}$ |
|  |   | dominant; $V_{TXD} = 0\text{ V}$                         | -           | 170  | 300            | $\mu\text{A}$ |
| $V_{uvd(\text{swoff})(V_{IO})}$            | switch-off undervoltage detection voltage on pin $V_{IO}$ | variants with a $V_{IO}$ pin <sup>[3]</sup>              | 2.4         | 2.6  | 2.8            | V             |
| <b>Standby mode control input; pin STB</b> |   |  |             |      |                |               |
| $V_{IH}$                                   | HIGH-level input voltage                                  | variants with a $V_{IO}$ pin                             | $0.7V_{IO}$ | -    | $V_{IO} + 0.3$ | V             |
|  |   | TJA1044C   | $0.7V_{CC}$ | -    | $V_{CC} + 0.3$ | V             |
|  |   | TJA1044T, GT, GTK  | 2           | -    | $V_{CC} + 0.3$ | V             |
| $V_{IL}$                                   | LOW-level input voltage                                   | variants with a $V_{IO}$ pin                             | -0.3        | -    | $+0.3V_{IO}$   | V             |
|  |   | TJA1044C   | -0.3        | -    | $+0.3V_{CC}$   | V             |
|  |   | TJA1044T, GT, GTK  | -0.3        | -    | +0.8           | V             |
| $I_{IH}$                                   | HIGH-level input current                                  | $V_{STB} = V_{IO}$ <sup>[4]</sup>                        | -1          | -    | +1             | $\mu\text{A}$ |
| $I_{IL}$                                   | LOW-level input current                                   | $V_{STB} = 0\text{ V}$                                   | -15         | -    | -1             | $\mu\text{A}$ |
| <b>CAN transmit data input; pin TXD</b>    |   |  |             |      |                |               |
| $V_{IH}$                                   | HIGH-level input voltage                                  | variants with a $V_{IO}$ pin                             | $0.7V_{IO}$ | -    | $V_{IO} + 0.3$ | V             |
|  |   | TJA1044C   | $0.7V_{CC}$ | -    | $V_{CC} + 0.3$ | V             |
|  |   | TJA1044T, GT, GTK  | 2           | -    | $V_{CC} + 0.3$ | V             |
| $V_{IL}$                                   | LOW-level input voltage                                   | variants with a $V_{IO}$ pin                             | -0.3        | -    | $+0.3V_{IO}$   | V             |
|  |   | TJA1044C   | -0.3        | -    | $+0.3V_{CC}$   | V             |
|  |   | TJA1044T, GT, GTK  | -0.3        | -    | +0.8           | V             |
| $I_{IH}$                                   | HIGH-level input current                                  | $V_{TXD} = V_{IO}$ <sup>[4]</sup>                        | -5          | -    | +5             | $\mu\text{A}$ |
| $I_{IL}$                                   | LOW-level input current                                   | $V_{TXD} = 0\text{ V}$ ; variants with a $V_{IO}$ pin    | -270        | -150 | -60            | $\mu\text{A}$ |
|  |   | $V_{TXD} = 0\text{ V}$ ; variants without a $V_{IO}$ pin | -270        | -150 | -65            | $\mu\text{A}$ |
| $C_i$                                      | input capacitance   | <sup>[5]</sup>   | -           | 5    | 10             | pF            |
| <b>CAN receive data output; pin RXD</b>    |   |  |             |      |                |               |
| $I_{OH}$                                   | HIGH-level output current                                 | $V_{RXD} = V_{IO}$ <sup>[4]</sup> - 0.4 V                | -9          | -3   | -1             | mA            |
| $I_{OL}$                                   | LOW-level output current                                  | $V_{RXD} = 0.4\text{ V}$ ; bus dominant                  | 1           | -    | 12             | mA            |

