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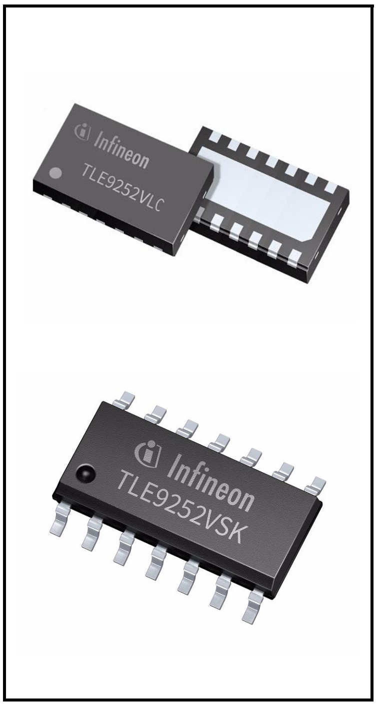
TLE9252V

High-Speed CAN FD Transceiver

1 Overview



Qualified for Automotive Applications according to AEC-Q100

Features

- Fully compliant to ISO 11898-2 (2016) and SAE J2284-4/-5
- Reference device and part of Interoperability Test Specification for CAN Transceiver
- Guaranteed loop delay symmetry to support CAN FD data frames up to 5 MBit/s
- Bus Wake-up Pattern (WUP) function with optimized filter time for worldwide OEM usage: 0.5µs < t_{Filter} < 1.8µs
- Excellent ESD robustness +/-10kV (HBM) and +/-9kV (IEC 61000-4-2)
- Very low current consumption in Sleep Mode of max. 25µA
- Extended supply range on V_{CC} and V_{IO} supply
- Dual Power Supply Solution via V_{BAT} and V_{CC} for robust behaviour during battery cranking
- Fail safe features like TxD time-out, RxD Recessive Clamping and Overtemperature shut-down
- Very low electromagnetic emission (EME) for chokeless usage
- Wide common mode range for electromagnetic immunity (EMI)
- CAN short circuit proof to ground, battery and V_{CC}
- Undervoltage detection on V_{BAT}, V_{CC} and V_{IO}
- Autonomous bus biasing according to ISO 11898-2 (2016)
- Bus Wake-up (WUP) and Local Wake-Up (LWU)
- INH output to control external circuity
- Improved robust local failure diagnosis via NERR output pin
- Green Product (RoHS compliant)

Potential Applications

- Infotainment applications
- Cluster Modules
- Radar applications
- HVAC

Decription

The TLE9252V is a transceiver designed for HS CAN networks up to 5 Mbit/s in automotive and industrial applications. As an interface between the physical bus layer and the CAN protocol controller, the TLE9252V drives the signals to the bus and protects the microcontroller against interferences generated within the network. Based on the high symmetry of the CANH and CANL signals, the TLE9252V provides very low electromagnetic emission allowing the operation without a common mode choke. The non-low power modes (Normal-operating Mode and Receive-only Mode) and low power modes (Sleep Mode and Stand-by Mode) are optimized for reduced current consumption based on the required functionality. Even in Sleep Mode with a quiescent current below 25 µA over the full temperature range, the TLE9252V is able to detect a Wake-Up Pattern (WUP) on the HS CAN bus. The V_{IO} voltage reference input is used to support 3.3 V and 5 V supplied microcontrollers. The TLE9252V is integrated in an RoHS compliant PG-DSO-14 or PG-TSON-14 package and fulfills the requirements of the ISO11898-2 (2016).

Type	Package	Marking
TLE9252VSK	PG-DSO-14	9252V
TLE9252VLC	PG-TSON-14	9252V

Table of contents

2 Block diagram

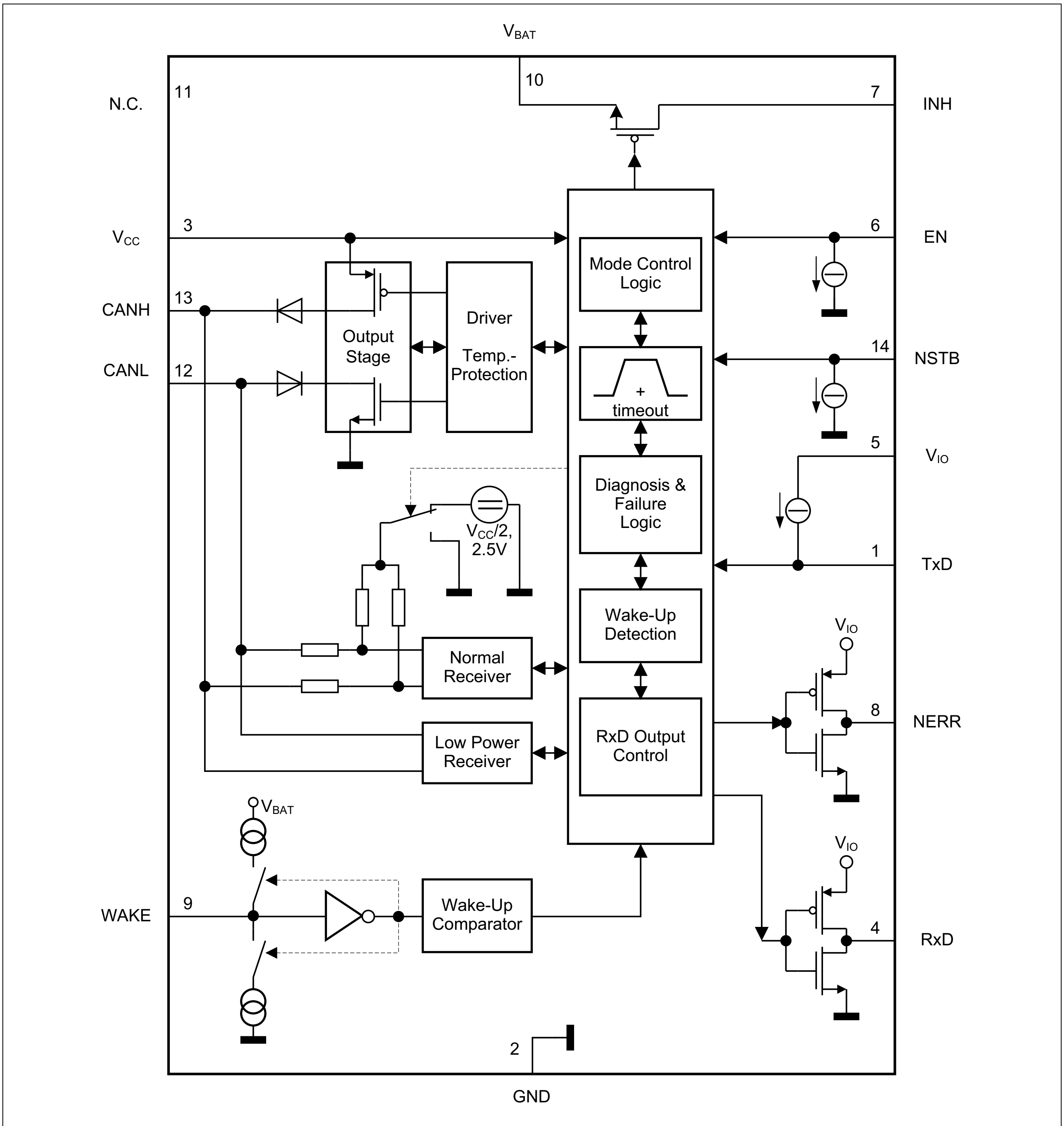


Figure 1 Block diagram

3 Pin configuration

3.1 Pin assignment

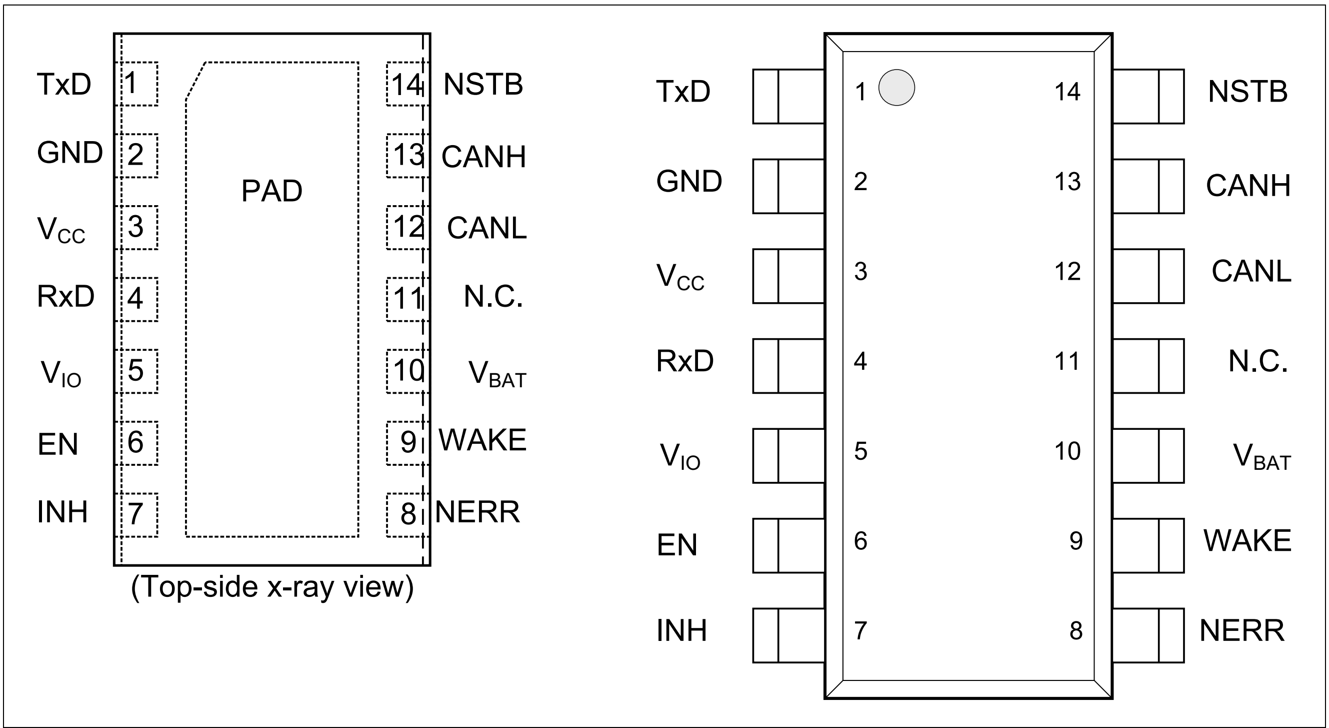


Figure 2 Pin configuration

3.2 Pin definitions

Table 1 Pin definitions and functions

Pin	Symbol	Function
1	TxD	**Transmit Data input** Integrated "pull-up" current source to V_{IO}; Logical "low" to drive a "dominant" signal on CANH and CANL.
2	GND	**Ground**
3	V_{CC}	**Transmitter supply voltage** 100 nF decoupling capacitor to GND recommended.
4	RxD	**Receive Data output** Logical "low" while a "dominant" signal is on the HS CAN bus; Output voltage adapted to the voltage on the V_{IO} level shift input.
5	V_{IO}	**Level shift input** Reference voltage for the digital input and output pins; 100 nF decoupling capacitor to GND recommended.
6	EN	**Mode control input** Integrated "pull-down" current source to GND; Logical "high" for Normal-operating Mode.

