

# TLE9250Xxx

Z8F57889425



Family  
overview



Support

## Preface

### Scope and purpose

This document provides application information for the transceiver TLE9250Xxx from Infineon Technologies AG as physical medium attachment within a Controller Area Network (CAN).

This document contains information about:

- Detailed TLE9250Xxx pin description, see [Pin description](#)
- Power supply concepts, see [Transceiver supply](#)
- Current consumption aspects, see [Current consumption](#)
- Mode control hints, see [Mode control](#)
- Quiescent current savings, see [Mode control](#)

This document refers to the datasheet of the Infineon Technologies AG CAN transceiver TLE9250Xxx.

*Note: The following information is given as a hint for the implementation of our devices only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.*

### Intended audience

This document is intended for engineers who develop applications.

For further information or further support please refer to [Infineon Support Webpage](#).

## Table of contents

	<b>Preface</b> .....	1
	<b>Table of contents</b> .....	1
<b>1</b>	<b>Pin description</b> .....	3
1.1	$V_{IO}$ pin .....	3
1.2	$V_{CC}$ pin .....	3
1.3	GND pin .....	3
1.4	RxD pin .....	3
1.5	TxD pin .....	4
1.6	RM pin .....	4
1.6.1	RM pin not connected .....	4
1.7	CANH and CANL pins .....	4
<b>2</b>	<b>Transceiver supply</b> .....	6
2.1	Voltage regulator .....	6
2.2	External circuitry on $V_{CC}$ and $V_{IO}$ .....	6
2.3	Power-up sequence for $V_{IO}$ and $V_{CC}$ .....	6

---

## Table of contents

2.4	$V_{IO}$ feature .....	7
2.4.1	$V_{IO}$ (3.3 V) power supply concept .....	7
2.5	Current consumption .....	8
2.6	Loss of battery (transceiver unsupplied) .....	8
2.7	Loss of ground .....	8
2.8	Ground shift .....	10
<b>3</b>	<b>Mode control</b> .....	<b>12</b>
3.1	Mode change by RM .....	12
3.2	.....	12
3.3	Pretended Networking usage (benefit of forced receive-only mode) .....	13
<b>4</b>	<b>Terms and abbreviations</b> .....	<b>15</b>
	<b>Revision history</b> .....	<b>16</b>
	<b>Disclaimer</b> .....	<b>17</b>

## Pin description

# 1 Pin description

## 1.1 $V_{IO}$ pin

The  $V_{IO}$  pin is needed for the operation with a microcontroller to match the voltage level between microcontroller and transceiver. It can also be used to decouple microcontroller and transmitter supply. Place a 100 nF capacitor directly at the  $V_{IO}$  pin to ground.

Benefits of using the  $V_{IO}$  pin:

- Improved EMC performance
- Transmitter supply  $V_{CC}$  can be switched off separately

The digital reference supply voltage  $V_{IO}$  has two functions:

- Supply of the internal logic of the transceiver (state machine)
- Supply of the normal receiver, see [Pretended Networking usage \(benefit of forced receive-only mode\)](#)
- Voltage adaption for external microcontroller ( $3.0\text{ V} < V_{IO} < 5.5\text{ V}$ )

As long as  $V_{IO}$  is supplied ( $V_{IO} > V_{IO\_UV}$ ) the state machine of the transceiver supports mode changes. If a microcontroller uses  $V_{CC} \neq 5\text{ V}$ , then the  $V_{IO}$  pin must be connected to the power supply of the microcontroller. Due to the  $V_{IO}$  pin feature the TLE9250Xxx can work with various microcontroller supplies. If  $V_{IO}$  is available, then both transceiver and microcontroller are fully functional. Below  $V_{IO} < V_{IO\_UV}$  the TLE9250Xxx is in power on reset. To enter the normal-operating mode  $V_{IO} \geq V_{IO\_UV}$  is required.

## 1.2 $V_{CC}$ pin

The  $V_{CC}$  pin supplies the transmitter output stage. Place a 100 nF capacitor directly at  $V_{CC}$  pin to ground.

**Table 1** Transmitter state depending on  $V_{CC}$

$V_{CC}$	Transmitter state	Note
$V_{CC} < V_{CC\_UV}$	Disabled	$3.8\text{ V} < V_{CC\_UV} < 4.3\text{ V}$
$V_{CC\_UV} < V_{CC} < 4.5\text{ V}$	Enabled; parameters may be outside the specified range	–
$4.5\text{ V} < V_{CC} < 5.5\text{ V}$	Enabled	–
$5.5\text{ V} < V_{CC} < 6\text{ V}$	Enabled; parameters may be outside the specified range	–
$V_{CC} > 6\text{ V}$	Damage of TLE9250Xxx possible	–

## 1.3 GND pin

The GND pin must be connected as close as possible to module ground in order to reduce ground shift. It is not recommended to place filter elements or an additional resistor between GND pin and module ground. Use the same GND for transceiver, microcontroller and the HS CAN bus system.

## 1.4 RxD pin

RxD is an output pin. In normal-operating mode the device displays the data stream received from the HS CAN bus on the RxD output pin. Do not use a series resistor within the RxD line between transceiver and microcontroller. A series resistor may add delay, which has impact on the timing symmetry and delay timings, especially in high data rate applications with CAN FD.

