

## Features

- CAN FD Transceiver Fully Compliant to ISO 11898-2, ISO 11898-5, ISO 11898-2: 2016 and SAEJ 2962-2
- ISO 26262 Functional Safety Ready
- Wake-Up Pattern (WUP) Detection According to ISO 11898-2: 2016
- Communication Speed up to 5 Mbps
- Low Electromagnetic Emission (EME) and High Electromagnetic Immunity (EMI)
- Differential Receiver with Wide Common-Mode Range
- Functional Behavior Predictable Under All Supply Conditions
- VIO Input Allows for Direct Interfacing with 3V and 5V Microcontrollers
- Transceiver Disengages from the Bus when Not Powered-Up
- RXD Recessive Clamping Detection
- Silent Mode (Receive Only) for Node Diagnosis and Failure Containment
- High Electrostatic Discharge (ESD) Handling Capability on the Bus Pins
- Bus Pins Protected Against Transients in Automotive Environments
- Transmit Data (TXD) Dominant Time-Out Function
- Undervoltage Detection on VS, VCC and VIO Pins
- CANH/CANL Short Circuit and Overtemperature Protected
- Power-Up Diagnosis
- INH Output to the Control External Voltage Regulator
- High-Voltage WAKE Input Pin
- Remote Wake-Up Capability through CAN Bus
- Wake-Up Source Recognition
- Fulfills the OEM Hardware Requirements for CAN in Automotive Applications, Rev. 1.3
- AEC Q100 and AEC Q006 Qualified
- Two Ambient Temperature Grades:
  - ATA6571-GNQW1 and ATA6571-GCQW1 up to  $T_{amb} = +125^{\circ}\text{C}$
  - ATA6571-GNQW0 and ATA6571-GCQW0 up to  $T_{amb} = +150^{\circ}\text{C}$
- Available Packages: SOIC14 and VDFN14 with Wettable Flanks (Moisture Sensitivity Level 1)

## Description

The ATA6571 is a standalone high-speed CAN FD transceiver that interfaces a Controller Area Network (CAN) protocol controller and the physical two-wire CAN bus. The transceiver is designed for high-speed (up to 5 Mbit/s) CAN FD applications in the automotive industry, providing differential transmit and receive capability

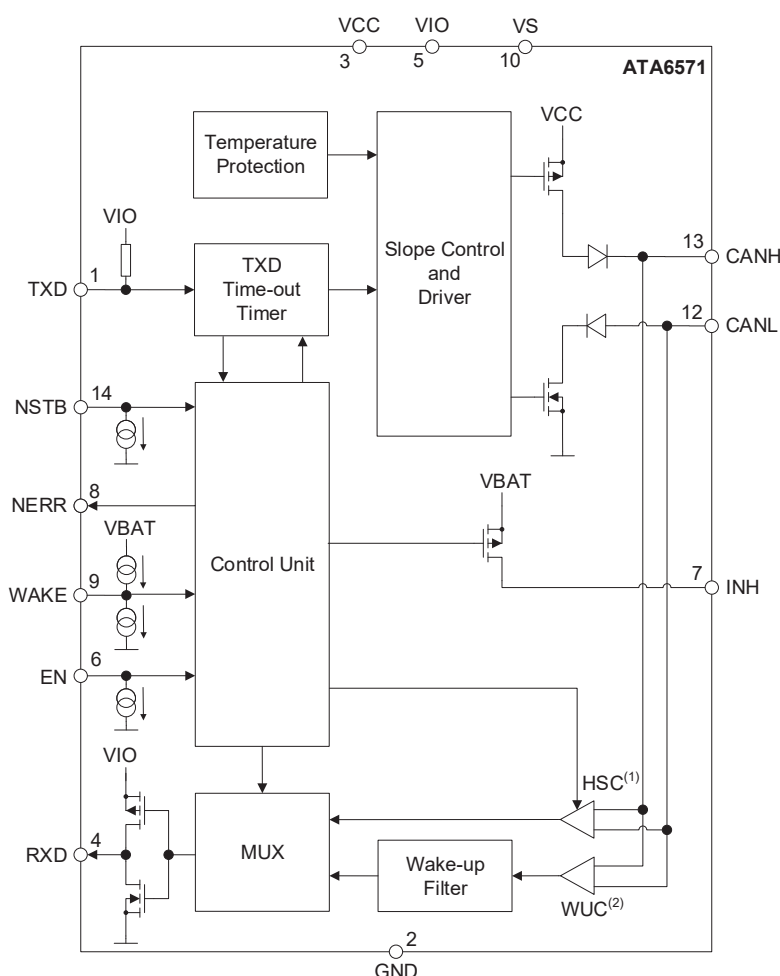
to (a microcontroller with) a CAN protocol controller. It offers improved Electromagnetic Compatibility (EMC) and ESD performance and very low power consumption, as well as features such as:

- Ideal passive behavior to the CAN bus when unpowered
- Direct interfacing to microcontrollers with supply voltages from 3V to 5V
- Advanced low-power management with local and remote wake-up support, available at all times, even when the internal VIO and VCC supplies are switched off
- Protection and diagnostic functions including bus line short-circuit and battery connection detection

**Table 1.** ATA6571 Family Members

| Device        | Grade 0 | Grade 1 | SOIC14 | VDFN14 |
|---------------|---------|---------|--------|--------|
| ATA6571-GNQW1 |         | x       | x      |        |
| ATA6571-GNQW0 | x       |         | x      |        |
| ATA6571-GCQW1 |         | x       |        | x      |
| ATA6571-GCQW0 | x       |         |        | x      |

**Figure 1.** Simplified Block Diagram



**Notes:**

1. High-Speed Comparator.
2. Wake-Up Comparator.

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# 1. Pin Configuration

Figure 1-1. Pin Configuration

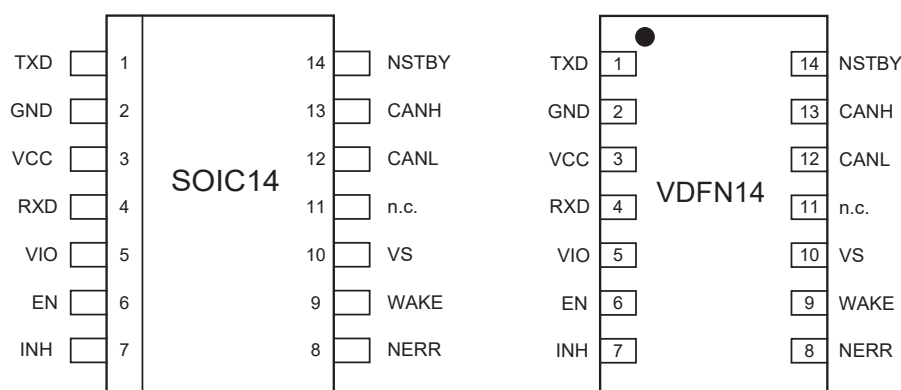


Table 1-1. Pin Description

| ATA6571 |        | Symbol | Function                                                                         |
|---------|--------|--------|----------------------------------------------------------------------------------|
| SOIC14  | VDFN14 |        |                                                                                  |
| 1       |        | TXD    | Transmit Data Input Pin                                                          |
| 2       |        | GND    | Ground Pin                                                                       |
| 3       |        | VCC    | Transceiver Supply Voltage Pin                                                   |
| 4       |        | RXD    | Receive Data Output Pin                                                          |
| 5       |        | VIO    | Supply Voltage for the I/O Pins                                                  |
| 6       |        | EN     | Enable Control Input Pin                                                         |
| 7       |        | INH    | Inhibit Output for Switching External Voltage Regulators                         |
| 8       |        | NERR   | Error and Power-on Indication Output (Active-Low)                                |
| 9       |        | WAKE   | Local Wake-Up Input. Connect directly to the VS pin or the GND pin, if not used. |
| 10      |        | VS     | Battery Supply Voltage Pin                                                       |
| 11      |        | NC     | Not Connected                                                                    |
| 12      |        | CANL   | Low-Level CAN Bus Line                                                           |
| 13      |        | CANH   | High-Level CAN Bus Line                                                          |
| 14      |        | NSTBY  | Standby Mode Control Input (Active-Low)                                          |
| —       | 15     | EP     | Heat Slug, Internally Connected to the GND Pin                                   |

## 1.1. Battery Supply Voltage Pin (VS)

This is the power supply pin. In an application, this pin is usually connected to the battery through a serial diode for reverse battery protection. This pin sustains standard automotive conditions, such as 40V during load dump. An undervoltage detection circuit is implemented to avoid a malfunction or false bus messages. After switching on the VS pin, the device starts in Standby mode and the INH output is switched on.

## 1.2. Ground Pin (GND)

The device does not affect the CAN bus in the event of a GND disconnection.

## 1.3. Transceiver Supply Voltage Pin (VCC)

This is the supply pin for the CANH and CANL bus drivers, the bus differential receiver and the bus biasing voltage circuitry. The device monitors the VCC pin for undervoltage conditions.

#### 1.4. Supply Pin for I/O Level Adapter (VIO)

This is the supply pin for the digital input/output pins. This pin should be connected to the microcontroller's supply voltage to adjust the signal levels of pins TXD, RXD, NSTBY, EN and NERR to the I/O levels of the microcontroller. The device monitors the VIO pin for undervoltage conditions.

#### 1.5. Bus Pins (CANH and CANL)

These are the CAN bus terminals.

The CANL pin is a low-side driver to GND, and the CANH pin is a high-side driver to VCC. In Normal mode and if TXD is high, the CANH and CANL drivers are OFF, and the voltage at CANH and CANL is approximately 2.5V, provided by the internal bus biasing circuitry. This state is called recessive.

When TXD is low, CANL is pulled to GND and CANH to VCC, creating a differential voltage on the CAN bus. This state is called dominant.

In Standby mode, the CANH and CANL drivers are OFF. If the device is in unpowered mode or Sleep mode, CANH and CANL are highly resistive with extremely low leakage current to GND, making the device ideally passive.

The CANH and CANL pins have integrated ESD protection and extremely high robustness versus external disturbance, such as EMC and electrical transients. The CANH and CANL bus outputs are short-circuit protected against GND or a positive supply voltage and are also protected against overtemperature conditions.

#### 1.6. Transmit Data Input Pin (TXD)

This is the device input pin used to control the CAN bus level. In the application, this pin is connected to the microcontroller transmit terminal. The TXD pin has an internal pull-up toward VIO to ensure a safe defined recessive driver state in case this pin is left floating.

In Normal mode, when TXD is high or floating, the CANH and CANL drivers are OFF, setting the bus in the recessive state.

The TXD pin must be pulled to GND in order to activate the CANH and CANL drivers, and the bus is set to the dominant state. A TXD dominant time-out timer starts when the TXD pin is set to low. If the low state on the TXD pin persists for longer than  $t_{to(dom)}$ , 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 the TXD pin is set to high.

The transmitter is also disabled, if the TXD pin is held low (for example, by a short circuit to GND) while the device is switched into Normal mode, the bus lines are in the recessive state. The transceiver remains in this state, until the TXD pin goes high.

#### 1.7. Receive Data Output Pin (RXD)

In Normal and Silent mode, this pin reports the state of the CAN bus to the microcontroller. In the application, this pin is connected to the microcontroller receive terminal. RXD is high when the bus is recessive. When the bus is dominant, RXD is low.

The output is a push-pull structure; the high side is connected to VIO and the low side to GND.

In Standby mode, the RXD is switched to VIO. When a wake-up event is detected, the RXD will be forced to low.

A RXD recessive clamping function (see section [RXD Recessive Clamping](#)) is implemented. This fail-safe feature prevents the controller from sending data on the bus if the RXD line is clamped to high (for example, recessive).

#### 1.8. Inhibit Output Pin (INH)

The inhibit output pin provides an internal switch toward the VS pin and is used to control external voltage regulators. If the device is in Normal or Standby mode, the inhibit high-side switch is turned

on. When the device is in Sleep mode, the inhibit switch is turned off, thus disabling the connected external voltage regulators or other connected external devices.

A wake-up event on the CAN bus or at the WAKE pin switches the INH pin to the VS level. After a system power-up (VS rises from zero), the INH pin switches to the VS level automatically.

### 1.9. Wake Pin (WAKE)

This pin is a high-voltage input used for waking up the device from Sleep mode. It is usually connected to an external switch in the application to generate a local wake-up. If the WAKE pin is not needed in the application, it should be connected to VS or GND to ensure optimal EMI performance.

The WAKE pin has a special design structure and is triggered by a low-to-high or a high-to-low transition, allowing maximum flexibility when designing a local wake-up circuit.

An internal filter is implemented to avoid a false wake-up event due to parasitic pulses. A serial resistor should be inserted in order to limit the input current mainly during transient pulses and ESD. The recommended resistor value is 10 kΩ. An external 10 nF capacitor is recommended for better EMC and ESD performances.

To reduce the battery current during Low-Power mode, the internal pull-up/pull-down circuit follows the logic level at the WAKE pin:

- a high level on the pin is followed by an internal pull-up toward VS
- a low level is followed by an internal pull-down towards GND.

### 1.10. Enable Pin (EN)

The enable input pin together with the NSTBY pin controls the operating mode of the device.

The internal pull-down on the EN pin forces the transceiver into Recessive mode if EN is disconnected.

### 1.11. Error Indication Pin (NERR)

The NERR pin signals the status of the device. The ATA6571 supports system diagnosis using seven internal flags. Five of these flags can be polled by the controller through NERR pin. The signaled flag on the pin NERR depends on the active operating mode and on a number of other conditions. Switching between modes gives access to the different diagnostic flags through the NERR pin.