Table 7. Static characteristics...continued

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.91\text{ V}$  to  $5.5\text{ V}$ <sup>[1]</sup>;  $R_L = 60\text{ }\Omega$ ;  $C_L = 100\text{ pF}$  unless otherwise specified; 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>Bus lines; pins CANH and CANL</b>  |  |   |  |              |              |      |  |
| $V_{O(\text{dom})}$                   | dominant output voltage                  | $V_{\text{TXD}} = 0\text{ V}$ ; $t < t_{\text{to}(\text{dom})\text{TXD}}$   |  |              |              |      |  |
|                                       |  | 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    |  |
| $V_{\text{dom}(\text{TX})\text{sym}}$ | transmitter dominant voltage symmetry    | $V_{\text{dom}(\text{TX})\text{sym}} = V_{CC} - V_{\text{CANH}} - V_{\text{CANL}}$  | -400   | -            | +400         | mV   |  |
| $V_{\text{TXsym}}$                    | transmitter voltage symmetry             | $V_{\text{TXsym}} = V_{\text{CANH}} + V_{\text{CANL}}$ ;<br>$f_{\text{TXD}} = 250\text{ kHz}$ , $1\text{ MHz}$ and $2.5\text{ MHz}$ ;<br>$C_{\text{SPLIT}} = 4.7\text{ nF}$ | <sup>[5]</sup><br><sup>[6]</sup><br>0.9 $V_{CC}$ | -            | 1.1 $V_{CC}$ | V    |  |
| $V_{O(\text{dif})}$                   | differential output voltage              | dominant; Normal mode;<br>$V_{\text{TXD}} = 0\text{ V}$ ; $t < t_{\text{to}(\text{dom})\text{TXD}}$   |  |              |              |      |  |
|                                       |  | $R_L = 50\text{ }\Omega$ to $65\text{ }\Omega$  | 1.5  | -            | 3            | V    |  |
|                                       |  | $R_L = 45\text{ }\Omega$ to $70\text{ }\Omega$  | 1.4  | -            | 3.3          | V    |  |
|                                       |  | $R_L = 2240\text{ }\Omega$  | 1.5  | -            | 5            | V    |  |
|                                       |  | recessive   |  |              |              |      |  |
|                                       |  | Normal mode: $V_{\text{TXD}} = V_{IO}$ <sup>[4]</sup> ;<br>no load  | -50  | -            | +50          | mV   |  |
| $V_{O(\text{rec})}$                   | recessive output voltage                 | Normal mode; $V_{\text{TXD}} = V_{IO}$ <sup>[4]</sup> ; no load   | 2  | 0.5 $V_{CC}$ | 3            | V    |  |
|                                       |  | Standby mode; no load   | -0.1   | -            | +0.1         | V    |  |
| $V_{\text{th}(\text{RX})\text{dif}}$  | differential receiver threshold voltage  | $-12\text{ V} \leq V_{\text{CANL}} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{\text{CANH}} \leq +12\text{ V}$  |  |              |              |      |  |
|                                       |  | Normal mode   | 0.5  | -            | 0.9          | V    |  |
|                                       |  | Standby mode  | 0.4  | -            | 1.15         | V    |  |
| $V_{\text{rec}(\text{RX})}$           | receiver recessive voltage               | $-12\text{ V} \leq V_{\text{CANL}} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{\text{CANH}} \leq +12\text{ V}$  |  |              |              |      |  |
|                                       |  | Normal mode <sup>[5]</sup>  | -4   | -            | +0.5         | V    |  |
|                                       |  | Standby mode <sup>[5]</sup>   | -4   | -            | +0.4         | V    |  |
| $V_{\text{dom}(\text{RX})}$           | receiver dominant voltage                | $-12\text{ V} \leq V_{\text{CANL}} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{\text{CANH}} \leq +12\text{ V}$  |  |              |              |      |  |
|                                       |  | Normal mode <sup>[5]</sup>  | 0.9  | -            | 9.0          | V    |  |
|                                       |  | Standby mode <sup>[5]</sup>   | 1.15   | -            | 9.0          | V    |  |
| $V_{\text{hys}(\text{RX})\text{dif}}$ | differential receiver hysteresis voltage | $-12\text{ V} \leq V_{\text{CANL}} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{\text{CANH}} \leq +12\text{ V}$ ; Normal mode  | 50   | -            | 300          | mV   |  |
| $I_{O(\text{sc})\text{dom}}$          | dominant short-circuit output current    | $V_{\text{TXD}} = 0\text{ V}$ ; $t < t_{\text{to}(\text{dom})\text{TXD}}$ ; $V_{CC} = 5\text{ V}$   |  |              |              |      |  |
|                                       |  | pin CANH; $V_{\text{CANH}} = -15\text{ V}$ to $+40\text{ V}$  | -100   | -70          | -            | mA   |  |
|                                       |  | pin CANL; $V_{\text{CANL}} = -15\text{ V}$ to $+40\text{ V}$  | -  | 70           | 100          | mA   |  |

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

$T_{vj} = -40\text{ °C to }+150\text{ °C}$ ;  $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ;  $V_{IO} = 2.91\text{ V to }5.5\text{ V}^{[1]}$ ;  $R_L = 60\text{ }\Omega$ ;  $C_L = 100\text{ pF}$  unless otherwise specified; all voltages are defined with respect to ground; positive currents flow into the IC.<sup>[2]</sup>

| Symbol                       | Parameter                              | Conditions   | Min               | Typ | Max | Unit               |
|------------------------------|--|--|-------------------|-----|-----|--------------------|
| $I_{O(sc)rec}$               | recessive short-circuit output current | Normal mode; $V_{TXD} = V_{IO}^{[4]}$ ;<br>$V_{CANH} = V_{CANL} = -27\text{ V to }+32\text{ V}$  | -5                | -   | +5  | mA                 |
| $I_L$                        | leakage current                        | $V_{CC} = V_{IO} = 0\text{ V}$ or<br>$V_{CC} = V_{IO} = \text{shorted to GND via }47\text{ k}\Omega$ ;<br>$V_{CANH} = V_{CANL} = 5\text{ V}$ | -5                | -   | +5  | $\mu\text{A}$      |
| $R_i$                        | input resistance                       | $-2\text{ V} \leq V_{CANL} \leq +7\text{ V}$ ;<br>$-2\text{ V} \leq V_{CANH} \leq +7\text{ V}$   | <sup>[5]</sup> 9  | 15  | 28  | k $\Omega$         |
| $\Delta R_i$                 | input resistance deviation             | $0\text{ V} \leq V_{CANL} \leq +5\text{ V}$ ;<br>$0\text{ V} \leq V_{CANH} \leq +5\text{ V}$   | <sup>[5]</sup> -3 | -   | +3  | %                  |
| $R_{i(dif)}$                 | differential input resistance          | $-2\text{ V} \leq V_{CANL} \leq +7\text{ V}$ ;<br>$-2\text{ V} \leq V_{CANH} \leq +7\text{ V}$   | <sup>[5]</sup> 19 | 30  | 52  | 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 detection</b> |  |  |                   |     |     |                    |
| $T_{j(sd)}$                  | shutdown junction temperature          |  | <sup>[5]</sup> -  | 185 | -   | $^{\circ}\text{C}$ |

[1] Only the TJA1044GT(K)/3 and TJA1044BT(K) variants have a  $V_{IO}$  pin; all circuitry is connected to  $V_{CC}$  in the other variants.  
 [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] Undervoltage is detected between min and max values. Undervoltage is guaranteed to be detected below min value and guaranteed not to be detected above max value.  
 [4]  $V_{IO} = V_{CC}$  in non- $V_{IO}$  product variants.  
 [5] Not tested in production; guaranteed by design.  
 [6] The test circuit used to measure the bus output voltage symmetry and the common-mode voltages (which includes  $C_{SPLIT}$ ) is shown in [Figure 9](#).