## Pin description

### 1.5 TxD pin

TxD is an input pin. The TxD pin receives the data stream from the microcontroller. If in normal-operating mode  $V_{IO} > V_{IO\_UV}$ , the device transmits the data stream to the HS CAN bus. In all other modes the TxD input pin is blocked. A "low" signal causes a dominant state on the bus and a "high" signal causes a recessive state on the bus. The TxD input pin has an integrated pull-up resistor to  $V_{IO}$ . If TxD is permanently "low", for example due to a short circuit to GND, then the TxD time-out feature blocks the signal on the TxD input pin. Do not use a series resistor within the TxD line between transceiver and microcontroller. A series resistor may add delay, which degrades the performance of the transceiver, especially in high data rate applications.

### 1.6 RM pin

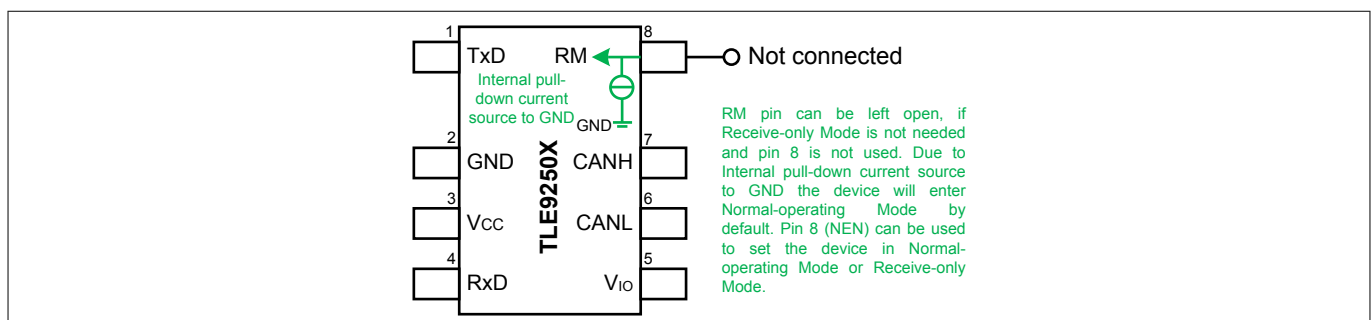
The RM pin sets the mode of TLE9250Xxx and is usually directly connected to an output port of a microcontroller. To set the device to normal-operating mode, in order to activate the data stream from the microcontroller on the TxD pin, the RM pin must be set to "low". Due to the integrated pull-down resistor to GND, the TLE9250Xxx is in normal-operating mode by default. If usage of the receive-only mode is not intended, the RM pin must be connected to GND to protect the transceiver from disturbance. The user can deactivate the transmitter of TLE9250Xxx either by setting the RM pin to "high" or by switching off  $V_{CC}$ . This can be used to implement two different fail safe paths in case a failure is detected in the ECU. [Table 2](#) shows mode changes by the RM pin, assuming  $V_{IO} > V_{IO\_UV}$ .

**Table 2** Mode selection via RM

Mode of operation	RM	$V_{CC}$	Note	Receiver	Transmitter
Receive-only mode	"high"	$> V_{CC\_UV}$	–	Enabled	Disabled
Normal-operating mode	"low"	$> V_{CC\_UV}$	–	Enabled	Enabled

#### 1.6.1 RM pin not connected

If an application does not make use of the receive-only mode, then the RM input pin can be left unconnected. The internal pull-down resistor to GND then sets the RM signal to "low" and the TLE9250Xxx enters normal-operating mode.



**Figure 1** RM pin not connected

### 1.7 CANH and CANL pins

CANH and CANL are the CAN bus input and output pins. The TLE9250Xxx is connected to the bus via pin CANH and CANL. Both transmitter output stage and the receiver are connected to CANH and CANL.

Data on the TxD pin is

- Transmitted to CANH and CANL
- Simultaneously received by the receiver input and signalled on the RxD output pin

---

## **Pin description**

To achieve optimum electromagnetic emission performance, transitions from dominant to recessive and from recessive to dominant are performed as smooth as possible also at high data rate. Due to the excellent ESD robustness on CANH and CANL no external ESD components are necessary to fulfill OEM requirements.

ESD robustness:

- HBM (Human Body Model):  $\pm 8$  kV
- IEC 61000-4-2 Gun Test:  $\pm 11$  kV, see EMC Test Report Nr. 01-07-2017 and Nr. 06-08-2017

## **2 Transceiver supply**

The  $V_{IO}$  pin supplies the internal logic of the TLE9250Xxx. The  $V_{CC}$  pin 5 V supply is used to create the CANH and CANL signal. The  $V_{CC}$  pin supplies the transmitter output stage as well. The  $V_{IO}$  pin supplies the receiver. This chapter describes aspects of power consumption and voltage supply concepts of TLE9250Xxx.

### **2.1 Voltage regulator**

It is recommended to use one of the following Infineon low drop output voltage regulators:

- 3.3 V  $V_{IO}$  power supply: TLS850D0TAV33 (500 mA), TLS850F0TAV33 (500 mA), TLS810B1LDV33 (100 mA), [TLE4266-2GS V33](#) (150 mA),
- 5 V  $V_{IO}$  and  $V_{CC}$  power supply: TLS850D0TAV50 (500 mA), [TLS850F0TA V50](#) (500 mA), [TLS810D1EJ V50](#) (100 mA), [TLS810B1LD V50](#) (100 mA), [TLE4266-2](#) (150 mA)
- 3.3 V and 5 V dual voltage power supply: [TLE4476D](#)
- Dual 5 V voltage power supply: [TLE4473G V55](#)

Refer to [Infineon Linear Voltage Regulators](#) for voltage regulator portfolio, data sheets and app notes.

