

# TJA1448

## Dual high-speed CAN transceiver with Standby mode

Rev. 2 — 15 October 2021

Product data sheet

## 1 General description

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The TJA1448 is a member of the TJA144x family of transceivers that provide an interface between a Controller Area Network (CAN) or CAN FD (Flexible Data rate) protocol controller and the physical two-wire CAN bus. TJA144x transceivers implement the CAN physical layer as defined in ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5, and are fully interoperable with high-speed Classical CAN and CAN FD transceivers. All TJA144x variants enable reliable communication in the CAN FD fast phase at data rates up to 5 Mbit/s.

The TJA1448 is intended as a simple replacement for dual high-speed Classical CAN and CAN FD transceivers, such as the TJA1059 from NXP. It offers pin compatibility and is designed to avoid changes to hardware and software design, allowing the TJA1448 to be easily retrofitted to existing applications.

An AEC-Q100 Grade 0 variant, the TJR1448, is available for high temperature applications, supporting operation at 150 °C ambient temperature.

### 1.1 TJA1448 variants

The TJA1448 comes in three variants. The TJA1448A and TJA1448B are available in SO14 and HVSON14 packages. The TJA1448C comes in a HVSON14 package:

- The TJA1448A is a dual high-speed CAN transceiver with Normal and Standby modes and a VIO supply pin. The VIO pin allows for direct interfacing with 3.3 V and 5 V-supplied microcontrollers.
- The TJA1448B is a high-speed CAN transceiver with Normal and Standby modes.
- The TJA1448C is a dual high-speed CAN transceiver with Normal and Standby modes, a VIO supply pin and RXD latching. The VIO pin allows for direct interfacing with 3.3 V and 5 V-supplied microcontrollers.

## 2 Features and benefits

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### 2.1 General

- ISO 11898-2:2016, SAE J2284-1 to SAE J2284-5 and SAE J1939-14 compliant
- Standard CAN and CAN FD data bit rates up to 5 Mbit/s
- Low Electromagnetic Emission (EME) and high Electromagnetic Immunity (EMI)
- Qualified according to AEC-Q100 Grade 1
- TJA1448A/C only: VIO input for interfacing with 3.3 V to 5 V microcontrollers
- Fully independent control of two transceivers combined monolithically in a single package
- All variants are available in a leadless HVSON14 (3.0 mm x 4.5 mm) package with improved Automated Optical Inspection (AOI) capability; TJA1448A/B available in an SO14 package.



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

## 2.2 Predictable and fail-safe behavior

- Undervoltage detection with defined handling on all supply pins
- Full functionality guaranteed from the undervoltage detection thresholds up to the maximum limiting voltage values
- Defined behavior below the undervoltage detection thresholds
- Transceiver disengages from the bus (high-ohmic) when the supply voltage drops below the Off mode threshold
- Internal biasing of TXD and mode selection input pins, to enable defined fail-safe behavior

## 2.3 Low-power management

- Very low-current Standby mode with host and bus wake-up capability
- TJA1448A/C only: CAN wake-up receiver powered by  $V_{IO}$  allowing  $V_{CC}$  to be shut down
- CAN wake-up pattern filter time of 0.5  $\mu$ s to 1.8  $\mu$ s meeting Classical CAN and CAN FD requirements
- TJA1448C variant offers RXD wake-up latching to enable wake-up source readout in gateway applications

## 2.4 Protection

- High ESD handling capability on the bus pins (8 kV IEC and HBM)
- Bus pins protected against transients in automotive environments
- Transmit Data (TXD) dominant time-out function
- Thermally protected

### 3 Quick reference data

Table 1. Quick reference data

| Symbol                | Parameter  | Conditions  | Min  | Typ     | Max  | Unit         |
|-----------------------|--|---|------|---------|------|--------------|
| $V_{CC}$              | supply voltage                                       |   | 4.5  | -       | 5.5  | V            |
| $I_{CC}$              | supply current                                       | Normal mode   |      |         |      |              |
|                       |  | both channels recessive                                     | -    | 8       | 14   | mA           |
|                       |  | one channel dominant  | -    | 42      | 67   | mA           |
|                       |  | both channels dominant                                      | -    | 77      | 120  | mA           |
|                       |  | both channels in Standby mode                               |      |         |      |              |
|                       |  | TJA1448A/C  | -    | -       | 2    | $\mu$ A      |
| TJA1448B              | -  | 11  | 18   | $\mu$ A |      |              |
| $V_{uvd(stb)(VCC)}$   | standby undervoltage detection voltage on pin VCC    |   | 4    | -       | 4.5  | V            |
| $V_{uvhys(stb)(VCC)}$ | standby undervoltage hysteresis voltage on pin VCC   |   | 50   | -       | -    | mV           |
| $V_{uvd(swoff)(VCC)}$ | switch-off undervoltage detection voltage on pin VCC | TJA1448B  | 2.65 | -       | 2.95 | V            |
| $V_{IO}$              | supply voltage on pin VIO                            |   | 2.95 | -       | 5.5  | V            |
| $I_{IO}$              | supply current on pin VIO                            | Normal mode   |      |         |      |              |
|                       |  | both channels recessive                                     | -    | 270     | 750  | $\mu$ A      |
|                       |  | one channel dominant  | -    | 360     | 1000 | $\mu$ A      |
|                       |  | both channels dominant                                      | -    | 450     | 1250 | $\mu$ A      |
|                       |  | both channels in Standby mode                               | -    | 11      | 16   | $\mu$ A      |
| $V_{uvd(swoff)(VIO)}$ | switch-off undervoltage detection voltage on pin VIO |   | 2.65 | -       | 2.95 | V            |
| $V_{ESD}$             | electrostatic discharge voltage                      | IEC 61000-4-2 on pins CANHx and CANLx                       | -8   | -       | +8   | kV           |
| $V_{CANH}$            | voltage on pin CANH                                  | pins CANH1 and CANH2; limiting value according to IEC 60134 | -36  | -       | +40  | V            |
| $V_{CANL}$            | voltage on pin CANL                                  | pins CANL1 and CANL2; limiting value according to IEC 60134 | -36  | -       | +40  | V            |
| $T_{vj}$              | virtual junction temperature                         |   | -40  | -       | +150 | $^{\circ}$ C |

## 4 Ordering information

Table 2. Ordering information

| Type number | Package |  |           |
|-------------|---------|--|-----------|
|             | Name    | Description  | Version   |
| TJA1448AT   | SO14    | plastic small outline package; 14 leads; body width 3.9 mm   | SOT108-1  |
| TJA1448BT   |         |  |           |
| TJA1448ATK  | HVSON14 | plastic thermal enhanced very thin small outline package; no leads; 14 terminals; body 3 × 4.5 × 0.85 mm | SOT1086-2 |
| TJA1448BTK  |         |  |           |
| TJA1448CTK  |         |  |           |

Table 3. TJA1448 feature overview

See [Section 19](#) for a feature overview of the complete Tjx144x/Tjx146x/TjF1441 family.

| Device <sup>[1]</sup> | Modes  |         |       |                    |                | Supplies |         |          | Data rate             |                       | Additional features               |   |   |  |                      |                                 |
|-----------------------|--------|---------|-------|--------------------|----------------|----------|---------|----------|-----------------------|-----------------------|-----------------------------------|---|---|--|----------------------|---------------------------------|
|                       | Normal | Standby | Sleep | Silent/Listen-only | Selectable Off | VCC pin  | VIO pin | VBAT pin | Up to 5 Mbit/s CAN FD | Up to 8 Mbit/s CAN FD | Signal improvement <sup>[2]</sup> | Wake-up source recognition <sup>[3]</sup> | Short WUP support [0.5 - 1.8 μs] <sup>[4]</sup> | Single supply pin wake-up <sup>[5]</sup> | TXD dominant timeout | Local diagnostics via ERR_N pin |
| TJA1448A              | •      | •       |       |                    |                | •        | •       |          | •                     |                       |                                   |   | •   | •  | •                    |                                 |
| TJA1448B              | •      | •       |       |                    |                | •        |         |          | •                     |                       |                                   |   | •   |  | •                    |                                 |
| TJA1448C              | •      | •       |       |                    |                | •        | •       |          | •                     |                       |                                   | •   | •   | •  | •                    |                                 |

[1] TJA1448 is AEC-Q100 Grade 1.

[2] CAN FD Signal Improvement Capability (SIC) according to CiA 601-4:2019.

[3] RXD is held LOW after wake-up request, enabling wake-up source recognition.

[4] WUP = wake-up pattern according ISO11898-2:2016.

[5] Only VIO supply needed for wake-up.

5 Block diagrams

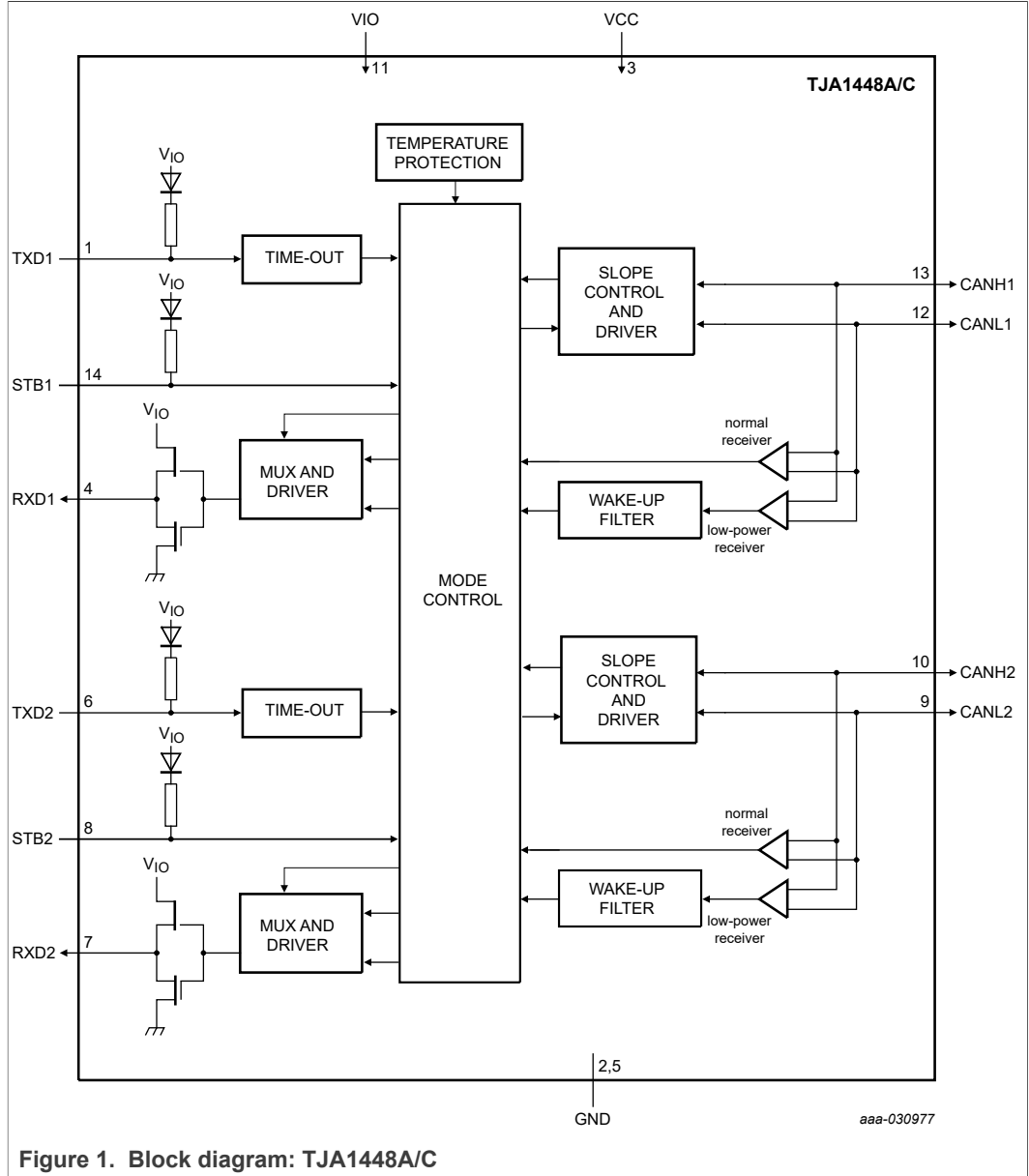
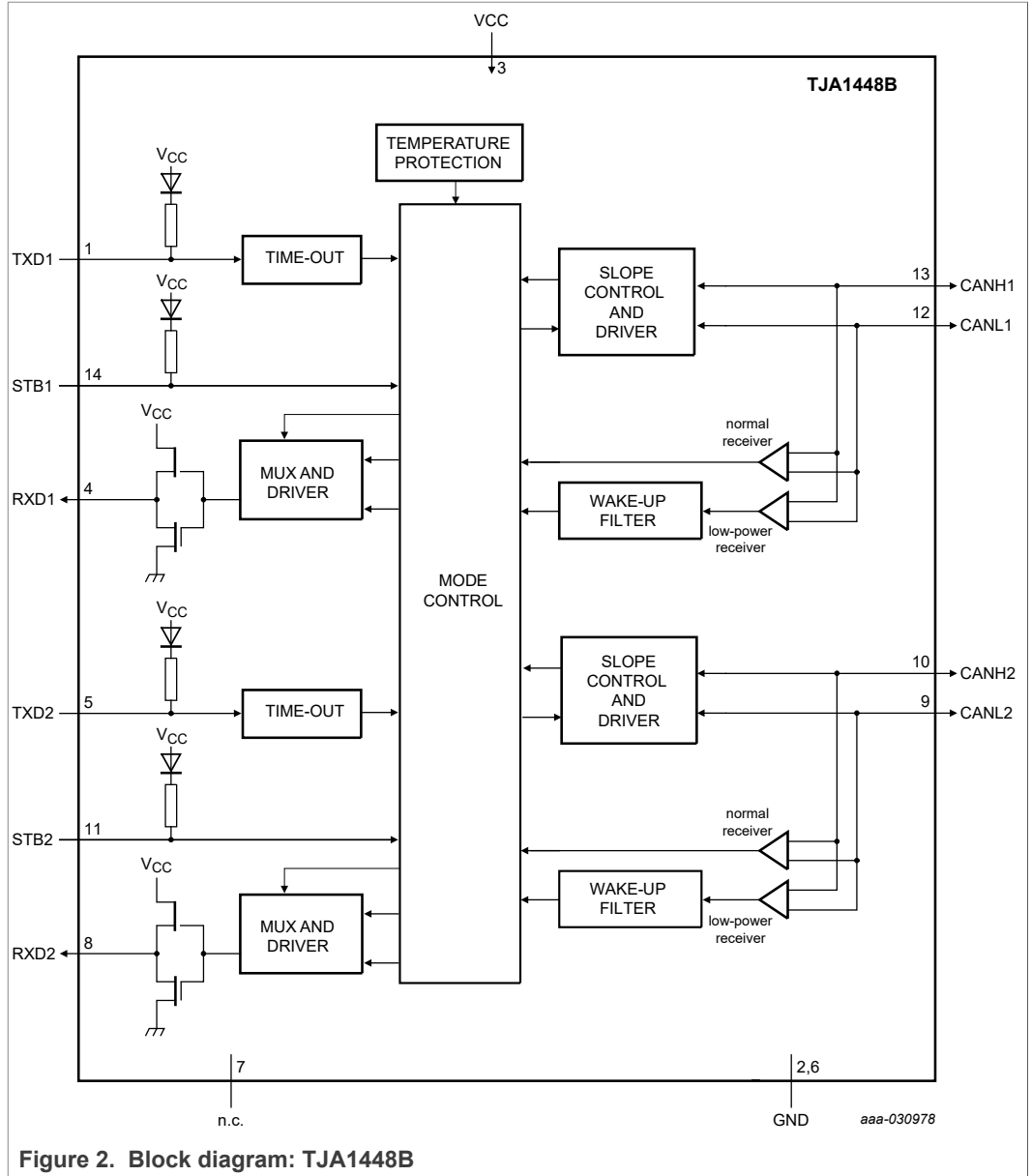