Table 1 Pin definitions and functions (cont'd)

Pin	Symbol	Function
7	INH	**Inhibit output** Open drain output to control external circuitry; High impedance in Sleep Mode.
8	NERR	**Error flag output** Failure and wake-up indication output; Active "low".
9	WAKE	**Wake-up input** Local wake-up input, terminated against GND and V_{BAT}; Wake-up input sensitive on rising and falling edge.
10	V_{BAT}	**Battery supply voltage** 100 nF decoupling capacitor to GND recommended.
11	N.C.	**Not connected**
12	CANL	**Low-level HS CAN bus line**
13	CANH	**High-level HS CAN bus line**
14	NSTB	**Stand-by control input** Integrated "pull-down" current source to GND; Logical "high" for Normal-operating Mode.

4 High-Speed CAN functional description

HS CAN is a serial bus system which connects microcontrollers, sensors and actuators for real-time control applications. The use of the Controller Area Network (abbreviated CAN) within road vehicles is described by the international standard ISO 11898. According to the 7-layer OSI reference model the physical layer of a HS CAN bus system specifies the data transmission from one CAN node to all other available CAN nodes within the network. The physical layer specification of a CAN bus system includes all electrical specifications of a CAN network. The CAN transceiver is part of the physical layer specification. The TLE9252V supports both Bus Wake-up Pattern (WUP) functionality and Local Wake-up as defined by the ISO 11898 Standard. Additionally, the TLE9252V supports CAN Flexible data rate (CAN FD) transmission up to 5 Mbit/s.

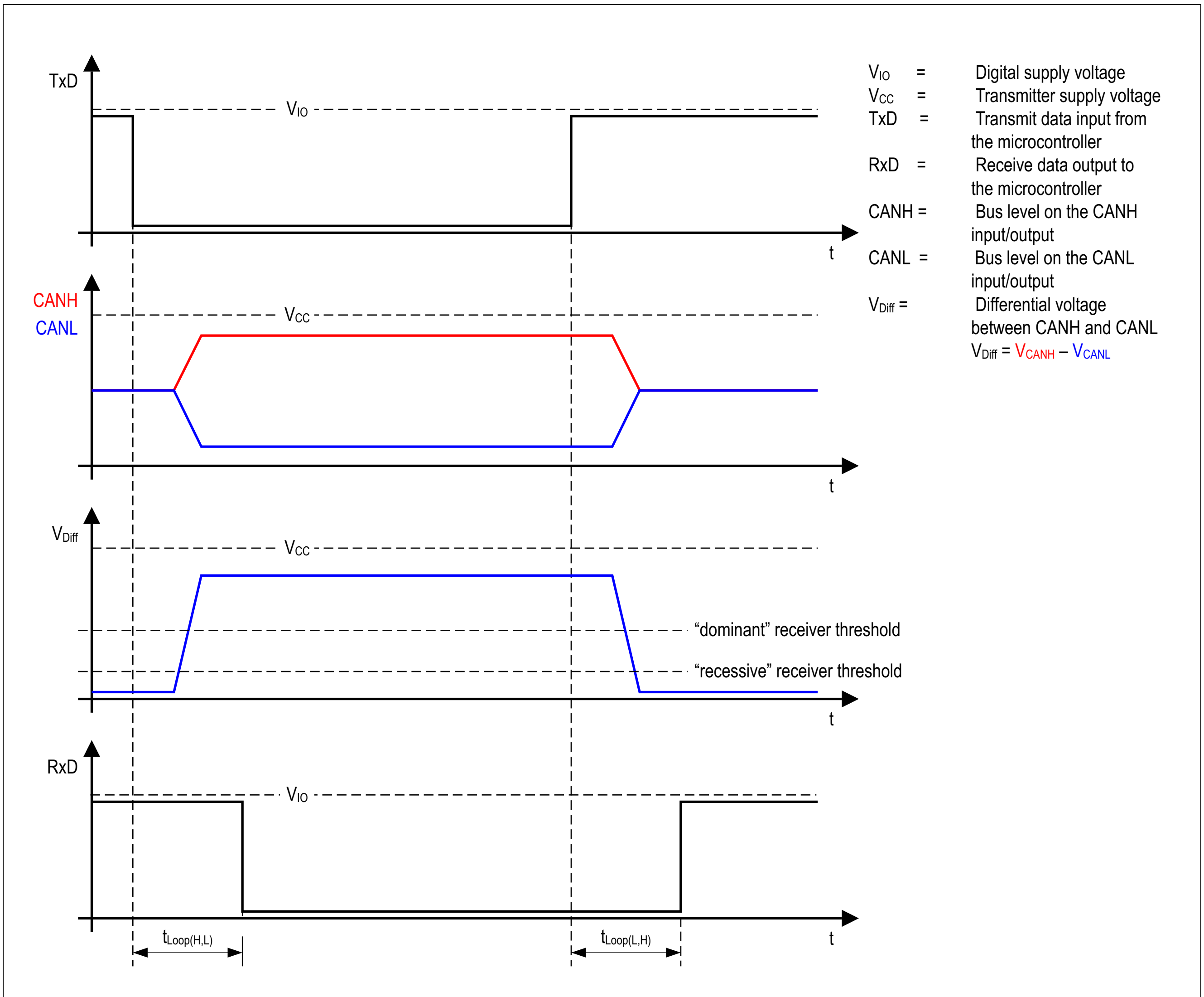


Figure 3 High-Speed CAN bus signals and logic signals

The TLE9252V is a High-Speed CAN transceiver operating as an interface between the CAN controller and the physical bus medium. A HS CAN network is a two wire, differential network which allows data transmission rates up to 5 MBit/s. The characteristic for a HS CAN network are the two signal states on the CAN bus: “dominant” and “recessive” (see **Figure 3**). The CANH and CANL pins are the interface to the CAN bus and operate as an input and output. The RxD and TxD pins are the interface to the microcontroller. The TxD pin is the serial data input from the CAN controller. The RxD pin is the serial data output to the CAN controller.

The HS CAN transceiver TLE9252V includes a receiver and a transmitter unit, allowing the transceiver to send data to the bus medium and monitors the data from the bus medium at the same time. The HS CAN transceiver TLE9252V converts the serial data stream which is available on the transmit data input TxD, into a differential output signal on the CAN bus, provided by the CANH and CANL pins. The receiver stage of the TLE9252V monitors the data on the CAN bus and converts it to a serial, single-ended signal on the RxD output pin. A logical “low” signal on the TxD pin creates a “dominant” signal on the CAN bus, followed by a logical “low” signal on the RxD pin (see **Figure 3**). The feature, broadcasting data to the CAN bus and listening to the data traffic on the CAN bus simultaneously is essential to support the bit-to-bit arbitration within CAN networks.

The voltage levels for HS CAN transceivers are defined in ISO 11898-2. Whether a data bit is “dominant” or “recessive” depends on the voltage difference between the CANH and CANL pins:

$V_{Diff} = V_{CANH} - V_{CANL}$.

To transmit a “dominant” signal to the CAN bus the amplitude of the differential signal V_{Diff} is higher than or equal to 1.5 V. To receive a “recessive” signal from the CAN bus the amplitude of the differential V_{Diff} is lower than or equal to 0.5 V.

In partially supplied CAN networks, participants have different power supply status. Some nodes are powered, other nodes are unpowered, or some other nodes are in Low-Power Mode. Therefore the TLE9252V provides the Sleep Mode in which the device is still able to recognize a Wake-Up Pattern or a local wake-up and signals the wake-up event to the external microcontroller via RxD and NERR output pin. The INH output pin allows to control an external device e.g. a voltage regulator. The HS CAN transceiver TLE9252V provides tow Low-Power Modes Sleep Mode and Stand-by Mode with optimized very low current consumption.

The voltage level on the digital input TxD and the digital output RxD is determined by the reference supply level at the V_{IO} pin. Depending on the voltage level at the V_{IO} pin, the signal levels on the logic pins (EN, NERR, NSTB, TxD and RxD) are compatible with microcontrollers having a 5 V or 3.3 V I/O supply. Usually the digital power supply V_{IO} of the transceiver is connected to the I/O power supply of the microcontroller.

5 Modes of operation

The TLE9252V supports five different Modes of operation (see **Figure 4**). Each mode with specific characteristics in terms of quiescent current, data transmission or failure diagnostic. For the mode selection the digital input pins EN and NSTB are used. Both digital input pins are event triggered. A mode change via the mode selection pins EN and NSTB is only possible if the power supply voltages V_{BAT} OR V_{CC} AND the digital reference voltage V_{IO} is in the functional range.

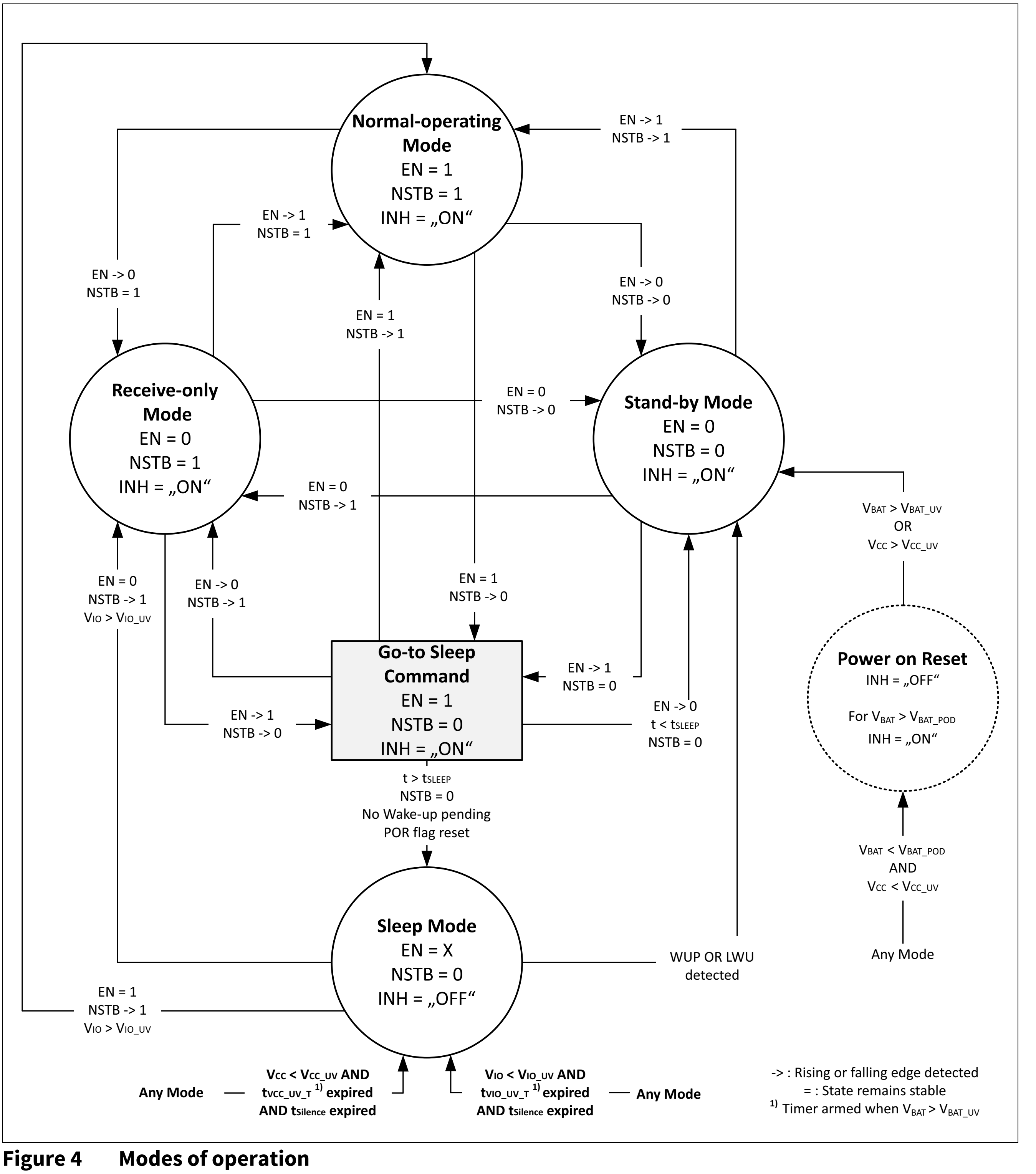


Figure 4 Modes of operation

The following operation modes are available on the TLE9252V:

- Normal-operating Mode (**Chapter 5.1**)
- Receive-only Mode (**Chapter 5.2**)
- Stand-by Mode (**Chapter 5.3**)
- Sleep Mode (**Chapter 5.5**)
- Go-to-Sleep command (**Chapter 5.4**)

Depending on the mode, the output driver stage, the receiver stage and the bus biasing are active or inactive. **Table 2** shows the different operation modes depending on the logic signal on the input pins EN and NSTB with the related status of the INH pin and the bus biasing.

Table 2 Overview operation modes

Operation mode	EN	NSTB	INH	Bus biasing
Normal-operating Mode	1	1	V_{BAT}	$V_{CC}/2$
Receive-only Mode	0	1	V_{BAT}	$V_{CC}/2$
Stand-by Mode	0	0	V_{BAT}	GND [1)]
Go-to-Sleep command	1	0	V_{BAT} [2)]	GND [1)]
Sleep Mode	0	0	High-Z	GND [1)]
Power On Reset	0	0	follows V_{BAT}	Floating

1) Valid if $t_{Silence}$ has expired. The Bus biasing follows the Autonomous Bus Biasing described in **Chapter 5.7**.

2) INH stays connected to V_{BAT} as long as t_{SLEEP} has not expired OR if a wake-up is pending OR if the POR flag is set. If t_{SLEEP} expires AND no Wake-up is pending AND the POR flag is reset the INH is High Z.

5.1 Normal-operating Mode

In Normal-operating Mode all functions of the TLE9252V are available and the device is fully functional. Data can be received from the HS CAN bus as well as transmitted to the HS CAN bus.

- The transmitter is active and drives data stream on the TxD input pin to the bus pins CANH and CANL.
- The receiver is active and converts the signals from the bus to a serial data stream on the RxD output pin.
- The bus biasing is connected to $V_{CC}/2$.
- The TxD time-out function is enabled (see **Chapter 6.5**).
- The overtemperature protection is enabled (see **Chapter 6.6**).
- The RxD Recessive Clamping detection is enabled (see **Chapter 6.7**)
- The undervoltage detection on V_{BAT}, V_{CC} and V_{IO} are enabled (see **Chapter 6.2**).
- The Local Wake-Up pin is disabled.
- The INH output pin is connected to V_{BAT}.
- Local failure detection is active and failures are indicated at the NERR output pin (see **Chapter 7**).

The TLE9252V enters Normal-operating Mode by setting the mode selection pins EN and NSTB to logical "high" (see **Figure 4** and **Table 2**). Normal-operating Mode can be entered if V_{BAT} or V_{CC} is in the functional range and the reference voltage V_{IO} is in the functional range.

Possible mode changes are described in **Figure 5**.

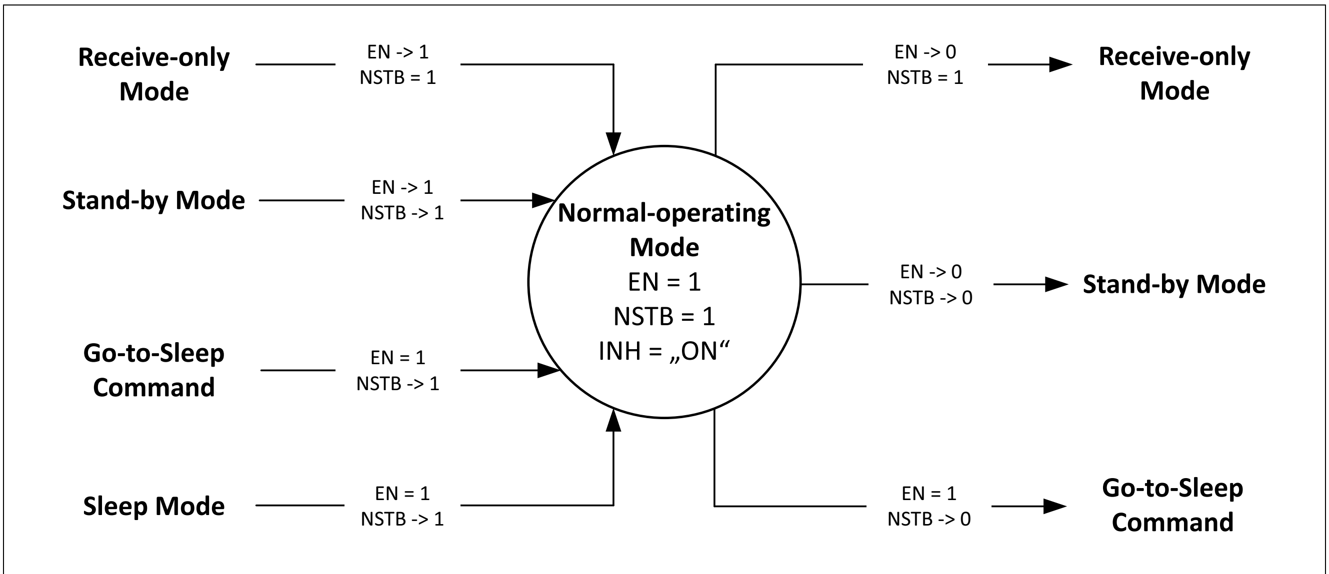


Figure 5 Mode changes in Normal-operating Mode

5.2 Receive-only Mode

In Receive-only Mode the transmitter is disabled and the receiver is enabled. The TLE9252V can receive data from the HS CAN bus, but cannot transmit data to the HS CAN bus.

- The transmitter is disabled and the data available on the TxD input is blocked.
- The receiver is active and converts the signals from the bus to a serial data stream on the RxD output pin.
- The bus biasing is connected to $V_{CC}/2$.
- The TxD time-out function is disabled.
- The RxD Recessive Clamping detection is disabled.
- The overtemperature protection is disabled.
- The undervoltage detection on V_{BAT}, V_{CC} and V_{IO} is enabled (see **Chapter 6.2**).
- The INH output pin is connected to V_{BAT}.
- The Local Wake-Up pin is disabled.
- The Power-up flag is signalled at the pin NERR when coming from Standby, Sleep or Go-to Sleep Command mode.
- The V_{CC} undervoltage detection is active and an undervoltage is indicated at the NERR output pin when coming from Normal-operating Mode (see **Chapter 7**).

Conditions for Entering Receive-only Mode:
The TLE9252V enters Receive-only Mode by setting the mode selection pin EN to logical "low" and the NSTB to logical "high" (see **Figure 4** and **Table 2**). Receive-only Mode can only be entered if V_{BAT} or V_{CC} is in the functional range and the reference voltage V_{IO} is in the functional range.

Possible mode changes are described in **Figure 6**.

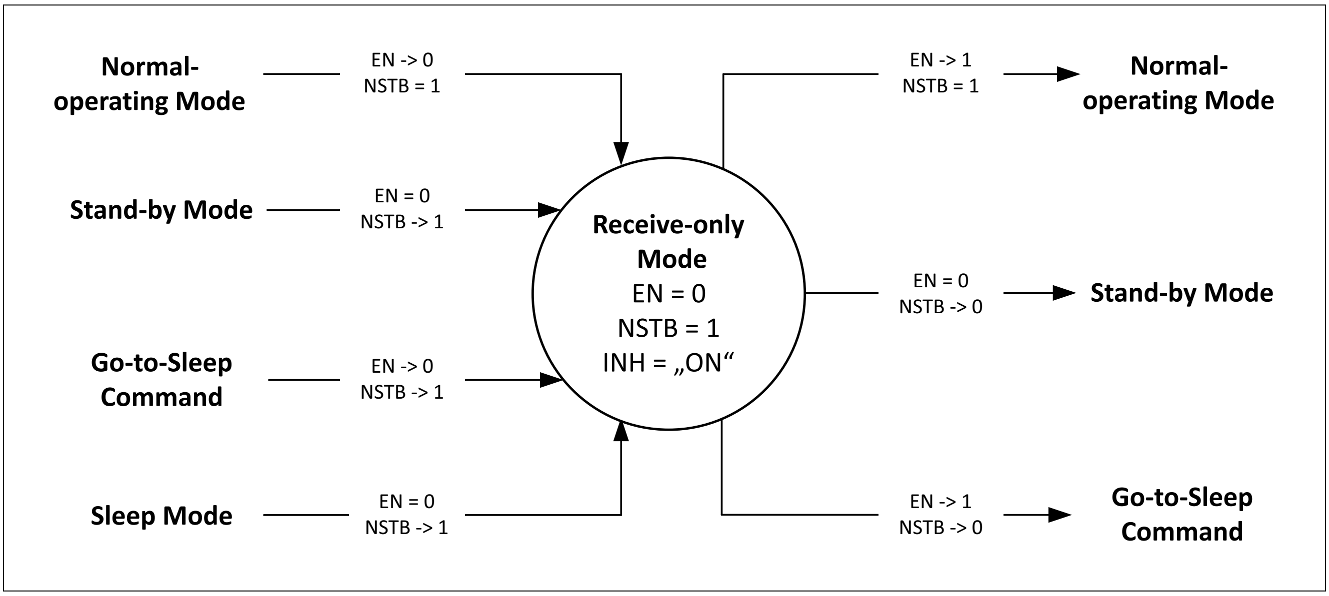


Figure 6 Mode changes in Receive-only Mode

5.3 Stand-by Mode

Stand-by Mode is a low power mode of the TLE9252V and the transmitter and the receiver are disabled. In Stand-by Mode the transceiver can neither send data to the HS CAN bus nor receive data from the HS CAN bus:

- The transmitter is disabled and the data available on the TxD input is blocked.
- The low power receiver is enabled and monitors the HS CAN bus for a valid Wake-Up Pattern. The RxD output pin and NERR display a wake-up event (**Chapter 5.9**). After Power On Reset RxD and NERR output pins are logical "high". The default value of the RxD and NERR output pins are logical "high" if no wake-up event is pending.
- The Local Wake-Up (LWU) pin is active.
- After Power On Reset the bus biasing connected to GND. The conditions for the bus biasing are defined in **Chapter 5.7**.
- TxD Dominant time-out function is disabled.
- RxD Recessive Clamping detection is disabled.
- The overtemperature protection is disabled.
- The undervoltage detection on V_{BAT}, V_{CC} and V_{IO} is enabled (see **Chapter 6.2**).
- The INH output pin is connected to V_{BAT}.
- Local failure detection on NERR pin is disabled.