### **2.2 External circuitry on $V_{CC}$ and $V_{IO}$**

In order to reduce electromagnetic emission and to improve the stability of the input voltage level on  $V_{CC}$  and  $V_{IO}$  of the transceiver, it is recommended to place capacitors on the PCB. During sending a dominant bit to the HS CAN bus, the current consumption of TLE9250Xxx is higher than during sending a recessive bit. Data transmission changes the load profile on  $V_{CC}$ , which may reduce the load regulation of  $V_{CC}$ . If several CAN transceivers are connected in parallel and are supplied by the same  $V_{CC}$  and/or  $V_{IO}$  power supply, for example from a LDO, then the impact on the load regulation of  $V_{CC}$  is even stronger. It is required to place a 100 nF capacitor directly at  $V_{CC}$  and  $V_{IO}$  pin to ground. Without 100 nF decoupling capacitance higher electromagnetic emission has to be expected. Ceramic capacitors are recommended due to their low ESR. The output of the  $V_{CC}$  and  $V_{IO}$  power supply has to be stabilized by a capacitor in the range of 1 to 50  $\mu$ F, depending on the load profile.

### **2.3 Power-up sequence for $V_{IO}$ and $V_{CC}$**

As the TLE9250Xxx has  $V_{CC}$  and  $V_{IO}$  supply pin, this chapter describes possible scenarios for powering up the device.  $V_{CC}$  supplies the transmitter output stage while  $V_{IO}$  supplies the internal state machine of the TLE9250Xxx. There is no limitation for the start-up sequence for TLE9250Xxx:

- Scenario 1: If  $V_{IO}$  is supplied first, the internal state machine starts working for  $V_{IO} > V_{IO\_UV}$ . Then the mode of operation can be changed by the mode selection pin RM. The transmitter of the TLE9250Xxx remains disabled in normal-operating mode if  $V_{CC} < V_{CC\_UV}$  and also in all other modes.
- Scenario 2: If  $V_{CC}$  is supplied first, then only the transmitter output stage is supplied. But as  $V_{IO}$  is not yet supplied, the output of the transmitter is high impedance (disabled, in order to not disturb the bus communication).
- Scenario 3: If  $V_{CC}$  and  $V_{IO}$  are connected to the same supply voltage ( $V_{supply} = 5$  V), then the state machine starts working for  $V_{supply} > V_{IO\_UV}$  (max. 3.0 V) and the transmitter is enabled if  $V_{supply} > V_{CC\_UV}$  (max. 4.5 V).

## Transceiver supply

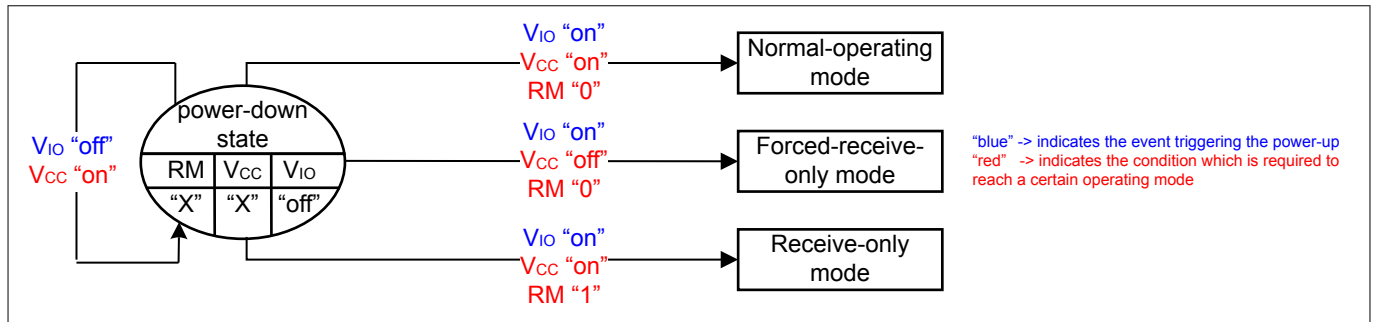


Figure 2 Power-up scenarios for TLE9250Xxx

## 2.4 $V_{IO}$ feature

The TLE9250Xxx offers a  $V_{IO}$  supply pin, which is a voltage reference input for adjusting the voltage levels on the digital input and output pins to the voltage supply of the microcontroller. In order to use the  $V_{IO}$  feature, connect the power supply of the microcontroller to the  $V_{IO}$  input pin of the TLE9250Xxx. Depending on the voltage supply of the microcontroller, the TLE9250Xxx can operate with the  $V_{IO}$  reference voltage input within the voltage range from 3.0 V to 5.5 V. The  $V_{CC}$  pin supplies the transmitter of the TLE9250Xxx. Therefore the  $V_{CC}$  supply input pin must be connected to a 5 V voltage regulator. Competitor devices use  $V_{CC}$  to supply the internal logic and the transmitter output stage and  $V_{IO}$  as a simple level shifter. Infineon's HS CAN transceivers can work in  $V_{CC}$  undervoltage condition or even with  $V_{CC}$  completely switched off in order to reduce quiescent current, see , [Pretended Networking usage \(benefit of forced receive-only mode\)](#).

### 2.4.1 $V_{IO}$ (3.3 V) power supply concept

In order to reduce the power consumption of ECUs, the microcontroller might not be supplied by  $V_{CC}$  but by a lower voltage, for example 3.3 V. Therefore the TLE9250Xxx offers a  $V_{IO}$  supply pin, which is a voltage reference input in order to adjust the voltage levels on the digital input and output pins to the voltage supply of the microcontroller. With the  $V_{IO}$  reference voltage input the TLE9250Xxx can operate from 3.0 V to 5.5 V. If the microcontroller uses  $V_{CC} = 5$  V supply, then  $V_{IO}$  supply must be connected to  $V_{CC}$  supply. The  $V_{IO}$  input must be connected to the supply voltage of the microcontroller, see [Figure 3](#).