### 1.12. Standby Mode Control Pin (NSTBY)

The NSTBY input pin together with the EN pin control the operating mode of the device. The NSTBY pin provides a pull-down current to force the transceiver into Standby mode, if STBY is disconnected.

## 2. Functional Description

The ATA6571 high-speed CAN transceiver offers a number of operating modes, diagnostic features and fail-safe features that enable enhanced system reliability and advanced power management.

### 2.1. Device Operation Modes

The control pins NSTBY and EN are used to select one of the five operating modes supported by the ATA6571. Switching between modes allows access to a number of diagnostic flags through the NERR pin. [Table 2-1](#) describes how to switch between modes and [Figure 2-1](#) illustrates the different mode transitions.

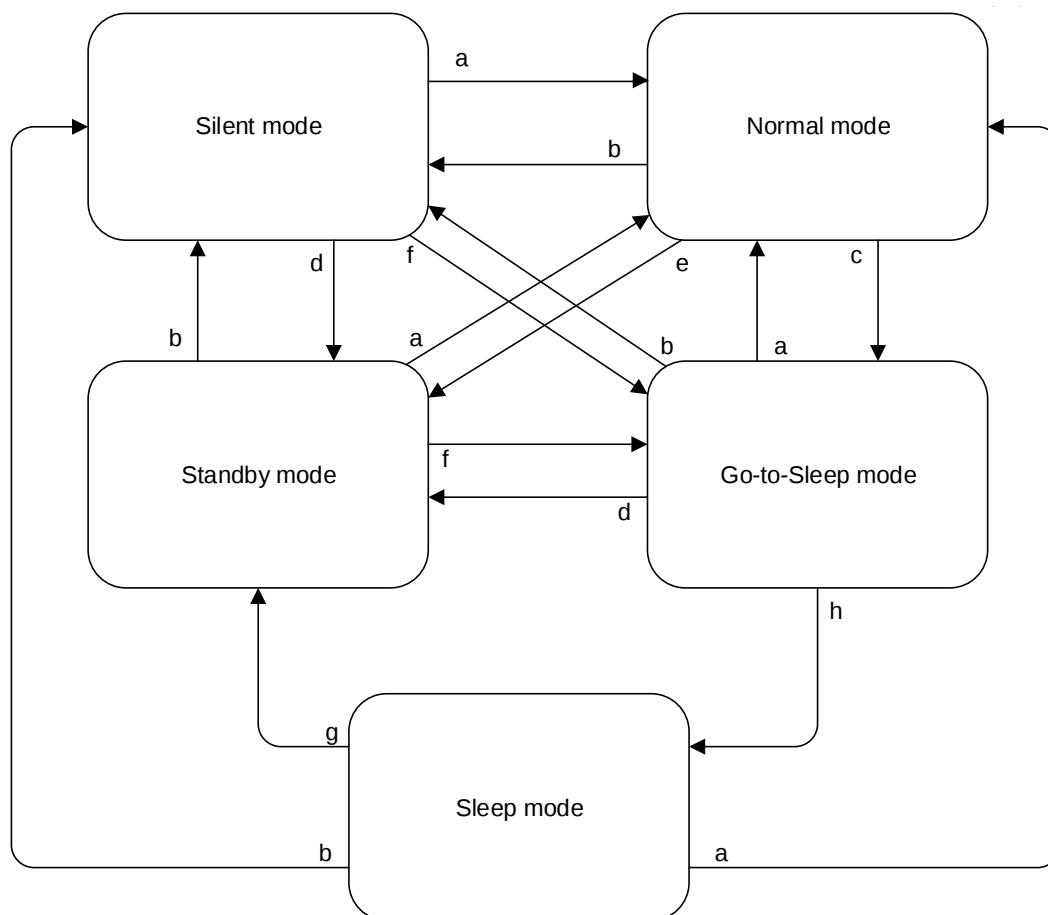
**Table 2-1.** Operating Modes

| Mode                                               | Diagnostic Flags                     |                  |                     | NSTBY <sup>(3)</sup> | EN   | INH      |
|----------------------------------------------------|--------------------------------------|------------------|---------------------|----------------------|------|----------|
|                                                    | UV <sub>VCC/MIO</sub> <sup>(1)</sup> | UV <sub>VS</sub> | Wake <sup>(2)</sup> |                      |      |          |
| From Normal, Silent, Standby and Go-to-Sleep modes |                                      |                  |                     |                      |      |          |
| Sleep mode                                         | Set                                  | X                | X                   | X                    | X    | Floating |
| Standby mode                                       | Cleared                              | Set              | X                   | High                 | X    | High     |
| Standby mode                                       | Cleared                              | X                | Set                 | Low                  | X    | High     |
| Standby mode                                       | Cleared                              | X                | Cleared             | Low                  | Low  | High     |
| Go-to-Sleep mode                                   | Cleared                              | X                | Cleared             | Low                  | High | High     |
| Silent mode                                        | Cleared                              | Cleared          | X                   | High                 | Low  | High     |
| Normal mode                                        | Cleared                              | Cleared          | X                   | High                 | High | High     |
| From Sleep mode                                    |                                      |                  |                     |                      |      |          |
| Sleep mode                                         | Set                                  | X                | X                   | X                    | X    | Floating |
| Standby mode                                       | Cleared                              | Set              | X                   | High                 | X    | High     |
| Standby mode                                       | Cleared                              | X                | Set                 | Low                  | X    | High     |
| Sleep mode                                         | Cleared                              | X                | Cleared             | Low                  | X    | Floating |
| Silent mode                                        | Cleared                              | Cleared          | X                   | High                 | Low  | High     |
| Normal mode                                        | Cleared                              | Cleared          | X                   | High                 | High | High     |

**Notes:**

1. Setting the UV<sub>VCC/MIO</sub> flag clears the Wake flag.
2. Setting the Wake flag clears the UV<sub>VCC/MIO</sub> flag.
3. A low-to-high transition on pin NSTBY clears the UV<sub>VCC/MIO</sub> flag.

Figure 2-1. Operating Modes



Where:

- a = NSTBY = 1, EN = 1
- b = NSTBY = 1, EN = 0
- c = NSTBY = 0, EN = 1
- d = NSTBY = 0, EN = 0 (wake flag set)
- e = NSTBY = 0, EN = 0
- f = NSTBY = 0, EN = 1 (wake flag cleared)
- g = NSTBY = 0 (wake flag set)
- h = wake flag cleared,  $t > t_{\text{hold(min)}}$

### 2.1.1. Normal Mode

In Normal mode, the transceiver can transmit and receive data through the bus lines CANH and CANL. The output driver stage is active and drives data from the TXD input to the CAN bus. The High-Speed Comparator (HSC) converts the analog data on the bus lines into digital data, which is output to the RXD pin. The bus biasing is set to  $V_{\text{VCC}/2}$  and the undervoltage monitoring of VCC is active. The slope of the output signals on the bus lines is controlled and optimized in a way that guarantees the lowest possible Electromagnetic Emission (EME). The INH pin is active, so voltage regulators controlled by the INH pin are active too.

### 2.1.2. Silent Mode

This Receive-Only mode can be used to test the connection of the bus medium. In Silent mode, the ATA6571 can still receive data from the bus, but the transmitter is disabled and therefore no

data can be sent to the CAN bus. The bus pins are released to recessive state ( $V_{VCC/2}$ ). All other IC functions, including the HSC, continue to operate as they do in Normal mode. The Silent mode can be used to prevent a faulty CAN controller from disrupting network communication.

### 2.1.3. Standby Mode

The Standby mode is the first level of power-saving mode for the ATA6571, offering reduced current consumption. In this mode, the transceiver is not able to transmit or correctly receive data through the bus lines. The transmitter and the HSC are switched off to reduce current consumption and only the low-power Wake-Up Comparator (WUC) monitors the bus lines for a valid wake-up signal. The bus pins are biased at ground level.

Pin INH is still active, so voltage regulators controlled by this pin are also active.

Pins RXD and NERR reflect any active wake-up requests (provided that VIO and VS are present).

### 2.1.4. Go-to-Sleep Mode

The Go-to-Sleep mode is the controlled route for entering Sleep mode. In Go-to-Sleep mode, the transceiver behaves as in Standby mode, with the addition that a Go-to-Sleep command is issued to the transceiver. The transceiver remains in Go-to-Sleep mode for the minimum hold time ( $t_{hold}$ ) before entering Sleep mode. The transceiver does not enter Sleep mode if the state of pin NSTBY or pin EN is changed or if the Wake flag is set before  $t_{hold}$  has elapsed.

### 2.1.5. Sleep Mode

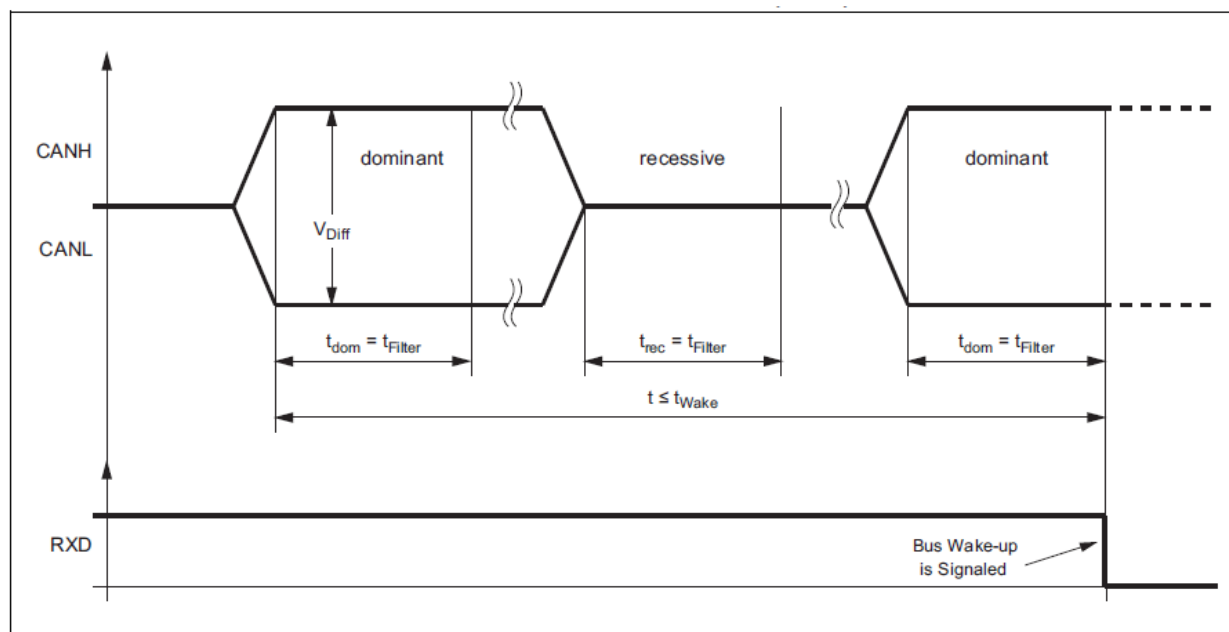
The Sleep mode is the highest power-saving mode of the device. In this mode, the INH output is switched off. Therefore the external voltage regulator(s) controlled by this pin is also switched off. This is the only difference between Sleep mode and Standby mode.

The Sleep mode is entered through Go-to-Sleep mode, and also when the undervoltage detection time on either VCC or VIO elapses before the relevant voltage level has recovered. Pins NSTBY, EN, and the Wake flag can be used to wake up a node from Sleep mode.

### 2.1.6. Remote Wake-Up through the CAN Bus

In Standby and Sleep mode, the bus lines are biased to ground to reduce current consumption to a minimum. The ATA6571 monitors the bus lines for a valid WUP as specified in the ISO 11898-2: 2016. This filtering helps to avoid spurious wake-up events, which can be triggered by scenarios such as a dominant clamped bus or by a dominant phase due to noise, spikes on the bus, automotive transients or EMI.

The wake-up pattern consists of at least two consecutive dominant bus levels for a duration of at least  $t_{Filter}$ , each separated by a recessive bus level with a duration of at least  $t_{Filter}$ . Dominant or recessive bus levels shorter than  $t_{Filter}$  are always ignored. The complete dominant-recessive-dominant pattern must be received within the bus wake-up time-out time  $t_{wake}$ , to be recognized as a valid wake-up pattern, as shown in [Figure 2-2](#). Otherwise, the internal wake-up logic is reset and then the complete wake-up pattern must be retransmitted to trigger a wake-up event. Pin RXD remains at high level until a valid wake-up event is detected. During Normal mode, at a VCC or VIO undervoltage condition or when the complete wake-up pattern is not received within  $t_{wake}$ , no wake-up is signalled at the RXD pin.

**Figure 2-2.** Timing of the Bus WUP in Standby Mode

When a valid CAN WUP is detected on the bus, the RXD pin switches to low to signal a wake-up request.

## 2.2. Internal Flags

For Fail-Safe Fallback mode control and system diagnosis, the ATA6571 has seven internal flags. Five of these flags can be polled by the controller through pin NERR. Depending on the current operating mode and on a number of other conditions, a different flag is available on the NERR pin. [Table 2-2](#) describes how to access and control these flags.