Conditions for entering the Stand-by Mode:

- After Power On Reset if V_{BAT} or V_{CC} is in the functional range for at least $t_{PON}$the TLE9252V will enter Stand-by Mode. Mode changes by host command are only possible if V_{IO} is in the functional range.
- Stand-by Mode will be entered if a wake-up (WUP or LWU) has been detected in Sleep Mode or Go-to-Sleep command.
- The device is in Go-to-Sleep command and the EN pin goes logical "low" before the time $t < t_{SLEEP}$ has expired.
- The device is in Normal-operating Mode or Receive-only Mode and the input pins EN and NSTB are set to logical "low".

Possible mode changes are described in **Figure 7**.

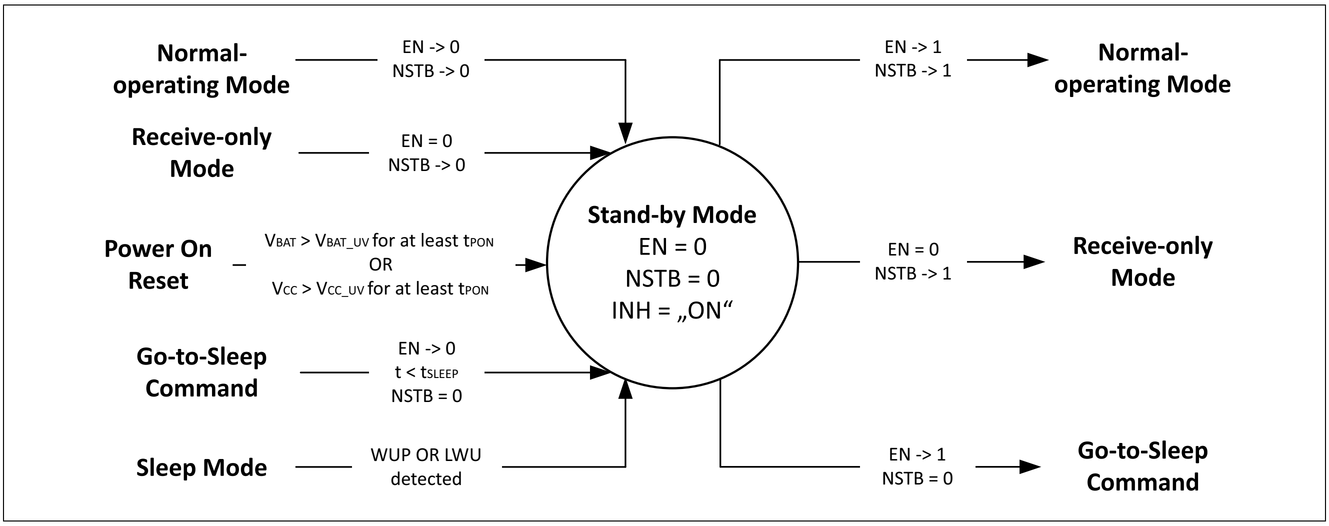


Figure 7 Mode changes in Stand-by Mode

5.4 Go-to-Sleep command

Go-to-Sleep command is a transition mode allowing external circuitry like a microcontroller to prepare the ECU to go to Sleep Mode. The TLE9252V stays for the maximum time $t = t_{SLEEP}$ in Go-to-Sleep command. After exceeding the time t_{SLEEP} the device changes to Sleep Mode if no wake-up is pending AND the POR flag has been reset. If a wake-up is pending OR the POR flag is set the device remains in Go-to-Sleep command and INH is connected to V_{BAT}. A wake-up is indicated on the RxD and NERR output pins. A mode change to Sleep Mode via Host Command is only possible via the Go-to-Sleep command. The following conditions are valid for the Go-to-Sleep command:

- The transmitter is disabled and the data available on the TxD input is blocked.
- The low power receiver is enabled and monitors the HS CAN bus for a valid Wake-Up Pattern. The RxD output pin and NERR indicate a wake-up event (**Chapter 5.9**). The default value of the RxD and NERR output pin are logical "high" if no wake-up event is pending.
- The Local Wake-Up pin is active.
- The bus biasing is GND if $t_{Silence}$ is expired. The conditions for the bus biasing are defined in **Chapter 5.7**.
- The TxD time-out function is disabled.
- The RxD Recessive Clamping detection is disabled.
- The overtemperature protection is disabled.
- The undervoltage detection on V_{BAT}, V_{CC} and V_{IO} are enabled (see **Chapter 6.2**).
- The INH output pin is connected to V_{BAT} if the timer t_{SLEEP} is not expired OR a wake-up is pending OR the POR is set. If t_{SLEEP} is expired and no wake-up is pending and the POR Flag is reset, the INH output pin is high impedance.

Conditions for entering the Go-to-Sleep command:

Go-to-Sleep command is entered from Normal-operating Mode, Receive-only Mode and Stand-by Mode by setting the NSTB input pin to logical "low" AND EN input pin to logical "high".

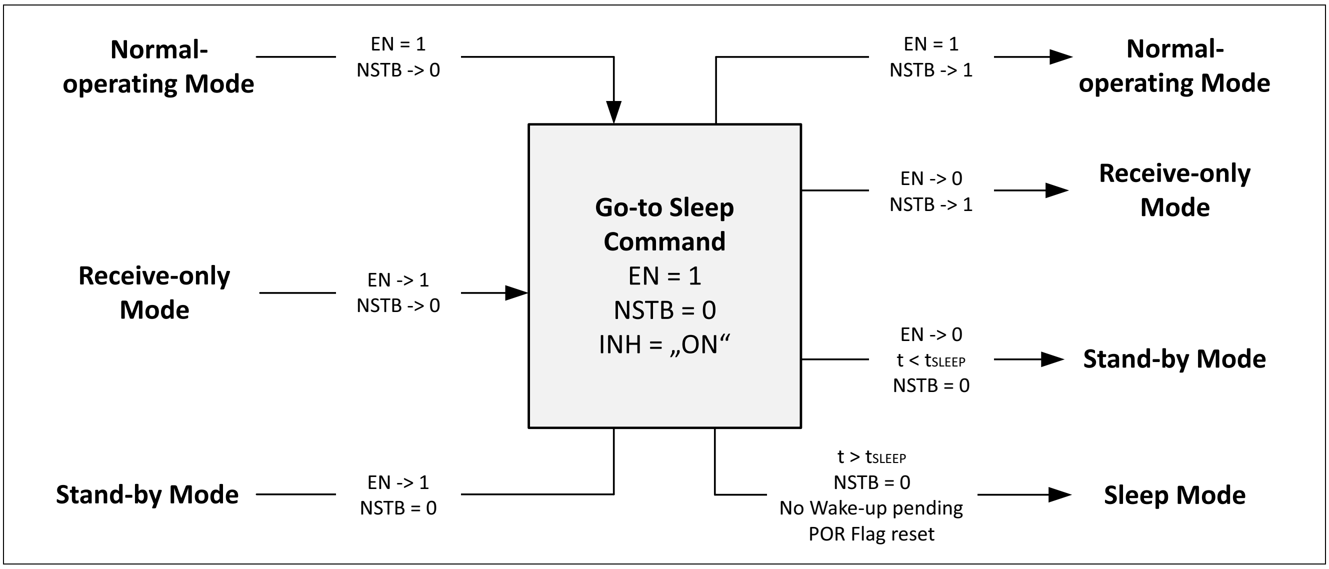


Figure 8 Mode changes in Go-to-Sleep command

5.5 Sleep Mode

Sleep Mode is a low power mode of the TLE9252V. In Sleep Mode the current consumption is reduced to a minimum while the device is still able to detect a Wake-Up Pattern (WUP) on the HS CAN Bus OR a Local Wake-Up event on the WAKE pin. The following conditions are valid for the Sleep Mode:

- The transmitter is disabled and the data available on the TxD input is blocked.
- The low power receiver is enabled and monitors the HS CAN bus for a valid Wake-Up Pattern.
- The default value of the RxD and NERR output pin are logical "high" if no wake-up event is pending AND V_{IO} is in the functional range (see **Chapter 7**).
- The Local Wake-Up pin is active.
- The bus biasing is connected to GND. The conditions for the bus biasing are defined in **Chapter 5.7**.
- The TxD time-out function is disabled.
- The RxD Recessive Clamping detection is disabled.
- The overtemperature protection is disabled.
- The undervoltage detection on V_{BAT} is disabled.
- The undervoltage detection on V_{CC} is disabled.
- The undervoltage detection on V_{IO} is enabled (see **Chapter 6.2.3**).
- The INH output pin is High-Z.

Conditions for entering the Sleep Mode:

- The Sleep Mode will be entered if $V_{IO} < V_{IO\_UV}$ AND $t_{VIO\_UV\_T}$ AND $t_{Silence}$ has been expired in Normal-operating Mode, Receive-only Mode, Stand-by Mode and Go-to-Sleep command.
- The Sleep Mode will be entered if $V_{CC} < V_{CC\_UV}$ AND $t_{VCC\_UV\_T}$ AND $t_{Silence}$ has been expired in Normal-operating Mode, Receive-only Mode, Stand-by Mode and Go-to-Sleep command.
- The Sleep Mode can be entered through Go-to-Sleep command if NSTB is set to logical "low" AND t_{SLEEP} is expired AND no wake-up is pending AND the POR flag is reset.

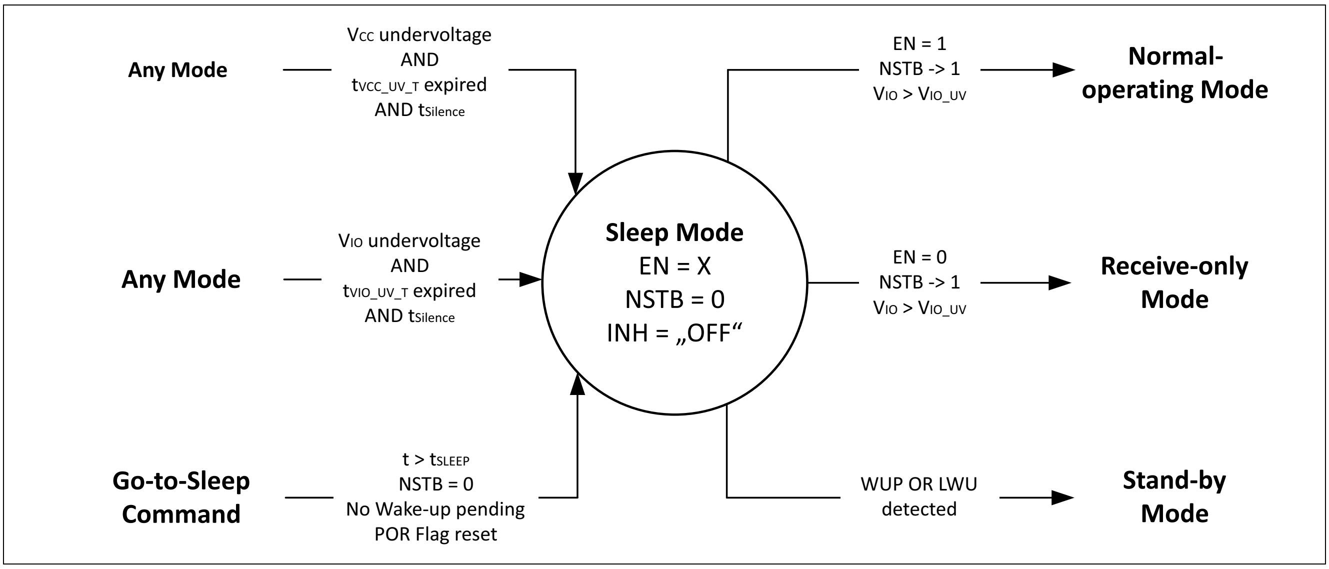


Figure 9 Mode changes in Sleep Mode

5.5.1 Mode change to Sleep Mode or Stand-by Mode

If the logical signal on the EN pin goes "low" before the transition time $t < t_{SLEEP}$ has been reached, the TLE9252V enters Stand-by Mode and the INH pin remains connected to V_{BAT}. In the case the logical signal on the EN pin goes "low" after the transition time $t > t_{SLEEP}$, the TLE9252V enters Sleep Mode with the expiration of t_{SLEEP}. The signal on the HS CAN bus has no impact to the mode change. The mode of operation can be changed regardless if the CAN bus is "dominant" or "recessive".