In order to decouple the microcontroller and the HS CAN bus from each other with respect to noise and disturbances, it is possible to use a dual 5 V voltage regulator like [TLE4473G V55](#). In this case two independent 5 V LDOs supply  $V_{IO}$  and  $V_{CC}$ . This power supply concept improves EMC behavior and reduces noise.

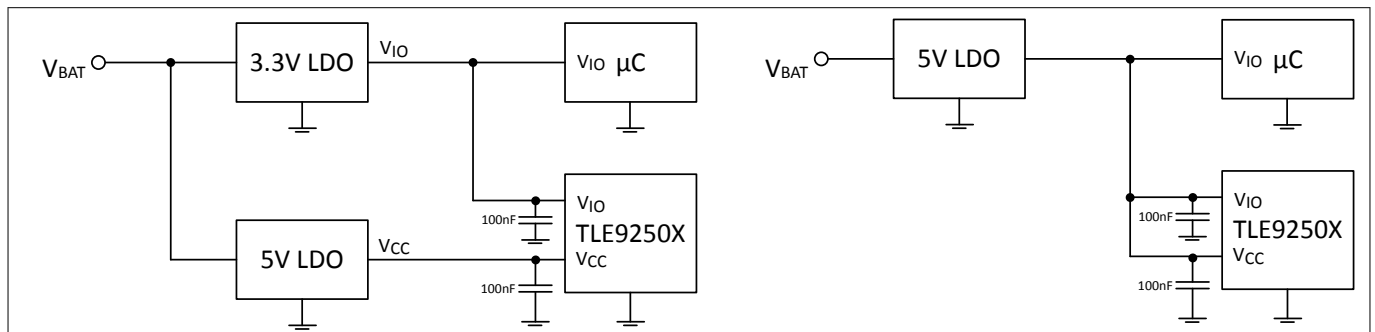


Figure 3 3.3 V power supply concept

---

## Transceiver supply

### 2.5 Current consumption

Current consumption depends on the mode of operation.

#### Normal-operating mode

Maximum current consumption of TLE9250Xxx on the  $V_{CC}$  supply is specified as 60 mA in dominant state and 4 mA in recessive state. Maximum current consumption of TLE9250Xxx on the  $V_{IO}$  supply is specified as 1.5 mA. To estimate theoretical current consumption in normal-operating mode, a duty cycle of 50% can be assumed, with fully loaded bus communication of 50% dominant state and 50% recessive state. In normal-operating mode the TLE9250Xxx consumes worst case maximum:

$$I_{CC\_AVG} = \frac{I_{CC\_REC} + I_{CC\_DOM}}{2} + I_{IO} = 32.75 \text{ mA}$$

#### Equation 1

Typically the current consumption is less than 15 mA.

#### Receive-only mode and forced receive-only mode

In receive-only mode the TLE9250Xxx has a worst case maximum current consumption of  $I_{ROM} = 1.5 \text{ mA}$ . Typically the current consumption is less than 800  $\mu\text{A}$ .

### 2.6 Loss of battery (transceiver unsupplied)

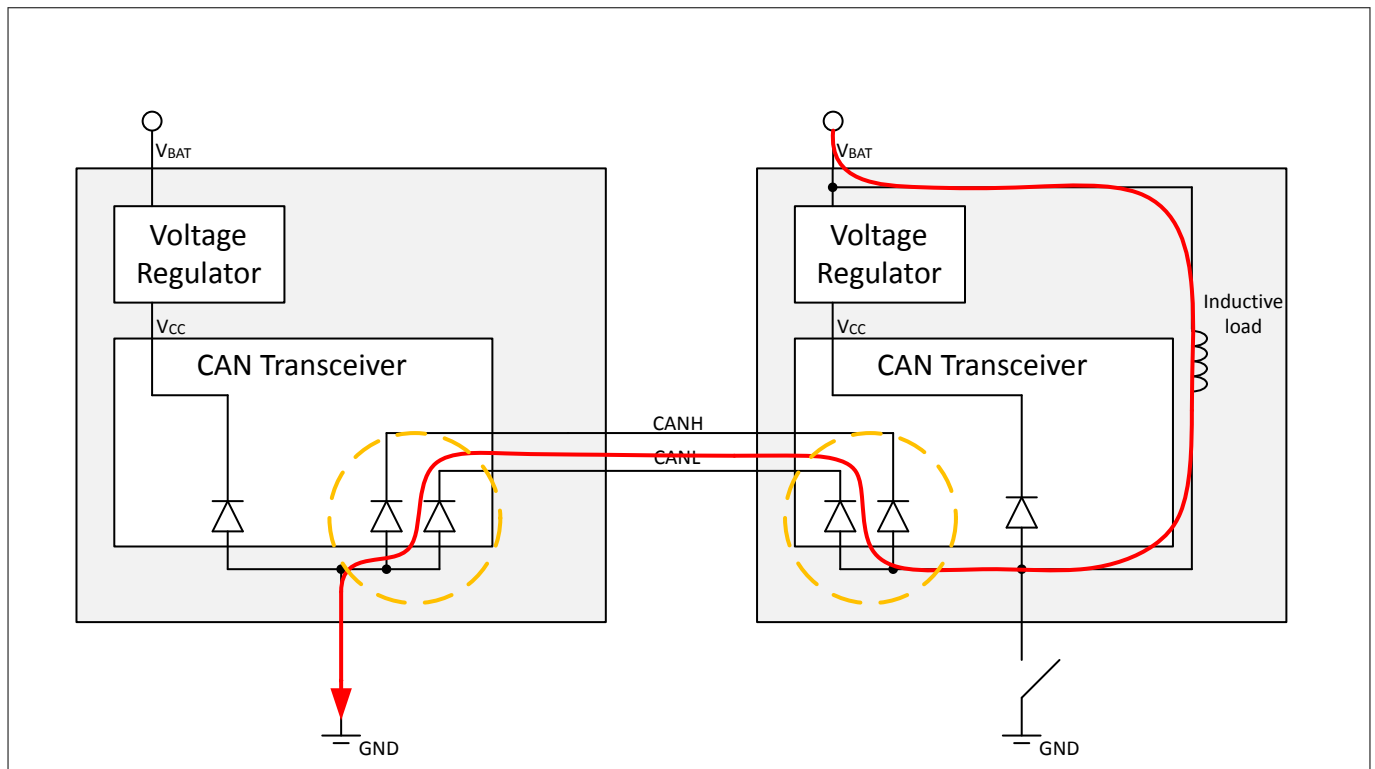
When TLE9250Xxx is unsupplied, CANH and CANL act as high impedance. The leakage current  $I_{CANH,IK}$ ,  $I_{CANL,IK}$  at CANH pin or CANL pin is limited to  $\pm 5 \mu\text{A}$  in worst case. When unsupplied, the TLE9250Xxx behaves like a  $1 \text{ M}\Omega$  resistor towards the bus. Therefore the device perfectly fits applications that use both clamp 15 and clamp 30.

