TLE7257LE, TLE7257SJ

LIN Transceivers

About this document

Scope and purpose

This document provides application information for the transceiver TLE7257LE/TLE7257SJ from Infineon Technologies AG as Physical Medium Attachment within a LIN.

This document contains technical information like:

- recommended set-ups for LIN slave application
- recommended set-ups for LIN master application
- mode control hints
- EMC aspects
- power consumption aspects

This document refers to the data sheet of the TLE7257LE/TLE7257SJ [1].

Intended audience

This document is intended for engineers who develop applications.

1 Introduction

The Local Interconnect Network (LIN) is a low speed (max. 20 kBaud) Class-A, serial bus protocol. A LIN sub-bus is primarily intended for modules like seat, door, roof, switch panel, steering wheel, etc. Its task is to connect switches, actuators and sensors into a sub-bus that links to the main bus, for example a CAN bus.

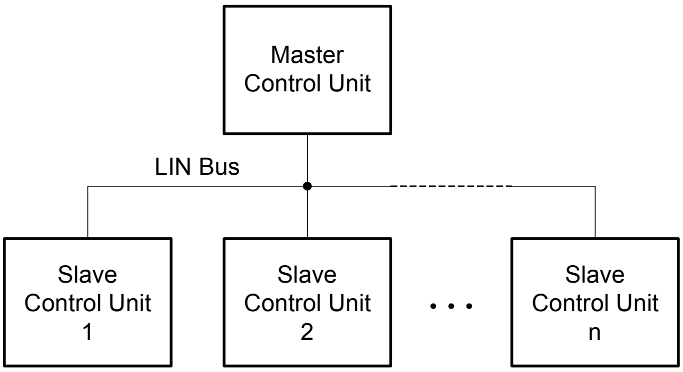

Figure 1 Single-Master / Multiple-Slave Concept

The LIN protocol [2] is based on the UART/SCI serial data link format using 8N1-coded byte fields. A LIN network consists of one master node and one or more slave nodes; the medium access is controlled by the master node. A single-master/multiple-slave concept is shown in Figure 1.

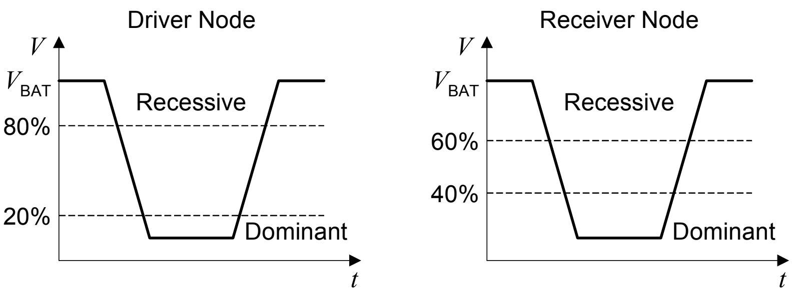

Figure 2 Voltage Levels on the LIN Bus Line

The LIN physical layer was derived from ISO 9141 [3], but it also includes some enhancements to meet the particular operation requirements in automotive environments such as EMC, ESD, etc. The LIN bus is a single-wire, wired AND bus with a 12 V-battery related recessive level. Figure 2 shows the voltage levels on the LIN bus line.

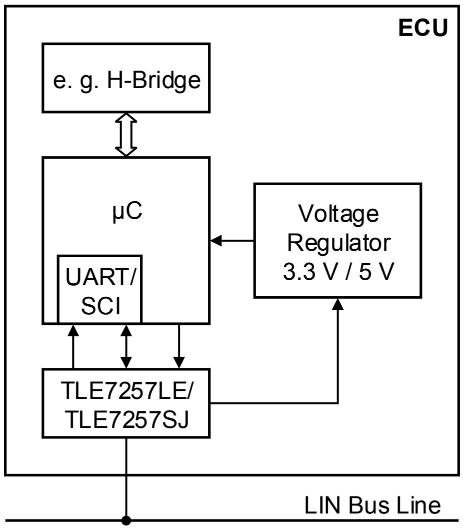

Figure 3 Typical LIN ECU

This document describes the technical implementation of the TLE7257LE/TLE7257SJ [1] as Physical Medium Attachment within LIN. Its focus is to provide application hints / recommendations for the design of LIN electronic control units (ECUs) using the LIN transceiver TLE7257LE/TLE7257SJ from Infineon Technologies AG (see Figure 3).

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2 General Description

The transceiver TLE7257LE/TLE7257SJ represents the Physical Medium Attachment, interfacing the LIN master/slave protocol controller to the LIN transmission medium. The transmit data stream of the protocol controller at the TxD input is converted by the LIN transceiver into a bus signal with controlled slew rate to minimize Electromagnetic Emission (EME). The receiver of the TLE7257LE/TLE7257SJ detects the data stream on the LIN bus line and transmits it via the RxD pin to the protocol controller.

The transceiver provides low-power management (see Chapter 2.3), consumes nearly no current in sleep mode (see Chapter 7.1) and minimizes power consumption in case of failure mode (see Chapter 7.2).

The TLE7257LE/TLE7257SJ transceiver is optimized for the maximum LIN transmission speed of 20 kBaud and is recommended for networks including up to 16 nodes [2].

2.1 Features

The main features of the TLE7257LE/TLE7257SJ are:

- Baud rate up to 20 kBaud
- Very low Electromagnetic Emission (EME) independent from battery voltage
- High Electromagnetic Immunity (EMI)
- Excellent ESD performance according to HBM and GUN
- Very low current consumption in sleep mode
- Battery discharge protection in case of LIN to GND short-circuit
- Transmit data (TxD) dominant time-out function
- Wide battery supply operation range, from voltage drops (5.5 V) up to jump start conditions (27 V)
- Control input levels compatible with 3.3 V and 5 V devices
- Integrated termination resistor for LIN slave applications
- Remote wake-up in sleep mode
- Fail-safe behavior in case of unpowered condition, no reverse current paths
- Bus terminal protected against short-circuit and transients in the automotive environment
- Direct battery operation with protection against load dump, jump start and transients
- No 5 V supply required
- Thermal protection