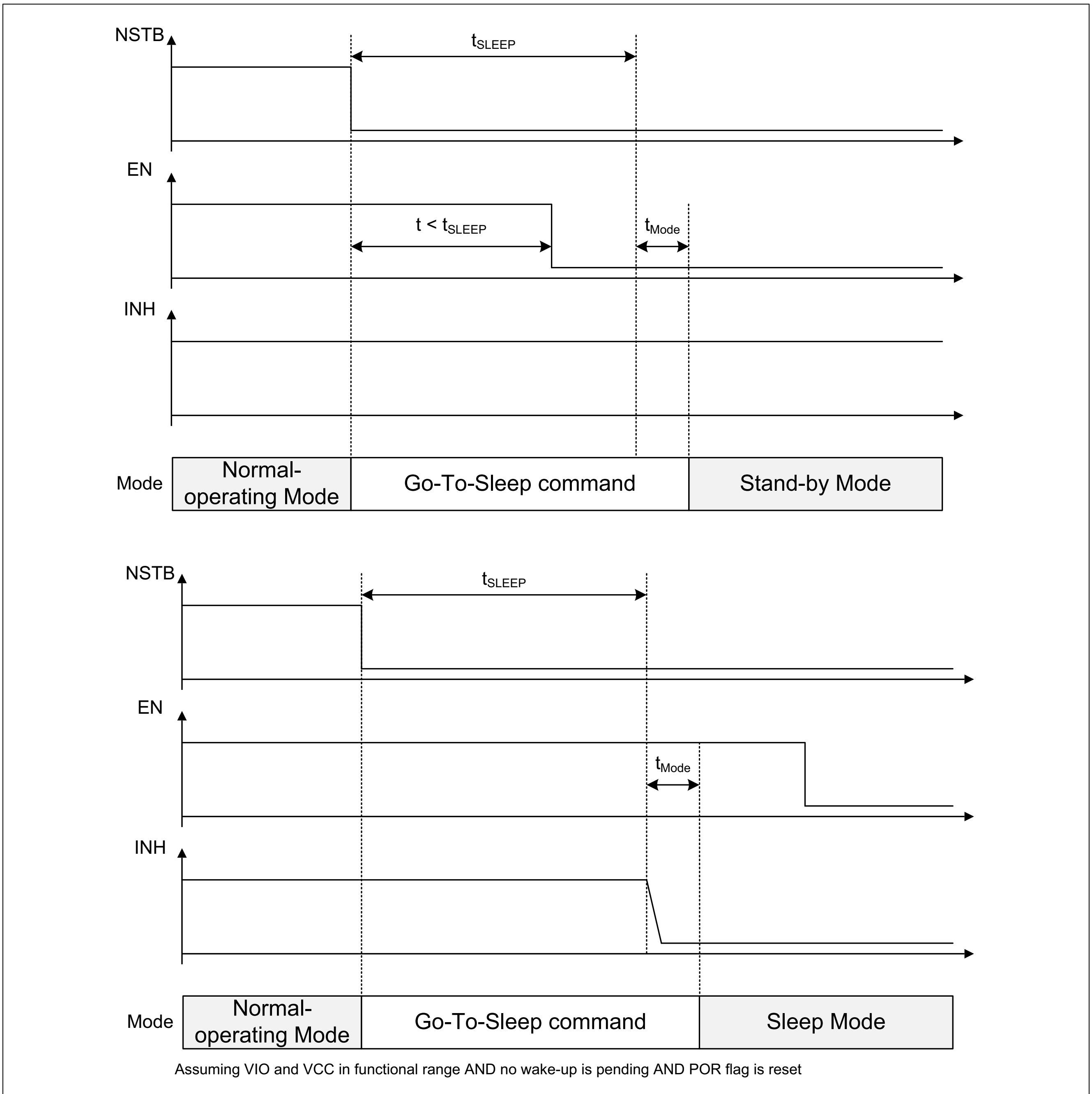


Figure 10 Mode change to Stand-by Mode or Sleep Mode

5.5.2 Mode Change via EN and NSTB pin

Besides a mode change from Sleep Mode to Stand-by Mode issued by a wake-up event, the mode of operation can be changed by changing the signals on the EN and NSTB input pins. Therefore the reference voltage V_{IO} has to be in the functional range. According to the mode diagram (see **Figure 4**) the mode of operation can be changed directly from Sleep Mode to Receive-only Mode or Normal-operating Mode. In Sleep Mode once a rising edge on the pin NSTB is detected ($V_{IO} > V_{IO\_UV}$) either Normal-operating Mode or Receive-only Mode will be entered, depending on the signal on the EN pin. The device will stay in Sleep Mode regardless of the signal on the EN input pin if NSTB is statically logical "low". A mode change to from Sleep Mode to Stand-by Mode is only possible via a wake-up event.

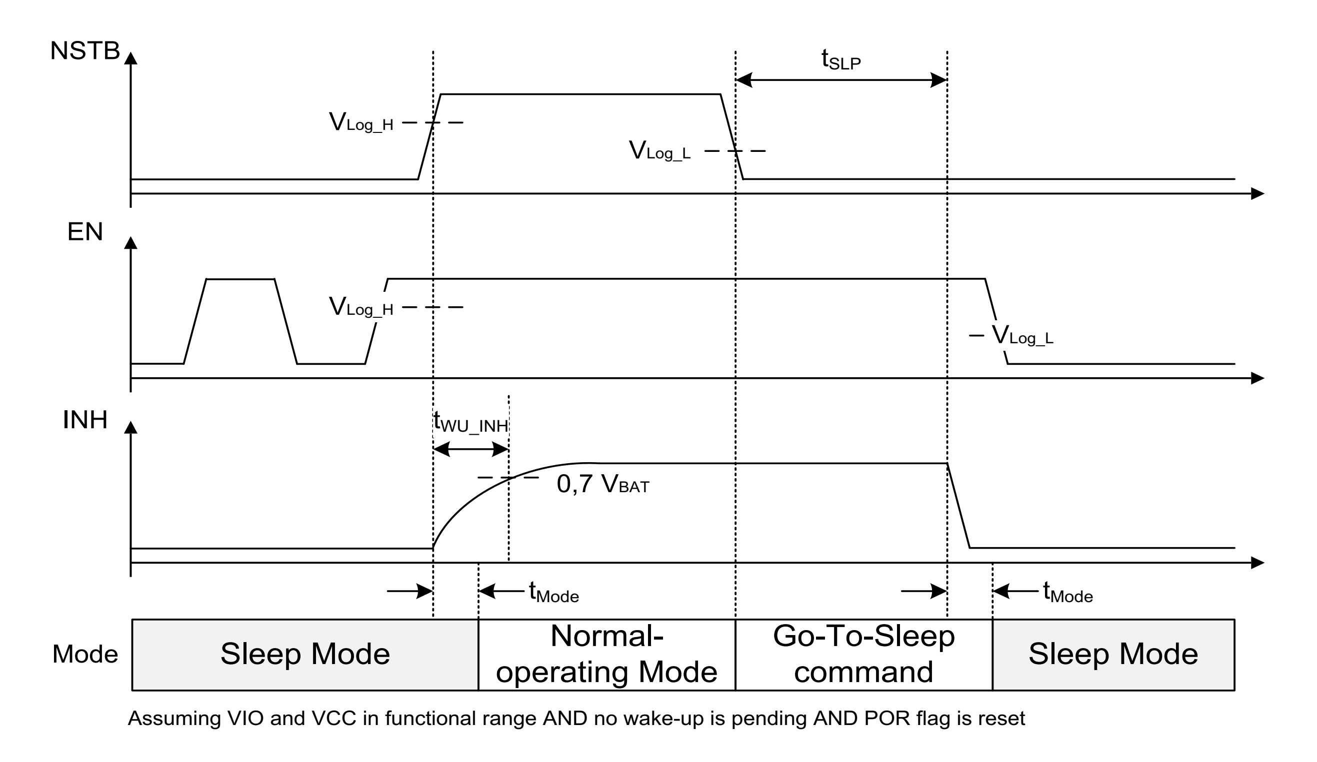


Figure 11 Mode change via EN and NSTB in Sleep Mode

5.6 Power On Reset

In Power On Reset all functions of the TLE9252V are disabled and the device is switched off.

- The transmitter and receiver are disabled.
- The bus biasing is connected to High impedance.
- The RxD Recessive Clamping detection is disabled
- The TxD time-out function is disabled.
- The overtemperature protection is disabled.
- The undervoltage detection on V_{BAT}, V_{CC} and V_{IO} is disabled.
- The logical input pins are blocked.
- RxD and NERR output pins are high impedance.
- Local Wake-Up is disabled.
- The INH output pin is connected to V_{BAT} if $V_{BAT} > V_{BAT\_POD}$ OR $V_{CC} > V_{CC\_UV}$.

Conditions for entering the Power On Reset:

- V_{BAT} is below the V_{BAT_POD} AND V_{CC} is below V_{CC_UV} threshold.

Conditions for leaving the Power On Reset:

- Once the power supply voltage V_{BAT} OR V_{CC} is within the functional range the transceiver enters Stand-by Mode within t_{PON}.

The internal Power On Reset flag will be set. After Power On Reset the TLE9252V enters Stand-by Mode.