Figure 1. Block diagram: TJA1448A/C



## 6 Pinning information

### 6.1 Pinning

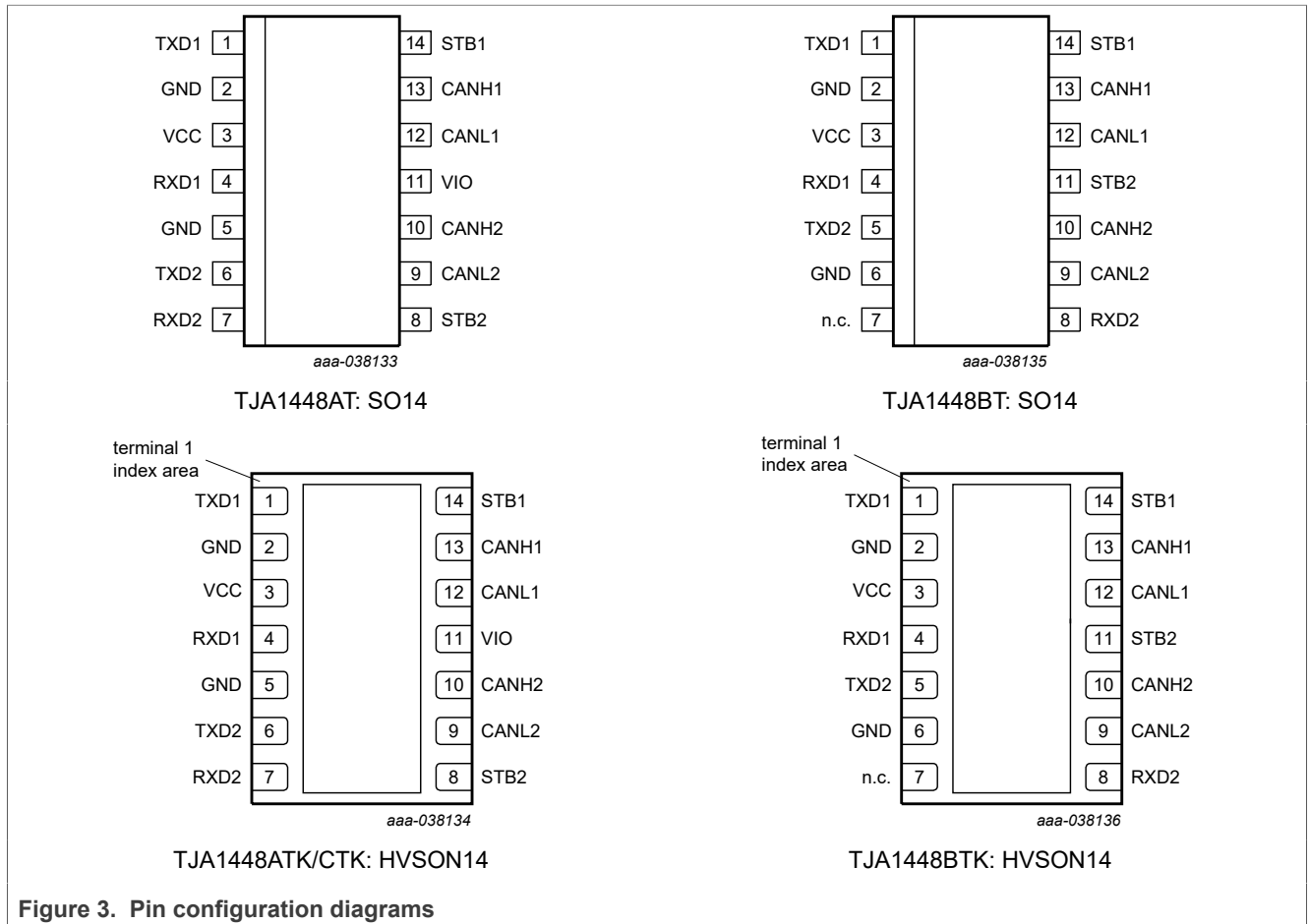


Figure 3. Pin configuration diagrams

## 6.2 Pin description

Table 4. Pin description: TJA1448A/C

| Symbol             | Pin | Type <sup>[1]</sup> | Description   |
|--------------------|-----|---------------------|---|
| TXD1               | 1   | I                   | transmit data input 1; inputs data (from the CAN controller) to be written to CANH1/CANL1 bus lines |
| GND <sup>[2]</sup> | 2   | G                   | ground  |
| VCC                | 3   | P                   | 5 V supply voltage input  |
| RXD1               | 4   | O                   | receive data output 1; outputs data read from bus lines CANH1/CANL1 (to the CAN controller)         |
| GND <sup>[2]</sup> | 5   | G                   | ground  |
| TXD2               | 6   | I                   | transmit data input 2; inputs data (from the CAN controller) to be written to CANH1/CANL1 bus lines |
| RXD2               | 7   | O                   | receive data output 2; outputs data read from bus lines CANH2/CANL2 (to the CAN controller)         |
| STB2               | 8   | I                   | Standby mode control input 2 (HIGH: Standby mode; LOW: Normal mode)                                 |
| CANL2              | 9   | AIO                 | LOW-level CAN bus line 2  |
| CANH2              | 10  | AIO                 | HIGH-level CAN bus line 2   |
| VIO                | 11  | P                   | supply voltage input for I/O level adapter  |
| CANL1              | 12  | AIO                 | LOW-level CAN bus line 1  |
| CANH1              | 13  | AIO                 | HIGH-level CAN bus line 1   |
| STB1               | 14  | I                   | Standby mode control input 1 (HIGH: Standby mode; LOW: Normal mode)                                 |

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

[2] HVSON 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 also recommended to solder the exposed center pad to board ground.



Table 5. Pin description: TJA1448B

| Symbol             | Pin | Type <sup>[1]</sup> | Description   |
|--------------------|-----|---------------------|---|
| TXD1               | 1   | I                   | transmit data input 1; inputs data (from the CAN controller) to be written to CANH1/CANL1 bus lines |
| GND <sup>[2]</sup> | 2   | G                   | ground  |
| VCC                | 3   | P                   | 5 V supply voltage input  |
| RXD1               | 4   | O                   | receive data output 1; outputs data read from bus lines CANH1/CANL1 (to the CAN controller)         |
| TXD2               | 5   | I                   | transmit data input 2; inputs data (from the CAN controller) to be written to CANH2/CANL2 bus lines |
| GND <sup>[2]</sup> | 6   | G                   | ground  |
| n.c.               | 7   | -                   | not connected   |
| RXD2               | 8   | O                   | receive data output 2; outputs data read from bus lines CANH2/CANL2 (to the CAN controller)         |
| CANL2              | 9   | AIO                 | LOW-level CAN bus line 2  |
| CANH2              | 10  | AIO                 | HIGH-level CAN bus line 2   |
| STB2               | 11  | I                   | Standby mode control input 2 (HIGH: Standby mode; LOW: Normal mode)                                 |
| CANL1              | 12  | AIO                 | LOW-level CAN bus line 1  |
| CANH1              | 13  | AIO                 | HIGH-level CAN bus line 1   |
| STB1               | 14  | I                   | Standby mode control input 1 (HIGH: Standby mode; LOW: Normal mode)                                 |

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

[2] HVSON 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 also recommended to solder the exposed center pad to board ground.

## 7 Functional description

### 7.1 Operating modes

The TJA1448 supports three operating modes per transceiver, Normal, Standby and Off. The operating mode is selected independently for each transceiver via pins STB1 and STB2. See [Table 6](#) for a description of the operating modes under normal supply conditions. Mode changes are completed after transition time  $t_{(moch)}$ .

Table 6. Operating modes

| Mode               | Inputs        |               | Outputs          |   |
|--------------------|---------------|---------------|------------------|---|
|                    | Pin STB1/STB2 | Pin TXD1/TXD2 | CAN1/CAN2 driver | Pin RXD1/RXD2   |
| Normal             | LOW           | LOW           | dominant         | LOW   |
|                    |               | HIGH          | recessive        | LOW when bus dominant<br>HIGH when bus recessive  |
| Standby            | HIGH          | X             | biased to ground | TJA1448A/B: follows BUS when wake-up detected<br>TJA1448C: LOW when wake-up detected<br>HIGH when no wake-up detected |
| Off <sup>[1]</sup> | X             | X             | high-ohmic state | high-ohmic state  |

[1] Off mode is entered when the voltage on pin VIO (TJA1448A/C) or pin VCC (TJA1448B) is below the switch-off undervoltage detection threshold.