2.2 Block Diagram

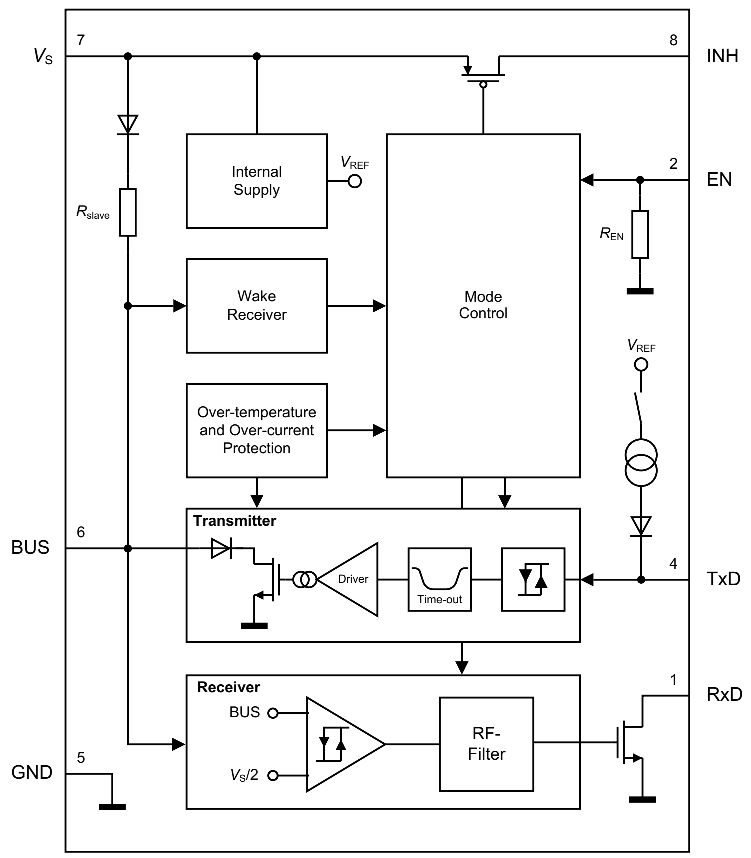


Figure 4 Block Diagram of the TLE7257LE/TLE7257SJ

2.3 Operating Modes

The TLE7257LE/TLE7257SJ provides three operating modes: normal mode, standby mode and sleep mode. The operating modes are shown in Table 1 and Figure 5

Table 1 Operating Modes

Mode	EN	TxD	RxD	INH	Transmitter	R_{SLAVE}	Remark
Sleep	0	floating	floating	floating	off	30 kΩ	see Chapter 2.3.1
Standby	0	weak pull-up	low	high (V_S)	off	30 kΩ	see Chapter 2.3.2
Normal	1	weak pull-up	high: recessive state low: dominant state	high (V_S)	on	30 kΩ	see Chapter 2.3.3

Figure 5 shows the state diagram of the TLE7257LE/TLE7257SJ.

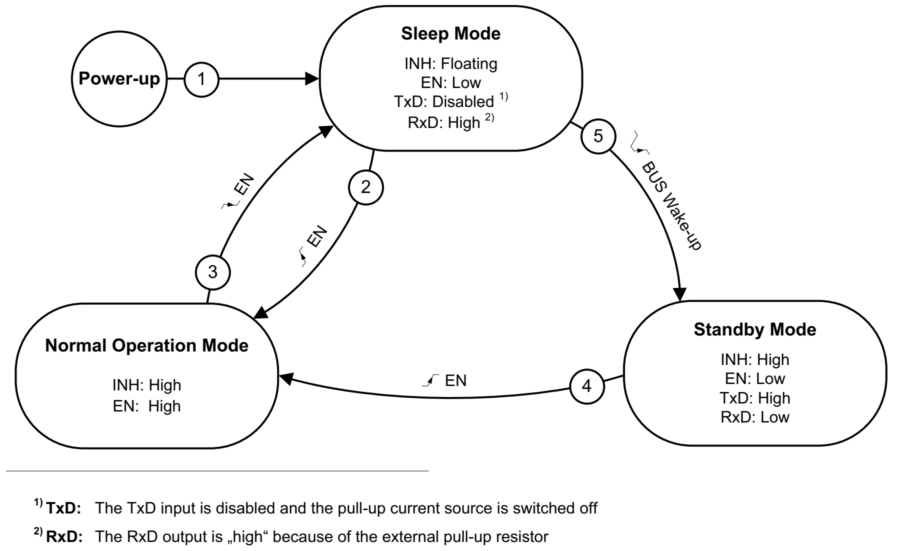


Figure 5 State Diagram

2.3.1 Sleep Mode

The sleep mode of the TLE7257LE/TLE7257SJ provides the lowest power consumption achievable within LIN ECUs. This is achieved by a very low current dissipation of the transceiver itself and by switching off the external voltage regulator through the INH output. During sleep mode the INH output is floating. To generate a defined voltage level in sleep mode a pull down resistor INH to ground is recommended. Recommended value range for this resistor is 10 kΩ to 100 kΩ.

Although power consumption is extremely low, remote wake-up via LIN will be recognized and will result in a mode change towards standby mode (see Chapter 2.3.2). Furthermore the TLE7257LE/TLE7257SJ provides a direct activation of normal mode via EN (see Chapter 2.3.3) which is useful for applications where the microcontroller supply is not controlled by the INH output.

The TLE7257LE/TLE7257SJ is protected against unwanted wake-up events caused by automotive transients or EMI. For this purpose the transceiver provides filters and/or timers at the input of the receiver (LIN) and of the sleep control input (EN). Therefore all wake-up events have to persist for a certain time period ($t_{WK,bus}$, t_{Mode}) at least.

The sleep mode is entered if a low level at the sleep control input pin EN persists for at least t_{Mode} [1] (see Figure 6) and no wake-up event occurs within this time. This filter time prevents unintended transition towards sleep mode caused by EMI. The activation of the sleep mode is even possible if LIN is clamped to ground, for example caused by a short-circuit to ground.

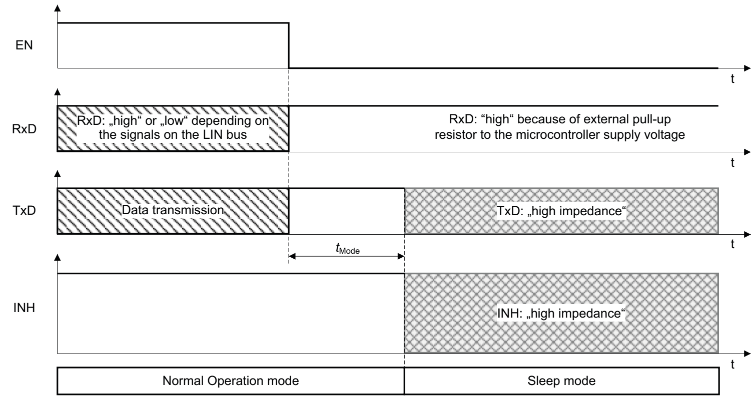


Figure 6 Sleep Mode Timing

2.3.2 Standby Mode

The standby mode is an intermediate mode that is entered only if a remote wake-up occurs while the TLE7257LE/TLE7257SJ is in sleep mode. In standby mode the INH pin puts out a battery related high level and therefore can activate an external voltage regulator.