Power-up and power-down transition is described in **Figure 12**:

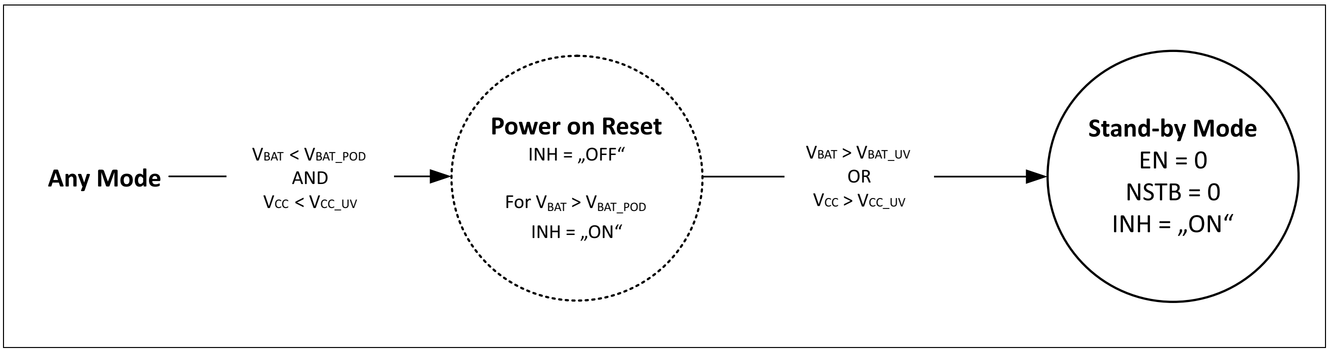


Figure 12 Power-down and power-up behavior

5.7 Autonomous bus voltage biasing

The autonomous bus voltage biasing was introduced for improving complete network EMC performance and increasing the reliability of communication performance in networks using CAN networks. The autonomous bus voltage biasing is enabled in all modes of Operation. The biasing unit will work independently from other transceiver functions and depends only on the status of detected network activity ($t_{Silence}$). **Figure 13** describes the behavior for active and for low power modes in Detail as well as the status after a power-on reset event.

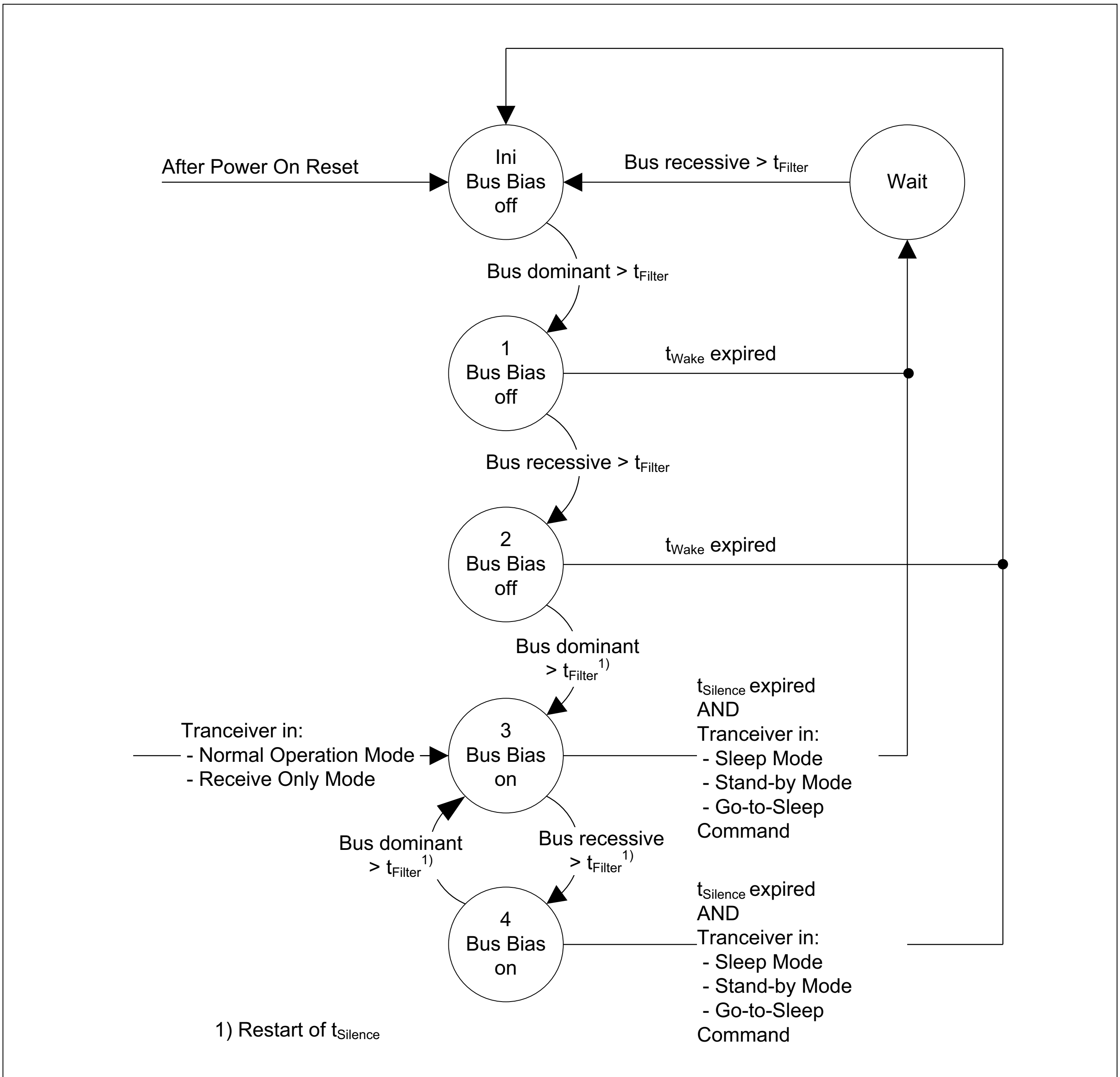


Figure 13 Autonomous Bus Voltage Biasing

In low power modes, in case there has been no activity on the bus for longer than $t_{Silence}$, the bus pins are biased towards GND via the internal resistors. With the detection of a valid Wake-Up Pattern (WUP), the internal biasing gets enabled and the biasing is stabilized via internal resistors towards 2.5 V . This activation is being performed within the time $t > t_{WU\_Bias}$ after the WUP detection.

5.8 Wake-Up functions

There are several possibilities for a mode change from Sleep Mode to another operation mode:

- Wake-Up Pattern (WUP)
- Local Wake-Up (LWU)

In typical applications the power supplies V_{CC} and V_{IO} are turned off in Sleep Mode. This means a mode change can only be caused by an external event as WUP OR LWU. The detection of a valid WUP or LWU triggers a mode change from Sleep Mode to Stand-by Mode.

5.8.1 Wake-up Pattern (WUP)

Within the maximum wake-up time t_{WAKE}, the Wake-Up Pattern consists of a "dominant" signal with the pulse width $t > t_{Filter}$, followed by a "recessive" signal with the pulse width $t > t_{Filter}$ and another "dominant" signal with the pulse width $t > t_{Filter}$ (see **Figure 14**).

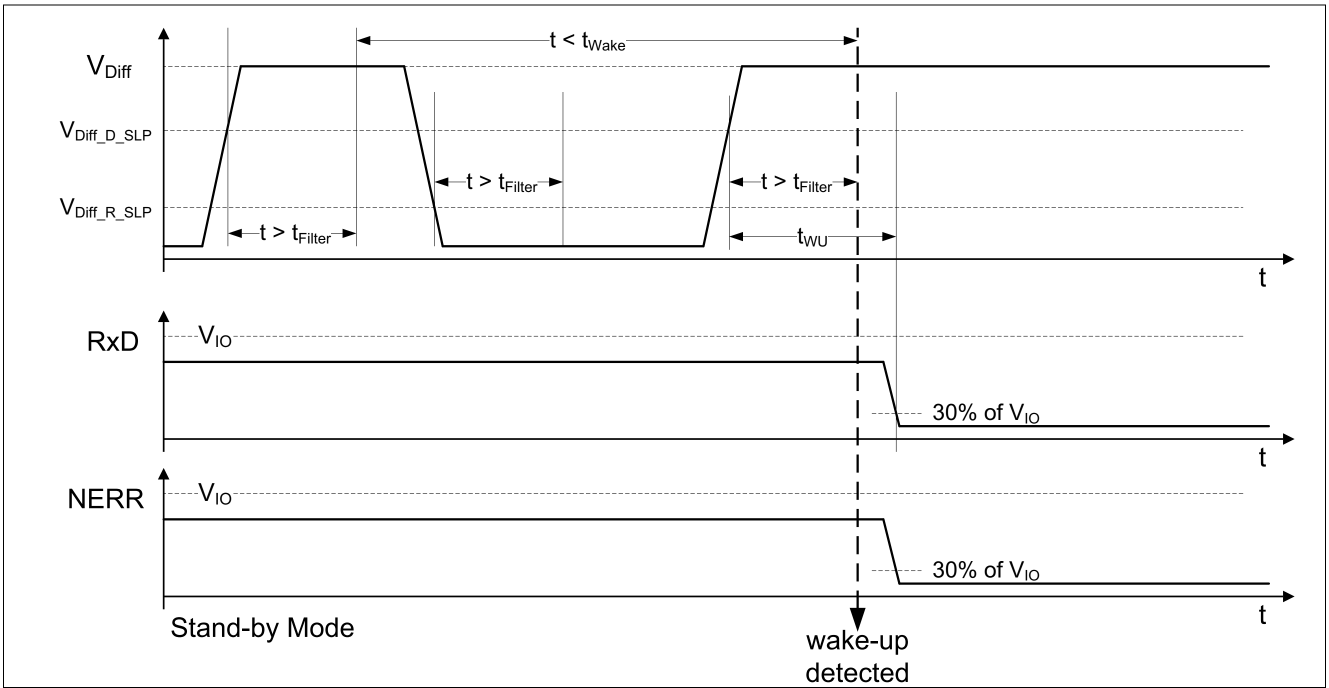


Figure 14 Wake-Up Pattern (WUP)

The diagnostic output NERR and RxD will indicate a valid Wake-Up Pattern on the HS CAN bus.

A Wake-Up Pattern is not valid under the following conditions:

- A mode change to Normal-operating Mode OR Receive-only Mode is performed during the Wake-Up Pattern.
- The maximum wake-up time t_{WAKE} expires before a valid WUP has been detected.
- The transceiver is powered down ($V_{BAT} < V_{BAT\_POD}$ AND $V_{CC} < V_{CC\_POD}$).

In Stand-by Mode the RxD output pin and the NERR diagnostic pin display the WUP detection (Details see **Chapter 7**).

5.8.2 Local Wake-Up (LWU)

The WAKE input pin works bi-sensitive, meaning it is able to detect a rising and falling edge as a wake-up event. Designed to withstand up to 40 V the WAKE pin can be directly connected to V_{BAT}. The Local Wake-Up detection works for $V_{BAT} > V_{BAT\_UV}$. The Local Wake-Up timings and behavior is described in **Figure 15**.