**Table 2-2.** Internal Flags Accessed through Pin NERR

| Internal flag        | Available flag on pin NERR (1)                                                       | Flag is cleared                                                                                                                                       |
|----------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| UV <sub>VCCVIO</sub> | No                                                                                   | By setting the Pwon or Wake flags, by a low-to-high transition on NSTBY or when both VIO and VCC have recovered.                                      |
| UV <sub>VS</sub>     | No                                                                                   | When VS has recovered.                                                                                                                                |
| Pwon                 | In Silent mode (coming from Standby mode, Go-to-Sleep mode, or Sleep mode).          | When entering Normal mode.                                                                                                                            |
| Wake                 | In Standby mode, Go-to-Sleep, and Sleep mode (provided that VIO and VS are present). | When entering Normal mode or by setting the UV <sub>VCCVIO</sub> flag.                                                                                |
| Wake-up source       | In Normal mode (before the fourth dominant-to-recessive edge on pin TXD (2)).        | When leaving Normal mode.                                                                                                                             |
| Bus failure          | In Normal mode (after the fourth dominant-to-recessive edge on pin TXD (2)).         | When re-entering Normal mode or by setting the Pwon flag.                                                                                             |
| Local failure        | In Silent mode (coming from Normal mode).                                            | When entering Normal mode or when RXD is dominant while TXD is recessive (provided that all local failures are resolved) or by setting the Pwon flag. |

### Notes:

- Pin NERR is an active-low output, so a low level indicates a set flag and a high level indicates a cleared flag. Allow pin NERR to stabilize for at least 8  $\mu$ s after changing operating modes.
- Allow a TXD dominant time of at least 4  $\mu$ s per dominant-recessive cycle.

### 2.2.1. UV<sub>VCC/VIO</sub> Flag

UV<sub>VCC/VIO</sub> is the VCC and/or VIO undervoltage detection flag. The flag is set when the voltage on pin VCC drops below the VCC undervoltage detection voltage,  $V_{VCC\_UV}$ , for longer than the undervoltage detection time,  $t_{VSUP\_UV\_set}$ , or when the voltage on pin VIO drops below  $V_{VIO\_UV}$  for longer than  $t_{VSUP\_UV\_set}$ . When the UV<sub>VCC/VIO</sub> flag is set, the transceiver enters Sleep mode to save power and to ensure the bus is not disturbed. In Sleep mode the voltage regulators connected to pin INH are disabled, avoiding any extra power consumption that might be caused by a short-circuit condition.

Any wake-up request, setting the Pwon flag or a low-to-high transition on NSTBY will clear UV<sub>VCC/VIO</sub> and the timers, allowing the voltage regulators to be reactivated (at least until UV<sub>VCC/VIO</sub> is set again). UV<sub>VCC/VIO</sub> is also cleared if both VCC and VIO recover for longer than the undervoltage recovery time,  $t_{VSUP\_UV\_clear}$ . The transceiver will then switch to the operating mode indicated by the logic levels on pins NSTBY and EN (see section [Device Operation Modes](#)).

### 2.2.2. UV<sub>VS</sub> Flag

The UV<sub>VS</sub> is the VS undervoltage detection flag. This flag is set when the voltage on pin VS drops below  $V_{VS\_UV\_CAN\_Set}$ . When UV<sub>VS</sub> is set, the transceiver enters Standby mode to save power and disengages from the bus (zero load). UV<sub>VS</sub> is cleared when the voltage on pin VS recovers. The transceiver then switches to the operating mode indicated by the logic levels on pins NSTBY and EN (see section [Device Operation Modes](#)).

### 2.2.3. Pwon Flag

The Pwon is the VS power-on flag. This flag is set when the voltage on pin VS recovers after previously dropping below  $V_{VS\_PWROFF}$  (usually because the battery was disconnected). Setting the Pwon flag clears the UV<sub>VCC/VIO</sub> flag and timers. The Wake and Wake-Up Source flags are set to ensure consistent system power-up under all supply conditions. In Silent mode, the Pwon flag can be polled through pin NERR (see [Table 2-2](#)). The flag is cleared when the transceiver enters Normal mode.

### 2.2.4. Wake Flag

The Wake flag is set when the transceiver detects a local or remote wake-up request. A local wake-up request is detected when the logic level on pin WAKE changes and the new level remains stable for at least  $t_{wake}$ . A remote wake-up request is triggered by two bus dominant states of at least  $t_{wake(busdom)}$  with the first dominant state followed by a recessive state of at least  $t_{wake(busrec)}$  (provided the dominant-recessive-dominant pattern is completed within  $t_{to(wake)bus}$ ). The Wake flag can be set in Standby mode, Go-to-Sleep mode or Sleep mode. Setting the Wake flag clears the UV<sub>VCC/VIO</sub> flag and timers. Once set, the Wake flag status is immediately available on pins NERR and RXD (if VIO and VS are present). This flag is also set at power-on and cleared when the UV<sub>VCC/VIO</sub> flag is set or the transceiver enters Normal mode.

### 2.2.5. Wake-Up Source Flag

The wake-up source recognition is provided through the Wake-Up Source flag, which is set when the Wake flag is set by a local wake-up request through the WAKE pin. The Wake-Up Source flag can be polled through the NERR pin in Normal mode (see [Table 2-2](#)). This flag is also set at power-on and cleared when the transceiver leaves the Normal mode.

### 2.2.6. Bus Failure Flag

The Bus Failure flag is set if the transceiver detects a bus line short-circuit condition to VS, VCC or GND during four consecutive dominant-recessive cycles on pin TXD, while trying to drive the dominant bus lines. The Bus Failure flag can be polled through the NERR pin in Normal mode (see [Table 2-2](#)). This flag is cleared at power-on or when the transceiver re-enters Normal mode.

### 2.2.7. Local Failure Flag

In Normal and Silent modes, the transceiver can detect five different local failure events, any of which will cause the Local Failure flag to be set. The five local failure events are: TXD dominant

clamping, TXD-to-RXD short circuit, bus dominant clamping, an overtemperature event, and an RXD recessive clamping event (see section [Fail-Safe Features](#)). The Local Failure flag can be polled through the NERR pin in Silent mode (see [Table 2-2](#)). This flag is cleared at power-on, when entering Normal mode or when RXD is dominant while TXD is recessive, provided that all local failures have been resolved.

## 2.3. Fail-Safe Features

The ATA6571 can detect a number of different local failure conditions. Any of these failures sets the Local Failure flag and in most cases the transmitter of the transceiver is disabled.

### 2.3.1. TXD Dominant Time-Out Function

A permanent low level on pin TXD (due to a hardware or software application failure) would drive the CAN bus into a permanent dominant state, blocking all network communication. The TXD dominant time-out function prevents such a network lock-up by disabling the transmitter. The TXD dominant time-out timer is started when the TXD pin is set to low. If the low state on the TXD pin persists for longer than  $t_{to(dom)}$ , the transmitter is disabled, releasing the bus lines to a recessive state. The  $t_{to(dom)}$  dominant time-out timer defines a minimum possible bit rate of 40 kbit/s. The transmitter remains disabled until the Local Failure flag is cleared.

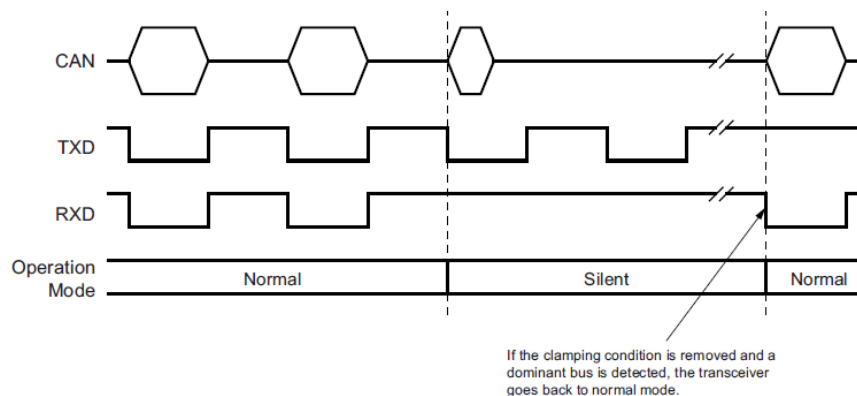
### 2.3.2. TXD-to-RXD Short-Circuit Detection

A short circuit between pins RXD and TXD would lock the bus in a permanent dominant state once it has been driven dominant, because the low-side driver of RXD is typically stronger than the high-side driver of the controller connected to TXD. The TXD-to-RXD short-circuit detection prevents this network lock-up by disabling the transmitter. The transmitter remains disabled until the Local Failure flag is cleared.

### 2.3.3. RXD Recessive Clamping

This fail-safe feature prevents the controller from sending data to the bus if its RXD line is clamped to high (for example, recessive). That is, if the RXD pin cannot signal a dominant bus state because it is shorted to VCC, the transmitter within the ATA6571 is disabled to avoid possible data collisions on the bus. In Normal and Silent mode, the device permanently compares the state of the the HSC with the state of the RXD pin. If the HSC indicates a dominant bus state for more than  $t_{RXD\_rec\_clmp}$ , without the RXD pin indicating the same, a recessive clamping situation is detected. The RXD recessive clamping detection is reset (LOCFAIL flag removed) by either entering Normal or unpowered mode or if the RXD pin is showing a dominant (for example, LOW) level again.

**Figure 2-3. RXD Recessive Clamping Detection**



### 2.3.4. Bus Dominant Clamping Detection

A CAN bus short circuit (to VS, VCC or GND) or a failure in one of the other network nodes can result in a differential voltage on the bus, high enough to represent a bus dominant state. Because

a node does not start transmission if the bus is dominant, the normal bus failure detection does not detect this failure, but the bus dominant clamping detection will. The Local Failure flag is set if the dominant state on the bus persists for longer than  $t_{\text{BUS\_dom}}$ . By checking this flag, the controller can determine if a clamped bus is blocking network communication. There is no need to disable the transmitter. RXD is low as long as the bus is still dominant and goes high when the bus is released to high.

**Note:** The Local Failure flag does not retain a bus dominant clamping failure and is released as soon as the bus returns to the recessive state.

### 2.3.5. Overtemperature Detection

The transceiver is protected against overtemperature conditions. If the junction temperature exceeds the shutdown junction temperature,  $T_{\text{Jsd}}$ , the transmitter is disabled until the Local Failure flag is cleared.

### 2.3.6. Bus Wake-Up only at Dedicated Wake-Up Pattern

Due to the implementation of the wake-up filtering, the ATA6571 does not wake up when the bus is in a long dominant phase, it only wakes up due to the wake-up pattern specified in the ISO 11898-2: 2016. This means that for a valid wake-up at least two consecutive dominant bus levels for a duration of at least  $t_{\text{Filter}}$ , each separated by a recessive bus level with a duration of at least  $t_{\text{Filter}}$  must be received from the bus. Dominant or recessive bus levels shorter than  $t_{\text{Filter}}$  are always ignored. The complete dominant-recessive-dominant pattern (as shown in [Figure 2-2](#)) must be received within the bus wake-up time-out time  $t_{\text{wake}}$  to be recognized as a valid wake-up pattern. This filtering leads to a higher robustness against EMI and transients and reduces therefore the risk of an unwanted bus wake-up significantly.

### 2.3.7. Undervoltage Detection on Pins VS, VCC and VIO

If  $V_{\text{VS}}$ ,  $V_{\text{VCC}}$  or  $V_{\text{VIO}}$  drop below their respective undervoltage detection levels ( $V_{\text{VS\_UV\_CAN\_Setr}}$ ,  $V_{\text{VCC\_UV}}$  and  $V_{\text{VIO\_UV}}$  (see section [Electrical Characteristics](#)), the transceiver switches off and disengages from the bus until  $V_{\text{VS}}$ ,  $V_{\text{VCC}}$  and  $V_{\text{VIO}}$  recover. The low-power wake-up comparator and local wake-up are switched off during a VS undervoltage.

### 3. Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Parameters                                                                                                               | Sym.                        | Min.   | Max. | Unit |
|--------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------|------|------|
| CANH, CANL<br>DC Voltage                                                                                                 | $V_{CANH}, V_{CANL}$        | -27    | +42  | V    |
| Transient Voltage, according to ISO 7637 part 2                                                                          |                             | -150   | +100 | V    |
| Maximum Differential Bus Voltage                                                                                         | $V_{Diff}$                  | -25    | +25  | V    |
| DC Voltage on Pins TXD, RXD, NSTBY, EN, NERR, VCC, VIO                                                                   | $V_x$                       | -0.3   | +5.5 | V    |
| DC Voltage on Pins VS, WAKE, INH                                                                                         | $V_{VS}, V_{WAKE}, V_{INH}$ | -0.3   | +40  | V    |
| ESD according to IBEE CAN EMC Test Specification following IEC 62228, IEC 61000-4-2:<br>Pins VS, CANH, CANL, WAKE to GND | —                           | +/-8   | —    | kV   |
| HBM JESD22-A114/AEC-Q100-002:                                                                                            | —                           | +/-8   | —    | kV   |
| • CANH, CANL                                                                                                             |                             | +/-6   | —    | kV   |
| • VS, WAKE to GND                                                                                                        |                             |        |      |      |
| HBM JESD22-A114/AEC-Q100-002: All Pins                                                                                   | —                           | +/-4   | —    | kV   |
| Charge Device Model ESD AEC-Q100-011                                                                                     | —                           | +/-750 | —    | V    |
| Machine Model ESD AEC-Q100-003                                                                                           | —                           | +/-100 | —    | V    |
| Storage Temperature                                                                                                      | $T_{stg}$                   | -55    | +150 | °C   |
| Virtual Junction Temperature                                                                                             | $T_{vj}$                    | -40    | +175 | °C   |

## 4. Thermal Characteristics

**Table 4-1.** Thermal Characteristics SOIC14

| Parameters                                                                                     | Sym.           | Min. | Typ. | Max. | Unit |
|------------------------------------------------------------------------------------------------|----------------|------|------|------|------|
| Thermal Resistance Virtual Junction to Ambient, where IC is soldered to PCB according to JEDEC | $R_{thvjA}$    | —    | 110  | —    | K/W  |
| Thermal Shutdown of the Bus Drivers for the ATA6571-GNQW1 (Grade 1)                            | $T_{Jsd}$      | 150  | —    | 200  | °C   |
| Thermal Shutdown of the Bus Drivers for the ATA6571-GNQW0 (Grade 0)                            | $T_{Jsd}$      | 170  | —    | 200  | °C   |
| Thermal Shutdown Hysteresis                                                                    | $T_{Jsd\_hys}$ | —    | 15   | —    | °C   |