## 11 Dynamic characteristics

**Table 8. Dynamic characteristics**

$T_{vj} = -40\text{ °C to }+150\text{ °C}$ ;  $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ;  $V_{IO} = 2.91\text{ V to }5.5\text{ V}^{[1]}$ ;  $R_L = 60\text{ }\Omega$ ;  $C_L = 100\text{ pF}$  unless specified otherwise; all voltages are defined with respect to ground.<sup>[2]</sup>

| Symbol   | Parameter                            | Conditions  | Min              | Typ | Max | Unit          |
|--|--------------------------------------|---|------------------|-----|-----|---------------|
| Transceiver timing; pins CANH, CANL, TXD and RXD; see <a href="#">Figure 4</a> , <a href="#">Figure 5</a> and <a href="#">Figure 8</a> |                                      |   |                  |     |     |               |
| $t_{d(TXD-busdom)}$  | delay time from TXD to bus dominant  | TJA1044B/C; Normal mode                             | -                | 62  | 90  | ns            |
|  |                                      | other variants; Normal mode                         | -                | 65  | 100 | ns            |
| $t_{d(TXD-busrec)}$  | delay time from TXD to bus recessive | TJA1044B/C; Normal mode                             | -                | 75  | 90  | ns            |
|  |                                      | other variants; Normal mode                         | -                | 90  | 100 | ns            |
| $t_{d(busdom-RXD)}$  | delay time from bus dominant to RXD  | TJA1044B/C; Normal mode                             | -                | 105 | 115 | ns            |
|  |                                      | other variants; Normal mode                         | -                | 60  | 140 | ns            |
| $t_{d(busrec-RXD)}$  | delay time from bus recessive to RXD | TJA1044B/C; Normal mode                             | -                | 90  | 110 | ns            |
|  |                                      | other variants; Normal mode                         | -                | 65  | 125 | ns            |
| $t_{d(TXDL-RXDL)}$   | delay time from TXD LOW to RXD LOW   | TJA1044B/C; Normal mode                             | 50               | -   | 185 | ns            |
|  |                                      | TJA1044T; Normal mode                               | 50               | -   | 230 | ns            |
|  |                                      | all other variants; Normal mode                     | 50               | -   | 210 | ns            |
| $t_{d(TXDH-RXDH)}$   | delay time from TXD HIGH to RXD HIGH | TJA1044B/C; Normal mode                             | 50               | -   | 185 | ns            |
|  |                                      | TJA1044T; Normal mode                               | 50               | -   | 230 | ns            |
|  |                                      | all other variants; Normal mode                     | 50               | -   | 210 | ns            |
| $t_{bit(bus)}$   | transmitted recessive bit width      | all variants except TJA1044T                        |                  |     |     |               |
|  |                                      | $t_{bit(TXD)} = 500\text{ ns}$ <sup>[3]</sup>       | 435              | -   | 530 | ns            |
|  |                                      | $t_{bit(TXD)} = 200\text{ ns}$ <sup>[3]</sup>       | 155              | -   | 210 | ns            |
| $t_{bit(RXD)}$   | bit time on pin RXD                  | all variants except TJA1044T                        |                  |     |     |               |
|  |                                      | $t_{bit(TXD)} = 500\text{ ns}$ <sup>[3]</sup>       | 400              | -   | 550 | ns            |
|  |                                      | $t_{bit(TXD)} = 200\text{ ns}$ <sup>[3]</sup>       | 120              | -   | 220 | ns            |
| $\Delta t_{rec}$   | receiver timing symmetry             | all variants except TJA1044T                        |                  |     |     |               |
|  |                                      | $t_{bit(TXD)} = 500\text{ ns}$                      | -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 <sup>[4]</sup> | 0.8              | 3   | 6.5 | ms            |
| $t_{d(stb-norm)}$  | standby to normal mode delay time    |   | <sup>[5]</sup> 7 | 25  | 47  | $\mu\text{s}$ |
| $t_{wake(busdom)}$   | bus dominant wake-up time            | Standby mode <sup>[6]</sup>                         |                  |     |     |               |
|  |                                      | TJA1044T, GT, GTK                                   | 0.5              | -   | 3   | $\mu\text{s}$ |
|  |                                      | all other variants                                  | 0.5              | -   | 1.8 | $\mu\text{s}$ |
| $t_{wake(busrec)}$   | bus recessive wake-up time           | Standby mode <sup>[6]</sup>                         |                  |     |     |               |
|  |                                      | TJA1044T, GT, GTK                                   | 0.5              | -   | 3   | $\mu\text{s}$ |
|  |                                      | all other variants                                  | 0.5              | -   | 1.8 | $\mu\text{s}$ |
| $t_{to(wake)bus}$  | bus wake-up time-out time            | Standby mode <sup>[4]</sup>                         | 0.8              | 3   | 6.5 | ms            |

Table 8. Dynamic characteristics...continued

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.91\text{ V}$  to  $5.5\text{ V}^{[1]}$ ;  $R_L = 60\text{ }\Omega$ ;  $C_L = 100\text{ pF}$  unless specified otherwise; all voltages are defined with respect to ground.<sup>[2]</sup>

| Symbol                    | Parameter               | Conditions                  | Min | Typ | Max | Unit          |
|---------------------------|-------------------------|-----------------------------|-----|-----|-----|---------------|
| $t_{\text{ftr(wake)bus}}$ | bus wake-up filter time | Standby mode <sup>[7]</sup> |     |     |     |               |
|                           |                         | TJA1044T, GT, GTK           | 0.5 | 1   | 3   | $\mu\text{s}$ |
|                           |                         | all other variants          | 0.5 | -   | 1.8 | $\mu\text{s}$ |

- [1] Only TJA1044GT(K)/3 and TJA1044BT(K) variants have a  $V_{IO}$  pin; all circuitry is connected to  $V_{CC}$  in the other variants.
- [2] All parameters are guaranteed over the junction temperature range by design. Factory testing uses correlated test conditions to cover the specified temperature and power supply voltage range.
- [3] See [Figure 5](#).
- [4] Time-out occurs between the min and max values. Time-out is guaranteed not to occur below the min value; time-out is guaranteed to occur above the max value.
- [5] Standby-to-Normal mode transition occurs between the min and max values. It is guaranteed not to occur below the min value; it is guaranteed to occur above the max value.
- [6] A dominant/recessive phase shorter than the min value is guaranteed not to be seen as a dominant/recessive bit; a dominant/recessive phase longer than the max value is guaranteed to be seen as a dominant/recessive bit.
- [7] Pulses shorter than the min value are guaranteed to be filtered out; pulses longer than the max value are guaranteed to be processed.