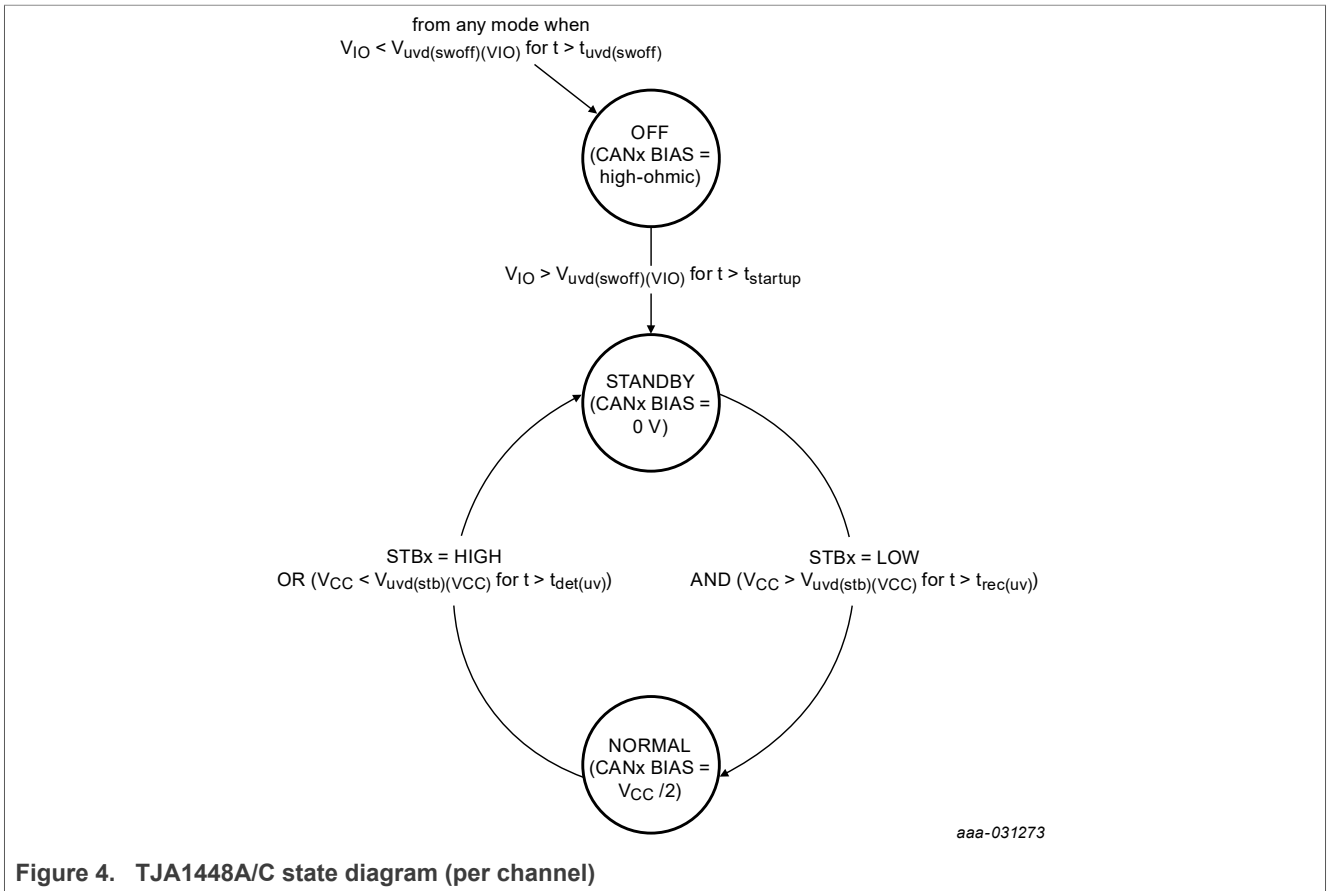


Figure 4. TJA1448A/C state diagram (per channel)

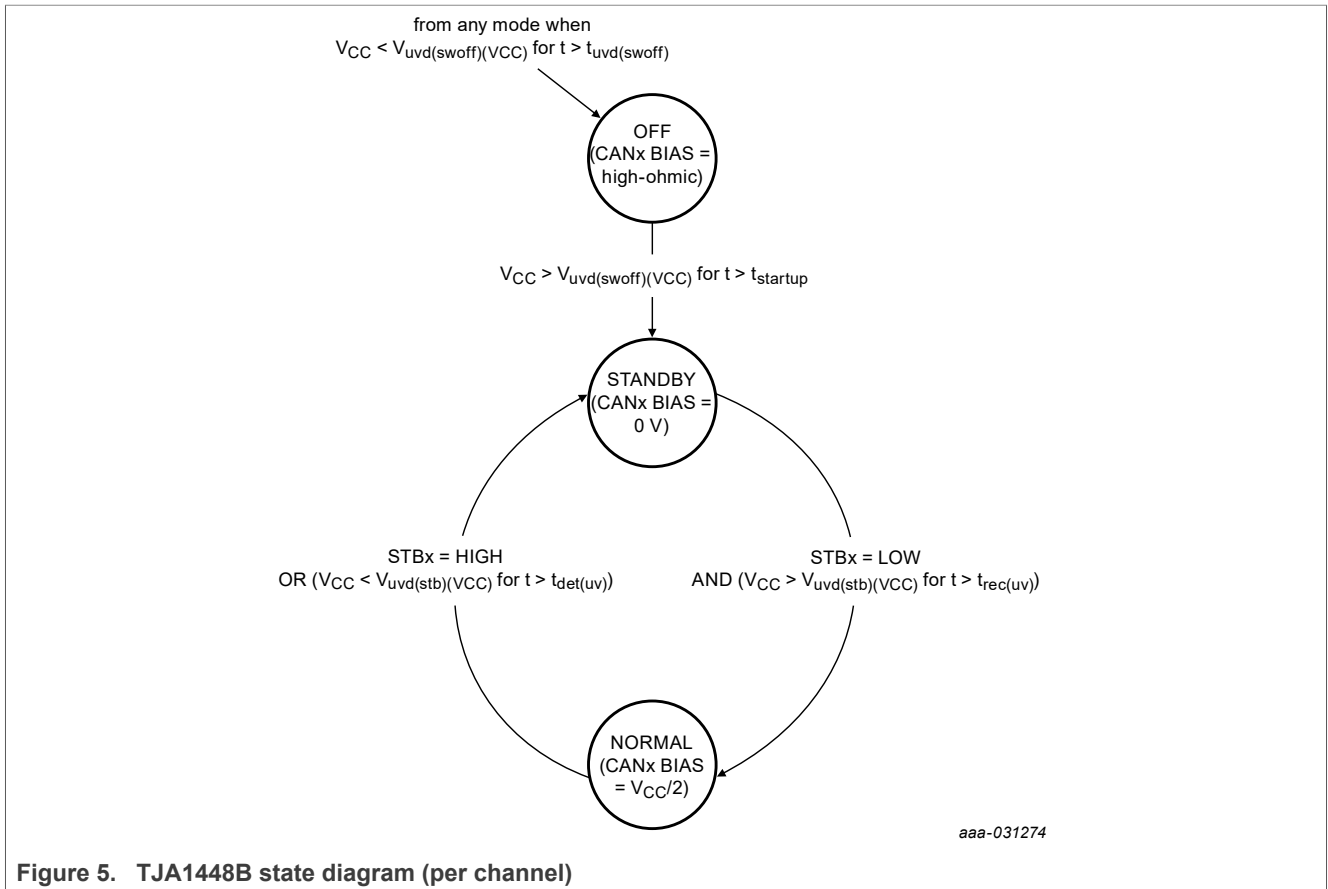


Figure 5. TJA1448B state diagram (per channel)

### 7.1.1 Off mode

The TJA1448 switches to Off mode from any mode when the supply voltage (on pin VIO in TJA1448A/C and VCC in TJA1448B) falls below the switch-off undervoltage threshold ( $V_{\text{uvd}(\text{swoff})}(V_{CC})$  or  $V_{\text{uvd}(\text{swoff})}(V_{IO})$ ). This is the default mode when the supply is first connected.

In Off mode, the CAN pins and RXDx pins are in a high-ohmic state.

### 7.1.2 Standby mode

When the supply voltage ( $V_{IO}$  for TJA1448A/C or  $V_{CC}$  for TJA1448B) rises above the switch-off undervoltage detection threshold, the TJA1448 starts to boot up, triggering an initialization procedure. The TJA1448 switches to the selected mode after  $t_{\text{startup}}$ .

Standby mode is selected when pin STBx goes HIGH. In this mode, the transceiver is unable to transmit or receive data and a low-power receiver is activated to monitor the bus for a wake-up pattern. The transmitter and Normal-mode receiver blocks are switched off and the bus pins are biased to ground to minimize system supply current. Pin RXDx in the TJA1448A/B follows the bus after a wake-up request has been detected. In the TJA1448C, RXDx is forced LOW when a wake-up request is detected.

A transition to Normal mode is triggered when STBx is forced LOW (provided  $V_{CC} > V_{\text{uvd}(\text{stb})}(V_{CC})$  and  $V_{IO} > V_{\text{uvd}(\text{swoff})}(V_{IO})$  in the TJA1448A/C).

If  $V_{CC}$  is below  $V_{\text{uvd(stb)}}(V_{CC})$  when STBx goes LOW (with  $V_{IO} > V_{\text{uvd(swoff)}}(V_{IO})$  in TJA1448A/C and  $V_{CC} > V_{\text{uvd(swoff)}}(V_{CC})$  in TJA1448B), the TJA1448 will remain in Standby mode. Pending wake-up events will be cleared and differential data on the bus pins converted to digital data via the low-power receiver and output on pin RXDx.

In the TJA1448A/C, the low-power receiver is supplied from  $V_{IO}$  and can detect CAN bus activity when  $V_{IO}$  is above  $V_{\text{uvd(swoff)}}(V_{IO})$  (even if  $V_{IO}$  is the only available supply voltage).

### 7.1.3 Normal mode

A LOW level on pin STBx selects Normal mode, provided the supply voltage on pin VCC is above the standby undervoltage detection threshold,  $V_{\text{uvd(stb)}}(V_{CC})$ .

In this mode, the transceiver can transmit and receive data via bus lines CANHx and CANLx. Pin TXDx must be HIGH at least once in Normal Mode before transmission can begin. The differential receiver converts the analog data on the bus lines into digital data on pin RXDx. 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. In recessive state, the output voltage on the bus pins is  $V_{CC}/2$ .

### 7.1.4 Operating modes and gap-free operation

Gap-free operation guarantees defined behavior at all voltage levels. Supply voltage-to-operating mode mapping is detailed in [Figure 6](#) and in the state diagrams ([Figure 4](#) and [Figure 5](#)).

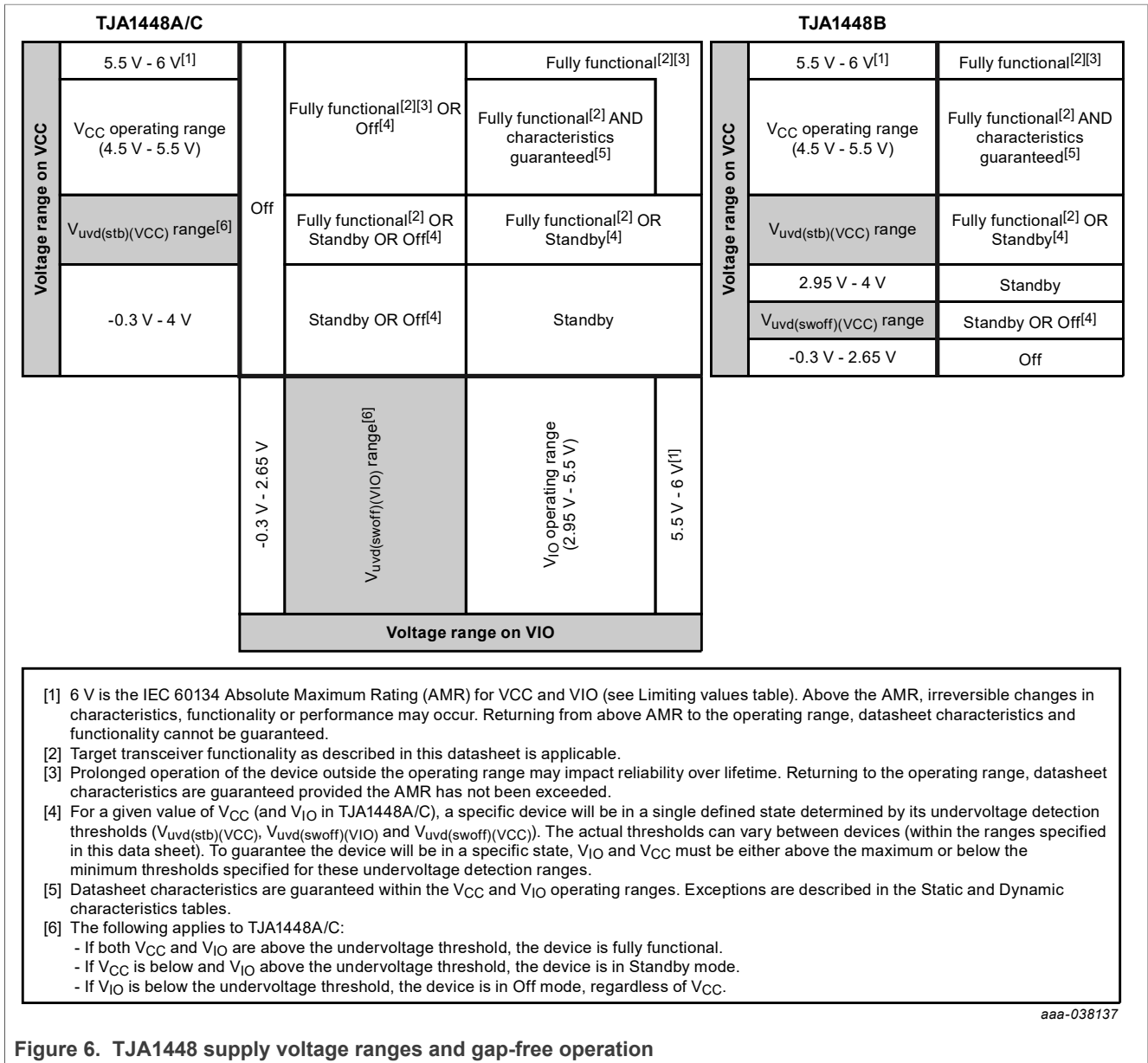


Figure 6. TJA1448 supply voltage ranges and gap-free operation

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

In Standby mode, the TJA1448 wakes up when a dedicated wake-up pattern (specified in ISO 11898-2: 2016) is detected on the bus.