### 2.7 Loss of ground

If loss of ground occurs, the transceiver is unsupplied and behaves like in unpowered state. In applications with inductive load connected to the same GND, for example a motor, loss of ground can damage the transceiver. Excessive current can flow through the CAN transceiver when the inductor demagnetizes after loss of ground. The ESD structure of the transceiver cannot withstand that kind of electrical overstress (EOS). In order to protect the transceiver and other components of the module, an inductive load must be equipped with a free wheeling diode.



## Transceiver supply

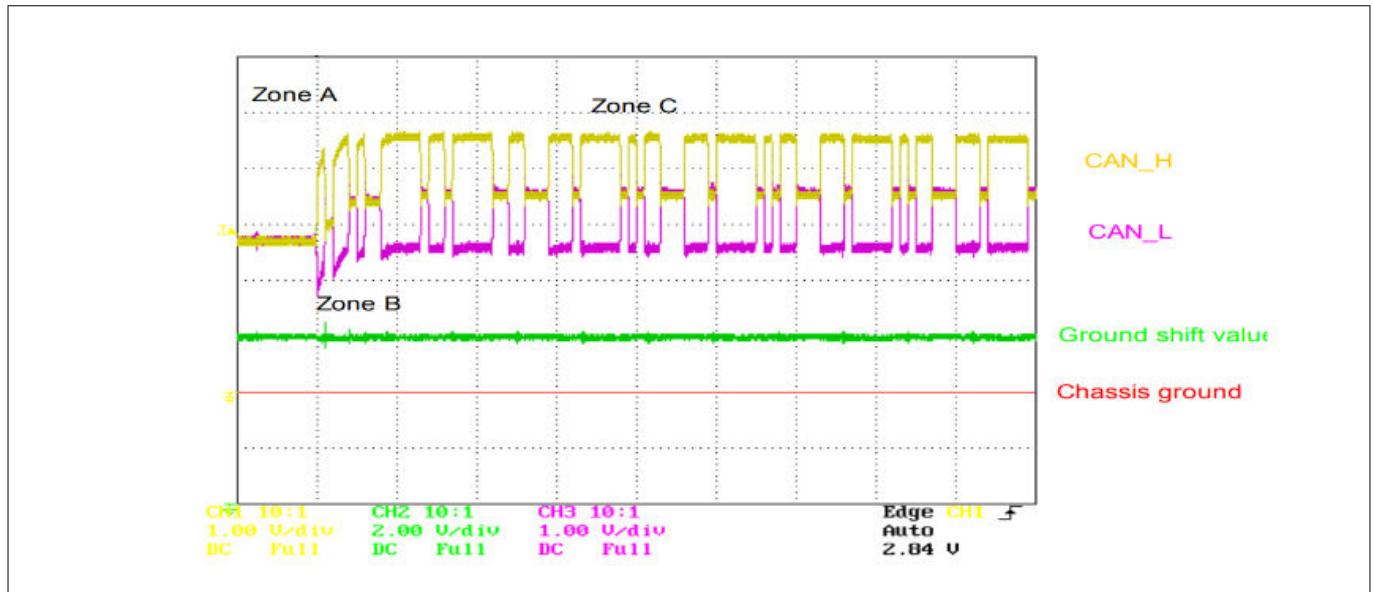


**Figure 4** Loss of ground with inductive load

## Transceiver supply

### 2.8 Ground shift

Due to ground shift the GND levels of CAN transceivers within a network may vary. Ground shift occurs in high current applications or in modules with long GND wires. Because the transmitting node has its GND shifted to  $V_{\text{Shift}}$ , the recessive voltage level  $V_{\text{rec}}$  from the chassis ground is no longer 2.5 V but  $V_{\text{rec}} + V_{\text{Shift}}$ . The same ground shift voltage  $V_{\text{Shift}}$  must be taken into account for the dominant signal. Because CAN uses a differential signal and because of the wide common mode range of  $\pm 12$  V for Infineon transceivers, any CANH and CANL DC works. Only the difference voltage (CAN\_H - CAN\_L) is relevant for the receiver. **Figure 5** shows a typical CAN signal with a DC ground shift of +2V.