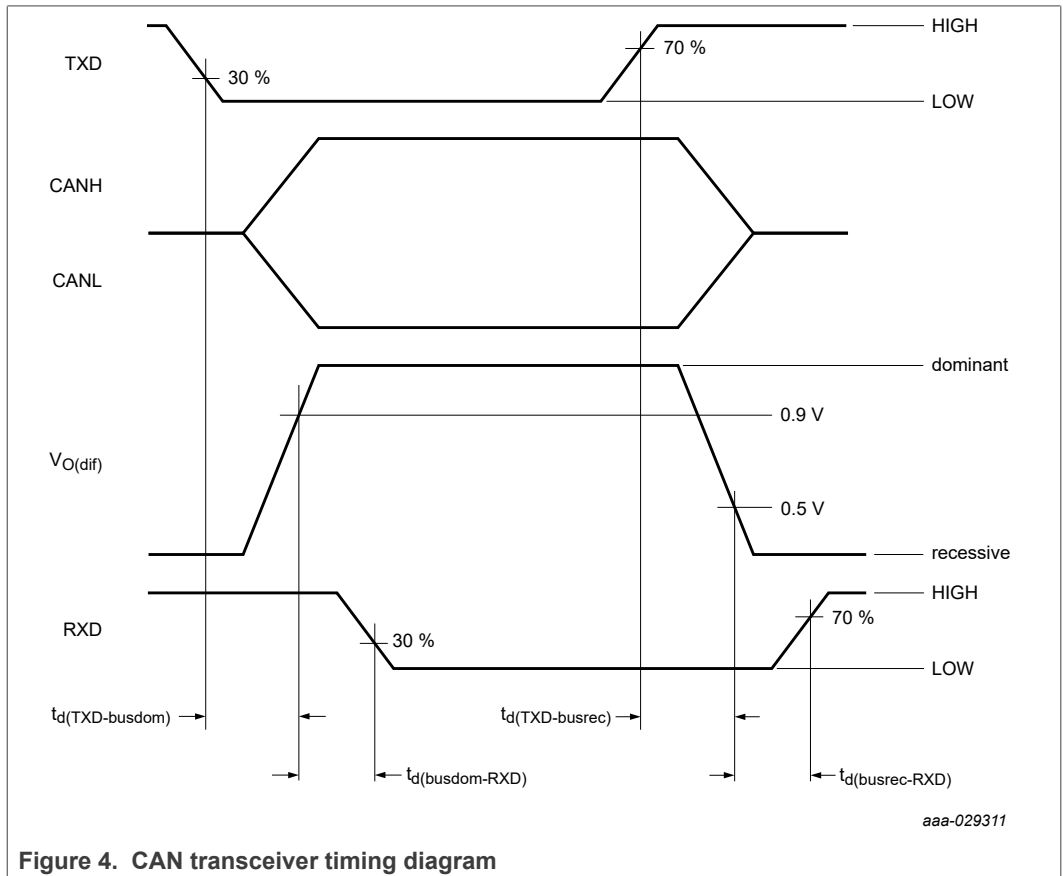


Figure 4. CAN transceiver timing diagram

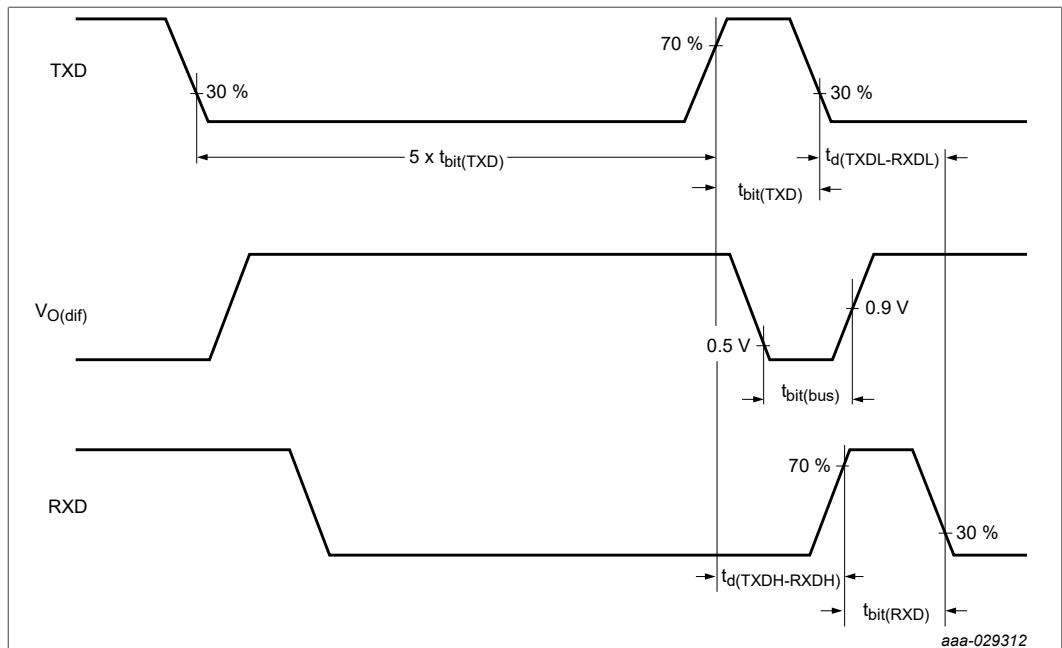


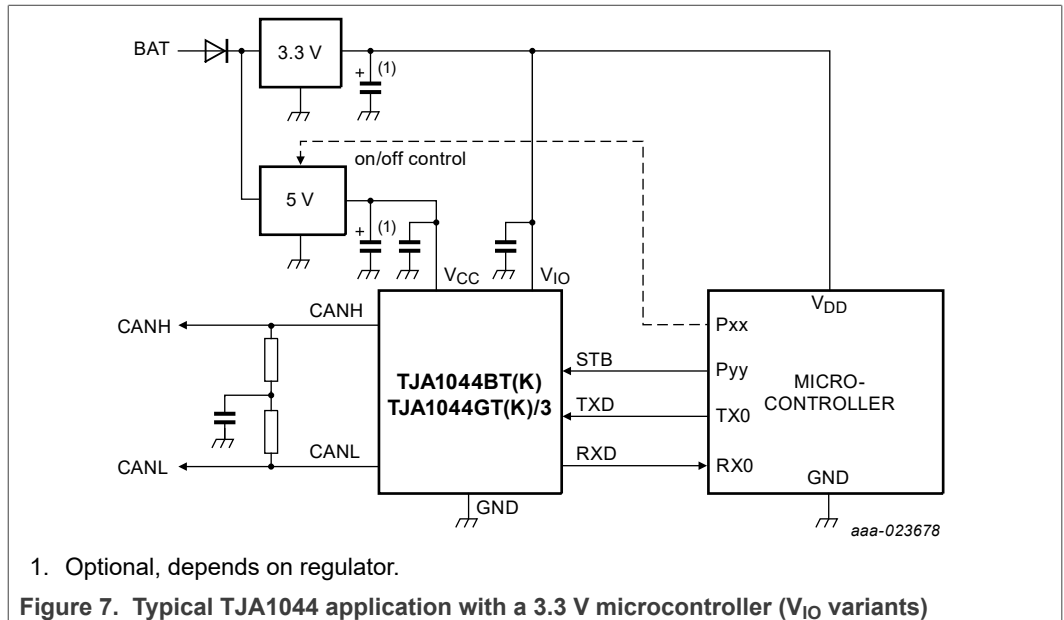
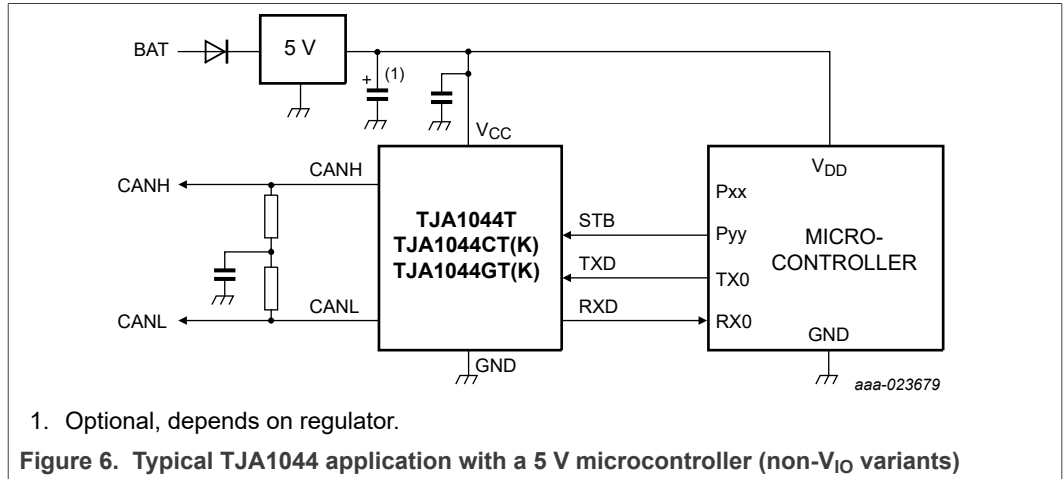
Figure 5. CAN FD timing definitions according to ISO 11898-2:2016



## 12 Application information

The minimum external circuitry needed with the TJA1044 is shown in [Figure 6](#) and [Figure 7](#). See the Application Hints ([Section 