The wake-up pattern consists of:

- a dominant phase of at least  $t_{wake(busdom)}$  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 7](#) for TJA1448A/B wake-up timing

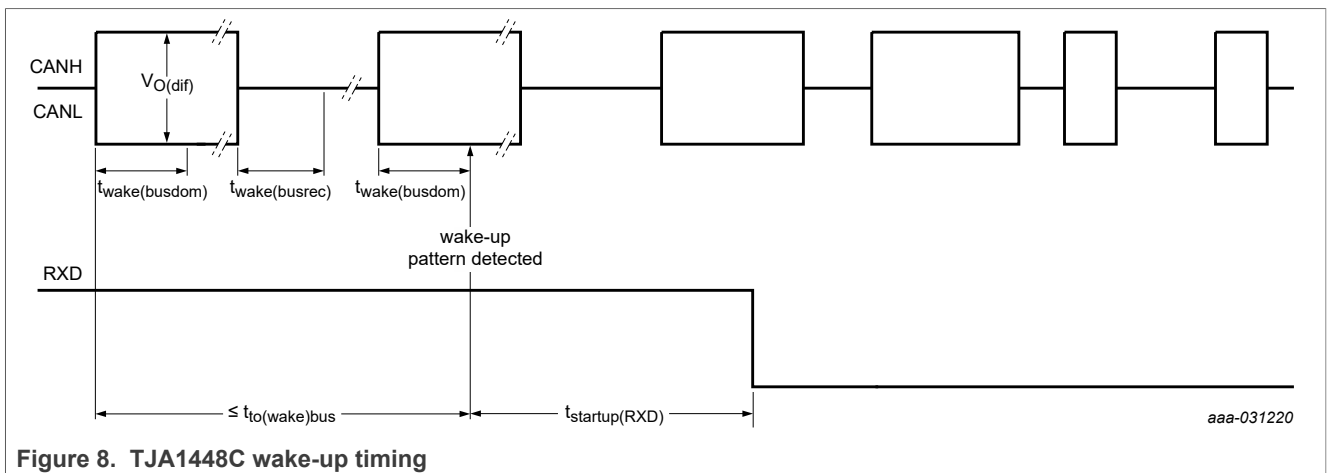
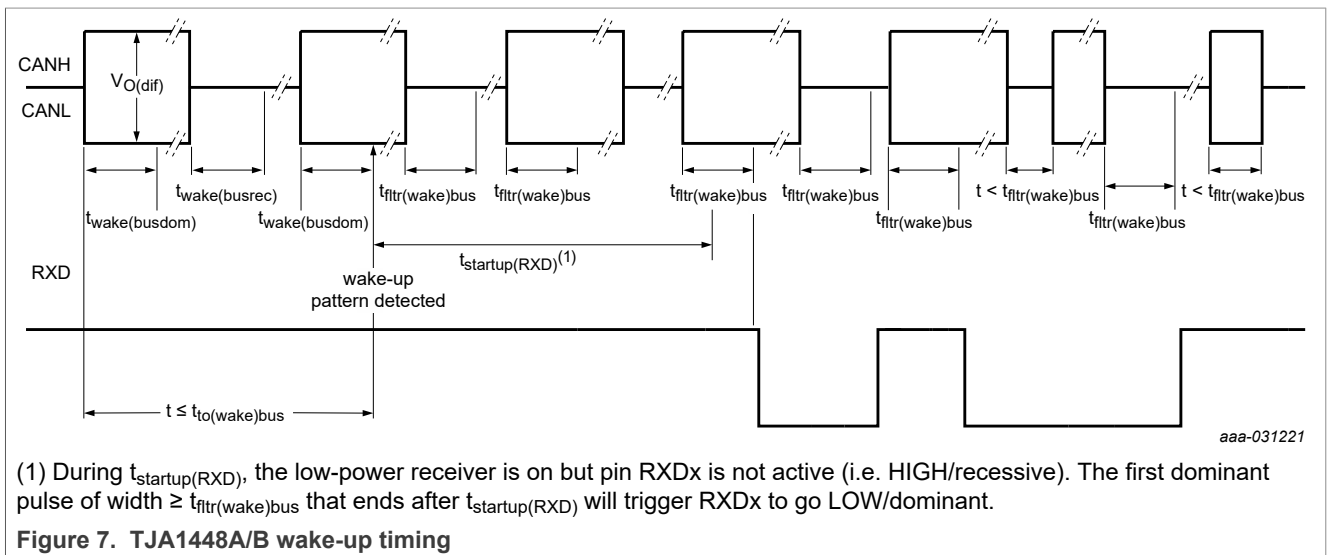
and Figure 8 for TJA1448C wake-up timing). Otherwise, the internal wake-up logic is reset. The complete wake-up pattern then needs to be retransmitted to trigger a wake-up event. Pin RXDx remains HIGH until the wake-up event has been triggered.

After a wake-up sequence has been detected, the TJA1448A/B remains in Standby mode with the bus signals reflected on RXDx after  $t_{startup(RXD)}$ . Note that dominant or recessive phases lasting less than  $t_{filtr(wake)bus}$  will not be detected by the low-power differential receiver and will not be reflected on RXDx in Standby mode (see Figure 7).

The TJA1448C also remains in Standby mode after a wake-up sequence has been detected, but pin RXDx switches LOW after  $t_{startup(RXD)}$  (see Figure 8).

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

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



## 7.3 Fail-safe features

### 7.3.1 TXD dominant timeout function

A hardware and/or software application failure in Normal mode that caused pin TXDx to be held LOW would drive the bus lines to a permanent dominant state (blocking all network communications). The TXD dominant time-out function prevents such a network lock-up. A 'TXD dominant timeout' timer is started when pin TXDx goes 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. The TXD dominant time-out timer is reset when pin TXDx is set HIGH.

### 7.3.2 Internal biasing of TXDx and STBx input pins

Pins TXDx and STBx have internal pull-ups to  $V_{CC}/V_{IO}$  to ensure a safe, defined state in case one, or both, of these pins is left or becomes floating. Pull-up resistors are active on these pins in all states; they should be held at the  $V_{CC}/V_{IO}$  level in Standby mode to minimize supply current.

### 7.3.3 Undervoltage detection on pins VCC and VIO

If  $V_{CC}$  drops below the standby undervoltage detection threshold ( $V_{uvd(stb)(VCC)}$ ) for  $t_{det(uv)}$ , both transceivers switch to Standby mode. The logic state of pin STBx is ignored until  $V_{CC}$  has recovered.

In the TJA1448A/C, if  $V_{IO}$  drops below the switch-off undervoltage detection threshold ( $V_{uvd(swoff)(VIO)}$ ) for  $t_{uvd(swoff)}$ , both transceiver switch to Off mode and disengage from the bus (high-ohmic) until  $V_{IO}$  has recovered.

In the TJA1448B, if  $V_{CC}$  drops below the switch-off undervoltage detection threshold ( $V_{uvd(swoff)(VCC)}$ ) for  $t_{uvd(swoff)}$ , both transceivers switch to Off mode and disengage from the bus (high-ohmic) until  $V_{CC}$  has recovered.

### 7.3.4 Overtemperature protection

The device is protected against overtemperature conditions. If the junction temperature exceeds the shutdown junction temperature,  $T_{j(sd)}$ , the CAN bus drivers are disabled. When the junction temperature drops below  $T_{j(sd)rel}$ , the CAN bus drivers recover once TXDx has been reset to HIGH and Normal mode is selected (waiting for TXDx to go HIGH prevents output driver oscillation due to small variations in temperature).

### 7.3.5 I/O levels

Pin VIO on the TJA1448A/C should be connected to the same supply voltage used to supply the microcontroller (see [Figure 1](#)). This adjusts the signal levels on pins TXDx, RXDx and STBx to the I/O levels of the microcontroller, allowing for direct interfacing without additional glue logic. Pin VIO also provides the internal supply voltage for the low-power differential receiver. 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 VCC.

All I/O levels are related to  $V_{CC}$  in the TJA1448B and are, therefore, compatible with 5 V microcontrollers. Spurious signals from the microcontroller on pins STB1 and STB2 are filtered out with a filter time of  $t_{ftr(IO)}$ .



## 8 Limiting values

**Table 7. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134); all voltages are referenced to pin GND, unless otherwise specified.

| Symbol                   | Parameter                             | Conditions   | Min                                 | Max               | Unit                                |
|--------------------------|---------------------------------------|--|-------------------------------------|-------------------|-------------------------------------|
| V <sub>x</sub>           | voltage on pin x <sup>[1]</sup>       | pins VCC, VIO (TJA1448A), TXDx, STBx                           | -0.3                                | +6                | V                                   |
|                          |                                       |  | -                                   | +7 <sup>[2]</sup> | V                                   |
|                          |                                       | pins CANHx, CANLx  | -36                                 | +40               | V                                   |
|                          |                                       | pin RXDx   |                                     |                   |                                     |
|                          |                                       |  | TJA1448A/C                          | -0.3              | V <sub>IO</sub> +0.3 <sup>[3]</sup> |
|                          | TJA1448B                              | -0.3   | V <sub>CC</sub> +0.3 <sup>[3]</sup> | V                 |                                     |
| V <sub>(CANH-CANL)</sub> | voltage between pin CANH and pin CANL | between pins CANH1 and CANL1 and between CANH2 and CANL2       | -40                                 | +40               | V                                   |
| V <sub>trt</sub>         | transient voltage                     | on pins CANHx, CANLx <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 CANHx, CANLx   | -8                                  | +8                | kV                                  |
|                          |                                       | Human Body Model (HBM)   |                                     |                   |                                     |
|                          |                                       | on any pin <sup>[6]</sup>                                      | -4                                  | +4                | kV                                  |
|                          |                                       | on pins CANHx, CANLx <sup>[7]</sup>                            | -8                                  | +8                | kV                                  |
|                          |                                       | Charged Device Model (CDM) <sup>[8]</sup>                      |                                     |                   |                                     |
|                          |                                       | on corner pins   | -750                                | +750              | V                                   |
| on any other pin         | -500                                  | +500   | V                                   |                   |                                     |
| T <sub>vj</sub>          | virtual junction temperature          | <sup>[9]</sup>   | -40                                 | +150              | °C                                  |
| T <sub>stg</sub>         | storage temperature                   | <sup>[10]</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] The device can withstand voltages between 6 V and 7 V for a total of 20 s over the product lifetime.

[3] Subject to the qualifications detailed in Table notes 1 and 2 above for pins VCC, VIO, TXDx and STBx.

[4] Verified by an external test house according to IEC TS 62228, Section 4.2.4; parameters for standard pulses defined in ISO7637.

[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 1 and Figure 2). HBM pulse as specified in AEC-Q100-002 used.

[8] According to AEC-Q100-011.

[9] In accordance with IEC 60747-1. An alternative definition of virtual junction temperature is:  $T_{vj} = T_{amb} + P \times R_{th(j-a)}$ , where  $R_{th(j-a)}$  is a fixed value used in the calculation of  $T_{vj}$ . The rating for  $T_{vj}$  limits the allowable combinations of power dissipation (P) and ambient temperature ( $T_{amb}$ ).

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

## 9 Thermal characteristics

**Table 8. Thermal characteristics**

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

| Symbol         | Parameter  | Conditions <sup>[1]</sup> | Typ | Unit |
|----------------|--|---------------------------|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient                        | SO14                      | 62  | K/W  |
|                |  | HVSON14                   | 42  | K/W  |
| $R_{th(j-c)}$  | thermal resistance from junction to case <sup>[2]</sup>            | HVSON14                   | 10  | K/W  |
| $\Psi_{j-top}$ | thermal characterization parameter from junction to top of package | SO14                      | 8   | K/W  |
|                |  | HVSON14                   | 4   | 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  $\mu$ m) and thermal via array under the exposed pad connected to the first inner copper layer (thickness: 70  $\mu$ m).

[2] Case temperature refers to the center of the heatsink at the bottom of the package.