The TLE7257LE/TLE7257SJ signals standby mode with a low level at the RxD pin. This can be used as wake-up interrupt request for a microcontroller.

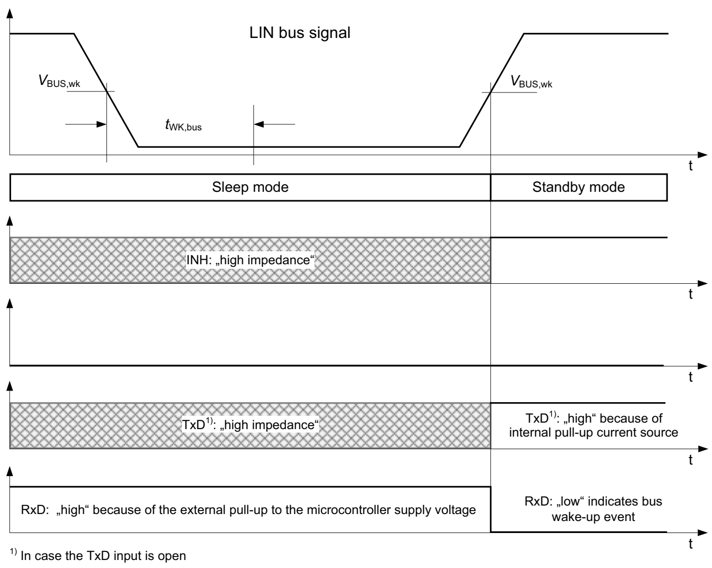


Figure 7 Standby Mode Timing of Remote Wake-up

Figure 7 shows the timing of remote wake-up and the particular outputs at RxD. A remote wake-up via LIN bus is detected, if the LIN wire becomes continuously dominant for at least $t_{WK,bus}$ [1], followed by an edge to recessive bus level.

2.3.3 Normal Mode

The normal mode is used to transmit and receive data via the LIN bus line. The bus data stream is converted by the receiver into a digital bit stream and output at RxD to the microcontroller. A high level on the RxD pin represents a recessive level on the LIN bus line. A low level on the RxD pin represents a dominant LIN bus line.

The transmitter of the TLE7257LE/TLE7257SJ converts the data stream of the microcontroller at TxD input into a LIN bus signal with a constant slew rate to minimize the EME independently of battery voltage. A low level TxD input results in a dominant LIN bus level, while a high level input results in a recessive bus level.

In normal mode the internal slave termination resistor R_{BUS} [1] pulls the LIN bus pin high. The INH pin provides a battery related high level to keep an external voltage regulator on.

2.4 Compatibility with 3.3 V Devices

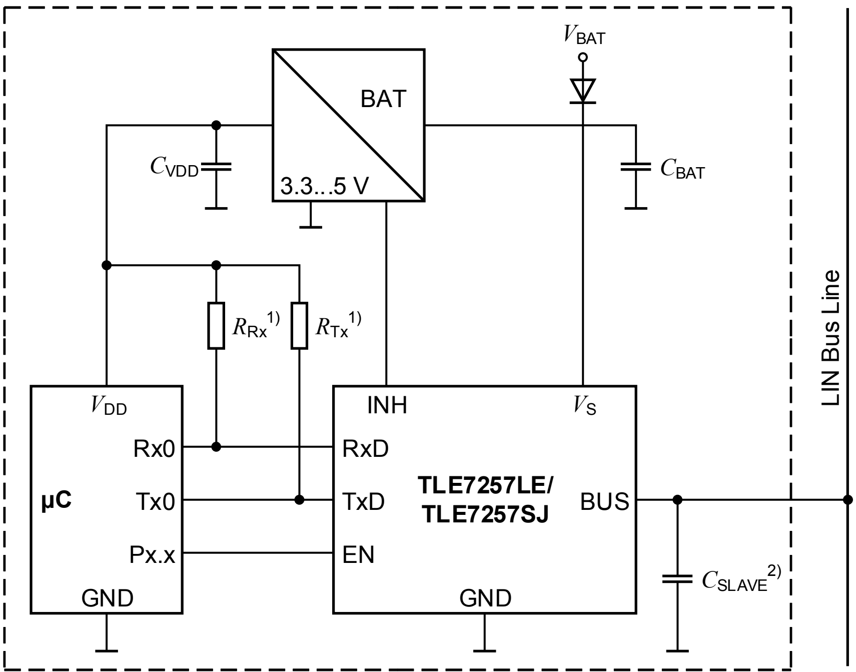
The TLE7257LE/TLE7257SJ is designed to support increasing demand for supply voltage lower than 5 V within automotive applications. It provides reduced input thresholds at the input pins TxD and EN and open drains at the output pins RxD. So it is compatible to 3.3 V supplied microcontrollers as well as to 5 V supplied devices. There is no 5 V tolerant behavior of interface pins between the TLE7257LE/TLE7257SJ and the host microcontroller needed. Furthermore no extra V_{CC} supply for the transceiver itself is required.

To achieve a suitable high level at RxD an external pull-up resistor might be required in case no pull-up resistor is included at the microcontroller port pin.

3 Slave Application

3.1 Set-up

A slave application of the LIN transceiver TLE7257LE/TLE7257SJ is shown in Figure 8. The protocol controller (for example a microcontroller) is connected to the LIN transceiver via a UART/SCI based interface or standard I/O port pins. The TxD pin of the TLE7257LE/TLE7257SJ is the transmit data input and the RxD pin is the receive data output. The sleep control input EN of the LIN transceiver can be controlled by a microcontroller port pin. The TLE7257LE/TLE7257SJ provides an internal slave termination resistor. Thus for a slave application no extra LIN bus termination resistor is needed. The capacitor C_{SLAVE} in Figure 8 is recommended in order to improve the EME as well as EMI performance of the LIN system, required in the LIN specifications 1.3 and 2.0 (see also Chapter 9).



1) Optional
2) Mandatory according to LIN Protocol Specification, Revision 2.2a

Figure 8 TLE7257LE/TLE7257SJ Application Example

3.2 Detailed Pin Description

3.2.1 EN Pin

The sleep control pin EN provides an internal pull-down resistor R_{EN} to support a defined input level in case of open circuit failure. A low level results in the sleep mode and reduces the power dissipation to a minimum. The range of the input threshold supports devices supplied at 5 V as well as devices supplied at 3.3 V. A typical EN pin application is shown in Figure 9.