**Figure 5** DC ground shift signal

Zone A : Shows the recessive voltage of the system, close to the nominal recessive value of 2.5 V. Zone B : When the transmitter starts to communicate the signal rises quickly. Zone C : The communication is stabilized, and the recessive voltage reaches the value, as computed on equation below. The recessive CAN bus level  $V_{\text{rec}}$  during a ground shifted node transmitting is equal to the average recessive voltage level of all transceivers:

$$V_{\text{rec}} = \frac{V_{\text{rec}_1} + V_{\text{Shift}_1} + V_{\text{rec}_2} + V_{\text{Shift}_2} + V_{\text{rec}_3} + V_{\text{Shift}_3} + \dots + V_{\text{rec}_n} + V_{\text{Shift}_n}}{n}$$

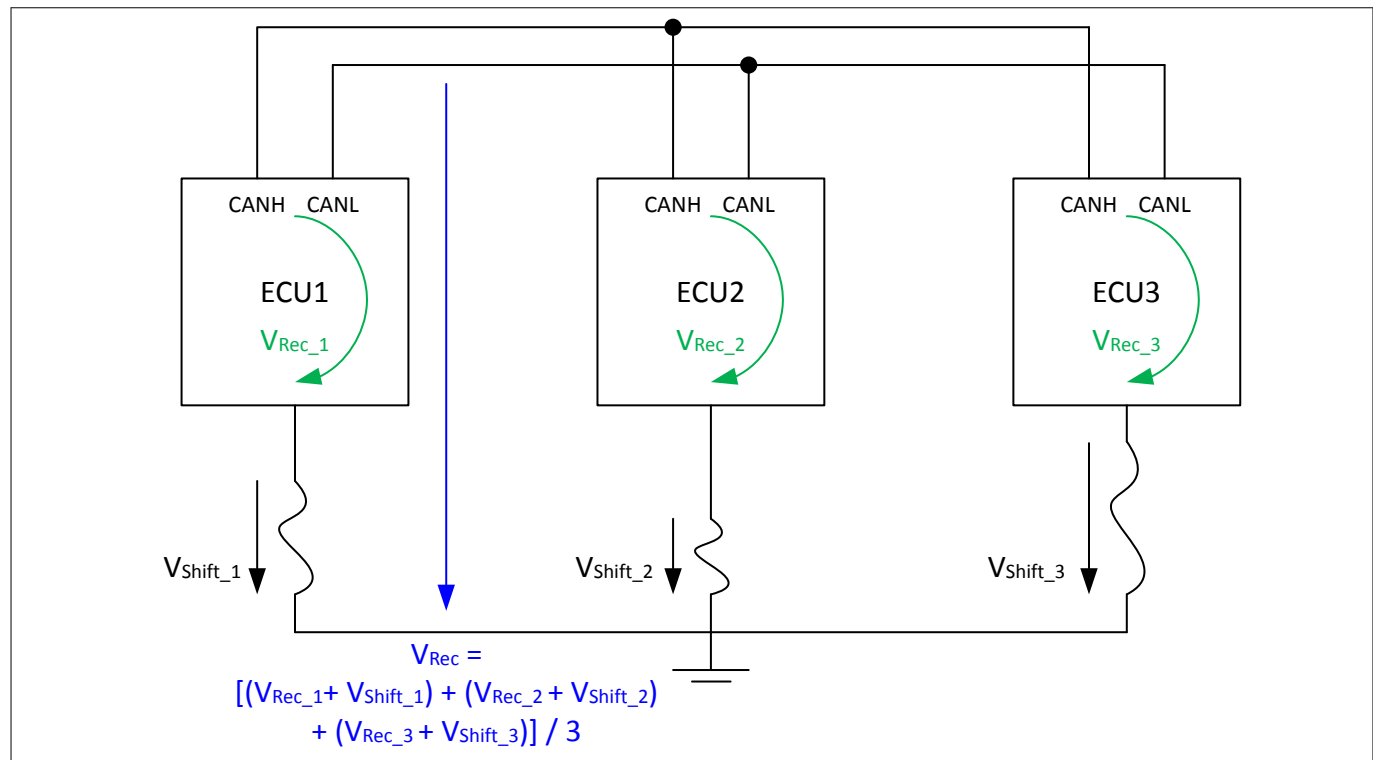
#### Equation 2

n: number of connected CAN nodes

$V_{\text{rec}_1}, V_{\text{rec}_2}, \dots, V_{\text{rec}_n}$ : specific recessive voltage level of the transceiver at nodes 1, 2, .. n

$V_{\text{Shift}_1}, V_{\text{Shift}_2}, \dots, V_{\text{Shift}_n}$ : specific ground shift voltage level of the transceiver at nodes 1, 2, .. n

Transceiver supply



**Figure 6** Ground shift on three nodes (system view)

### 3 Mode control

The modes of the TLE9250Xxx are controlled by the pinRM and by the transmitter voltage  $V_{CC}$ .

#### 3.1 Mode change by RM

The mode selection pin RM sets the mode of operation. By default the RM input pin is "low" due to the internal pull-down current source to GND.