## 10 Static characteristics

**Table 9. Static characteristics**

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.95\text{ V}$  to  $5.5\text{ V}$  (TJA1448A/C);  $R_L = 60\text{ }\Omega$  unless specified otherwise; all voltages are defined with respect to ground; positive currents flow into the IC.<sup>[1]</sup>

| Symbol   | Parameter                                 | Conditions  | Min                 | Typ | Max  | Unit    |
|--|---|---|---------------------|-----|------|---------|
| Supply; pin VCC                                |   |   |                     |     |      |         |
| $V_{CC}$                                       | supply voltage                            |   | 4.5                 | -   | 5.5  | V       |
| $V_{uvd(stb)}$                                 | standby undervoltage detection voltage    |   | <sup>[2]</sup> 4    | -   | 4.5  | V       |
| $V_{uvhys(stb)}$                               | standby undervoltage hysteresis voltage   |   | 50                  | -   | -    | mV      |
| $V_{uvd(swoff)}$                               | switch-off undervoltage detection voltage | TJA1448B  | <sup>[2]</sup> 2.65 | -   | 2.95 | V       |
| $I_{CC}$                                       | supply current                            | Normal mode   |                     |     |      |         |
|  |   | both channels recessive;<br>$V_{TXDx} = V_{IO}$ <sup>[3]</sup>  | -                   | 8   | 14   | mA      |
|  |   | one channel dominant; one channel recessive; $t < t_{to(dom)TXD}$   | -                   | 42  | 67   | mA      |
|  |   | both channels dominant;<br>$V_{TXDx} = 0\text{ V}$ ; $t < t_{to(dom)TXD}$   | -                   | 77  | 120  | mA      |
|  |   | both channels dominant;<br>$V_{TXDx} = 0\text{ V}$ ;<br>short circuit on bus lines;<br>$-3\text{ V} < (V_{CANHx} = V_{CANLx}) < +40\text{ V}$ | -                   | -   | 250  | mA      |
|  |   | Standby mode  |                     |     |      |         |
|  |   | TJA1448A,C; $T_{vj} < 85\text{ }^{\circ}\text{C}$   | -                   | -   | 2    | $\mu$ A |
|  |   | TJA1448B; $T_{vj} < 85\text{ }^{\circ}\text{C}$   | -                   | 11  | 18   | $\mu$ A |
| I/O level adapter supply; pin VIO (TJA1448A/C) |   |   |                     |     |      |         |
| $V_{IO}$                                       | supply voltage                            |   | 2.95                | -   | 5.5  | V       |

Table 9. Static characteristics...continued

$T_{vj} = -40\text{ °C}$  to  $+150\text{ °C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.95\text{ V}$  to  $5.5\text{ V}$  (TJA1448A/C);  $R_L = 60\ \Omega$  unless specified otherwise; all voltages are defined with respect to ground; positive currents flow into the IC.<sup>[1]</sup>

| Symbol  | Parameter                                 | Conditions  | Min                        | Typ | Max                        | Unit          |
|---|---|---|----------------------------|-----|----------------------------|---------------|
| $V_{uvd(swoff)}$                              | switch-off undervoltage detection voltage |   | [2] 2.65                   | -   | 2.95                       | V             |
| $I_{IO}$                                      | supply current                            | Normal mode   |                            |     |                            |               |
|   |   | both channels recessive;<br>$V_{TXDx} = V_{IO}$   | -                          | 270 | 750                        | $\mu\text{A}$ |
|   |   | one channel dominant; one channel recessive   | -                          | 360 | 1000                       | $\mu\text{A}$ |
|   |   | both channels dominant;<br>$V_{TXDx} = 0\text{ V}$  | -                          | 450 | 1250                       | $\mu\text{A}$ |
|   |   | Standby mode; $T_{vj} < 85\text{ °C}$   | -                          | 11  | 16                         | $\mu\text{A}$ |
| CAN transmit data input; pins TXD1 and TXD2   |   |   |                            |     |                            |               |
| $V_{IH}$                                      | HIGH-level input voltage                  |   | $0.7V_{IO}$ <sup>[3]</sup> | -   | -                          | V             |
| $V_{IL}$                                      | LOW-level input voltage                   |   | -                          | -   | $0.3V_{IO}$ <sup>[3]</sup> | V             |
| $V_{hys(TXD)}$                                | hysteresis voltage on pin TXD             |   | 50                         | -   | -                          | mV            |
| $R_{pu}$                                      | pull-up resistance                        |   | 20                         | -   | 80                         | k $\Omega$    |
| $C_i$   | input capacitance                         |   | [4] -                      | -   | 10                         | pF            |
| CAN receive data output; pins RXD1 and RXD2   |   |   |                            |     |                            |               |
| $I_{OH}$                                      | HIGH-level output current                 | $V_{RXDx} = V_{IO}$ <sup>[3]</sup> - 0.4 V  | -10                        | -   | -1                         | mA            |
| $I_{OL}$                                      | LOW-level output current                  | $V_{RXDx} = 0.4\text{ V}$ ; bus dominant  | 1                          | -   | 10                         | mA            |
| Standby control input; pins STB1 and STB2     |   |   |                            |     |                            |               |
| $V_{IH}$                                      | HIGH-level input voltage                  |   | $0.7V_{IO}$ <sup>[3]</sup> | -   | -                          | V             |
| $V_{IL}$                                      | LOW-level input voltage                   |   | -                          | -   | $0.3V_{IO}$ <sup>[3]</sup> | V             |
| $V_{hys}$                                     | hysteresis voltage                        |   | 50                         | -   | -                          | mV            |
| $R_{pu}$                                      | pull-up resistance                        |   | 20                         | -   | 80                         | k $\Omega$    |
| $C_i$   | input capacitance                         |   | [4] -                      | -   | 10                         | pF            |
| Bus lines; pins CANH1, CANH2, CANL1 and CANL2 |   |   |                            |     |                            |               |
| $V_{O(dom)}$                                  | dominant output voltage                   | $V_{TXD} = 0\text{ V}$ ; $t < t_{to(dom)TXD}$ ;<br>$V_{CC} \geq 4.75\text{ V}$ ; $R_L = 50\ \Omega$ to $65\ \Omega$                       |                            |     |                            |               |
|   |   | pin CANHx   | 2.75                       | 3.5 | 4.5                        | V             |
|   |   | pin CANLx   | 0.5                        | 1.5 | 2.25                       | V             |
| $V_{TXsym}$                                   | transmitter voltage symmetry              | $V_{TXsym} = V_{CANHx} + V_{CANLx}$ ;<br>$C_{SPLIT} = 4.7\text{ nF}$ ;<br>$f_{TXD} = 250\text{ kHz}$ , $1\text{ MHz}$ or $2.5\text{ MHz}$ | [4] [5] $0.9V_{CC}$        | -   | $1.1V_{CC}$                | V             |
| $V_{cm(step)}$                                | common mode voltage step                  |   | [4] [5] [6] -150           | -   | +150                       | mV            |

Table 9. Static characteristics...continued

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.95\text{ V}$  to  $5.5\text{ V}$  (TJA1448A/C);  $R_L = 60\text{ }\Omega$  unless specified otherwise; all voltages are defined with respect to ground; positive currents flow into the IC.<sup>[1]</sup>

| Symbol           | Parameter                                | Conditions   | Min                       | Typ | Max  | Unit          |  |
|------------------|--|--|---------------------------|-----|------|---------------|--|
| $V_{cm(p-p)}$    | peak-to-peak common mode voltage         |  | [4]<br>[5]<br>[6]<br>-300 | -   | +300 | mV            |  |
| $V_{O(dif)}$     | differential output voltage              | dominant; Normal mode; $V_{TXDx} = 0\text{ V}$ ;<br>$t < t_{to(dom)TXD}$ ; $V_{CC} \geq 4.75\text{ V}$   |                           |     |      |               |  |
|                  |  | $R_L = 50\text{ }\Omega$ to $65\text{ }\Omega$   | 1.5                       | -   | 3    | V             |  |
|                  |  | $R_L = 45\text{ }\Omega$ to $70\text{ }\Omega$   | 1.4                       | -   | 3.3  | V             |  |
|                  |  | $R_L = 2240\text{ }\Omega$   | [4]<br>1.5                | -   | 5    | V             |  |
|                  |  | recessive; no load   |                           |     |      |               |  |
|                  |  | Normal mode; $V_{TXDx} = V_{IO}$ <sup>[3]</sup>  | -50                       | -   | +50  | mV            |  |
| $V_{O(rec)}$     | recessive output voltage                 | Normal mode; $V_{TXDx} = V_{IO}$ <sup>[3]</sup> ; no load  | 2                         | 2.5 | 3    | V             |  |
|                  |  | Standby mode; no load  | -0.1                      | -   | +0.1 | V             |  |
| $V_{th(RX)dif}$  | differential receiver threshold voltage  | $-12\text{ V} \leq V_{CANHx} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{CANLx} \leq +12\text{ V}$   |                           |     |      |               |  |
|                  |  | Normal mode  | 0.5                       | -   | 0.9  | V             |  |
|                  |  | Standby mode   | 0.4                       | -   | 1.1  | V             |  |
| $V_{rec(RX)}$    | receiver recessive voltage               | $-12\text{ V} \leq V_{CANHx} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{CANLx} \leq +12\text{ V}$   |                           |     |      |               |  |
|                  |  | Normal mode  | -4                        | -   | +0.5 | V             |  |
|                  |  | Standby mode   | -4                        | -   | +0.4 | V             |  |
| $V_{dom(RX)}$    | receiver dominant voltage                | $-12\text{ V} \leq V_{CANHx} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{CANLx} \leq +12\text{ V}$   |                           |     |      |               |  |
|                  |  | Normal mode  | 0.9                       | -   | 9    | V             |  |
|                  |  | Standby mode   | 1.1                       | -   | 9    | V             |  |
| $V_{hys(RX)dif}$ | differential receiver hysteresis voltage | $-12\text{ V} \leq V_{CANHx} \leq +12\text{ V}$ ;<br>$-12\text{ V} \leq V_{CANLx} \leq +12\text{ V}$ ; Normal mode                                       | 50                        | -   | -    | mV            |  |
| $I_{O(sc)}$      | short-circuit output current             | $-15\text{ V} \leq V_{CANHx} \leq +40\text{ V}$ ;<br>$-15\text{ V} \leq V_{CANLx} \leq +40\text{ V}$   | -                         | -   | 115  | mA            |  |
| $I_{O(sc)rec}$   | recessive short-circuit output current   | $-27\text{ V} \leq V_{CANHx} \leq +32\text{ V}$ ;<br>$-27\text{ V} \leq V_{CANLx} \leq +32\text{ V}$ ; Normal mode;<br>$V_{TXD} = V_{IO}$ <sup>[3]</sup> | -3                        | -   | +3   | mA            |  |
| $I_L$            | leakage current                          | $V_{CC} = V_{IO} = 0\text{ V}$ or pins shorted to GND<br>via $47\text{ k}\Omega$ ; $V_{CANHx} = V_{CANLx} = 5\text{ V}$                                  | -10                       | -   | +10  | $\mu\text{A}$ |  |
| $R_i$            | input resistance                         | $-2\text{ V} \leq V_{CANLx} \leq +7\text{ V}$ ;<br>$-2\text{ V} \leq V_{CANHx} \leq +7\text{ V}$   | 25                        | 40  | 50   | k $\Omega$    |  |
| $\Delta R_i$     | input resistance deviation               | $0\text{ V} \leq V_{CANLx} \leq +5\text{ V}$ ;<br>$0\text{ V} \leq V_{CANHx} \leq +5\text{ V}$   | -3                        | -   | +3   | %             |  |
| $R_{i(dif)}$     | differential input resistance            | $-2\text{ V} \leq V_{CANL} \leq +7\text{ V}$ ;<br>$-2\text{ V} \leq V_{CANH} \leq +7\text{ V}$   | 50                        | 80  | 100  | k $\Omega$    |  |

**Table 9. Static characteristics...continued**

$T_{vj} = -40\text{ °C to }+150\text{ °C}$ ;  $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ;  $V_{IO} = 2.95\text{ V to }5.5\text{ V (TJA1448A/C)}$ ;  $R_L = 60\ \Omega$  unless specified otherwise; all voltages are defined with respect to ground; positive currents flow into the IC.<sup>[1]</sup>

| Symbol                | Parameter                             | Conditions | Min | Typ | Max | Unit |
|-----------------------|---------------------------------------|------------|-----|-----|-----|------|
| $C_{i(cm)}$           | common-mode input capacitance         | [4]        | -   | -   | 20  | pF   |
| $C_{i(dif)}$          | differential input capacitance        | [4]        | -   | -   | 10  | pF   |
| Temperature detection |                                       |            |     |     |     |      |
| $T_{j(sd)}$           | shutdown junction temperature         | [4]        | 180 | -   | 200 | °C   |
| $T_{j(sd)rel}$        | release shutdown junction temperature | [4]        | 175 | -   | 195 | °C   |

[1] All parameters are guaranteed over the virtual junction temperature range by design. Factory testing uses correlated test conditions to cover the specified temperature and power supply voltage ranges.

[2] 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.

[3]  $V_{CC}$  in TJA1448B

[4] Not tested in production; guaranteed by design.

[5] The test circuit used to measure the bus output voltage symmetry and the common-mode voltages (which includes  $C_{SPLIT}$ ) is shown in [Figure 15](#).