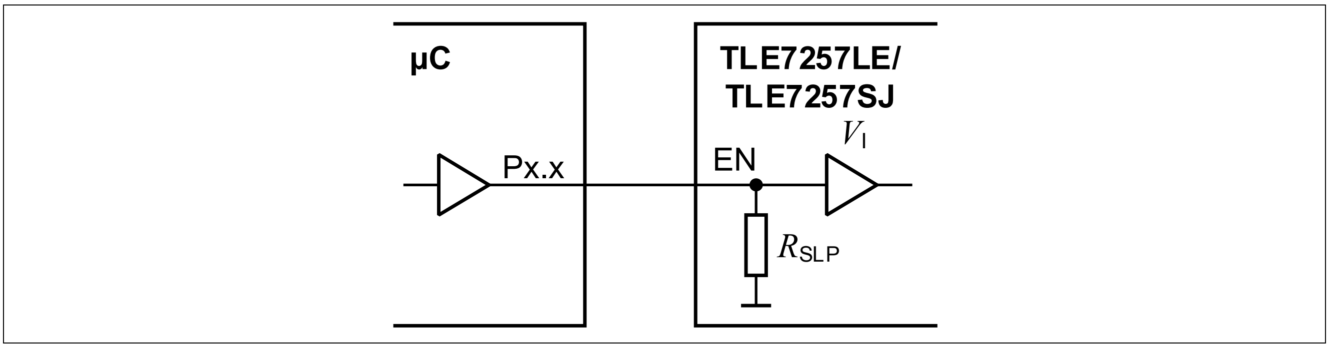


Figure 9 Typical EN Pin Application

The minimum drive capability of the microcontroller port pin for the EN pin is specified in the data sheet.

3.2.2 TxD Pin

In normal mode and in standby mode the TxD pin provides an internal weak pull-up current source I_{TxD} [1] to ensure a defined input level in case of open circuit failure. In case of permanent dominant TxD input level, the TxD dominant time-out function prevents the LIN bus from being clamped to a dominant level by disabling the transmitter. Furthermore the weak pull-up allows providing an output level free TxD pin.

3.2.3 RxD Pin

The receive data output RxD provides an open drain behavior in order to achieve an output level, which can be adapted to the microcontroller supply voltage. Thus 3.3 V microcontroller derivatives without 5 V tolerant ports can be used. In case the microcontroller port pin does not provide an integrated pull-up resistor, an external pull-up resistor connected to the microcontroller supply voltage V_{CC} is required. In Figure 10 typical RxD applications are shown.

The pull-up resistor R_{Rx} is defined by the drive capability of the TLE7257LE/TLE7257SJ RxD output pin and can be calculated by the equations below:

Range of pull-up resistor:

$R_{Rx,\,min} < R_{Rx} < R_{Rx,\,max}$ with

$$R_{Rx,\,min} = \frac{V_{CC,\,max} - V_{LOW(Rx),\,max}}{V_{LOW(Rx),\,max}} \times \frac{V_{RxD}}{I_{OL(RxD),\,min}},\ V_{RxD} = 0.4\ \text{V and} \quad (3.1)$$

$$R_{Rx,\,max} = \frac{V_{CC,\,min} - V_{HIGH(Rx),\,min}}{I_{LH(RxD),\,max}} \quad (3.2)$$

with

$I_{RxD,H,Leak}$ maximum RxD HIGH-level leakage current [1]

$I_{RxD,L}$ minimum RxD LOW-level output current [1]

$V_{HIGH(Rx),\,min}$ minimum µC port pin (Rx) HIGH-level input voltage

$V_{LOW(Rx),\,max}$ maximum µC port pin (Rx) LOW-level input voltage

Note: For LIN the signal symmetry of the falling and rising transition on RxD has an impact on the overall system tolerance. Thus it is recommended to keep the RC-load time constant on the RxD output as low as possible, but the pull-up resistor R_{Rx} should not be below 1 kΩ.

Example: If the supply voltage of the microcontroller ($V_{CC} = V_{CC,\ min} = V_{CC,\ max}$) is 5 V and the minimum microcontroller port input threshold voltage range is from
$V_{LOW(Rx),\ max}$ = 0.8 V to $V_{HIGH(Rx),\ min}$ = 2 V, then the range of the pull-up resistor R_{Rx} is:

$$R_{Rx,\ min} = \frac{V_{CC,\ max} - V_{LOW(Rx),\ max}}{V_{LOW(Rx),\ max}} \times \frac{V_{RxD}}{I_{OL(RxD),\ min}} = 1.4\ k\Omega \tag{3.3}$$

$$R_{Rx,\ max} = \frac{V_{CC,\ min} - V_{HIGH(Rx),\ min}}{I_{LH(RxD),\ max}} \approx 600\ k\Omega \tag{3.4}$$

A recommended value for the pull-up resistor R_{Rx} is 2.2 kΩ.

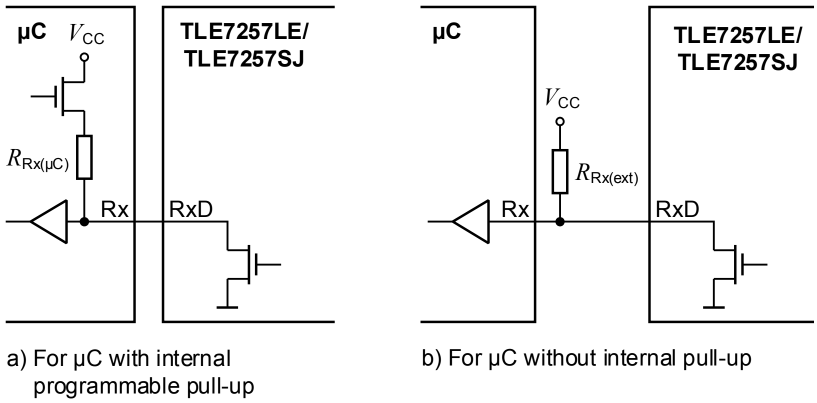


Figure 10 Typical RxD Pin Application

3.2.4 Wake-up after Power-on

After power-on the TLE7257LE/TLE7257SJ enters sleep mode to reduce current consumption in ramp up phase. To wake up the transceiver a remote wake up is necesssary or a high level on EN pin.

3.2.5 INH Pin

The output pin INH is a battery related open drain output to control an external voltage regulator. Therefore, an external pull-down resistor R_{INH} connected to ground is necessary. This pull-down resistor is typically included in the voltage regulator. A typical INH pin application is shown in Figure 11.