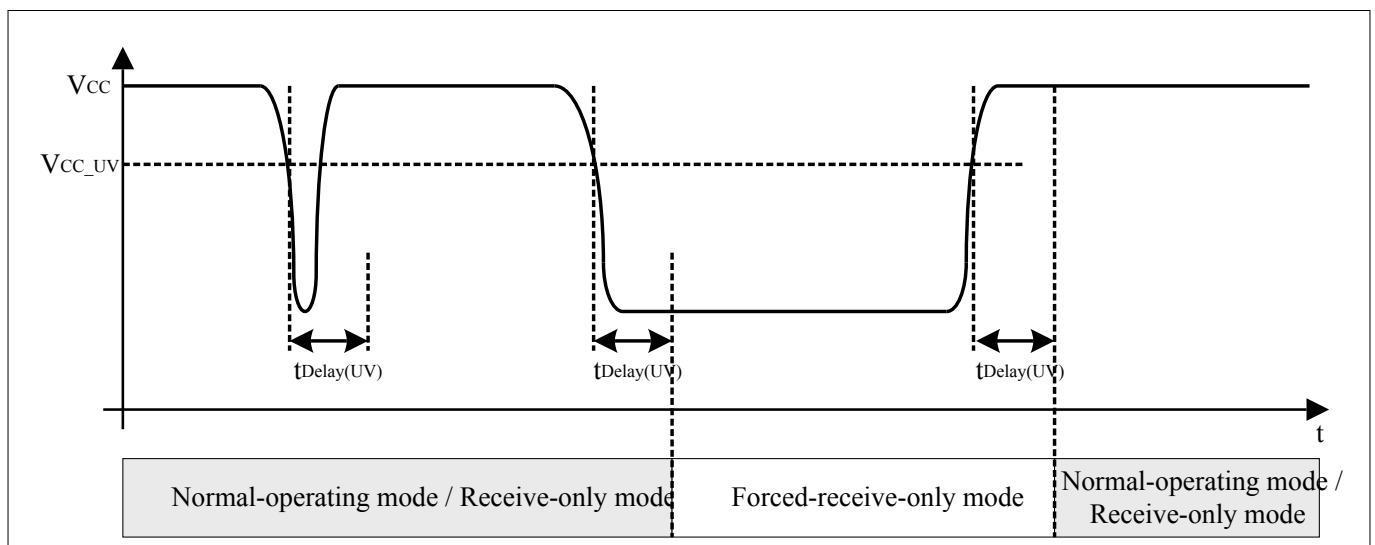
If  $V_{CC} > V_{CC\_UV}$ , then the TLE9250Xxx is in receive-only mode. In order to change the mode to normal-operating mode, NEN must be switched to "low" and  $V_{CC}$  must be available.

#### 3.2

A mode change due to  $V_{CC}$  undervoltage is only possible in normal-operating mode and in receive-only mode. If  $V_{CC}$  undervoltage persists longer than  $t_{Delay(UV)}$ , the TLE9250Xxx changes from normal-operating mode or receive-only mode to forced receive-only mode. As soon as the TLE9250Xxx detects undervoltage, it disables the transmitter output stage so that no faulty data is sent to the HS CAN bus.

During  $V_{CC} < V_{CC(UV)}$  fault condition, the TLE9250Xxx is set to forced receive-only mode and the TLE9250Xxx behaves as in receive-only mode. The receiver is enabled and converts the signals from the bus to a serial data stream on the RxD output pin.

If  $V_{CC}$  recovers, then  $V_{CC} > V_{CC\_UV}$  triggers a mode change back to normal-operating mode.



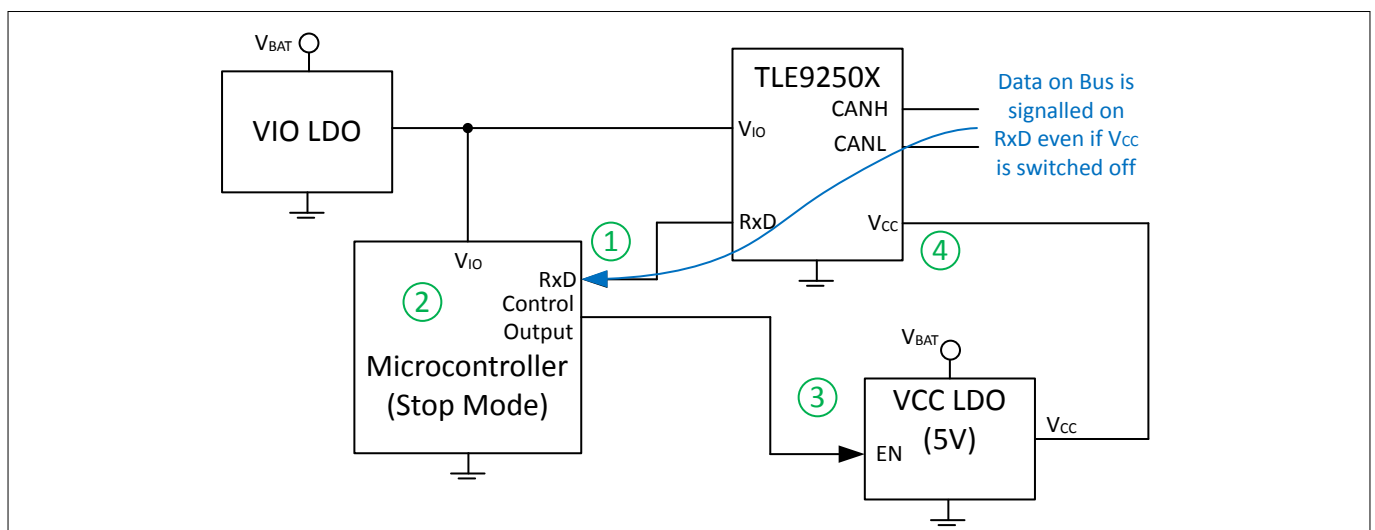
**Figure 7**  $V_{CC}$  undervoltage and recovery