**Table 4-2.** Thermal Characteristics VDFN14

| Parameters                                                                                            | Sym.           | Min. | Typ. | Max. | Unit |
|-------------------------------------------------------------------------------------------------------|----------------|------|------|------|------|
| Thermal Resistance Virtual Junction to Heat Slug                                                      | $R_{thvjC}$    | —    | 8    | —    | K/W  |
| Thermal Resistance Virtual Junction to Ambient, where Heat Slug is soldered to PCB according to JEDEC | $R_{thvjA}$    | —    | 45   | —    | K/W  |
| Thermal Shutdown of the Bus Drivers for the ATA6571-GCQW1 (Grade 1)                                   | $T_{Jsd}$      | 150  | —    | 200  | °C   |
| Thermal Shutdown of the Bus Drivers for the ATA6571-GCQW0 (Grade 0)                                   | $T_{Jsd}$      | 170  | —    | 200  | °C   |
| Thermal Shutdown Hysteresis                                                                           | $T_{Jsd\_hys}$ | —    | 30   | —    | °C   |

## 5. Electrical Characteristics

All parameters valid for Grade 1:  $T_{amb} = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , Grade 0:  $T_{amb} = -40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ ;  $T_{vj} \leq 170^{\circ}\text{C}$ ;  $4.5\text{V} \leq V_{VS} \leq 28\text{V}$ ;  $4.5\text{V} \leq V_{VCC} \leq 5.5\text{V}$ ;  $2.8\text{V} \leq V_{VIO} \leq 5.5\text{V}$ ; all voltages are defined with respect to ground;  $R_{(CANH-CANL)} = 60\Omega$ ;  $C_L = 100\text{pF}$ ; typical values are given at  $V_{VS} = 13\text{V}$ ,  $T_{amb} = +25^{\circ}\text{C}$ ; unless otherwise noted.

| No.          | Parameters                                                          | Test Conditions                                                                                                                      | Pin       | Sym.                         | Min.                   | Typ. | Max.                   | Unit | Type* |
|--------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------|------------------------|------|------------------------|------|-------|
| VS           |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 0.10         | Supply Voltage Threshold for Power-On Detection                     | V <sub>VS</sub> rising                                                                                                               | VS        | V <sub>VS_PWRON</sub>        | —                      | —    | 4.8                    | V    | B     |
| 0.20         | Supply Voltage Threshold for Power-Off Detection                    | V <sub>VS</sub> falling                                                                                                              | VS        | V <sub>VS_PWROFF</sub>       | 2.8                    | —    | 3.1                    | V    | A     |
| 0.30         | Supply Voltage Threshold for CAN TRX Undervoltage Detection Release | V <sub>VS</sub> rising                                                                                                               | VS        | V <sub>VS_UV_CAN_Clear</sub> | 4.3                    | —    | 4.6                    | V    | A     |
| 0.40         | Supply Voltage Threshold for CAN TRX Undervoltage Detection         | V <sub>VS</sub> falling                                                                                                              | VS        | V <sub>VS_UV_CAN_Set</sub>   | 4.2                    | —    | 4.5                    | V    | A     |
| 0.50         | VS Supply Current                                                   | Standby mode; V <sub>INH</sub> = V <sub>WAKE</sub> = V <sub>VS</sub> , V <sub>VS</sub> < 18V                                         | VS        | I <sub>VS_Stby</sub>         | —                      | —    | 32                     | μA   | A     |
| 0.51         |                                                                     | Normal or Silent mode; V <sub>VS</sub> < 18V                                                                                         | VS        | I <sub>VS_Norm</sub>         | —                      | —    | 350                    | μA   | A     |
| 0.52         |                                                                     | Sleep mode; V <sub>INH</sub> = V <sub>VCC</sub> = V <sub>VIO</sub> = 0V; V <sub>WAKE</sub> = V <sub>VS</sub> ; V <sub>VS</sub> < 18V | VS        | I <sub>VS_sleep</sub>        | —                      | 18   | 30                     | μA   | A     |
| VCC          |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 1.10         | VCC Undervoltage Detection Threshold                                |                                                                                                                                      | VCC       | V <sub>VCC_UV</sub>          | 4                      | —    | 4.5                    | V    | A     |
| 1.20         | VCC Supply Current                                                  | Normal mode (dominant)                                                                                                               | VCC       | I <sub>VCC_dom</sub>         | 20                     | —    | 65                     | mA   | A     |
| 1.31         |                                                                     | Normal mode (recessive)                                                                                                              | VCC       | I <sub>VCC_rec</sub>         | 2                      | —    | 6.2                    | mA   | A     |
| 1.310        |                                                                     | Silent mode                                                                                                                          | VCC       | I <sub>VCC_sil</sub>         | 0.2                    | —    | 1.8                    | mA   | A     |
| 1.32         |                                                                     | Normal mode short between CANH and CANL                                                                                              | VCC       | I <sub>VCC_short</sub>       | —                      | —    | 80                     | mA   | B     |
| 1.33         |                                                                     | Sleep mode or Standby mode                                                                                                           | VCC       | I <sub>VCC_sleep</sub>       | —                      | —    | 4                      | μA   | A     |
| VIO          |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 2.10         | VIO Undervoltage Detection Threshold                                |                                                                                                                                      | VIO       | V <sub>VIO_UV</sub>          | 2.4                    | —    | 2.8                    | V    | A     |
| 2.20         | VIO Supply Current                                                  | Normal (V <sub>TXD</sub> = 0V)                                                                                                       | VIO       | I <sub>VIO_norm</sub>        | —                      | —    | 130                    | μA   | A     |
| 2.21         |                                                                     | Normal mode or Silent mode (recessive)                                                                                               | VIO       | I <sub>VIO_rec</sub>         | —                      | —    | 4.5                    | μA   | A     |
| 2.22         |                                                                     | Standby mode or Sleep mode                                                                                                           | VIO       | I <sub>VIO_sleep</sub>       | —                      | —    | 4.5                    | μA   | A     |
| NSTBY and EN |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 3.10         | High-Level Input Voltage                                            |                                                                                                                                      | NSTBY/EN  | V <sub>NSTBY/EN_H</sub>      | 0.7 × V <sub>VIO</sub> | —    | V <sub>VIO</sub> + 0.3 | V    | A     |
| 3.20         | Low-Level Input Voltage                                             |                                                                                                                                      | NSTBY/EN  | V <sub>NSTBY/EN_L</sub>      | −0.3                   | —    | 0.3 × V <sub>VIO</sub> | V    | A     |
| 3.30         | High-Level Input Current                                            | V <sub>NSTBY</sub> , V <sub>EN</sub> > 0.7*VIO                                                                                       | NSTBY/EN  | I <sub>NSTBY/EN_H</sub>      | 1                      | 4    | 10                     | μA   | A     |
| 3.40         | Low-Level Input Current                                             | V <sub>NSTBY</sub> , V <sub>EN</sub> = 0V                                                                                            | NSTBY/EN  | I <sub>NSTBY/EN_L</sub>      | −1                     | 0    | +1                     | μA   | B     |
| NERR, RXD    |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 4.10         | High-Level Output Current                                           | V <sub>NERR/RXD</sub> = V <sub>VIO</sub> - 0.4V                                                                                      | NERR, RXD | I <sub>NERR_H, IRXD_H</sub>  | −3                     | —    | —                      | mA   | A     |
| 4.20         | Low-Level Output Current                                            | V <sub>NERR</sub> = 0.4V                                                                                                             | NERR, RXD | I <sub>NERR_L, IRXD_L</sub>  | —                      | —    | 3                      | mA   | A     |
| TXD          |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 5.10         | High-Level Input Voltage                                            |                                                                                                                                      | TXD       | V <sub>TXD_H</sub>           | 0.7 × V <sub>VIO</sub> | —    | V <sub>VIO</sub> + 0.3 | V    | A     |
| 5.20         | Low-Level Input Voltage                                             |                                                                                                                                      | TXD       | V <sub>TXD_L</sub>           | −0.3                   | —    | 0.3 × V <sub>VIO</sub> | V    | A     |
| 5.30         | Pull-Up Resistor                                                    |                                                                                                                                      | TXD       | R <sub>PU_TXD</sub>          | 40                     | 60   | 80                     | kΩ   | A     |
| 5.40         | Input Capacitance                                                   |                                                                                                                                      | TXD       | C <sub>TXD</sub>             | —                      | 5    | 10                     | pF   | D     |
| WAKE         |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |
| 6.10         | High-Level Input Current                                            | V <sub>WAKE</sub> = V <sub>VS</sub> - 1.9V                                                                                           | WAKE      | I <sub>WAKE_H</sub>          | −10                    | −5   | −1                     | μA   | A     |
| 6.20         | Low-Level Input Current                                             | V <sub>WAKE</sub> = V <sub>VS</sub> - 3.9V                                                                                           | WAKE      | I <sub>WAKE_L</sub>          | 1                      | 5    | 10                     | μA   | A     |
| 6.30         | Threshold Voltage                                                   |                                                                                                                                      | WAKE      | V <sub>WAKE_TH</sub>         | V <sub>VS</sub> - 3.8  | —    | V <sub>VS</sub> - 2    | V    | A     |
| INH          |                                                                     |                                                                                                                                      |           |                              |                        |      |                        |      |       |

## Electrical Characteristics (continued)

| No.                                                                                            | Parameters                                            | Test Conditions                                                                                                               | Pin           | Sym.                                | Min.           | Typ.                 | Max.     | Unit       | Type* |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------|----------------|----------------------|----------|------------|-------|
| 7.10                                                                                           | High-Level Voltage                                    | Normal mode or Standby mode,<br>$I_{INH} = -180 \mu A$                                                                        | INH           | $V_{INH\_H}$                        | $V_{VS} - 0.8$ | —                    | $V_{VS}$ | V          | A     |
| 7.20                                                                                           | Off Mode Leakage Current                              | Off mode leakage current, INH pin grounded                                                                                    | INH           | $I_{INH\_Off}$                      | -2             | —                    | 2        | $\mu A$    | A     |
| <b>CANH, CANL (see Figure 6-3 for the definition of <math>R_L</math> and the test circuit)</b> |                                                       |                                                                                                                               |               |                                     |                |                      |          |            |       |
| 8.10                                                                                           | Single-Ended Dominant Output Voltage                  | $R_L = 50\Omega$ to $65\Omega$                                                                                                | CANH          | $V_{CANH}$                          | 2.75           | 3.5                  | 4.5      | V          | A     |
| 8.11                                                                                           |                                                       |                                                                                                                               | CANL          | $V_{CANL}$                          | 0.5            | 1.5                  | 2.25     | V          | A     |
| 8.30                                                                                           | Transmitter Voltage Symmetry                          | $V_{Sym} = (V_{CANH} + V_{CANL})/V_{CC}$ ,<br>$R_L = 60\Omega$ , $C_1 = 4.7 \text{ nF}$ ,<br>$f_{TXD} = 1 \text{ MHz}$        | —             | $V_{SYM}$                           | 0.9            | —                    | 1.1      | V          | D     |
| 8.40                                                                                           | Dominant Differential Output Voltage                  | Normal mode, $V_{TXD} = 0V$ , $V_{VCC} = 4.7V$<br>to $5.5V$ , $t < t_{to(dom)}$<br>$R_L = 50\Omega$ to $65\Omega$             | —             | $V_{Diff}$                          | 1.5            | —                    | 3        | V          | B     |
| 8.41                                                                                           |                                                       | Normal mode, $V_{TXD} = 0V$ , $V_{VCC} = 4.7V$<br>to $5.5V$ , $t < t_{to(dom)}$<br>$R_L = 45\Omega$ to $70\Omega$             | —             | $V_{Diff}$                          | 1.4            | —                    | 3.2      | V          | B     |
| 8.42                                                                                           |                                                       | Normal mode, $V_{TXD} = 0V$ , $V_{VCC} = 4.7V$<br>to $5.5V$ , $t < t_{to(dom)}$<br>$R_L = 2240\Omega$                         | —             | $V_{Diff}$                          | 1.5            | —                    | 5        | V          | D     |
| 8.50                                                                                           | Recessive Output Voltage                              | Single-Ended output voltage on<br>CANH/CANL, Normal mode/Silent<br>mode, $V_{TXD} = V_{VIO}$ , no load                        | CANH,<br>CANL | $V_{CANH}$ , $V_{CANL}$             | 2              | $0.5 \times V_{VCC}$ | 3        | V          | A     |
| 8.51                                                                                           |                                                       | Single-Ended output voltage on<br>CANH/CANL, Standby mode,<br>$V_{TXD} = V_{VIO}$ , no load                                   | CANH,<br>CANL | $V_{CANH}$ , $V_{CANL}$             | -0.1           | —                    | 0.1      | V          | A     |
| 8.53                                                                                           |                                                       | Differential output voltage (bus<br>biasing active), no load                                                                  | CANH,<br>CANL | $V_{Diff}$                          | -50            | —                    | 50       | mV         | A     |
| 8.54                                                                                           |                                                       | Differential output voltage (bus<br>biasing inactive), no load                                                                | CANH,<br>CANL | $V_{Diff}$                          | -200           | —                    | 200      | mV         | A     |
| 8.60                                                                                           | Differential Receiver Threshold Voltage               | Normal/Silent mode;<br>$V_{CANL} = V_{CANH} = -12V$ to $+12V$                                                                 | —             | $V_{Diff\_rx\_th}$                  | 0.5            | 0.7                  | 0.9      | V          | A     |
| 8.61                                                                                           |                                                       | Standby/Sleep mode;<br>$V_{CANL} = V_{CANH} = -12V$ to $+12V$                                                                 | —             | $V_{Diff\_rx\_th}$                  | 0.4            | 0.7                  | 1.15     | V          | A     |
| 8.70                                                                                           | Differential Receiver Hysteresis Voltage              | Normal/Silent mode;<br>$V_{CANL} = V_{CANH} = -12V$ to $+12V$                                                                 | —             | $V_{hys\_rx}$                       | 50             | 120                  | 200      | mV         | B     |
| 8.80                                                                                           | Input Leakage Current                                 | $V_{VS} = V_{VCC} = V_{VIO} = 0V$ ,<br>$V_{CANH} = V_{CANL} = 5V$                                                             | —             | $I_{leak\_in} (I_{CANH}, I_{CANL})$ | -5             | —                    | +5       | $\mu A$    | A     |
|                                                                                                |                                                       | $V_{VS} = V_{VCC} = V_{VIO}$ shorted to ground<br>through $47 \text{ k}\Omega$ , $V_{CANH} = V_{CANL} = 5V$                   | —             | $I_{leak\_in} (I_{CANH}, I_{CANL})$ | -5             | —                    | +5       | $\mu A$    | D     |
| 8.90                                                                                           | Maximum Driver Output Current                         | Normal mode, CAN dominant,<br>$V_{TXD} = 0$ , $t < t_{to(dom)}$ , $V_{VCC} = 5V$ ,<br>$V_{CANH} = -5V$ (short circuit)        | —             | $I_{CANH\_max}$                     | -100           | —                    | -35      | mA         | A     |
| 8.91                                                                                           |                                                       | Normal mode, CAN dominant;<br>$V_{TXD} = 0$ , $t < t_{dom}$ , $V_{VCC} = 5V$ ,<br>$V_{CANL} = 18V$ (short circuit)            | —             | $I_{CANL\_max}$                     | 35             | —                    | 100      | mA         | A     |
| 8.92                                                                                           |                                                       | Normal mode, CAN dominant;<br>$V_{TXD} = 0$ , $t < t_{dom}$ , $V_{VCC} = 5V$ ,<br>$V_{CANL} = 27V$ (short circuit)            | —             | $I_{CANL\_max}$                     | 35             | —                    | 115      | mA         | D     |
| 8.100                                                                                          | Single-Ended Input Resistance                         | $V_{CANH} = V_{CANL} = 4V$                                                                                                    | CANH,<br>CANL | $R_{CANH}$ , $R_{CANL}$             | 9              | 15                   | 28       | k $\Omega$ | A     |
|                                                                                                |                                                       | $-2V \leq V_{CANH} \leq 7V$ ,<br>$-2V \leq V_{CANL} \leq 7V$                                                                  | CANH,<br>CANL | $R_{CANH}$ , $R_{CANL}$             | 9              | 15                   | 28       | k $\Omega$ | D     |
| 8.110                                                                                          | Matching of Internal Resistance Between CANH and CANL | $V_{CANH} = V_{CANL} = 4V$ ,<br>$mR = 2 \times (R_{CANH} - R_{CANL}) / (R_{CANH} + R_{CANL})$                                 | —             | mR                                  | -1             | —                    | 1        | %          | A     |
|                                                                                                |                                                       | $-2V \leq V_{CANH} \leq 7V$ ,<br>$-2V \leq V_{CANL} \leq 7V$<br>$mR = 2 \times (R_{CANH} - R_{CANL}) / (R_{CANH} + R_{CANL})$ | —             | mR                                  | -1             | —                    | 1        | %          | D     |