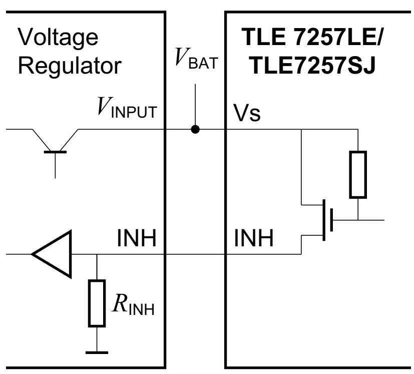


Figure 11 Typical INH Pin Application

The range of the pull-down resistor R_{INH} can be calculated with the equations below:

Range of pull-down resistor:

$R_{INH, min} < R_{INH} < R_{INH, max}$ with

$$R_{INH, min} = \frac{V_{BAT, max}}{I_{INH, max}} \tag{3.5}$$

for $I_{INH, max}$ see [1] (Chapter 12).

$$R_{INH, max} = \frac{V_{LOW(Volt Reg), max}}{I_{LH(INH), max}} \tag{3.6}$$

with

$I_{LH(INH), max}$ maximum INH HIGH-level leakage current [1]

$V_{LOW(Volt Reg), max}$ maximum INH LOW-level input voltage (voltage regulator)

3.2.6 BUS Pin

The pin BUS is used to transmit and receive data on the LIN bus line. Transmission is performed by a low side switch with controlled wave shaping, and reception is undertaken by an implemented receiver. The threshold of the receiver $V_{th(Rx)}$ [1] is battery related and has a hysteresis of $V_{thr(hys)}$ [1].

The LIN pin has a slave termination resistor of R_{SLAVE} [1]. The slave termination resistor as well as the low side switch are implemented using a reverse current diode. Thus no external components are required. Nevertheless, improvement of EME and EMI can be achieved by applying a capacitive load at the LIN bus line as shown in Figure 8.

The current source of $I_{IL(LIN)}$ is used as an additional weak pull-up, because the slave termination resistor R_{SLAVE} [1] is switched off in sleep mode. Thus a transition into sleep mode minimizes current consumption in case of LIN short-circuit to ground (see Chapter 7.1).

4 Master Application

A master application differs from a slave application mainly in the requirement of an additional master termination resistor R_{MASTER} [2]. The capacitance load C_{MASTER} [2] is recommended in order to improve EME as well as EMI (see also Chapter 9). The TLE7257LE/TLE7257SJ provides several master application solutions, which are described in this chapter.

4.1 Master Termination Directly to BAT

This master application is realized by a reverse current diode in series with the resistor R_{MASTER} [2] connected between LIN and BAT as shown in Figure 12.

R_{MASTER} is specified in the LIN 2.x specification and in ISO 17987 with 1 kΩ. C_{MASTER} is defined by the OEM.

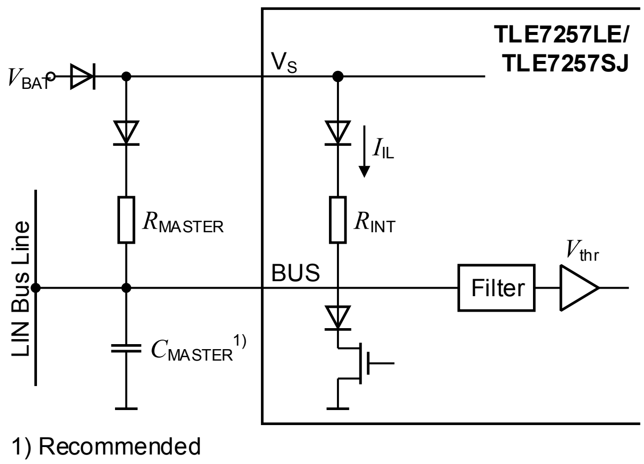


Figure 12 Typical Master Termination

5 Transceiver Control

The modes of the TLE7257LE/TLE7257SJ are controlled by the pins EN and TxD. This chapter describes the mode control of TLE7257LE/TLE7257SJ and how to deal with LIN bus failures.

The transceiver control can be split into two basic applications:

- microcontroller power supply is controlled via the INH pin of the TLE7257LE/TLE7257SJ
- microcontroller is permanently supplied, regardless of the mode TLE7257LE/TLE7257SJ is in

5.1 INH Controlled Microcontroller Power Supply

After remote wake-up standby mode is entered automatically. As a result the INH pin outputs a battery related high level and thus switches on the external voltage regulator. As a consequence, the microcontroller is supplied and initializes. The TLE7257LE/TLE7257SJ indicates the wake-up event by an active low at RxD.

Depending on the use of the EN pin two different software-flows for mode control are recommended.

5.1.1 Applications

The software flow is shown within Figure 13. The TxD input of the TLE7257LE/TLE7257SJ defines the next mode before the EN input is set to a high level.