12.2](#)) for further information about external components and PCB layout requirements.

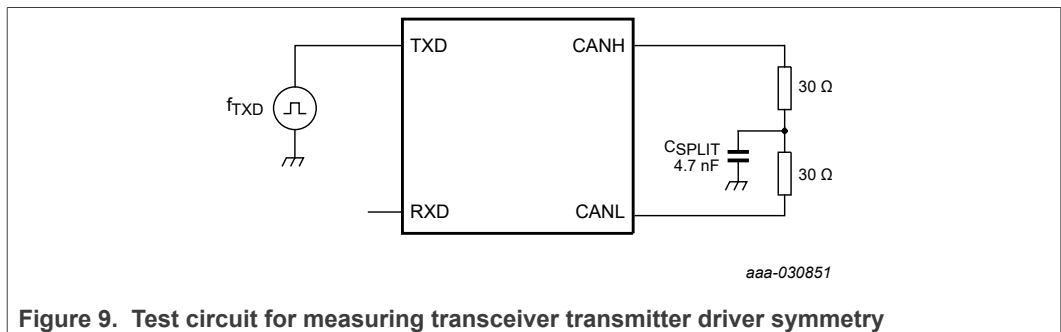
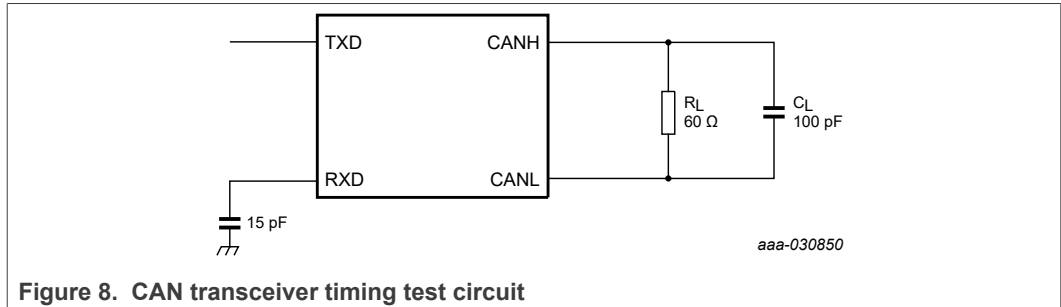
### 12.1 Application diagrams



### 12.2 Application hints

Further information on the application of the TJA1044 can be found in NXP application hints *AH1308 Application Hints - Standalone high-speed CAN transceivers Mantis TJA1044/TJA1057 and Dual-Mantis TJA1046*.