### 3.3 Pretended Networking usage (benefit of forced receive-only mode)

Infineon's HS CAN transceivers use the  $V_{IO}$  pin to supply the internal logic of the transceiver. The transmitter of the TLE9250Xxx is supplied by  $V_{CC}$  (typically = 5 V). This enables the TLE9250Xxx to support the forced receive-only mode, which is similar to the receive-only mode. Even if  $V_{CC} < V_{CC(UV)}$  due to a fault condition, such as undervoltage or short circuit of  $V_{CC}$  to GND, or if  $V_{CC}$  is completely switched off, the receiver is enabled and provides data from the CAN bus to the RxD pin. This means the microcontroller can still receive all data sent to the CAN bus by other ECUs in CAN FD at up to 5 Mbit/s.

The microcontroller can control the  $V_{CC}$  voltage regulator. In order to set the TLE9250Xxx to forced receive-only mode, the microcontroller switches off the  $V_{CC}$  voltage regulator. Typical use cases for forced receive-only mode are:

- **Pretended Networking:**  
 Most microcontrollers include power saving modes. Power saving modes set parts of the microcontroller to a low-power mode while other function blocks remain active. This mode is also known as stop mode. The  $V_{CC}$  LDO is switched off and the TLE9250Xxx is in forced receive-only mode. The CAN protocol handler of the microcontroller is enabled and monitors communication on the HS CAN bus. If the microcontroller detects a specific CAN message, the microcontroller exits the low power mode and switches on the  $V_{CC}$  LDO. After switching on the  $V_{CC}$  LDO, the TLE9250Xxx enters normal-operating mode and the ECU is fully functional and able to participate in the CAN communication. During vehicle operation, the aim is to reduce power consumption any time functions are not being used. Therefore Pretended Networking can be used to reduce current consumption of an ECU.
- **Babbling idiot protection:**  
 If a CAN controller gets out of control and transmits unwanted messages to the bus, this will block other communication on the HS CAN bus. In forced receive-only mode the transmitter of the TLE9250Xxx is disabled, a potential babbling idiot stops transmitting and the CAN bus is released, allowing other CAN controllers to communicate. This is important for high system reliability of an application.
- **During voltage transient on  $V_{CC}$  supply, when  $V_{CC} < V_{CC\_UV}$ , the normal receiver remains fully functional. If there is ongoing communication on the HS CAN bus, the receiving node can still receive messages (classical CAN and CAN FD) on the bus when  $V_{CC} < V_{CC\_UV}$  and is not disconnected from communication. As a result during  $V_{CC} < V_{CC\_UV}$  failure, less error messages will be sent out to the CAN bus, which enables more robust and reliable communication in the CAN bus network.**



**Figure 8 Pretended Networking using forced receive-only mode**

Procedure for Pretended Networking:

1. The TLE9250Xxx is in forced receive-only mode. All messages on the bus are indicated on the RxD output.

---

## Mode control

2. The microcontroller is in stop mode. The CAN protocol handler is enabled. On detection of a dedicated valid CAN frame, the microcontroller exits the stop mode and ramps up to be fully functional.
3. The microcontroller switches on the  $V_{CC}$  LDO.
4. As soon as  $V_{CC} > V_{CC\_UV}$ , the TLE9250Xxx enters normal-operating mode and the ECU can participate in the CAN communication.

## **4 Terms and abbreviations**

**Table 3 Terms and abbreviations**

CMC	Common mode choke
EMC	Electromagnetic compatibility
EME	Electromagnetic emission
EMI	Electromagnetic interference
EOS	Electrical overstress
ESD	Electrostatic discharge
ESR	Equivalent Series Resistance
"high"	Logical high
"low"	Logical low
WUP	Wake-up pattern

---

## Revision history

### Revision history

Revision	Date	Changes
1.41	2021-02-17	Editorial changes
1.4	2020-07-27	Editorial changes
1.3	2019-03-26	<ul style="list-style-type: none"><li>Editorial changes</li></ul>
1.2	2018-07-13	<ul style="list-style-type: none"><li>Editorial changes</li></ul>
1.1	2018-01-15	Added description for pin behavior assessment: <ul style="list-style-type: none"><li><math>V_{IO}</math> short circuit to CANL</li><li>N.C. short circuit to GND, <math>V_{CC}</math>, CANL</li></ul> Changed description for RxD short circuit to $V_{CC}$ and $V_{IO}$ Rename pin FMEA to pin behavior assessment
1.0	2017-08-04	Document created



## Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

**Edition 2021-02-17**

**Published by**

**Infineon Technologies AG**  
**81726 Munich, Germany**

**© 2021 Infineon Technologies AG**  
**All Rights Reserved.**

**Do you have a question about any aspect of this document?**

**Email:** [erratum@infineon.com](mailto:erratum@infineon.com)

**Document reference**  
**IFX-Z8F57889425**

## IMPORTANT NOTICE

The information contained in this application note is given as a hint for the implementation of the product only and shall in no event be regarded as a description or warranty of a certain functionality, condition or quality of the product. Before implementation of the product, the recipient of this application note must verify any function and other technical information given herein in the real application. Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind (including without limitation warranties of non-infringement of intellectual property rights of any third party) with respect to any and all information given in this application note.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

## WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.