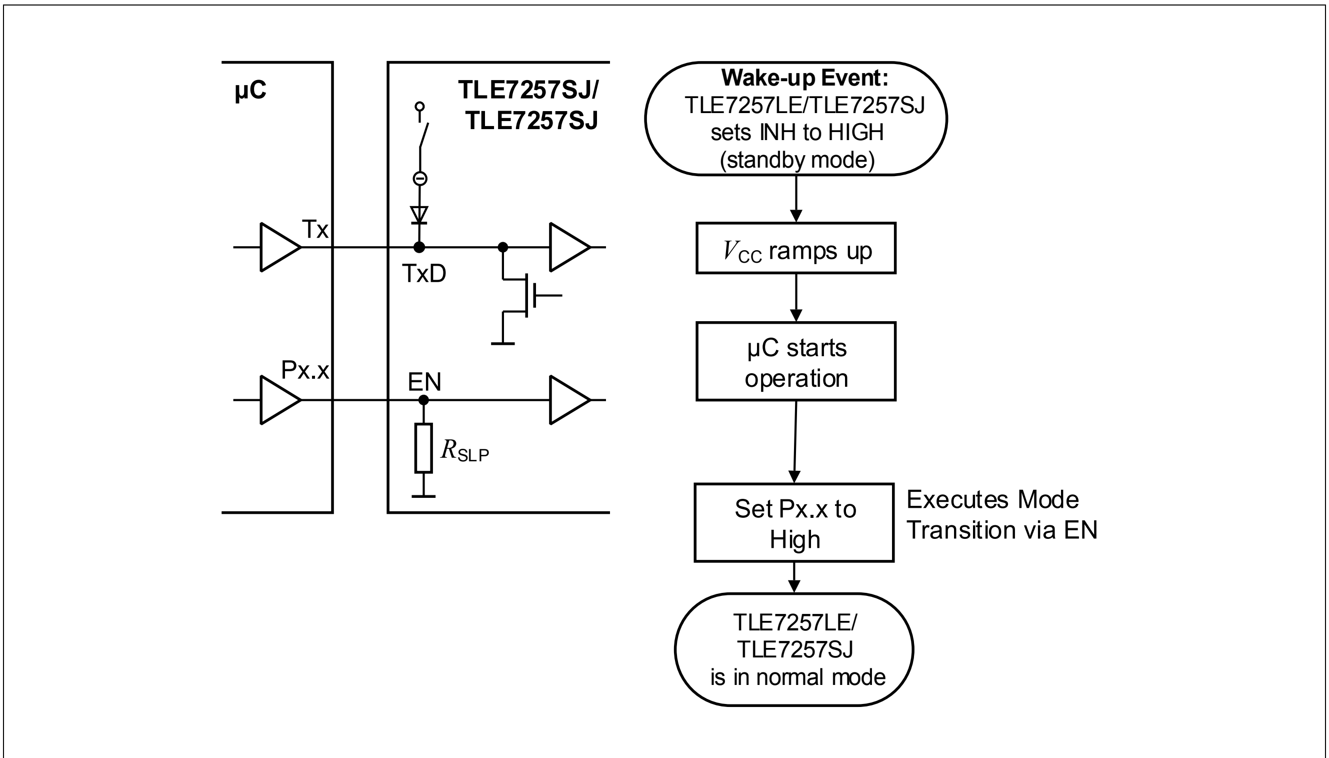


Figure 13 Flow Diagram of Standby to Normal Mode Transition

5.2 Permanently Supplied Microcontroller

In some applications the TLE7257LE/TLE7257SJ is not used to control the power supply of the microcontroller. Thus the INH pin is unused, or it is used for another purpose. For such applications the TLE7257LE/TLE7257SJ allows a direct transition from sleep mode into normal mode.

5.3 Transition from Normal Mode into Sleep Mode

The TLE7257LE/TLE7257SJ enters sleep mode if the EN input is low for at least $t_{gotosleep}$ [1].

The EN input should become low (see Figure 14). The "Set Tx as Input" step should not be performed, since the weak pull-down R_{TxD} [1] would cause a low level on TxD if the microcontroller port pin Tx is set into a high-impedance state without pull-up behavior. This would result in a dominant level on the LIN bus until EN is set low or the TxD dominant time-out phase is passed.

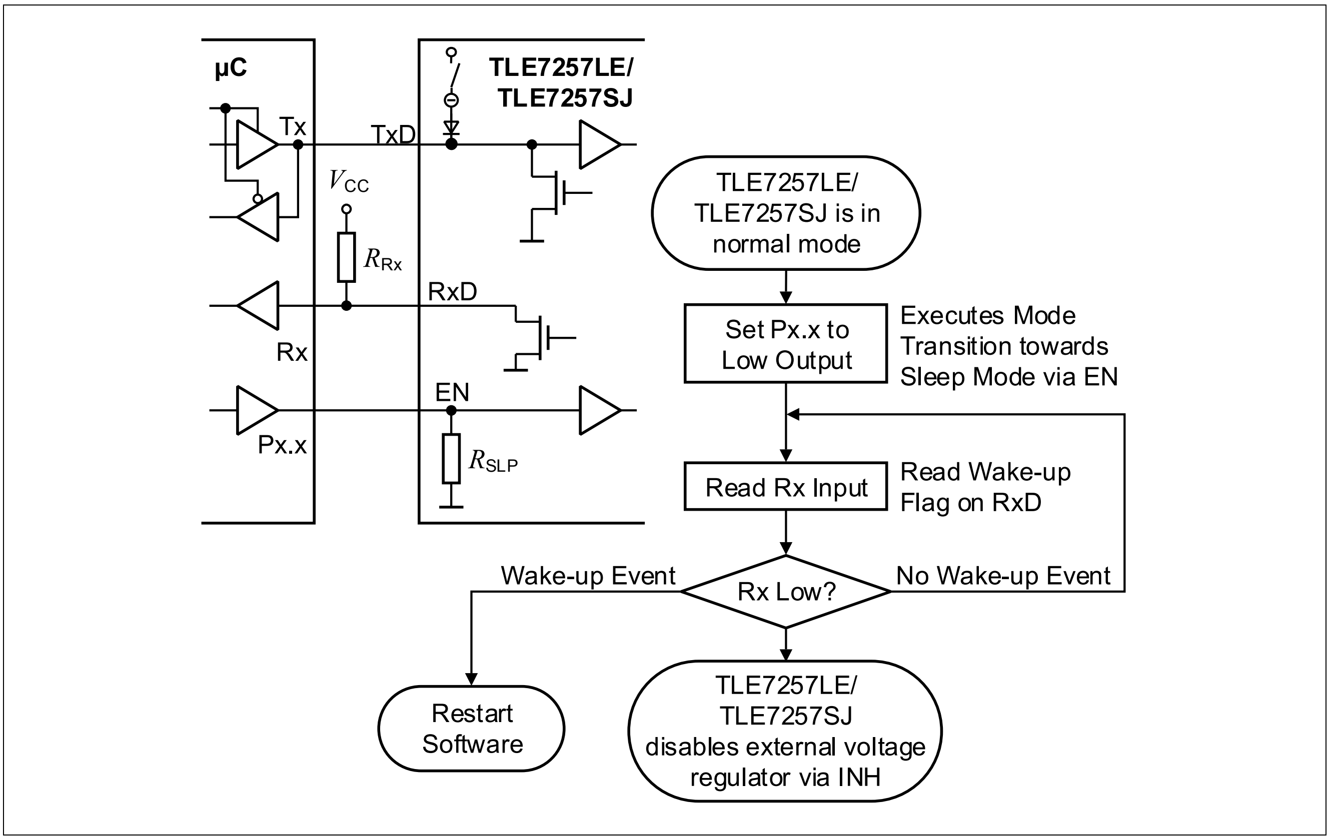


Figure 14 Flow Diagram of Normal Mode to Sleep Transition

6 Failure Management

6.1 TxD Dominant Failure

Usually in case a TxD pin is shorted to ground, the LIN bus is clamped to the dominant level and therefore overrules any transmission on the LIN bus. To protect the LIN bus from being continuously driven to the dominant level, the TLE7257LE/TLE7257SJ has an integrated TxD dominant timer. Thus the transmitter of the TLE7257LE/TLE7257SJ is disabled if a TxD dominant failure is detected, and the LIN bus is released again.

The TxD dominant timer can be reset after a dominant to recessive edge on the TxD pin.

TxD dominant failure is detected if the TxD input persists dominant for at least t_{DOM} [1]. As a consequence, LIN transmission speed is limited to a minimum baud rate. The calculation is shown in Chapter 6.2.

Furthermore, if one of the above failures is present, a change of the EN input signal does not modify the TxD dominant timer state and therefore makes sure that no dominant LIN signal is driven to the bus by the TLE7257LE/TLE7257SJ (fail-safe behavior).