## Electrical Characteristics (continued)

| No.                                                                                                                                                                      | Parameters                                                         | Test Conditions                                                                                                                                                                                     | Pin             | Sym.                                     | Min.        | Typ.   | Max.         | Unit | Type* |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------------|-------------|--------|--------------|------|-------|
| 8.120                                                                                                                                                                    | Differential Internal Resistance                                   | $V_{CANH} = V_{CANL} = 4V$                                                                                                                                                                          | —               | $R_{Diff}$                               | 18          | 30     | 56           | kΩ   | A     |
|                                                                                                                                                                          |                                                                    | $-2V \leq V_{CANH} \leq 7V$ ,<br>$-2V \leq V_{CANL} \leq 7V$                                                                                                                                        | —               | $R_{Diff}$                               | 18          | 30     | 56           | kΩ   | D     |
| 8.130                                                                                                                                                                    | Common-Mode Input Capacitance                                      | f=500kHz, CANH and CANL referring to ground                                                                                                                                                         | —               | $C_{l(cm)}$                              | —           | —      | 20           | pF   | D     |
| 8.140                                                                                                                                                                    | Differential Input Capacitance                                     | f=500kHz, between CANH and CANL                                                                                                                                                                     | —               | $C_{Diff}$                               | —           | —      | 10           | pF   | D     |
| 8.141                                                                                                                                                                    | Differential Bus Voltage Range for Recessive State Detection       | Bus biasing active<br>/inactive<br>$-12,0V \leq V_{CANL} \leq +12,0V$<br>$-12,0V \leq V_{CANH} \leq +12,0V$                                                                                         | —               | $V_{Diff\_rec\_a}$<br>$V_{Diff\_rec\_i}$ | -3<br>-3    | —<br>— | +0.5<br>+0.4 | V    | D     |
| 8.142                                                                                                                                                                    | Differential Bus Voltage Range for Dominant State Detection        | Bus biasing active<br>/inactive<br>$-12,0\text{ V} \leq V_{CANL} \leq +12,0\text{ V}$<br>$-12,0\text{ V} \leq V_{CANH} \leq +12,0\text{ V}$                                                         | —               | $V_{DIFF\_dom\_a}$<br>$V_{DIFF\_dom\_i}$ | 0.9<br>1.15 | —<br>— | 8<br>8       | V    | D     |
| Transceiver Timing, Pins WAKE, INH, CANH, CANL, TXD and RXD. See Figure 5-1, Figure 5-2 and Figure 6-3 for the definition of the timing parameters and the test circuit. |                                                                    |                                                                                                                                                                                                     |                 |                                          |             |        |              |      |       |
| 9.10                                                                                                                                                                     | Delay Time from TXD to Bus Dominant                                | $R_L = 60\Omega$ , $C_2 = 100\text{ pF}$                                                                                                                                                            | CANH, CANL, TXD | $t_{TXDBUS\_dom}$                        | —           | 65     | —            | ns   | C     |
| 9.20                                                                                                                                                                     | Delay Time from TXD to Bus Recessive                               | $R_L = 60\Omega$ , $C_2 = 100\text{ pF}$                                                                                                                                                            | CANH, CANL, TXD | $t_{TXDBUS\_rec}$                        | —           | 90     | —            | ns   | C     |
| 9.30                                                                                                                                                                     | Delay Time from bus Dominant to RXD                                | $R_L = 60\Omega$ , $C_2 = 100\text{ pF}$                                                                                                                                                            | CANH, CANL, RXD | $t_{BUSRXD\_dom}$                        | —           | 60     | —            | ns   | C     |
| 9.40                                                                                                                                                                     | Delay Time from Bus Recessive to RXD                               | $R_L = 60\Omega$ , $C_2 = 100\text{ pF}$                                                                                                                                                            | CANH, CANL, RXD | $t_{BUSRXD\_rec}$                        | —           | 65     | —            | ns   | C     |
| 9.50                                                                                                                                                                     | Propagation Delay from TXD to RXD                                  | $R_L = 60\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$                                                                                                                                 | TXD, RXD        | $t_{Loop}$                               | 100         | —      | 255          | ns   | A     |
| 9.51                                                                                                                                                                     |                                                                    | $R_L = 150\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$ ,<br>$f_{TXD} = 250\text{ KHz}$                                                                                                | TXD, RXD        | $t_{Loop}$                               | —           | —      | 300          | ns   | C     |
| 9.60                                                                                                                                                                     | Recessive Bit Time on Pin RXD                                      | $t_{B\_TXD} = 500\text{ ns}$ ,<br>$R_L = 60\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$                                                                                               | RXD             | $t_{Bit(RXD)}$                           | 400         | —      | 550          | ns   | C     |
| 9.61                                                                                                                                                                     |                                                                    | $t_{B\_TXD} = 200\text{ ns}$ ,<br>$R_L = 60\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$                                                                                               | RXD             | $t_{Bit(RXD)}$                           | 120         | —      | 220          | ns   | A     |
| 9.70                                                                                                                                                                     | Receiver Timing Symmetry                                           | $\Delta t_{Rec} = t_{Bit(RXD)} - t_{Bit(Bus)}$ , $t_{B\_TXD} = 500\text{ ns}$<br>(see no. 9.100 for $t_{Bit(Bus)}$ )<br>$R_L = 60\text{ }\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$ | —               | $\Delta t_{Rec}$                         | -65         | —      | +40          | ns   | C     |
| 9.71                                                                                                                                                                     |                                                                    | $\Delta t_{Rec} = t_{Bit(RXD)} - t_{Bit(Bus)}$ , $t_{B\_TXD} = 200\text{ ns}$<br>$R_L = 60\text{ }\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$                                        | —               | $\Delta t_{Rec}$                         | -45         | —      | +15          | ns   | B     |
|                                                                                                                                                                          |                                                                    | $\Delta t_{Rec} = t_{Bit(RXD)} - t_{Bit(Bus)}$ , $t_{B\_TXD} = 200\text{ ns}$<br>$R_L = 60\text{ }\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$ ,<br>Only valid for datecode >2540     | —               | $\Delta t_{Rec}$                         | -40         | —      | +10          | ns   | B     |
| 9.80                                                                                                                                                                     | TXD Dominant Time-Out Time                                         | $V_{TXD} = 0V$ , Normal mode                                                                                                                                                                        | TXD             | $t_{to(dom)}$                            | 2.7         | —      | 3.3          | ms   | B     |
| 9.90                                                                                                                                                                     | Bus Dominant Time-Out Time                                         | $V_{CANH-CANL} = 0.9V$                                                                                                                                                                              | —               | $t_{BUS\_dom}$                           | 2.7         | —      | 3.3          | ms   | B     |
| 9.100                                                                                                                                                                    | Transmitted Recessive Bit Width on the Bus                         | $t_{B\_TXD} = 500\text{ ns}$<br>$R_L = 60\text{ }\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$                                                                                         | —               | $t_{Bit(Bus)}$                           | 435         | —      | 530          | ns   | C     |
| 9.110                                                                                                                                                                    |                                                                    | $t_{B\_TXD} = 200\text{ ns}$<br>$R_L = 60\text{ }\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$                                                                                         | —               | $t_{Bit(Bus)}$                           | 155         | —      | 210          | ns   | A     |
|                                                                                                                                                                          |                                                                    | $t_{B\_TXD} = 200\text{ ns}$<br>$R_L = 60\text{ }\Omega$ , $C_2 = 100\text{ pF}$ , $C_{RXD} = 15\text{ pF}$ ,<br>Only valid for datecode >2540                                                      | —               | $t_{Bit(Bus)}$                           | 160         | —      | 205          | ns   | A     |
| 9.120                                                                                                                                                                    | CAN Activity Filter Time for Standard Remote Wake-Up Pattern (WUP) | First pulse (after first recessive) and second pulse for wake-up on pins CANH and CANL, Sleep mode                                                                                                  | CANH, CANL      | $t_{Filter}$                             | 0.5         | —      | 1.8          | μs   | A     |
| 9.170                                                                                                                                                                    | Go-to-Sleep Hold Time                                              | From issuing the Go-to-Sleep command to enter Sleep mode                                                                                                                                            | —               | $t_{hold}$                               | 20          | —      | 50           | μs   | B     |
| 9.180                                                                                                                                                                    | Undervoltage Detection Time                                        |                                                                                                                                                                                                     | VCC, VIO        | $t_{VSUP\_UV\_set}$                      | 100         | —      | 350          | ms   | B     |
| 9.190                                                                                                                                                                    | Undervoltage Recovery Time                                         |                                                                                                                                                                                                     | VCC, VIO        | $t_{VSUP\_UV\_clear}$                    | 1           | —      | 5            | ms   | B     |
| 9.200                                                                                                                                                                    | Start-Up Time after Power-On                                       | From $V_{VS}$ rises above the power-on detection threshold, $V_{VS\_PWON}$ until pin INH high                                                                                                       | VS              | $t_{startup}$                            | —           | 0.5    | 1            | ms   | A     |

## Electrical Characteristics (continued)

| No.   | Parameters                                             | Test Conditions                                                                               | Pin  | Sym.                     | Min. | Typ. | Max. | Unit    | Type* |
|-------|--------------------------------------------------------|-----------------------------------------------------------------------------------------------|------|--------------------------|------|------|------|---------|-------|
| 9.220 | Debouncing Time for Recessive Clamping State Detection | $V_{CANH} + CANL > 900$ mV, RXD = HIGH                                                        | RXD  | $t_{RXD\_rec\_clmp}$     | 60   | 90   | 175  | ns      | D     |
| 9.230 | Local Wake-Up Filter Time                              | In response to a falling or rising edge on pin WAKE; Standby or Sleep mode                    | WAKE | $t_{local\_wu}$          | 5    | —    | 50   | $\mu$ s | A     |
| 9.240 | Transmitter Resume Time                                | From TXD, it goes high to TX and it operates after the TXD dominant timeout event is detected | —    | $t_{TX\_resume\_TXDOUT}$ | —    | —    | 4    | $\mu$ s | D     |
| 9.250 | Bus Wake-Up Time-Out Time                              | Between the first and second dominant pulses, CAN TRX Standby mode                            | —    | $t_{wake}$               | 0.9  | —    | 1.2  | ms      | B     |
| 9.260 | Delay Time for Standby to Normal Mode Transition       | Rising edge at pin NSTBY, EN = HIGH                                                           | —    | $t_{del(stby-norm)}$     | —    | —    | 47   | $\mu$ s | D     |
| 9.270 | Delay Time for Normal Mode to Standby Mode Transition  | Falling edge at pin NSTBY, EN = LOW                                                           | —    | $t_{del(norm-stby)}$     | —    | —    | 5    | $\mu$ s | D     |
| 9.280 | Delay Time for Normal Mode to Silent Mode Transition   | Falling edge at pin EN, NSTBY = HIGH                                                          | —    | $t_{del(norm-silent)}$   | —    | —    | 10   | $\mu$ s | D     |
| 9.290 | Delay Time for Silent Mode to Normal Mode Transition   | Rising edge at pin EN, NSTBY = HIGH                                                           | —    | $t_{del(silent-norm)}$   | —    | —    | 10   | $\mu$ s | D     |
| 9.300 | Delay Time for Silent Mode to Standby Mode Transition  | Falling edge at pin EN, NSTBY = LOW                                                           | —    | $t_{del(silent-stby)}$   | —    | —    | 5    | $\mu$ s | D     |
| 9.310 | Delay Time for Standby Mode to Silent Mode Transition  | Rising edge at pin NSTBY, EN = LOW                                                            | —    | $t_{del(stby-silent)}$   | —    | —    | 47   | $\mu$ s | D     |
| 9.320 | Delay Time for Sleep Mode to Standby Mode Transition   | Wake event detected                                                                           | —    | $t_{del(sleep-stby)}$    | —    | —    | 5    | $\mu$ s | D     |

\* Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter.