[6] See [Figure 11](#)

## 11 Dynamic characteristics

**Table 10. Dynamic characteristics**

$T_{vj} = -40\text{ °C to }+150\text{ °C}$ ;  $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ;  $V_{IO} = 2.95\text{ V to }5.5\text{ V (TJA1448A/C)}$ ;  $R_L = 60\ \Omega$  unless specified otherwise; all voltages are defined with respect to ground.<sup>[1]</sup>

| Symbol   | Parameter                              | Conditions                           | Min                                  | Typ | Max   | Unit          |
|--|--|--------------------------------------|--------------------------------------|-----|-------|---------------|
| CAN timing characteristics; $t_{bit(TXD)} \geq 200\text{ ns}$ ; see <a href="#">Figure 9</a> , <a href="#">Figure 10</a> and <a href="#">Figure 14</a> |  |                                      |                                      |     |       |               |
| $t_{d(TXD-busdom)}$  | delay time from TXD to bus dominant    | Normal mode                          | -                                    | -   | 102.5 | ns            |
| $t_{d(TXD-busrec)}$  | delay time from TXD to bus recessive   | Normal mode                          | -                                    | -   | 102.5 | ns            |
| $t_{d(busdom-RXD)}$  | delay time from bus dominant to RXD    | Normal mode                          | -                                    | -   | 115   | ns            |
| $t_{d(busrec-RXD)}$  | delay time from bus recessive to RXD   | Normal mode                          | -                                    | -   | 115   | ns            |
| $t_{d(TXDL-RXDL)}$   | delay time from TXD LOW to RXD LOW     | Normal mode                          | -                                    | -   | 215   | ns            |
| $t_{d(TXDH-RXDH)}$   | delay time from TXD HIGH to RXD HIGH   | Normal mode                          | -                                    | -   | 215   | ns            |
| CAN FD timing characteristics according to ISO 11898-2:2016; see <a href="#">Figure 10</a> and <a href="#">Figure 14</a>                               |  |                                      |                                      |     |       |               |
| $t_{bit(bus)}$   | transmitted recessive bit width        | $t_{bit(TXD)} = 500\text{ ns}$       | 435                                  | -   | 530   | ns            |
|  |  | $t_{bit(TXD)} = 200\text{ ns}$       | 155                                  | -   | 210   | ns            |
| $\Delta t_{rec}$   | receiver timing symmetry               | $t_{bit(TXD)} = 500\text{ ns}$       | -65                                  | -   | +40   | ns            |
|  |  | $t_{bit(TXD)} = 200\text{ ns}$       | -45                                  | -   | +15   | ns            |
| $t_{bit(RXD)}$   | bit time on pin RXD                    | $t_{bit(TXD)} = 500\text{ ns}$       | 400                                  | -   | 550   | ns            |
|  |  | $t_{bit(TXD)} = 200\text{ ns}$       | 120                                  | -   | 220   | ns            |
| Dominant time-out time; pins TXD1 and TXD2   |  |                                      |                                      |     |       |               |
| <a href="#">t<sub>to(dom)TXD</sub></a>   | TXD dominant time-out time             | $V_{TXD} = 0\text{ V}$ ; Normal mode | <sup>[2]</sup><br><sub>[3]</sub> 0.8 | -   | 9     | ms            |
| Bus wake-up times; pins CANH1, CANH2 and CANL1, CANL2; see <a href="#">Figure 7</a> and <a href="#">Figure 8</a>                                       |  |                                      |                                      |     |       |               |
| <a href="#">t<sub>wake(busdom)</sub></a>   | bus dominant wake-up time              | Standby mode                         | <sup>[2]</sup><br><sub>[4]</sub> 0.5 | -   | 1.8   | $\mu\text{s}$ |
| <a href="#">t<sub>wake(busrec)</sub></a>   | bus recessive wake-up time             | Standby mode                         | <sup>[2]</sup><br><sub>[4]</sub> 0.5 | -   | 1.8   | $\mu\text{s}$ |
| <a href="#">t<sub>to(wake)bus</sub></a>  | bus wake-up time-out time              | Standby mode                         | <sup>[2]</sup><br><sub>[3]</sub> 0.8 | -   | 9     | ms            |
| <a href="#">t<sub>filtr(wake)bus</sub></a>   | bus wake-up filter time                | TJA1448A/B; Standby mode             | <sup>[2]</sup> -                     | -   | 1.8   | $\mu\text{s}$ |
| Mode transitions   |  |                                      |                                      |     |       |               |
| <a href="#">t<sub>t(moch)</sub></a>  | mode change transition time            |                                      | <sup>[2]</sup> -                     | -   | 50    | $\mu\text{s}$ |
| <a href="#">t<sub>startup</sub></a>  | start-up time                          |                                      | <sup>[2]</sup> -                     | -   | 1     | ms            |
| <a href="#">t<sub>startup(RXD)</sub></a>   | RXD start-up time                      | after wake-up detected               | <sup>[2]</sup><br><sub>[5]</sub> 4   | -   | 20    | $\mu\text{s}$ |
| IO filter; pins STB1 and STB2  |  |                                      |                                      |     |       |               |
| <a href="#">t<sub>filtr(IO)</sub></a>  | IO filter time                         |                                      | <sup>[6]</sup> 1                     | -   | 5     | $\mu\text{s}$ |
| Undervoltage detection; see <a href="#">Figure 4</a> and <a href="#">Figure 5</a>  |  |                                      |                                      |     |       |               |
| $t_{det(uv)}$  | undervoltage detection time            | on pin VCC                           | <sup>[2]</sup> -                     | -   | 30    | $\mu\text{s}$ |
| $t_{uvd(swoff)}$   | switch-off undervoltage detection time | on pin VCC; TJA1448B                 | <sup>[2]</sup> -                     | -   | 30    | $\mu\text{s}$ |

Table 10. Dynamic characteristics...continued

$T_{vj} = -40\text{ }^{\circ}\text{C}$  to  $+150\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ ;  $V_{IO} = 2.95\text{ V}$  to  $5.5\text{ V}$  (TJA1448A/C);  $R_L = 60\text{ }\Omega$  unless specified otherwise; all voltages are defined with respect to ground.<sup>[1]</sup>

| Symbol               | Parameter                  | Conditions                            | Min | Typ | Max | Unit          |
|----------------------|----------------------------|---------------------------------------|-----|-----|-----|---------------|
|                      |                            | on pin VIO; TJA1448A/C <sup>[2]</sup> |     |     | 30  | $\mu\text{s}$ |
| $t_{\text{rec(uv)}}$ | undervoltage recovery time | on pin VCC <sup>[2]</sup>             | -   | -   | 50  | $\mu\text{s}$ |

- [1] 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 ranges.
- [2] Not tested in production; guaranteed by design.
- [3] 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.
- [4] 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.
- [5] When a wake-up is detected, RXD start-up time is between the min and max values. RXD cannot be relied on below the min value; RXD can be relied on above the max value; see Figure 7 and Figure 8.
- [6] Pulses shorter than the min value are guaranteed to be filtered out; pulses longer than the max value are guaranteed to be processed.