6.2 Minimum Baud Rate and Maximum TxD Dominant Phase

Due to the TxD dominant failure detection of the TLE7257LE/TLE7257SJ the maximum TxD dominant phase is limited by the minimum TxD dominant time-out time $t_{DOM, min}$ [1]. As a consequence the transmission speed is also limited to a minimum baud rate.

6.2.1 Minimum Baud Rate of a Master Node

The maximum dominant phase of the LIN protocol [2] is the maximum SYNCH BREAK LOW PHASE $T_{SYNBRK, max}$ [2] of the SYNCH BREAK FIELD. The SYNCH BREAK FIELD is part of the message frame HEADER, which is only sent by the master node. The maximum SYNCH BREAK LOW PHASE $T_{SYNBRK, max}$ [2] represents the maximum number of dominant bits sent by the master. Depending on the length of the maximum SYNCH BREAK LOW PHASE $T_{SYNBRK, max}$ [2] and the minimum TxD dominant time out time $t_{DOM, min}$ [1] the minimum baud rate for the master node can be calculated by the following equation:

$$baudrate_{\text{min, MASTER}} = \frac{T_{\text{SYNBRK, max}}}{t_{\text{DOM, min}}} \quad \text{with} \quad T_{\text{SYNBRK, max}} > T_{\text{SYNBRK, min}} \tag{6.1}$$

where $T_{SYNBRK, min}$ is specified in [2]

Thus the TLE7257LE/TLE7257SJ allows operating within master application down to 2.4 kBaud.

6.2.2 Minimum Baud Rate of a Slave Node

A slave node sends the RESPONSE part [2] of the LIN message frame only, which has a maximum dominant phase of 9 bits (start bit + 8 data bits). The minimum baud rate of a slave can be calculated by this equation:

$$baudrate_{\text{min, SLAVE}} = \frac{9 + n_{\text{safe}}}{t_{\text{DOM, min}}} \quad \text{with } n_{\text{safe}} \text{ as safety margin} \tag{6.2}$$

Thus the TLE7257LE/TLE7257SJ allows operating within slave application down to 1.8 kBaud.

7 Power Consumption

In design of the TLE7257LE/TLE7257SJ special care was taken of low system power consumption since this is a key for introduction of this new LIN sub bus system in automotive applications.

Even with the extremely low system power consumption the TLE7257LE/TLE7257SJ provides full wake-up capability via the LIN bus, maintaining high immunity against electromagnetic disturbance.

7.1 Sleep Mode Power Consumption

The TLE7257LE/TLE7257SJ provides very low power consumption in sleep mode. If the transceiver is used to control the ECU supply via INH pin the only remaining system current flows into the BAT pin ($I_{BAT; sleep}$ [1]). All other pins do not sink or source any extra current (see Figure 15).

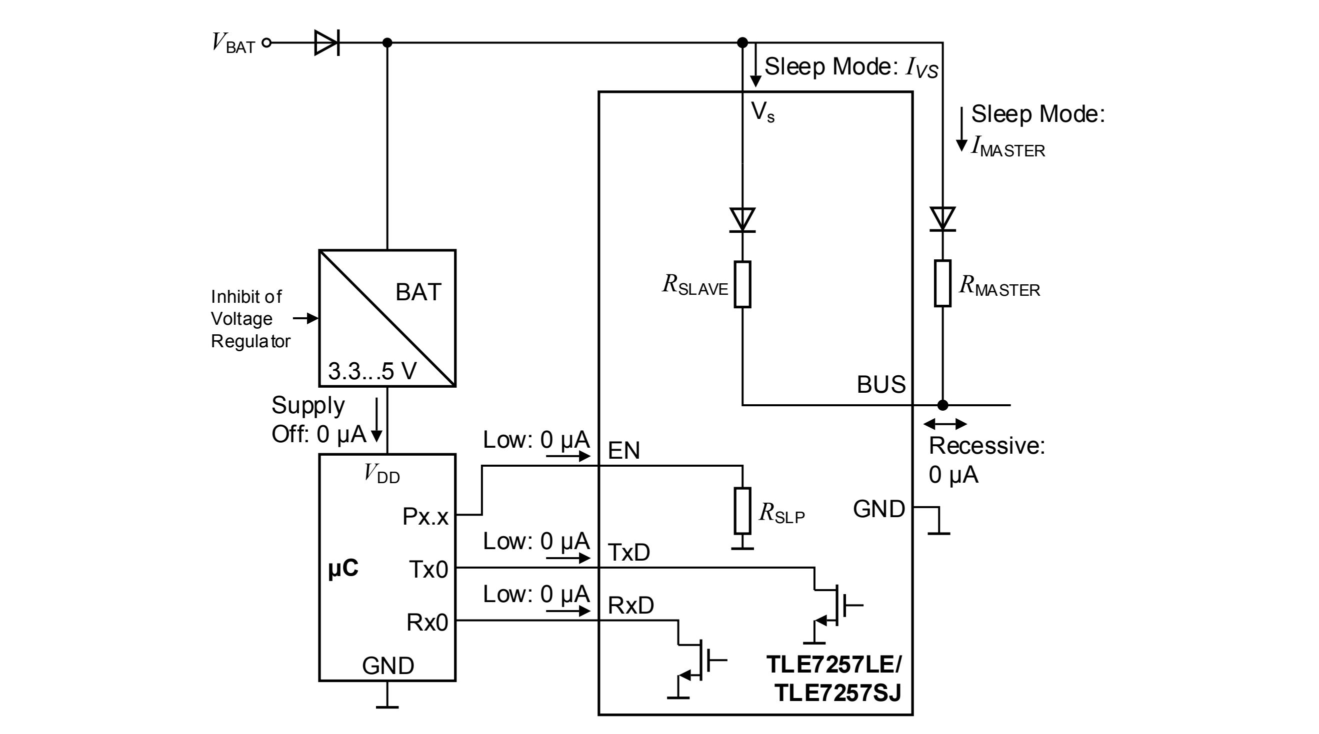


Figure 15 Current Consumption in Sleep Mode

7.2 Sleep Mode Power Consumption at Presence of LIN Bus Short-Circuit

In case of LIN short circuit to ground the power consumption of the TLE7257LE/TLE7257SJ is determined by the external Master termination resistor and the internal pull up termination resistors fo all Slaves. The TLE7257LE/TLE7257SJ remains in sleep mode and will not change into Standby mode to reduce the overall power consumption. Since the termination of the system becomes nearly disabled during sleep, the resulting short circuit current is defined by the internal bias current and the remaining pull-up current source for failure recovery (see Figure 16).