Figure 5-1. CAN Transceiver Timing Diagram 1

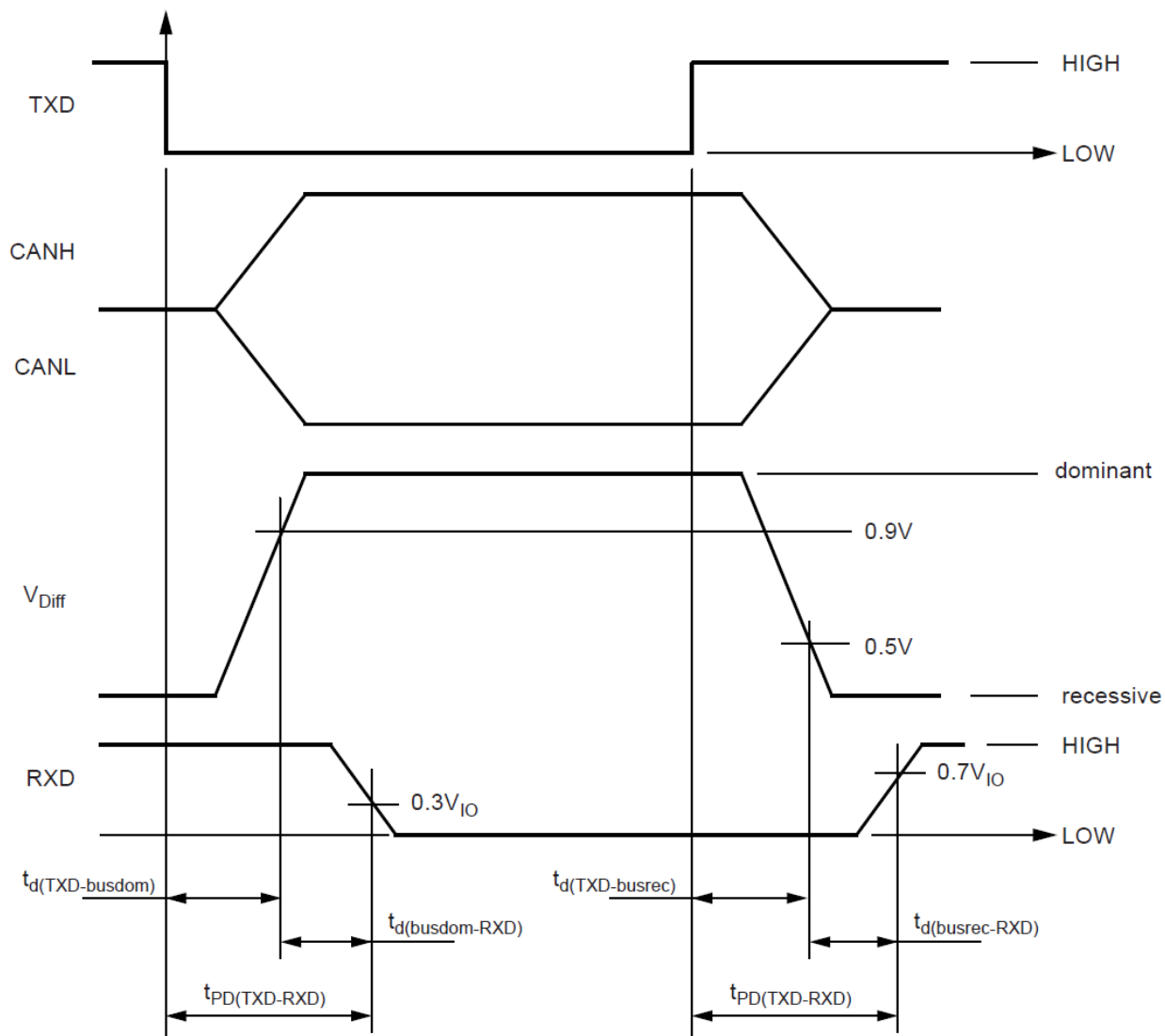
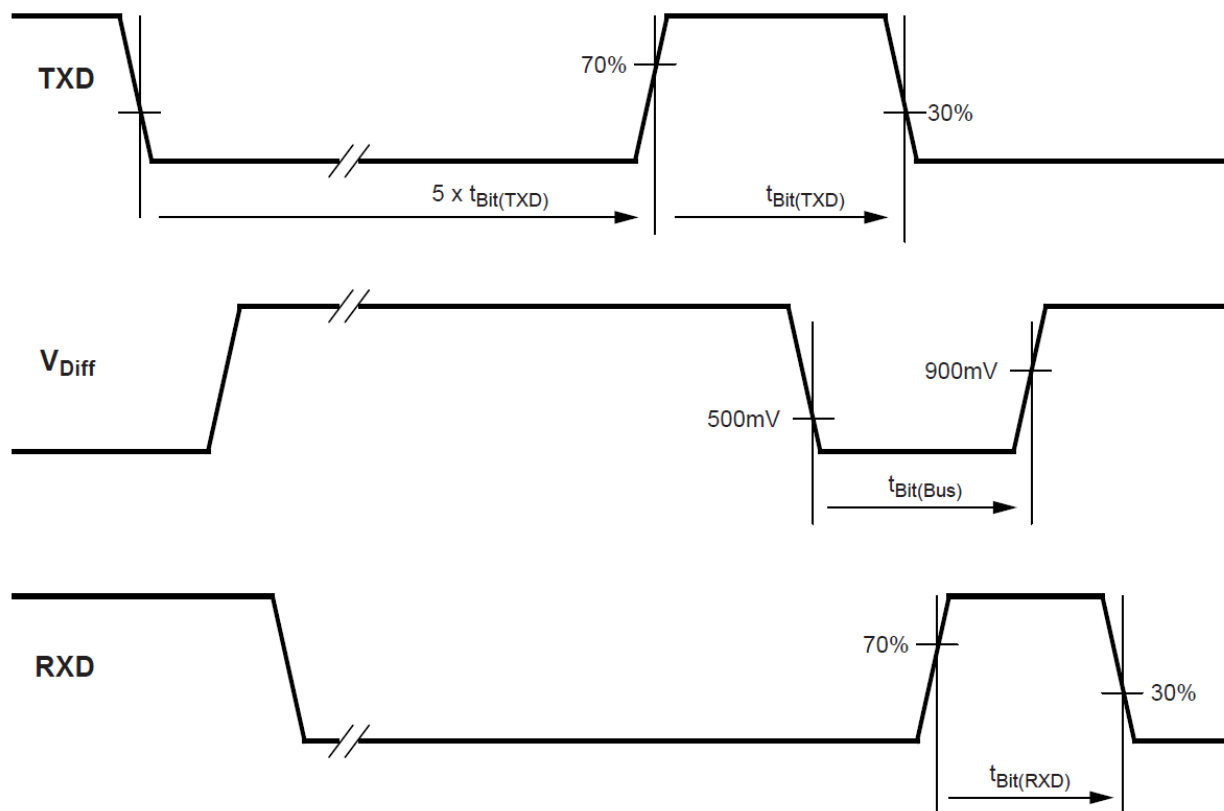
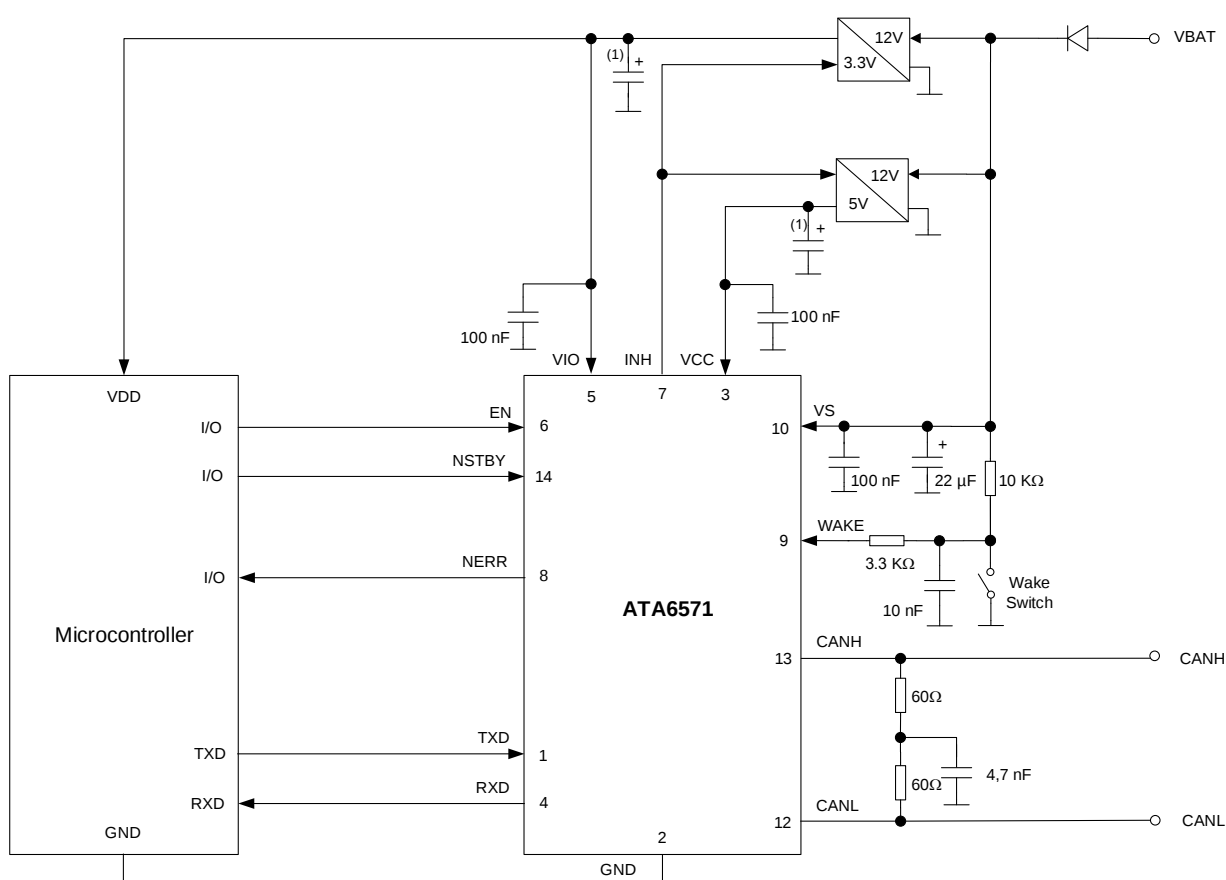


Figure 5-2. CAN Transceiver Timing Diagram 2



## 6. Application Circuits

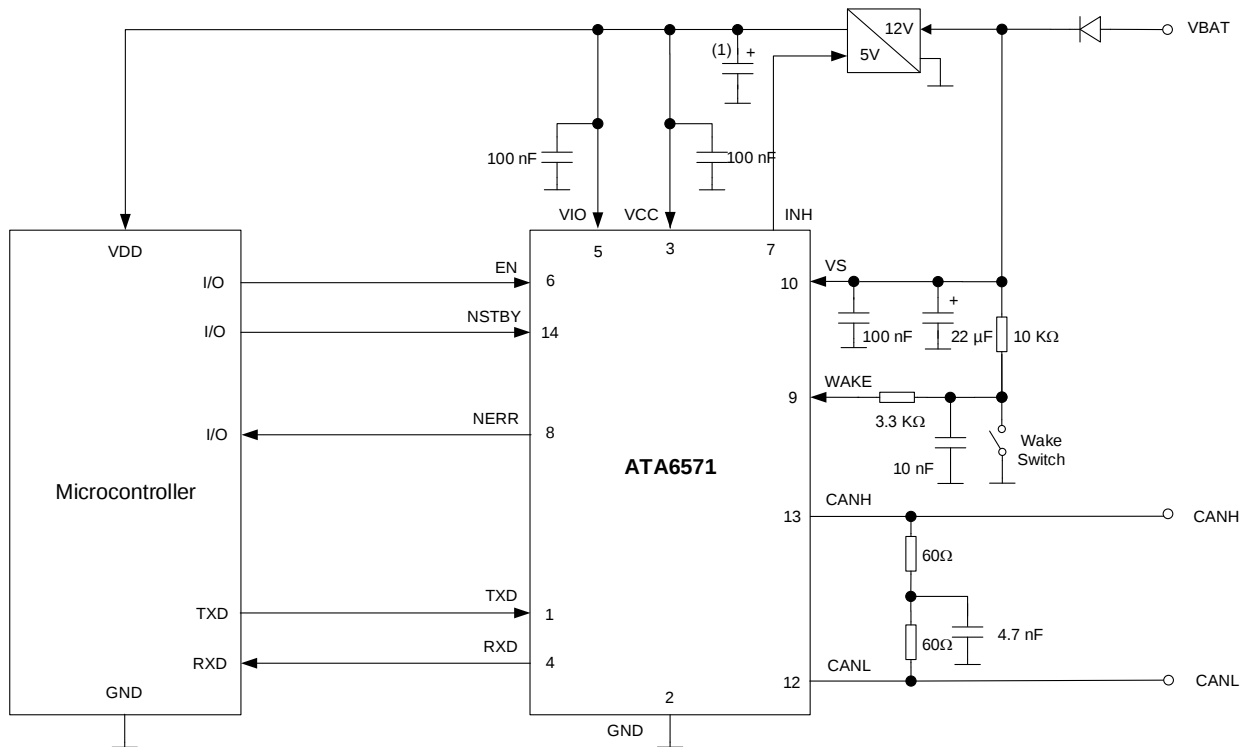
Figure 6-1. Typical Application Circuit



### Notes:

1. The value of these capacitors depends on the used external voltage regulators.
2. For the VDFN14 package, the exposed thermal pad must be always connected to GND.