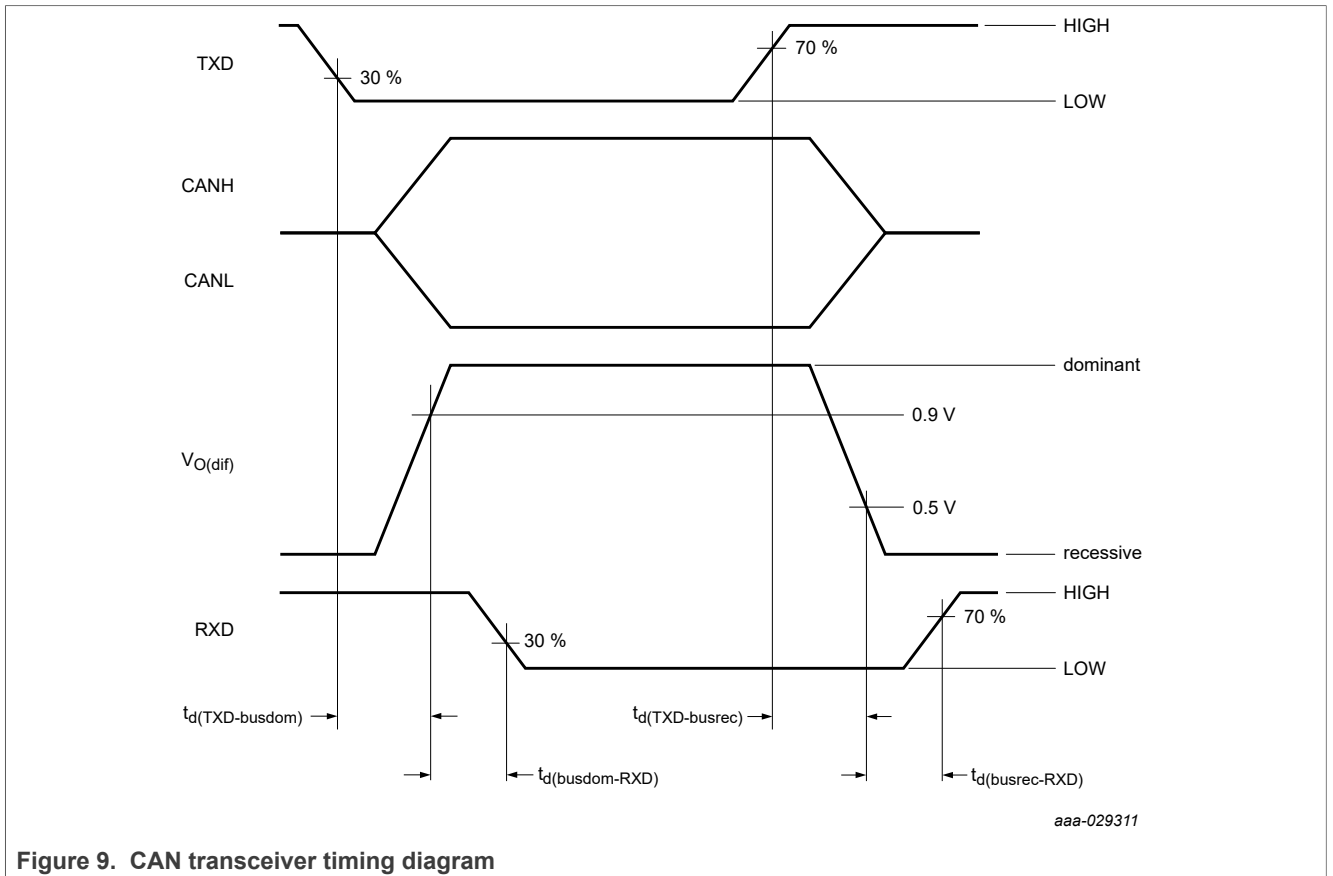


Figure 9. CAN transceiver timing diagram

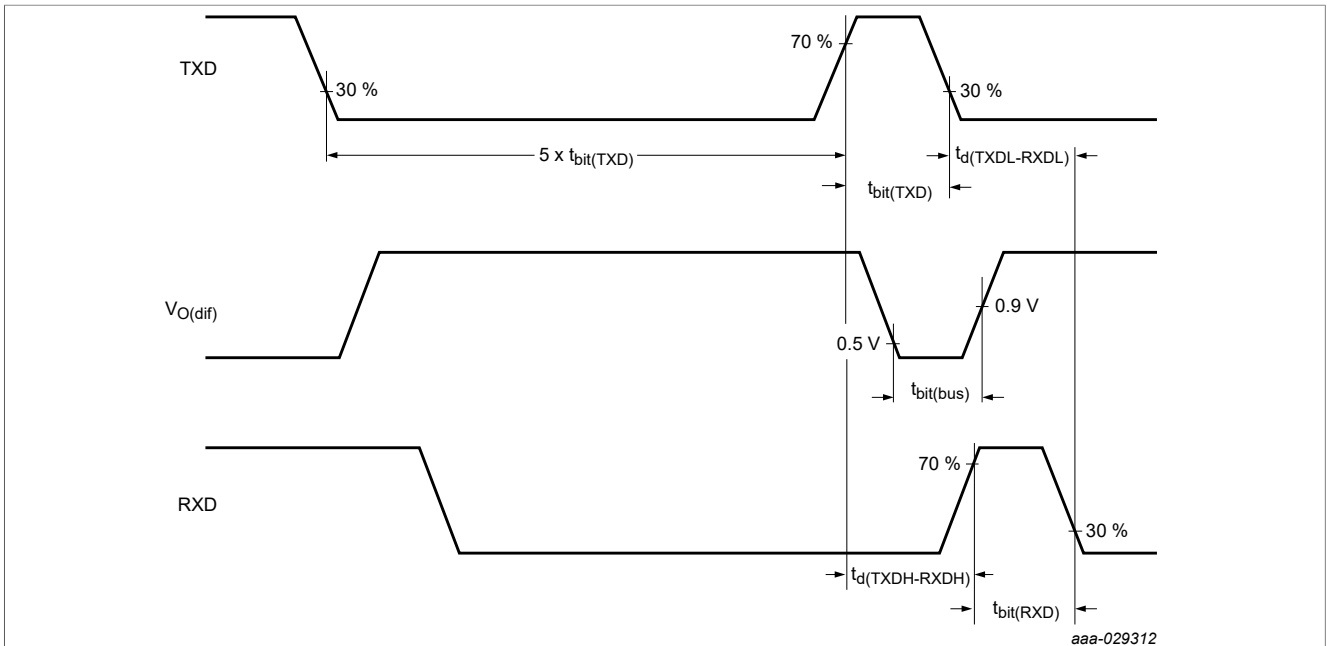


Figure 10. CAN FD timing definitions according to ISO 11898-2:2016

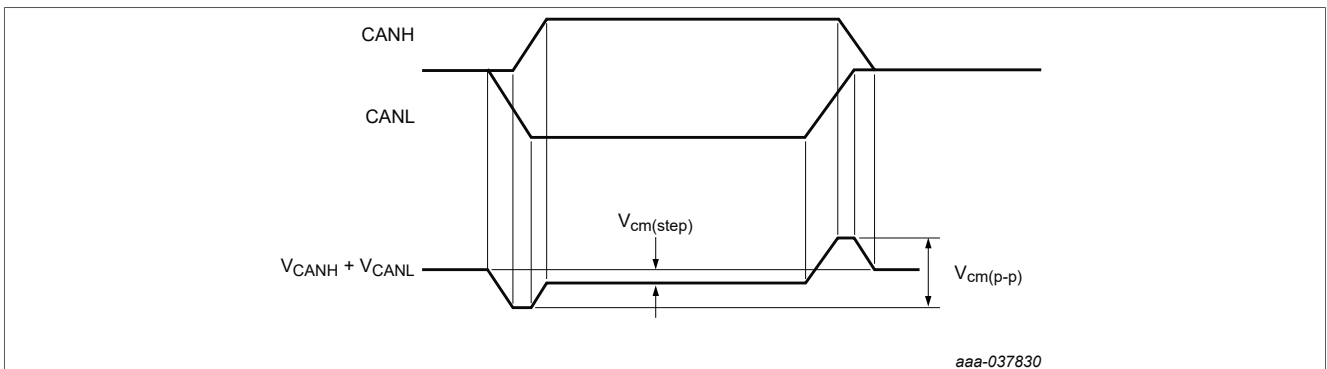
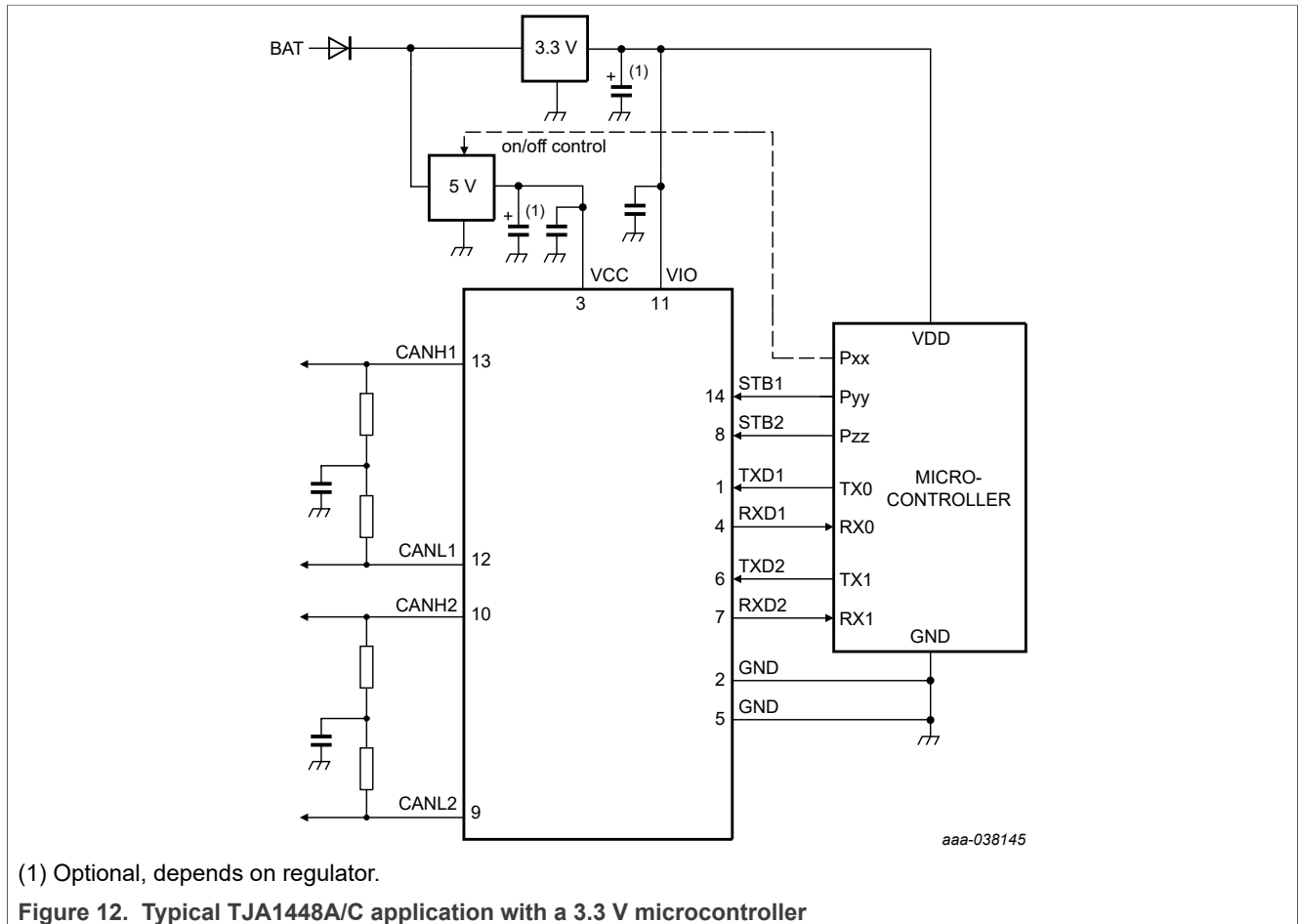


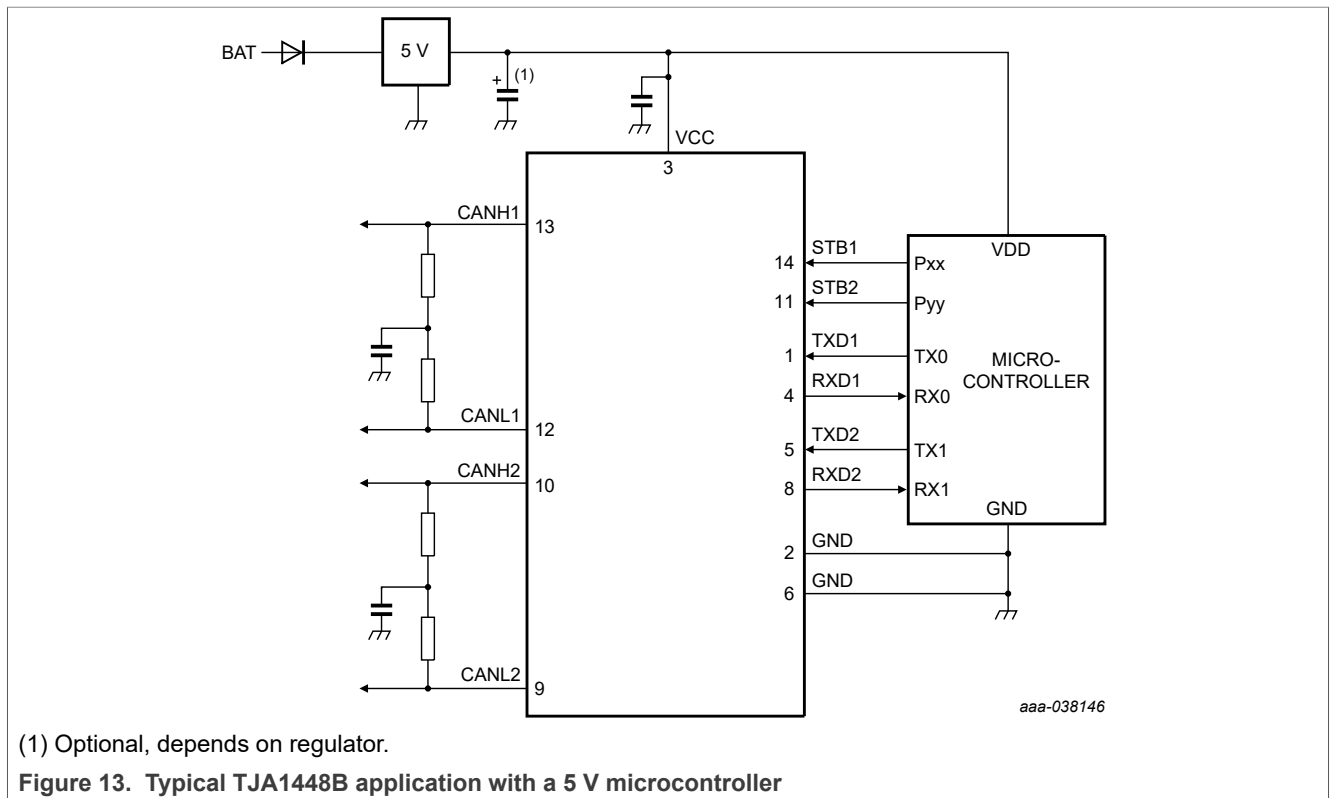
Figure 11. CAN bus common-mode voltage



## 12 Application information

### 12.1 Application diagrams





## 12.2 Application hints

Further information on the application of the TJA1448 can be found in NXP application hints AH2002 '*TJx144x/TJx146x Application Hints*', available on request from NXP Semiconductors.

### 13 Test information

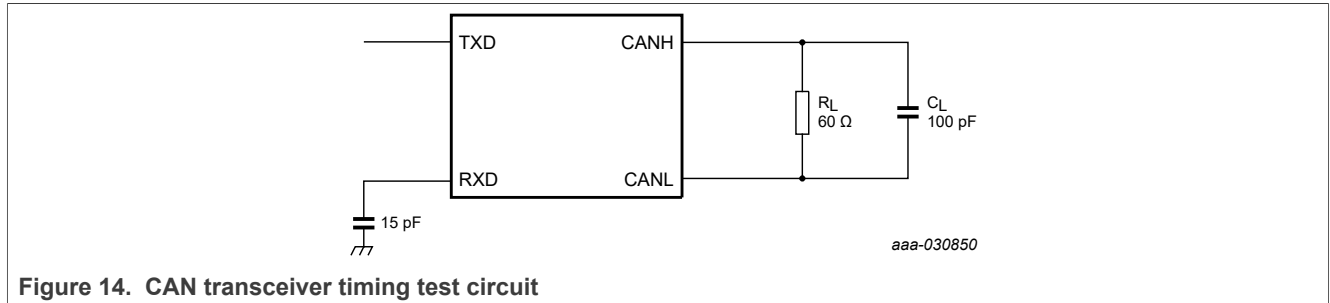


Figure 14. CAN transceiver timing test circuit

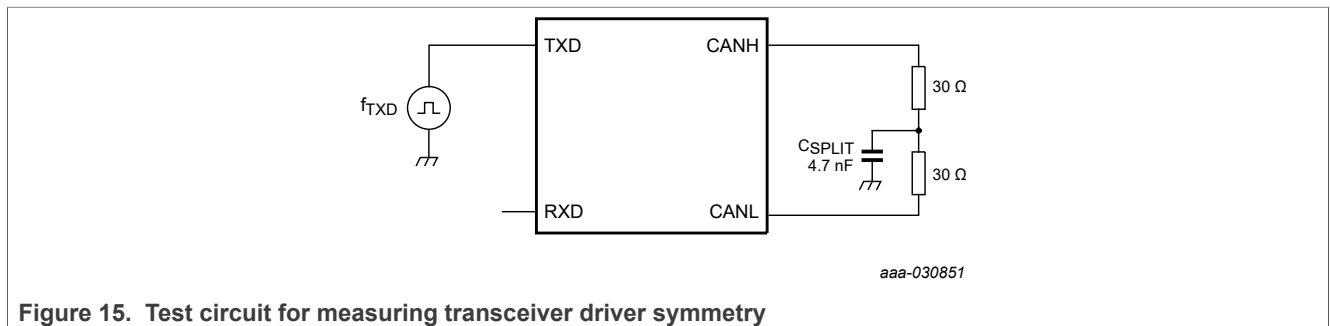


Figure 15. Test circuit for measuring transceiver driver symmetry

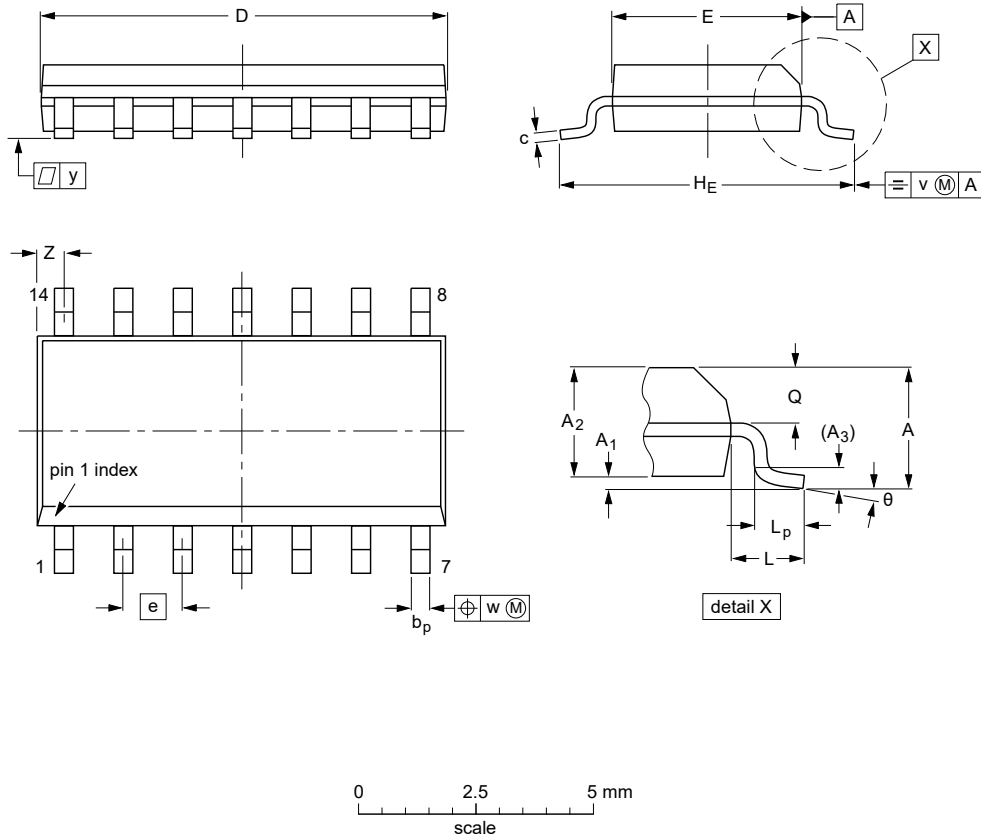
#### 13.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q100 Rev-H - *Failure mechanism based stress test qualification for integrated circuits*, and is suitable for use in automotive applications.