### 13 Test information



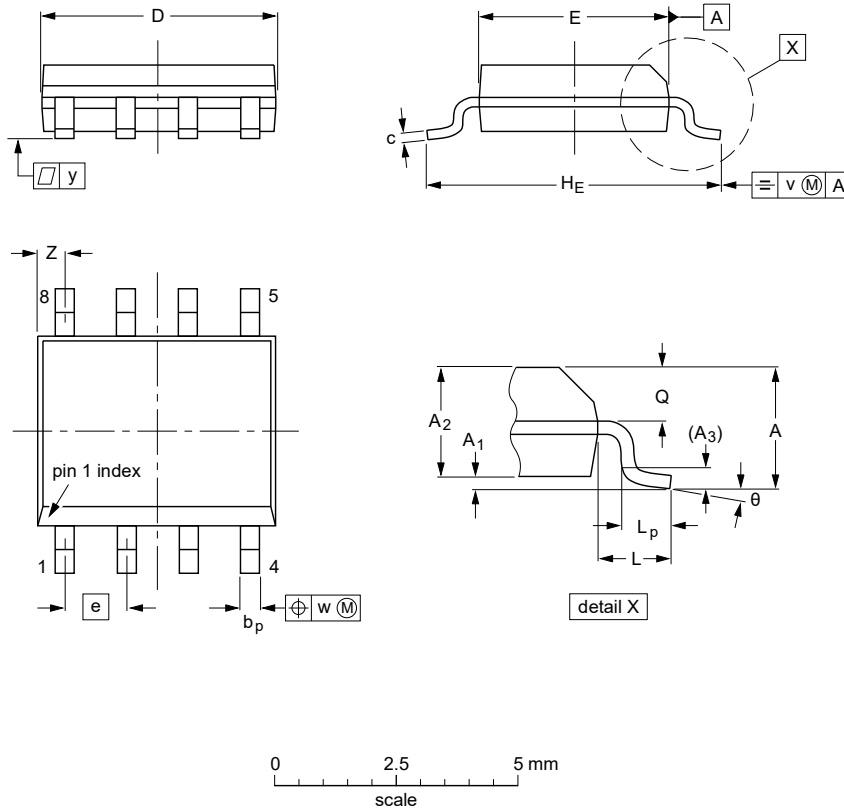
#### 13.1 Quality information

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



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT   | A max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c                | D <sup>(1)</sup> | E <sup>(2)</sup> | e    | H <sub>E</sub> | L     | L <sub>p</sub> | Q              | v    | w    | y     | Z <sup>(1)</sup> | θ        |
|--------|--------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm     | 1.75   | 0.25<br>0.10   | 1.45<br>1.25   | 0.25           | 0.49<br>0.36   | 0.25<br>0.19     | 5.0<br>4.8       | 4.0<br>3.8       | 1.27 | 6.2<br>5.8     | 1.05  | 1.0<br>0.4     | 0.7<br>0.6     | 0.25 | 0.25 | 0.1   | 0.7<br>0.3       | 8°<br>0° |
| inches | 0.069  | 0.010<br>0.004 | 0.057<br>0.049 | 0.01           | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.20<br>0.19     | 0.16<br>0.15     | 0.05 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.024 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012   |          |

Notes

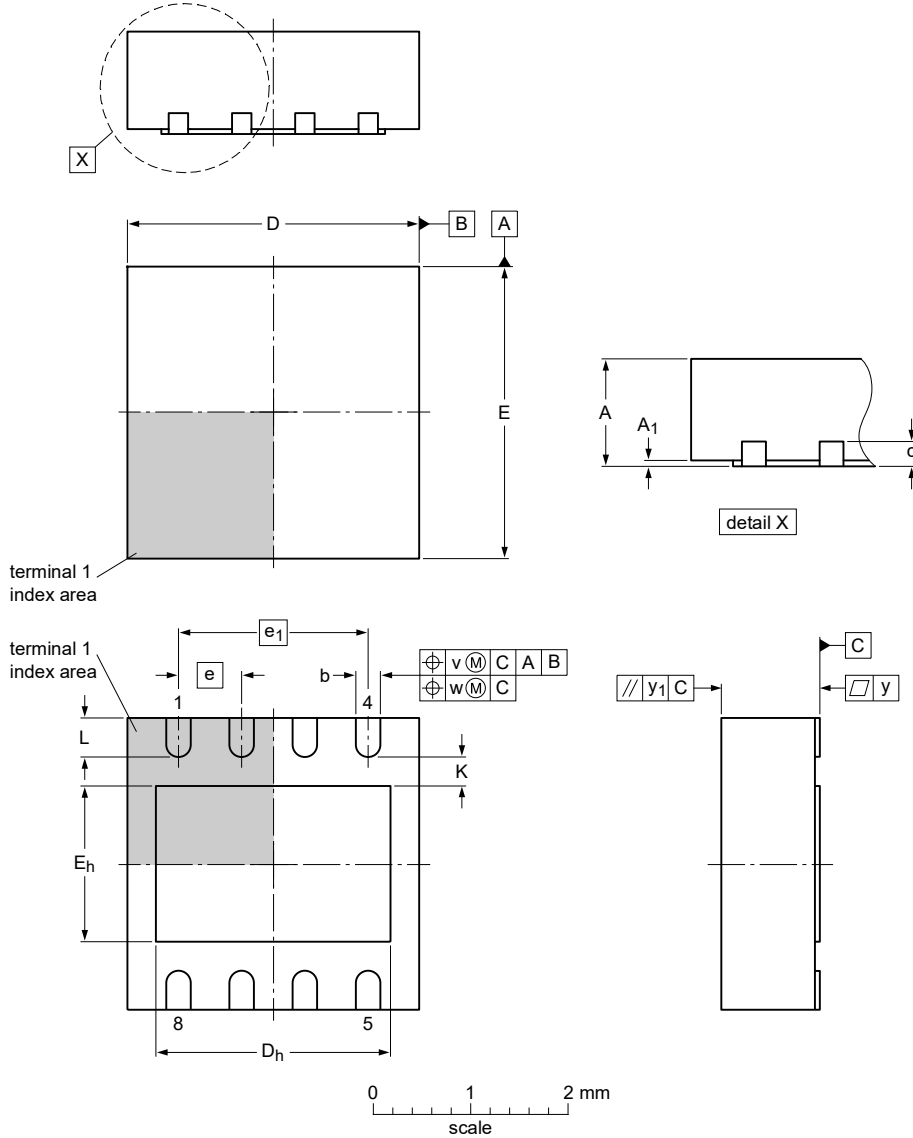
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