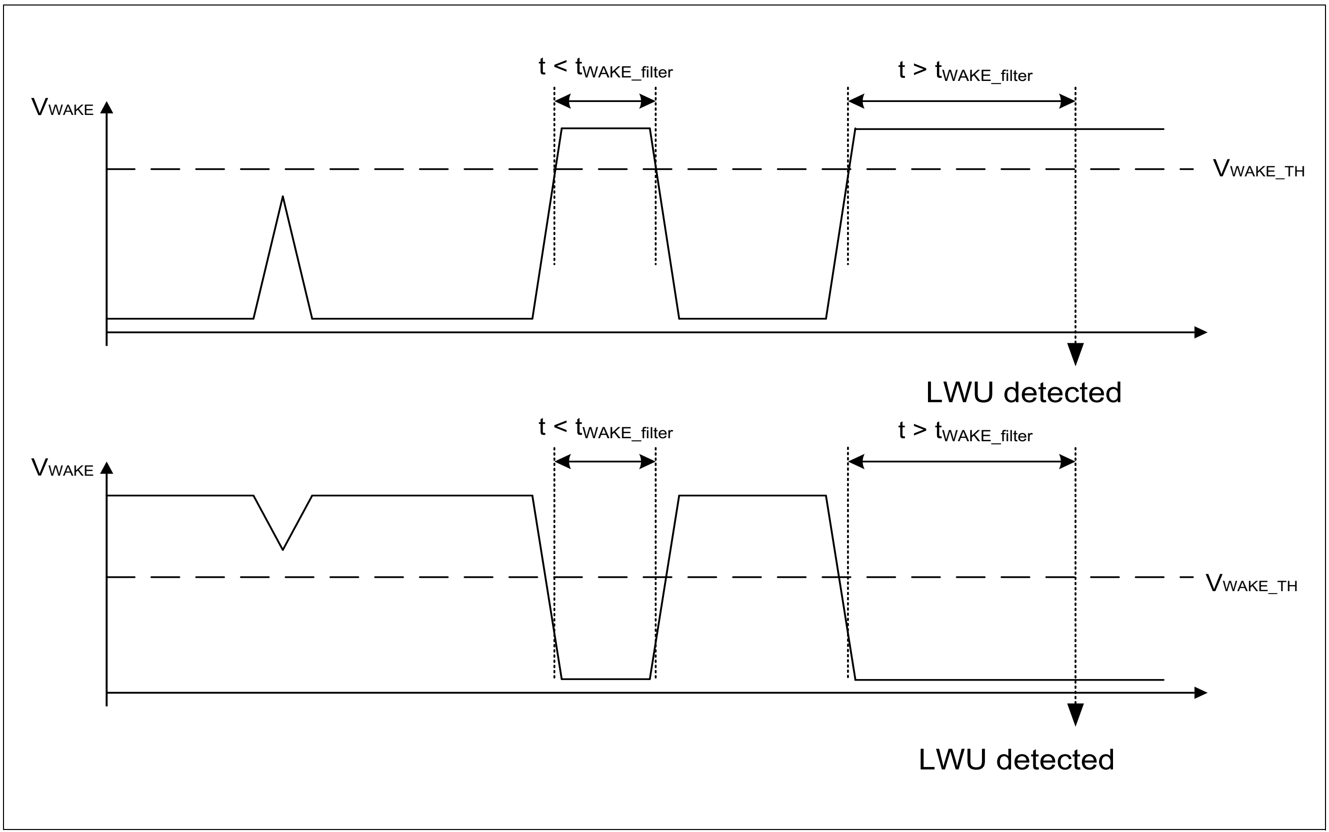


Figure 15 Local Wake-Up

The filter time t_{WAKE_filter} is implemented to protect the TLE9252V against unintended Wake-Ups, caused by spikes on the WAKE pin. The wake-up thresholds V_{WAKE_TH} depend on the level of the V_{BAT} power supply. In Stand-by Mode the RxD output pin and the NERR diagnostic pin display the wake-up event (Details see **Chapter 7**). Once a LWU has been recognized in Sleep Mode the device goes to Stand-by mode and the INH output pin is connected to V_{BAT}.

5.9 Wake-up: RxD and NERR behavior

The RxD and NERR output pin will signal a wake up event to the microcontroller (see **Chapter 7**). In Sleep Mode, Stand-by Mode and Go-to-Sleep command by default values of RxD and NERR are logical "high" when no wake-up event has been detected. If a valid wake up pattern (WUP) is detected, RxD and NERR will be logical "low". If a Local Wake-Up (LWU) is detected the RXD will be logical "low" and NERR will be logical "high".If both, LWU and WUP have been detected, then the WUP detection has higher priority and RxD and NERR pin are set to logical "low", regardless if a LWU event is pending.

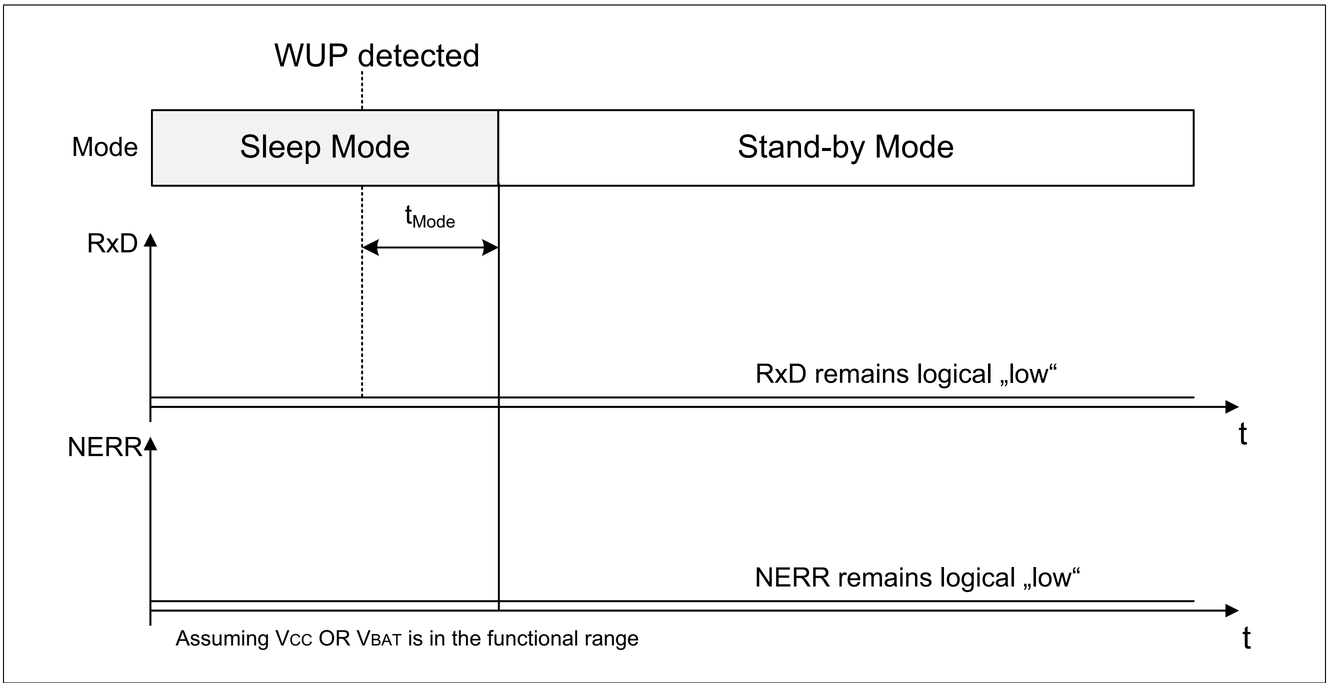


Figure 16 RxD and NERR: WUP detection (V_{IO} not supplied)

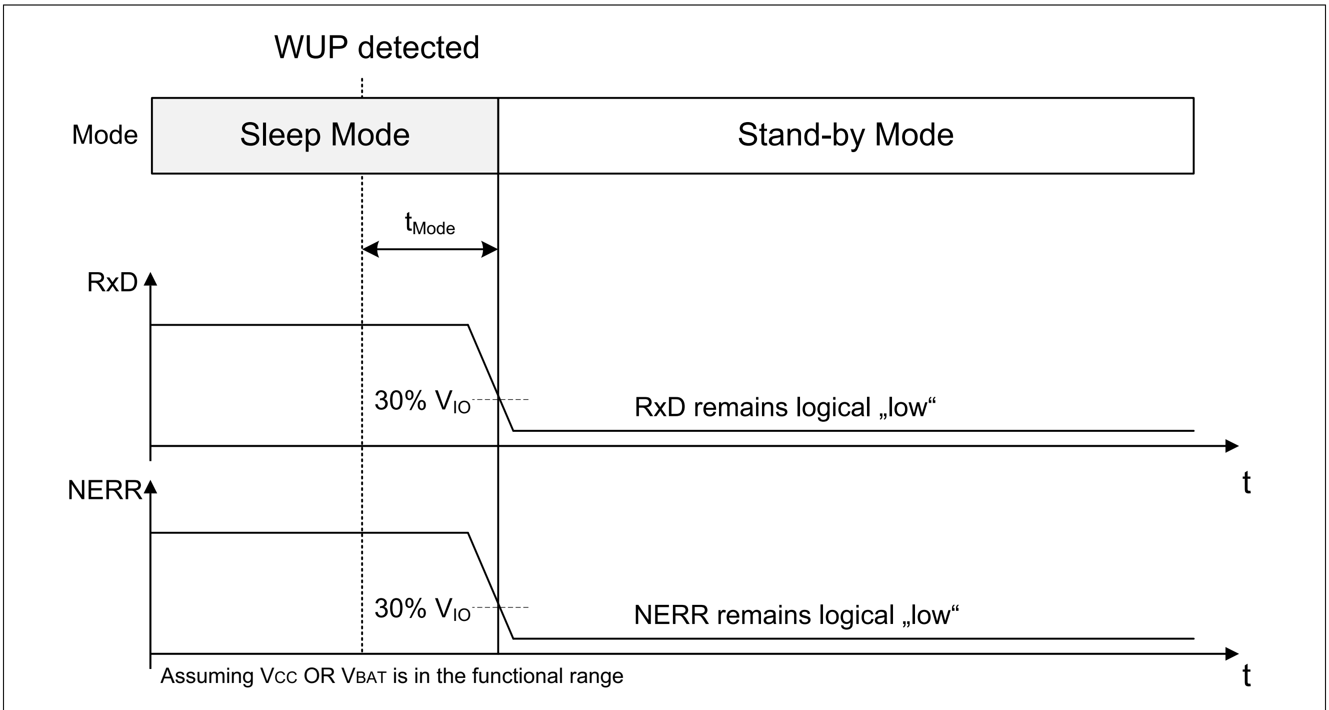


Figure 17 RxD and NERR: WUP detection (permanently supplied V_{IO})