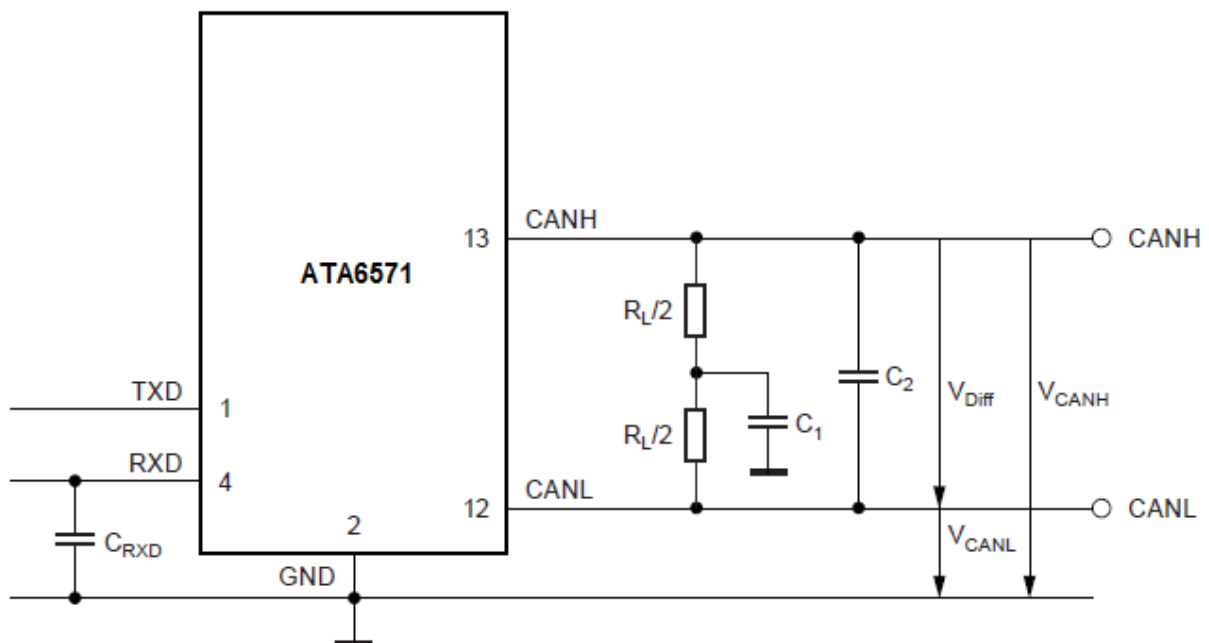
**Figure 6-2. Typical Application Circuit 5V Only**



**Notes:**

1. The value of this capacitor depends on the used external voltage regulator.
2. For the VDFN14 package, the exposed thermal pad must be always connected to GND.

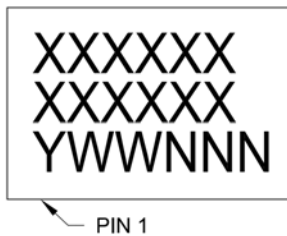
### Figure 6-3. Test Circuit



## 7. Package Information

### 7.1. Package Marking Information

14-Lead 4.5 x 3 mm VDFN



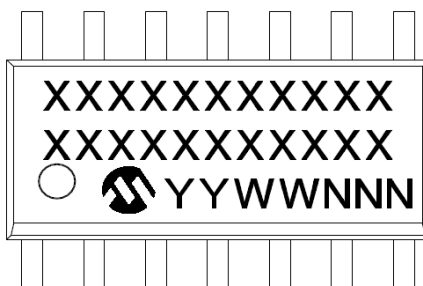
Example Grade 1



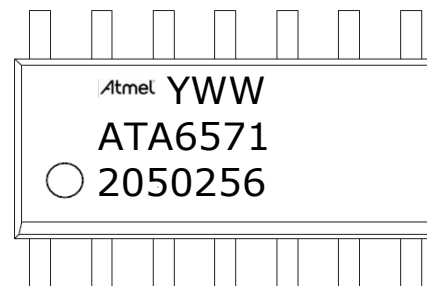
Example Grade 0



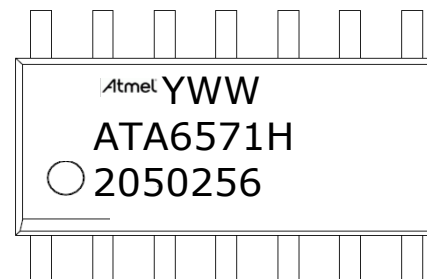
14-Lead 3.90 mm SOIC



Example Grade 1



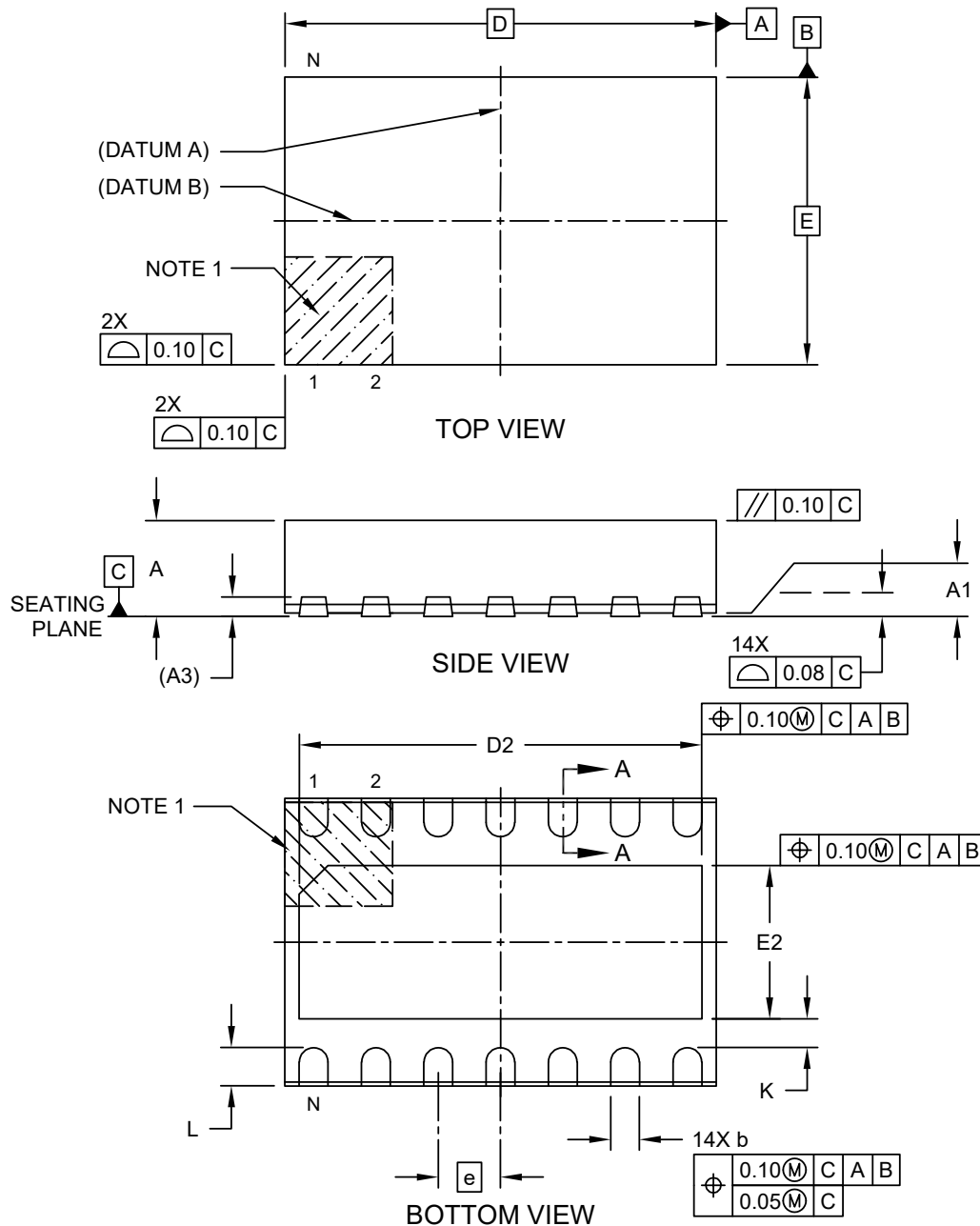
Example Grade 0



|                                                                                                                                                                                                                      |        |                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------------------------------------------------------------------------------------------------------------|
| <b>Legend:</b>                                                                                                                                                                                                       | XX...X | Customer-specific information                                                                                      |
|                                                                                                                                                                                                                      | Y      | Year code (last digit of calendar year)                                                                            |
|                                                                                                                                                                                                                      | YY     | Year code (last 2 digits of calendar year)                                                                         |
|                                                                                                                                                                                                                      | WW     | Week code (week of January 1 is week '01')                                                                         |
|                                                                                                                                                                                                                      | NNN    | Alphanumeric traceability code                                                                                     |
|                                                                                                                                                                                                                      | (e3)   | Pb-free JEDEC designator for Matte Tin (Sn)                                                                        |
|                                                                                                                                                                                                                      | *      | This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package. |
| <b>Note:</b> In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. |        |                                                                                                                    |

**14-Lead Very Thin Plastic Dual Flat, No Lead Package (QBB) - 4.5x3x1 mm Body [VDFN]  
With 1.6x4.2 mm Exposed Pad and Stepped Wettable Flanks**

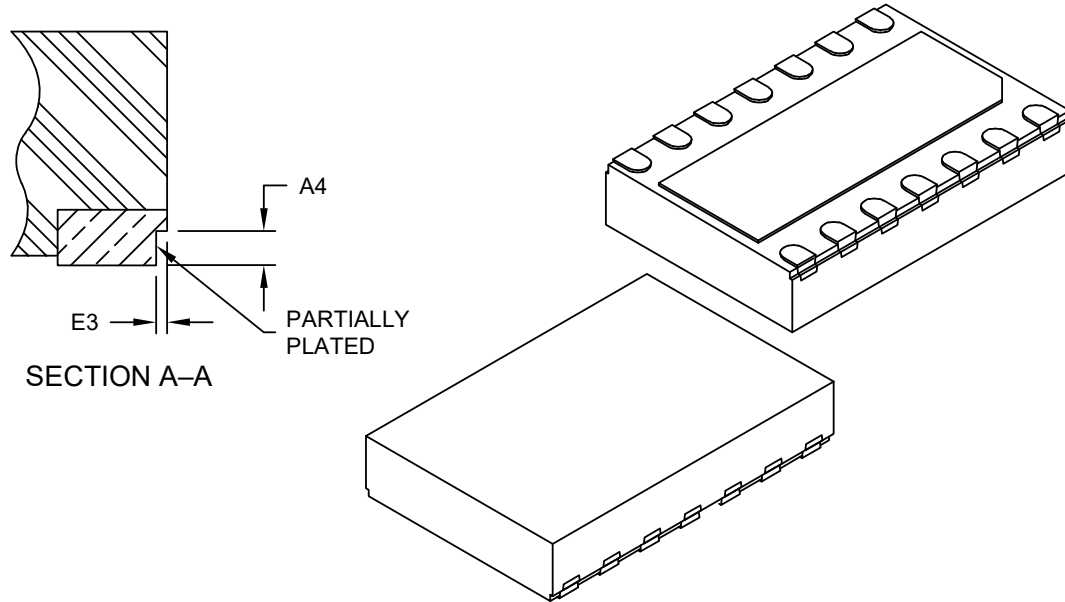
**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-21361 Rev D Sheet 1 of 2

# 14-Lead Very Thin Plastic Dual Flat, No Lead Package (QBB) - 4.5x3x1 mm Body [VDFN] With 1.6x4.2 mm Exposed Pad and Stepped Wettable Flanks