| OUTLINE VERSION | REFERENCES |        |       | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|--------|-------|---------------------|----------------------|
|                 | IEC        | JEDEC  | JEITA |                     |                      |
| SOT96-1         | 076E03     | MS-012 |       |                     | 99-12-27<br>03-02-18 |

Figure 10. 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



Dimensions

| Unit <sup>(1)</sup> | A    | A <sub>1</sub> | b    | c   | D    | D <sub>h</sub> | E    | E <sub>h</sub> | e    | e <sub>1</sub> | K    | L    | v   | w    | y    | y <sub>1</sub> |
|---------------------|------|----------------|------|-----|------|----------------|------|----------------|------|----------------|------|------|-----|------|------|----------------|
| max                 | 1.00 | 0.05           | 0.35 |     | 3.10 | 2.45           | 3.10 | 1.65           |      |                | 0.35 | 0.45 |     |      |      |                |
| mm nom              | 0.85 | 0.03           | 0.30 | 0.2 | 3.00 | 2.40           | 3.00 | 1.60           | 0.65 | 1.95           | 0.30 | 0.40 | 0.1 | 0.05 | 0.05 | 0.1            |
| min                 | 0.80 | 0.00           | 0.25 |     | 2.90 | 2.35           | 2.90 | 1.55           |      |                | 0.25 | 0.35 |     |      |      |                |

Note

1. Plastic or metal protrusions of 0.075 maximum per side are not included.

sot782-1\_po

| Outline version | References |        |       |  | European projection | Issue date            |
|-----------------|------------|--------|-------|--|---------------------|-----------------------|
|                 | IEC        | JEDEC  | JEITA |  |                     |                       |
| SOT782-1        | ---        | MO-229 | ---   |  |                     | 09-08-25-<br>09-08-28 |

Figure 11. 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 12](#)) 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 [Table 10](#)

Table 9. SnPb eutectic process (from J-STD-020D)

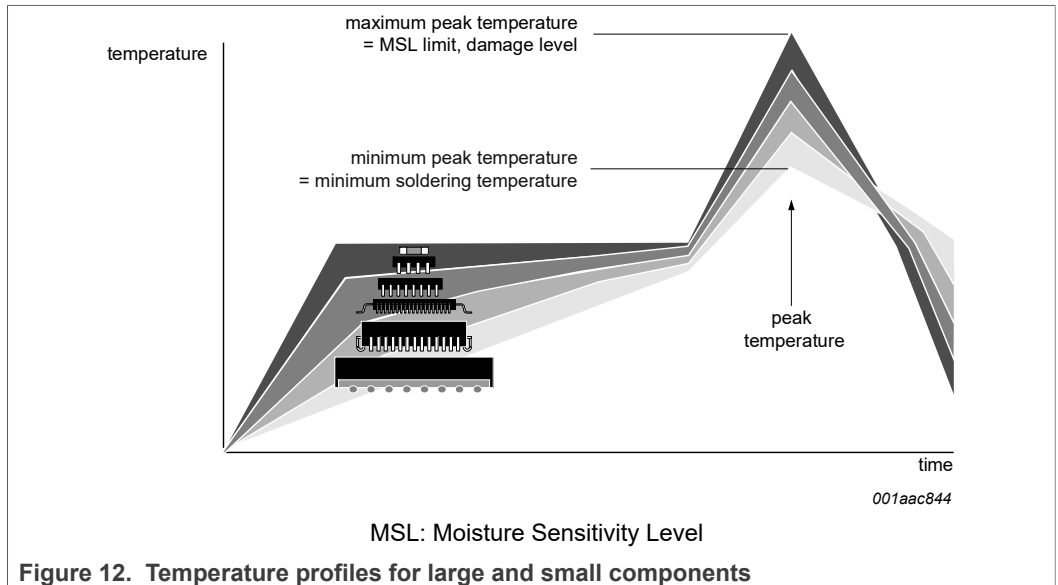
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 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 12](#).