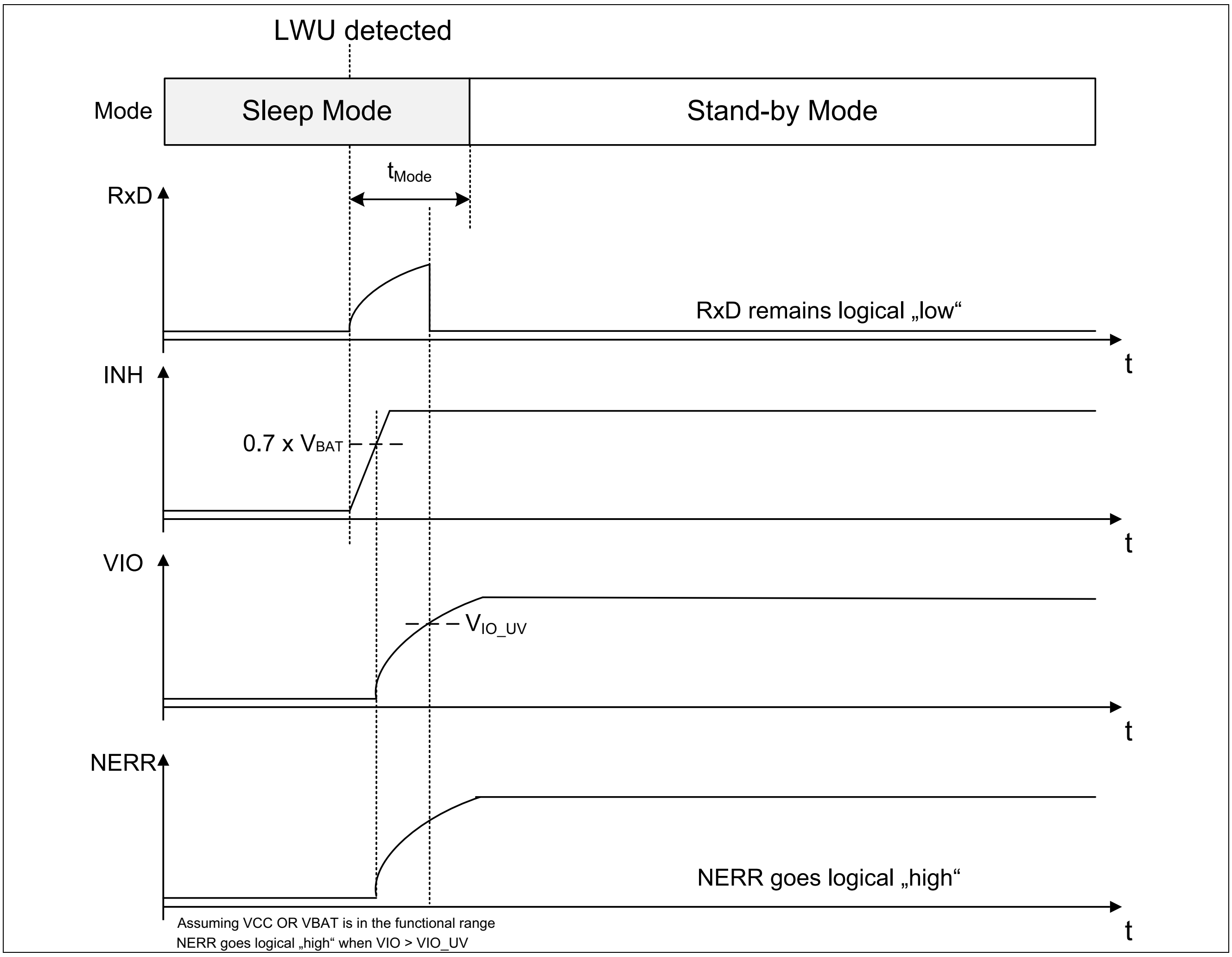


Figure 18 RxD and NERR: LWU detection (V_{IO} not supplied)

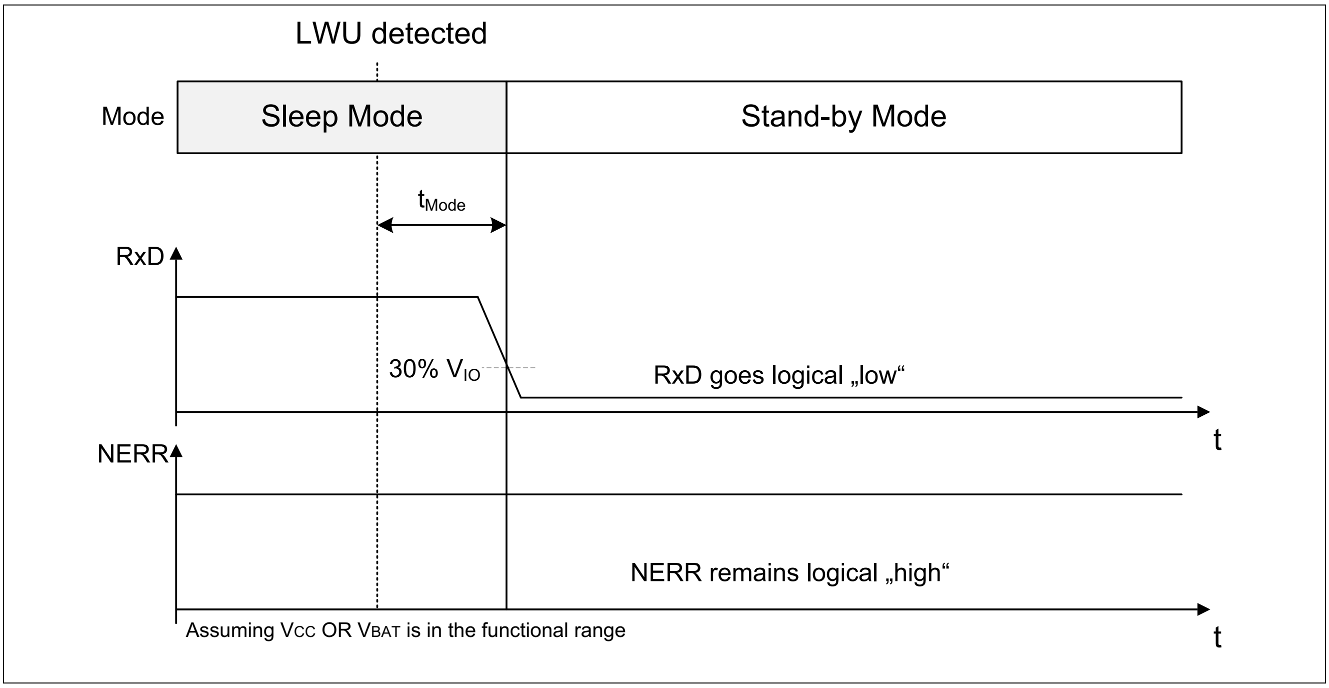


Figure 19 RxD and NERR: LWU detection (permanently supplied V_{IO})

6 Fail safe functions

6.1 Short Circuit Protection

The CANH and CANL bus pins are proven to withstand a short circuit fault against GND and against the supply voltages. A current limiting circuit protects the transceiver against damages.

6.2 Undervoltage detection

The TLE9252V has three independent undervoltage detections: V_{BAT}, V_{CC} and V_{IO}. Undervoltage events may have impact on the functionality of the device and also may change the mode of operation (see **Chapter 5**).

6.2.1 Undervoltage and power-down detection on V_{BAT}

The power-down is detected if the power supply V_{BAT} is below V_{BAT_POD} for more than the glitch filter time t_{VBAT_filter}. This glitch filter is implemented in order to prevent an undervoltage detection due to short voltage transients on V_{BAT}. In case of an power-down detection on V_{BAT} the TLE9252V is switched off (Power On Reset). If V_{BAT} recovers ($V_{BAT} > V_{BAT\_UV}$) the TLE9252V enters by default Stand-by Mode. If $V_{BAT} > V_{BAT\_POD}$ the INH output pin is connected to V_{BAT}. **Figure 20** shows the undervoltage scenario.

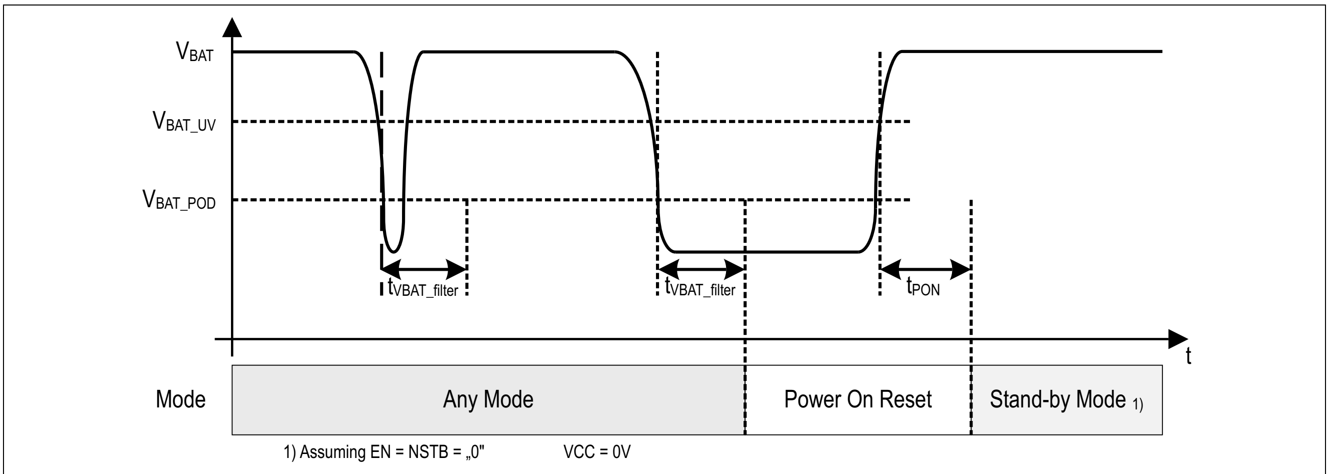


Figure 20 V_{BAT} power-down undervoltage detection (V_{CC} not available)

If an undervoltage is detected $V_{BAT} < V_{BAT\_UV}$ for $t > t_{VBAT\_filter}$ the Local Wake-Up function is disabled (**Figure 21**).

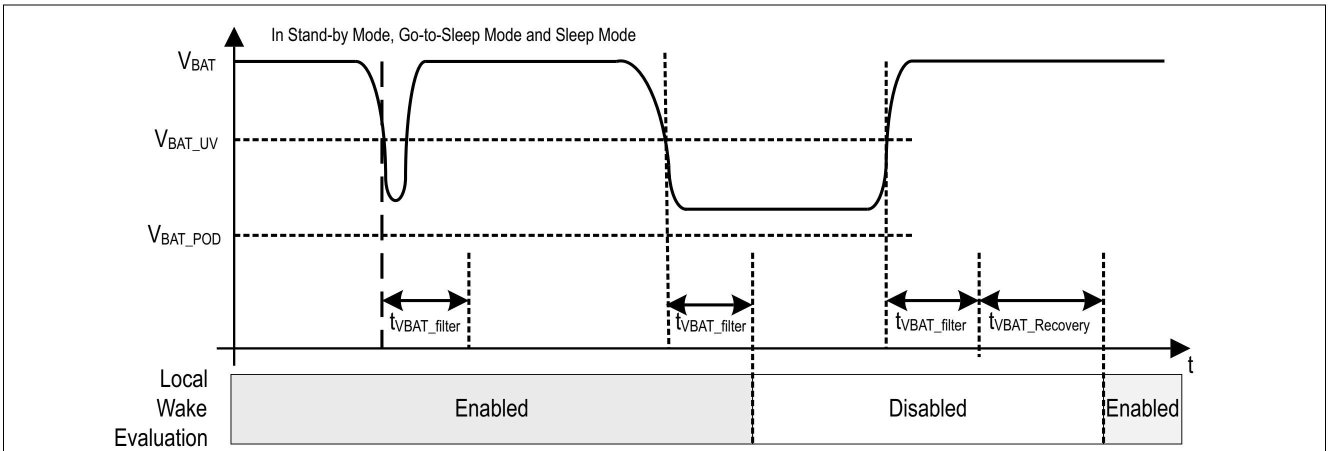


Figure 21 V_{BAT} undervoltage detection