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



|                               |    | Units | MILLIMETERS |      |       |
|-------------------------------|----|-------|-------------|------|-------|
| Dimension Limits              |    |       | MIN         | NOM  | MAX   |
| Number of Terminals           | N  |       | 14          |      |       |
| Pitch                         | e  |       | 0.65 BSC    |      |       |
| Overall Height                | A  |       | 0.80        | 0.90 | 1.00  |
| Standoff                      | A1 |       | 0.00        | 0.03 | 0.05  |
| Terminal Thickness            | A3 |       | 0.203 REF   |      |       |
| Overall Length                | D  |       | 4.50 BSC    |      |       |
| Exposed Pad Length            | D2 |       | 4.15        | 4.20 | 4.25  |
| Overall Width                 | E  |       | 3.00 BSC    |      |       |
| Exposed Pad Width             | E2 |       | 1.50        | 1.60 | 1.70  |
| Terminal Width                | b  |       | 0.27        | 0.32 | 0.37  |
| Terminal Length               | L  |       | 0.35        | 0.40 | 0.45  |
| Terminal-to-Exposed-Pad       | K  |       | 0.20        | -    | -     |
| Wettable Flank Step Cut Depth | A4 |       | 0.10        | -    | 0.19  |
| Wettable Flank Step Cut Width | E3 |       | -           | -    | 0.085 |

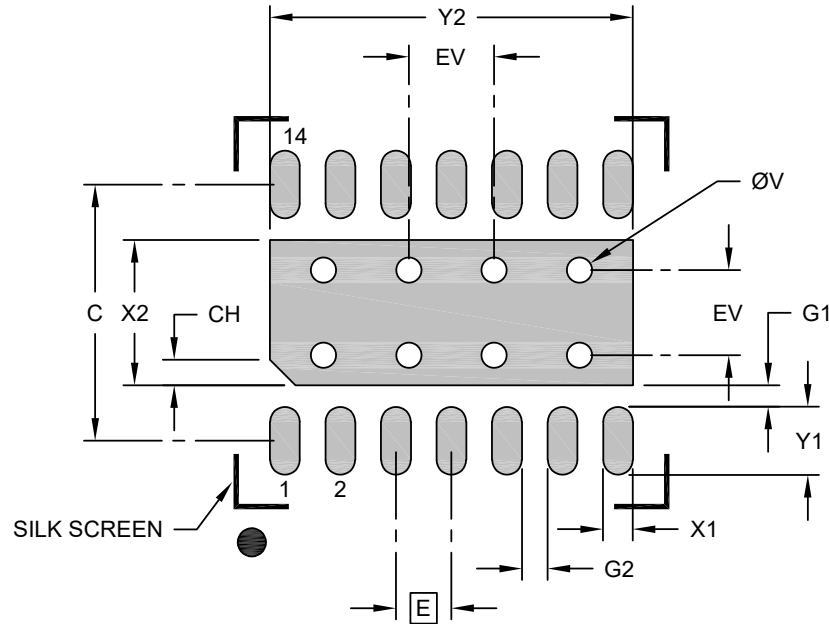
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Package is saw singulated
- Dimensioning and tolerancing per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
  - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-21361 Rev D Sheet 2 of 2

**14-Lead Very Thin Plastic Dual Flat, No Lead Package (QBB) - 4.5x3x1 mm Body [VDFN]  
With 1.6x4.2 mm Exposed Pad and Stepped Wettable Flanks**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



**RECOMMENDED LAND PATTERN**

| Dimension Limits                | Units | MILLIMETERS |      |      |
|---------------------------------|-------|-------------|------|------|
|                                 |       | MIN         | NOM  | MAX  |
| Contact Pitch                   | E     | 0.65 BSC    |      |      |
| Optional Center Pad Width       | X2    |             |      | 1.70 |
| Optional Center Pad Length      | Y2    |             |      | 4.25 |
| Contact Pad Spacing             | C     |             | 3.00 |      |
| Contact Pad Width (X14)         | X1    |             |      | 0.35 |
| Contact Pad Length (X14)        | Y1    |             |      | 0.80 |
| Pin 1 Index Chamfer             | CH    |             | 0.30 |      |
| Contact Pad to Center Pad (X14) | G1    | 0.20        |      |      |
| Contact Pad to Center Pad (X12) | G2    | 0.20        |      |      |
| Thermal Via Diameter            | V     |             | 0.30 |      |
| Thermal Via Pitch               | EV    |             | 1.00 |      |

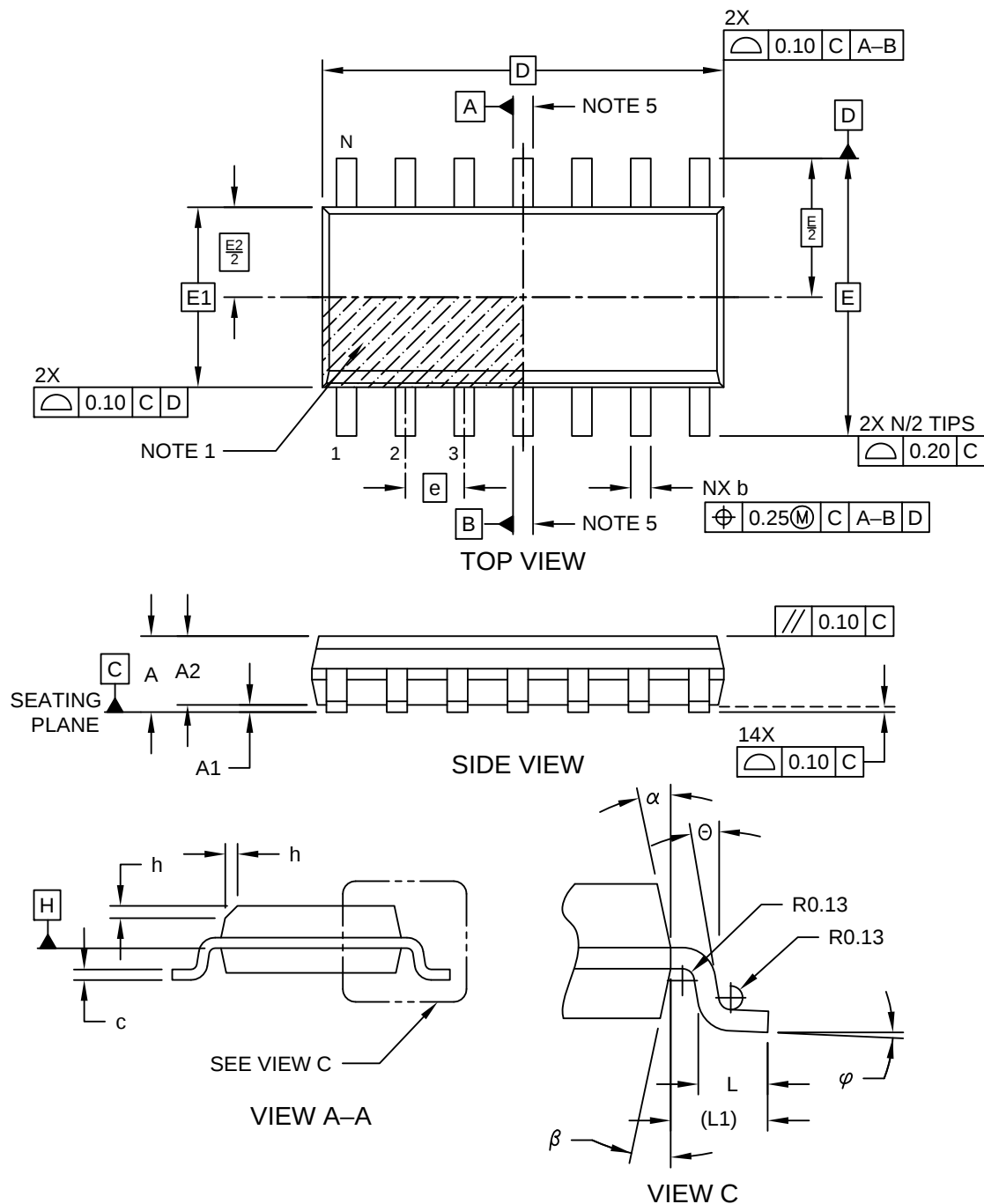
**Notes:**

- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-23361 Rev D

### 14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

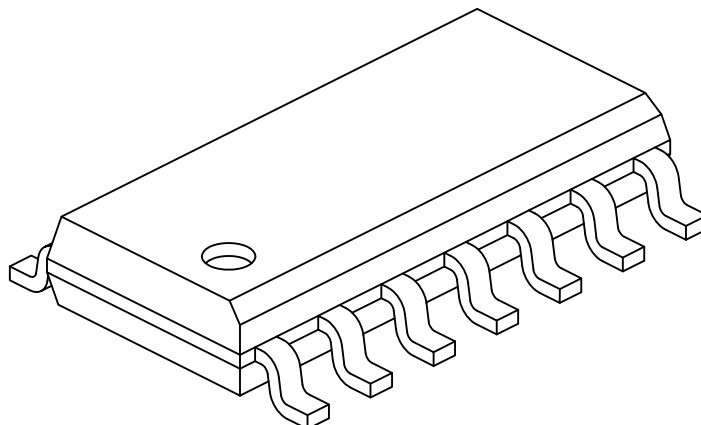
**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing No. C04-065-SL Rev D Sheet 1 of 2

**14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Units                    |    | MILLIMETERS |     |      |
|--------------------------|----|-------------|-----|------|
| Dimension Limits         |    | MIN         | NOM | MAX  |
| Number of Pins           | N  | 14          |     |      |
| Pitch                    | e  | 1.27 BSC    |     |      |
| Overall Height           | A  | -           | -   | 1.75 |
| Molded Package Thickness | A2 | 1.25        | -   | -    |
| Standoff §               | A1 | 0.10        | -   | 0.25 |
| Overall Width            | E  | 6.00 BSC    |     |      |
| Molded Package Width     | E1 | 3.90 BSC    |     |      |
| Overall Length           | D  | 8.65 BSC    |     |      |
| Chamfer (Optional)       | h  | 0.25        | -   | 0.50 |
| Foot Length              | L  | 0.40        | -   | 1.27 |
| Footprint                | L1 | 1.04 REF    |     |      |
| Lead Angle               | Ø  | 0°          | -   | -    |
| Foot Angle               | φ  | 0°          | -   | 8°   |
| Lead Thickness           | c  | 0.10        | -   | 0.25 |
| Lead Width               | b  | 0.31        | -   | 0.51 |
| Mold Draft Angle Top     | α  | 5°          | -   | 15°  |
| Mold Draft Angle Bottom  | β  | 5°          | -   | 15°  |

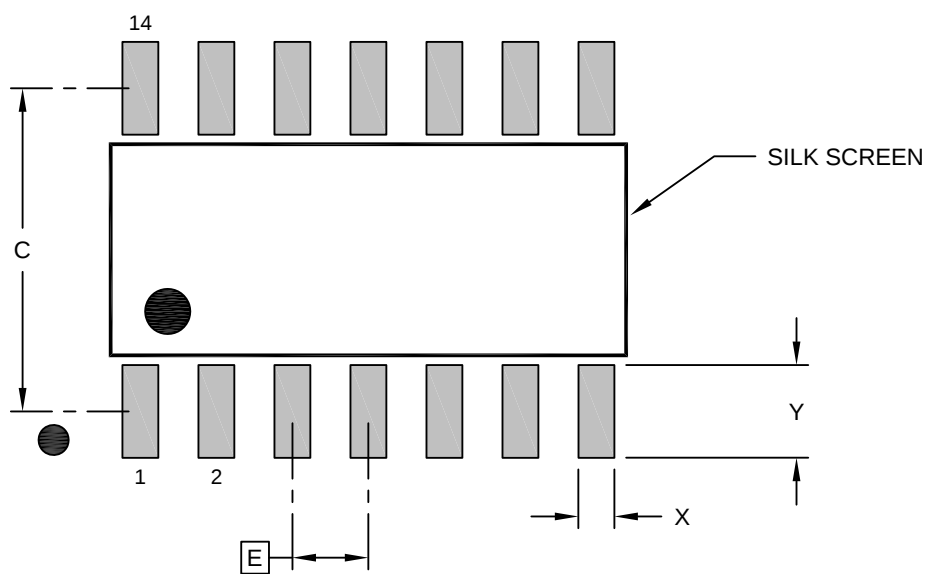
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- § Significant Characteristic
- Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.  
REF: Reference Dimension, usually without tolerance, for information purposes only.
- Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-065-SL Rev D Sheet 2 of 2

## 14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



### RECOMMENDED LAND PATTERN

| Units                    |   | MILLIMETERS |          |      |
|--------------------------|---|-------------|----------|------|
| Dimension Limits         |   | MIN         | NOM      | MAX  |
| Contact Pitch            | E |             | 1.27 BSC |      |
| Contact Pad Spacing      | C |             | 5.40     |      |
| Contact Pad Width (X14)  | X |             |          | 0.60 |
| Contact Pad Length (X14) | Y |             |          | 1.55 |

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2065-SL Rev D

## 8. Revision History

### Revision C (October 2025)

Updated Section [Electrical Characteristics](#): new lines for datacode >2540 test condition were added to parameters 9.71 and 9.110).

### Revision B (January 2021)

The following is the list of modifications:

- Added the VDFN14 package.
- Updated Section [Features](#).
- Updated Section [Description](#).
- Updated Section [Pin Configuration](#).
- Updated Section [Application Circuits](#).
- Updated Section [Package Marking Information](#).
- Updated Section *Product Identification System*.

### Revision A (November 2020)

Original Release of this Document.

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