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

## 17 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   | $R_{CAN\_H}$<br>$R_{CAN\_L}$ | $R_i$              | 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      |



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

| ISO 11898-2:2016   |  | NXP data sheet                  |                                       |
|--|--|---------------------------------|---------------------------------------|
| Parameter  | Notation                                   | Symbol                          | Parameter                             |
| <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  | $t_{\text{Bit(Bus)}}$                      | $t_{\text{bit(bus)}}$           | transmitted recessive bit width       |
| Received recessive bit width @ 2 Mbit/s / @ 5 Mbit/s   | $t_{\text{Bit(RXD)}}$                      | $t_{\text{bit(RXD)}}$           | bit time on pin RXD                   |
| Receiver timing symmetry @ 2 Mbit/s / @ 5 Mbit/s   | $\Delta t_{\text{Rec}}$                    | $\Delta t_{\text{rec}}$         | receiver timing symmetry              |
| <b>HS-PMA maximum ratings of <math>V_{\text{CAN\_H}}</math>, <math>V_{\text{CAN\_L}}</math> and <math>V_{\text{Diff}}</math></b>                             |  |                                 |                                       |
| Maximum rating $V_{\text{Diff}}$   | $V_{\text{Diff}}$                          | $V_{(\text{CANH-CANL})}$        | voltage between pin CANH and pin CANL |
| General maximum rating $V_{\text{CAN\_H}}$ and $V_{\text{CAN\_L}}$   | $V_{\text{CAN\_H}}$                        | $V_x$                           | voltage on pin x                      |
| Optional: Extended maximum rating $V_{\text{CAN\_H}}$ and $V_{\text{CAN\_L}}$  | $V_{\text{CAN\_L}}$                        |                                 |                                       |
| <b>HS-PMA maximum leakage currents on CAN_H and CAN_L, unpowered</b>   |  |                                 |                                       |
| Leakage current on CAN_H, CAN_L  | $I_{\text{CAN\_H}}$<br>$I_{\text{CAN\_L}}$ | $I_L$                           | leakage current                       |
| <b>HS-PMA bus biasing control timings</b>  |  |                                 |                                       |
| CAN activity filter time, long   | $t_{\text{Filter}}$                        | $t_{\text{wake(busdom)}}^{[1]}$ | bus dominant wake-up time             |
| CAN activity filter time, short  |  | $t_{\text{wake(busrec)}}^{[1]}$ | bus recessive wake-up time            |
| Wake-up timeout, short   | $t_{\text{Wake}}$                          | $t_{\text{to(wake)bus}}$        | bus wake-up time-out time             |
| Wake-up timeout, long  |  |                                 |                                       |
| Timeout for bus inactivity   | $t_{\text{Silence}}$                       | $t_{\text{to(silence)}}$        | bus silence time-out time             |
| Bus Bias reaction time   | $t_{\text{Bias}}$                          | $t_{\text{d(busact-bias)}}$     | delay time from bus active to bias    |

[1]  $t_{\text{filtr(wake)bus}}$  - bus wake-up filter time, in devices with basic wake-up functionality

## 18 Revision history

Table 12. Revision history

| Document ID    | Release date   | Data sheet status      | Change notice | Supersedes    |
|----------------|--|------------------------|---------------|---------------|
| TJA1044 v.7    | 20230116   | Product data sheet     | -             | TJA1044 v.6.1 |
| Modifications: | <ul style="list-style-type: none"> <li>• Added variants TJA1044BT(K) and TJA1044CT(K) with shorter propagation delay</li> <li>• <a href="#">Section 2.1</a>: SAE J1939-14 compliance added</li> <li>• <a href="#">Section 2.1</a>: EMC compliance updated to latest standards IEC 62228-3 and SAE J2962-2</li> <li>• <a href="#">Section 2.2</a>: updated text describing supply undervoltage behavior</li> <li>• <a href="#">Section 2.3</a>: section added</li> <li>• <a href="#">Figure 1</a>: figure note section revised</li> <li>• <a href="#">Table 3</a>: added pin type column</li> <li>• <a href="#">Table 5</a>: format and footnotes revised; no specification changes</li> <li>• <a href="#">Table 6</a>: parameter definitions and specifications updated</li> <li>• <a href="#">Table 1</a>, <a href="#">Table 7</a> and <a href="#">Table 8</a>: <math>V_{CC}</math> range extended to 4.5 V to 5.5 V</li> <li>• <a href="#">Table 1</a>, <a href="#">Table 7</a> and <a href="#">Table 8</a>: <math>V_{IO}</math> range extended to 2.91 V to 5.5 V</li> <li>• <a href="#">Table 7</a>: footnotes updated/added<br/>typos corrected: <math>V_{IL}</math> min. values for pins STB/TXD (<math>-0.3V_{IO}</math> changed to <math>-0.3</math>)<br/>parameter values changed: <ul style="list-style-type: none"> <li>– <math>I_{CC}</math> Standby mode supply current for variants with a <math>V_{IO}</math> pin</li> <li>– <math>I_{CC}</math> Normal mode dominant supply current (<math>V_{TXD} = 0</math> V)</li> <li>– <math>I_{IO}</math> Normal mode supply current values</li> <li>– <math>I_{IL}</math> (LOW-level input current) values for pin TXD</li> <li>– <math>I_{OH}</math> (HIGH-level output current) values for pin RXD</li> <li>– <math>I_{O(sc)dom}</math> (dominant short-circuit output current) values</li> </ul> </li> <li>• <a href="#">Table 8</a>: delay time parameter values revised and footnotes updated/added</li> <li>• <a href="#">Figure 4</a> and <a href="#">Figure 5</a>: timing diagrams revised</li> <li>• <a href="#">Section 12</a>: introductory paragraph added</li> <li>• <a href="#">Figure 8</a> and <a href="#">Figure 9</a>: drawings revised</li> <li>• <a href="#">Section 19</a>: legal information updated</li> </ul> |                        |               |               |
| TJA1044 v.6.1  | 20170824   | Product data sheet     | -             | TJA1044 v.5.1 |
| TJA1044 v.5.1  | 20160523   | Product data sheet     | -             | TJA1044 v.4   |
| TJA1044 v.4    | 20150710   | Product data sheet     | -             | TJA1044 v.3   |
| TJA1044 v.3    | 20141119   | Product data sheet     | -             | TJA1044 v.2   |
| TJA1044 v.2    | 20131030   | Product data sheet     | -             | TJA1044 v.1   |
| TJA1044 v.1    | 20130530   | Preliminary data sheet | -             | -             |

## 19 Legal information

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| 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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[2] The term 'short data sheet' is explained in section "Definitions".

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