14 Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



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>(1)</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     | 8.75<br>8.55     | 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 | 0.35<br>0.34     | 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   |          |

Note

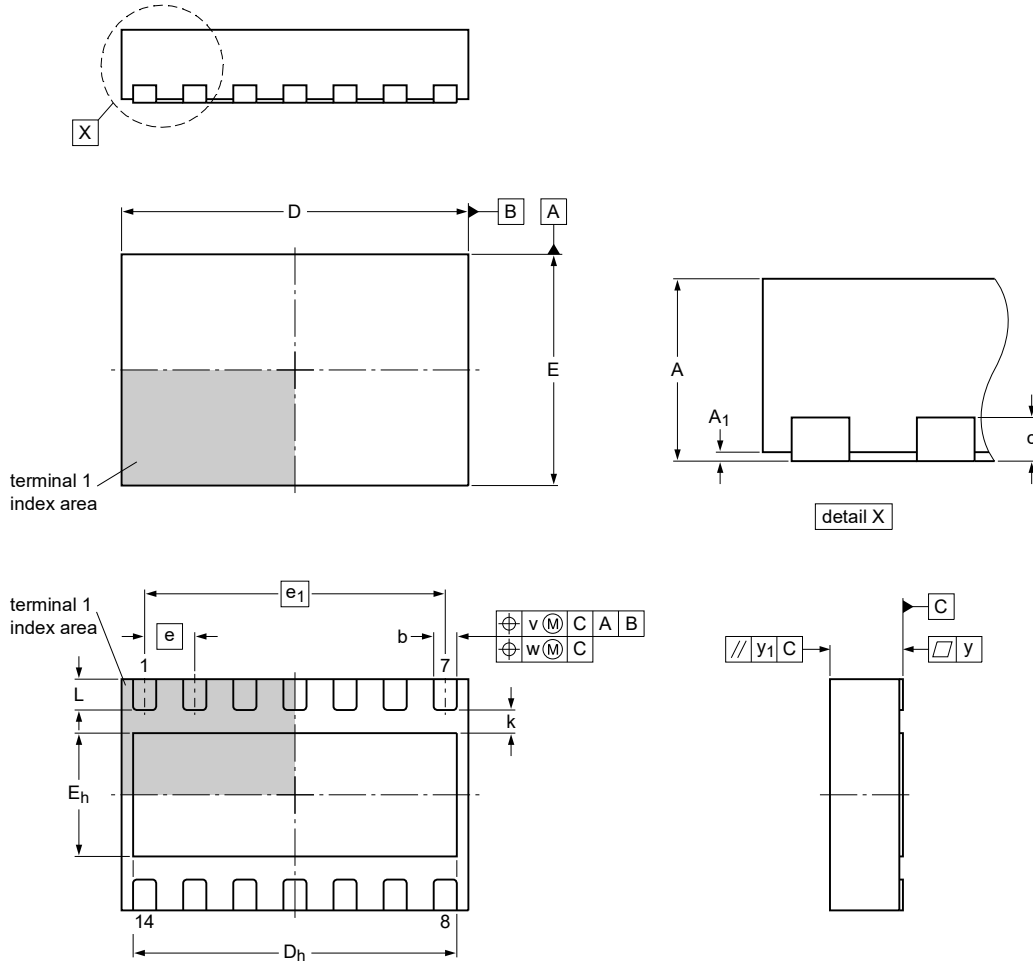
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

| OUTLINE VERSION | REFERENCES |        |       | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|--------|-------|---------------------|----------------------|
|                 | IEC        | JEDEC  | JEITA |                     |                      |
| SOT108-1        | 076E06     | MS-012 |       |                     | 99-12-27<br>03-02-19 |

Figure 16. Package outline SOT108-1 (SO14)

HVSON14: plastic, thermal enhanced very thin small outline package; no leads;  
14 terminals; body 3 x 4.5 x 0.85 mm

SOT1086-2



Dimensions

| Unit   | 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 |     | 4.6 | 4.25           | 3.1 | 1.65           |      |                | 0.35 | 0.45 |     |      |      |                |
| mm nom | 0.85 | 0.03           | 0.32 | 0.2 | 4.5 | 4.20           | 3.0 | 1.60           | 0.65 | 3.9            | 0.30 | 0.40 | 0.1 | 0.05 | 0.05 | 0.1            |
| min    | 0.80 | 0.00           | 0.29 |     | 4.4 | 4.15           | 2.9 | 1.55           |      |                | 0.25 | 0.35 |     |      |      |                |

sot1086-2

| Outline version | References |        |       |  | European projection | Issue date           |
|-----------------|------------|--------|-------|--|---------------------|----------------------|
|                 | IEC        | JEDEC  | JEITA |  |                     |                      |
| SOT1086-2       | ---        | MO-229 | ---   |  |                     | 10-07-14<br>10-07-15 |

Figure 17. Package outline SOT1086-2 (HVSON14)

## 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 18](#)) 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 11](#) and [Table 12](#)

Table 11. SnPb eutectic process (from J-STD-020D)

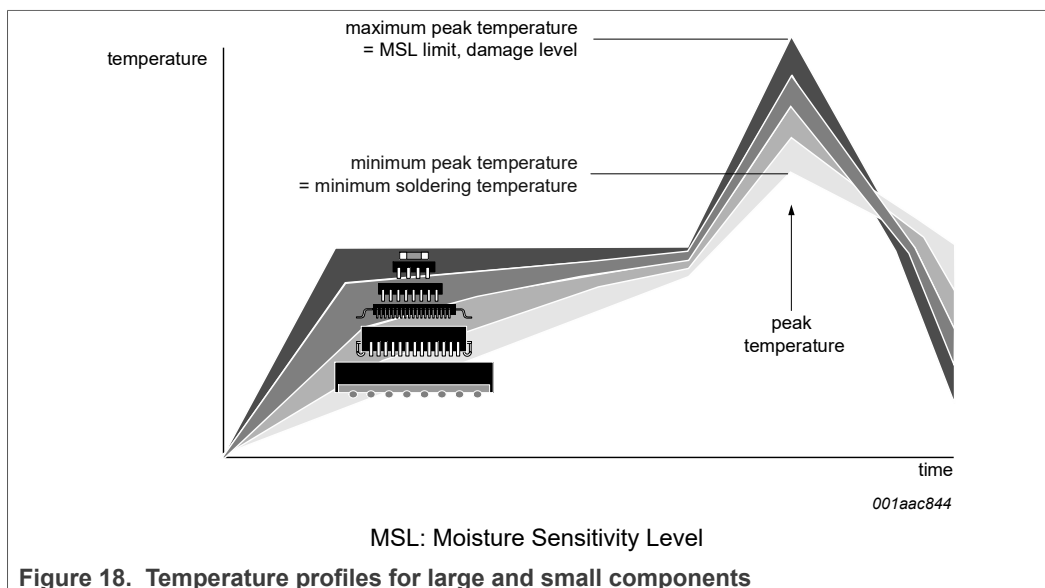
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                 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

Table 12. 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 18](#).



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 note:

- AN10365 “Surface mount reflow soldering description”



## 18 Appendix: ISO 11898-2:2016 parameter cross-reference list

Table 13. 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  | $I_{CAN\_H}$                 | $I_{O(sc)}$        | 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 time-out</b>                                |                              |                    |   |
| Transmit dominant time-out, long   | $t_{dom}$                    | $t_{to(dom)TXD}$   | TXD dominant time-out time              |
| Transmit dominant time-out, 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 13. 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  |  | $t_{\text{wake(busrec)}}$       | bus recessive wake-up time            |
| Wake-up time-out, short  | $t_{\text{Wake}}$                          | $t_{\text{to(wake)bus}}$        | bus wake-up time-out time             |
| Wake-up time-out, long   |  |                                 |                                       |

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

## 19 Appendix: TJx144x/TJx146x/TJF1441 family overview

Table 14. Feature overview of the complete TJx144x/TJx146x/TJF1441 family

| Device <sup>[1]</sup> | Modes  |         |       |                    |                | Supplies |         |          | Data rate             |                                      | Additional features               |   |   |  |                      |                                 |
|-----------------------|--------|---------|-------|--------------------|----------------|----------|---------|----------|-----------------------|--------------------------------------|-----------------------------------|---|---|--|----------------------|---------------------------------|
|                       | Normal | Standby | Sleep | Silent/Listen-only | Selectable Off | VCC pin  | VIO pin | VBAT pin | Up to 5 Mbit/s CAN FD | Up to 8 Mbit/s CAN FD <sup>[2]</sup> | Signal improvement <sup>[3]</sup> | Wake-up source recognition <sup>[4]</sup> | Short WUP support [0.5 - 1.8 μs] <sup>[5]</sup> | Single supply pin wake-up <sup>[6]</sup> | TXD dominant timeout | Local diagnostics via ERR_N pin |
| TJx1441A              | •      |         |       | •                  |                | •        | •       |          | •                     |                                      |                                   |   |   |  | •                    |                                 |
| TJx1441B              | •      |         |       | •                  |                | •        |         |          | •                     |                                      |                                   |   |   |  | •                    |                                 |
| TJx1441D              | •      |         |       | •                  | •              | •        |         |          | •                     |                                      |                                   |   |   |  | •                    |                                 |
| TJF1441A              | •      |         |       | •                  |                | •        | •       |          | •                     |                                      |                                   |   |   |  |                      | [7]                             |
| TJx1442A              | •      | •       |       |                    |                | •        | •       |          | •                     |                                      |                                   |   | •   | •  | •                    |                                 |
| TJx1442B              | •      | •       |       |                    |                | •        |         |          | •                     |                                      |                                   |   | •   |  | •                    |                                 |
| TJx1443A              | •      | •       | •     | •                  |                | •        | •       | •        | •                     |                                      |                                   | •   | •   | •  | •                    | •                               |
| TJx1448A              | •      | •       |       |                    |                | •        | •       |          | •                     |                                      |                                   |   | •   | •  | •                    |                                 |
| TJx1448B              | •      | •       |       |                    |                | •        |         |          | •                     |                                      |                                   |   | •   |  | •                    |                                 |
| TJx1448C              | •      | •       |       |                    |                | •        | •       |          | •                     |                                      |                                   | •   | •   | •  | •                    |                                 |
| TJx1462A              | •      | •       |       |                    |                | •        | •       |          | •                     | •                                    | •                                 |   | •   | •  | •                    |                                 |
| TJx1462B              | •      | •       |       |                    |                | •        |         |          | •                     | •                                    | •                                 |   | •   |  | •                    |                                 |
| TJx1463A              | •      | •       | •     | •                  |                | •        | •       | •        | •                     | •                                    | •                                 | •   | •   | •  | •                    | •                               |

[1] TJx: TJA14xxx is AEC-Q100 Grade 1; TJR14xxx is AEC-Q100 Grade 0; TJF1441A is non-automotive grade.

[2] Only guaranteed for TJA146x, AEC-Q100 Grade 1.

[3] CAN FD Signal Improvement Capability (SIC) according to CiA 601-4:2019.

[4] RXD is held LOW after wake-up request, enabling wake-up source recognition.

[5] WUP = wake-up pattern according ISO11898-2:2016.

[6] Only VIO supply needed for wake-up in TJA1442A, TJA1448A, TJA1448C, TJA1462A; only VBAT supply needed for wake-up in TJA1443A, TJA1463A.

[7] Not having TXD dominant timeout allows for very low data rates in non-automotive grade applications.

## 20 Revision history

Table 15. Revision history

| Document ID   | Release date  | Data sheet status  | Change notice | Supersedes  |
|---------------|---|--------------------|---------------|-------------|
| TJA1448 v.2   | 20211015  | Product data sheet | -             | TJA1448 v.1 |
| Modifications | <ul style="list-style-type: none"> <li>Added device (Table 3) and family (Section 19) feature overviews</li> <li>Table 7: table note 10 added</li> <li>Table 10: CAN delay timing characteristics revised; measurement conditions for parameter <math>t_{startup}(RXD)</math> revised</li> <li>Section 21: Suitability for use in Automotive applications and Security disclaimers revised</li> </ul> |                    |               |             |
| TJA1448 v.1   | 20200812  | Product data sheet | -             | -           |

## 21 Legal information

### 21.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition  |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

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

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