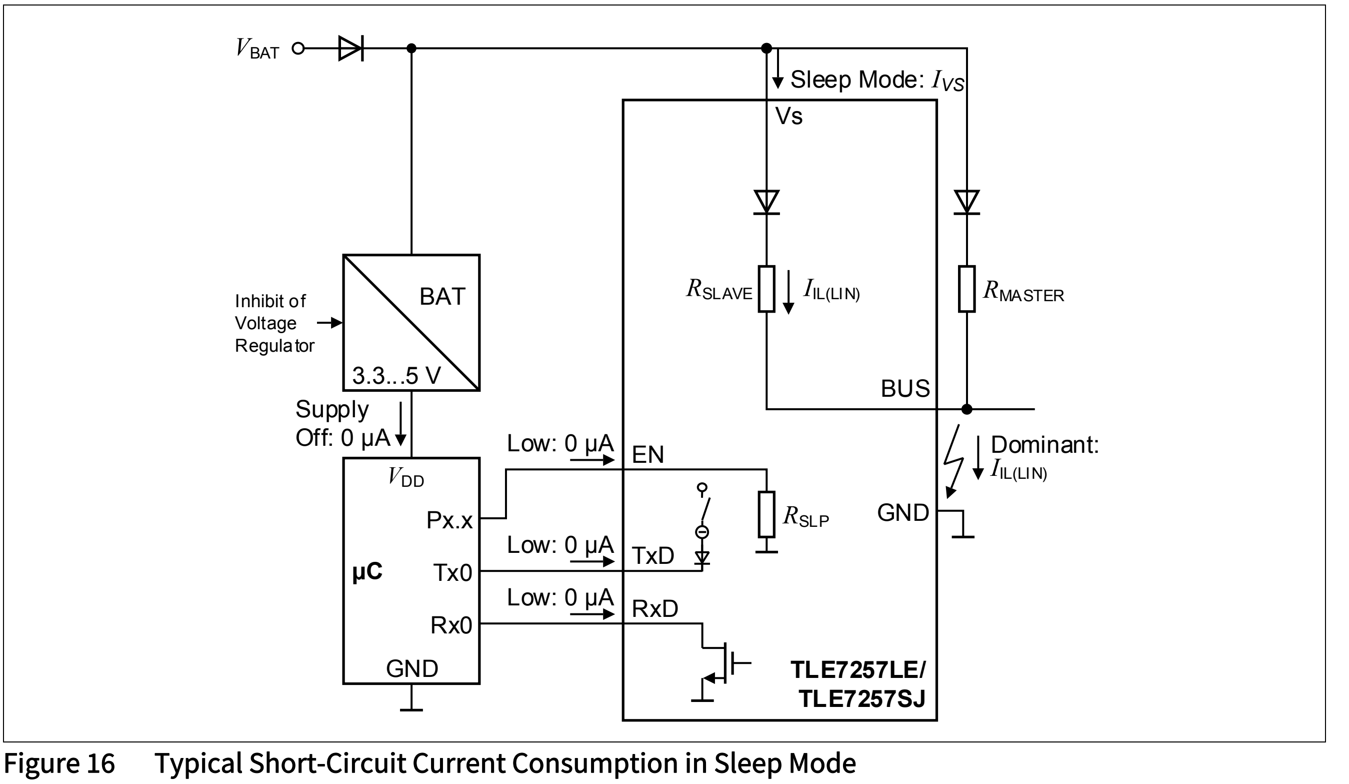


Figure 16 Typical Short-Circuit Current Consumption in Sleep Mode

8 V_{BAT}- and Ground-Shift

To ensure excellent communication between the master and all slaves a maximum V_{BAT}- and Ground-Shift up to 10% from V_{BAT} is mandatory and specified in ISO 17987-4. This is a very hard requirement, because it is a limitation for the complete network, not only for an ECU. So the following recommendation should help you solve that problem in your application:

- use a separate reverse polarity diode for the LIN transceiver
- the voltage drop on the reverse polarity diode must be less than 1 V at -40 °C
- connect V_{BAT} wire directly to the V_{BAT} pin of the plug
- no additional current flows in the LIN-V_{BAT}-wire
- connect the ground wire directly to the ground pin of the plug
- no additional current flows in the Ground wire
- the minimum V_{BAT} for V_{BAT}- and Ground Shift is 8.87 V
- the minimum V_{BAT} without Shift is 8 V

9 EMC Aspects

9.1 EME - Slope Control

The LIN physical layer is a single-wire, wired AND bus with a battery related recessive level. Here, no compensation effect of the electromagnetic field is present as known from dual-wire concepts making use of differential signals (for example High-Speed CAN). Thus smooth output wave shaping becomes more important. The Electromagnetic Emission EME mainly depends on the falling and rising slope of the LIN bus waveform. The weaker these slopes are, the more EME reduction can be achieved.

The TLE7257LE/TLE7257SJ provides a slope control adjustment by modifying the capacitive load (C_{MASTER} [2] or C_{SLAVE} [2]) on the LIN bus. The slope decreases with increasing capacitive load. Therefore increasing the total network capacitance

($C_{BUS} = C_{MASTER} + n \times C_{SLAVE} + C_{LINE}$ [2])

can further reduce the EME. For very high bit rates close to 20 kBaud the LIN bus slope times also have impact on system tolerance, such as ground shift. Thus, at very high bit rates it is not recommended to make use of the maximum capacitive load $C_{BUS,\ max}$ [2]allowed, in order to keep some safety margin for the system.

9.2 EMI - Capacitive Load

A capacitor on the LIN bus pin reduces the impact of RF-interference. Thus it is recommended to provide a capacitor (for example $C_{MASTER/SLAVE}$ = 220 pF) from LIN to ground at each node.

9.3 PCB Layout Recommendations for TLE7257LE/TLE7257SJ

The following layout rules should be considered to achieve best performance of the transceiver and the ECU:

- TxD and RxD connections to microcontroller are recommended to be as short as possible.
- Place a 100nF capacitor close to V_{BAT} for local decoupling. Due to their low resistance and lower inductance compared to other capacitor types, it is recommended to use ceramic capacitors.
- Avoid routing the LIN bus line in parallel to fast-switching lines or off-board signals in order to reduce noise injection to the LIN bus.
- It is recommended to place the master or slave capacitor, master termination resistor (only if master node) and the transceiver as close as possible together and close to the ECU connector in order to minimize track length of bus lines.
- GND connector should be placed as close as possible to the transceiver in order to avoid ground shift.

10 ESD recommendations

In case of an ESD event a very high current flows into the LIN-transceiver TLE7257LE/TLE7257SJ.

A very low ohmic ground wire is recommended to reduce the voltage drop in case of the ESD event. This is necessary to guarantee the excellent ESD behavior of the TLE7257LE/TLE7257SJ. Figure 17 shows a proposal for an ESD performance application circuit. Figure 18 shows the critical problem in case of ESD.

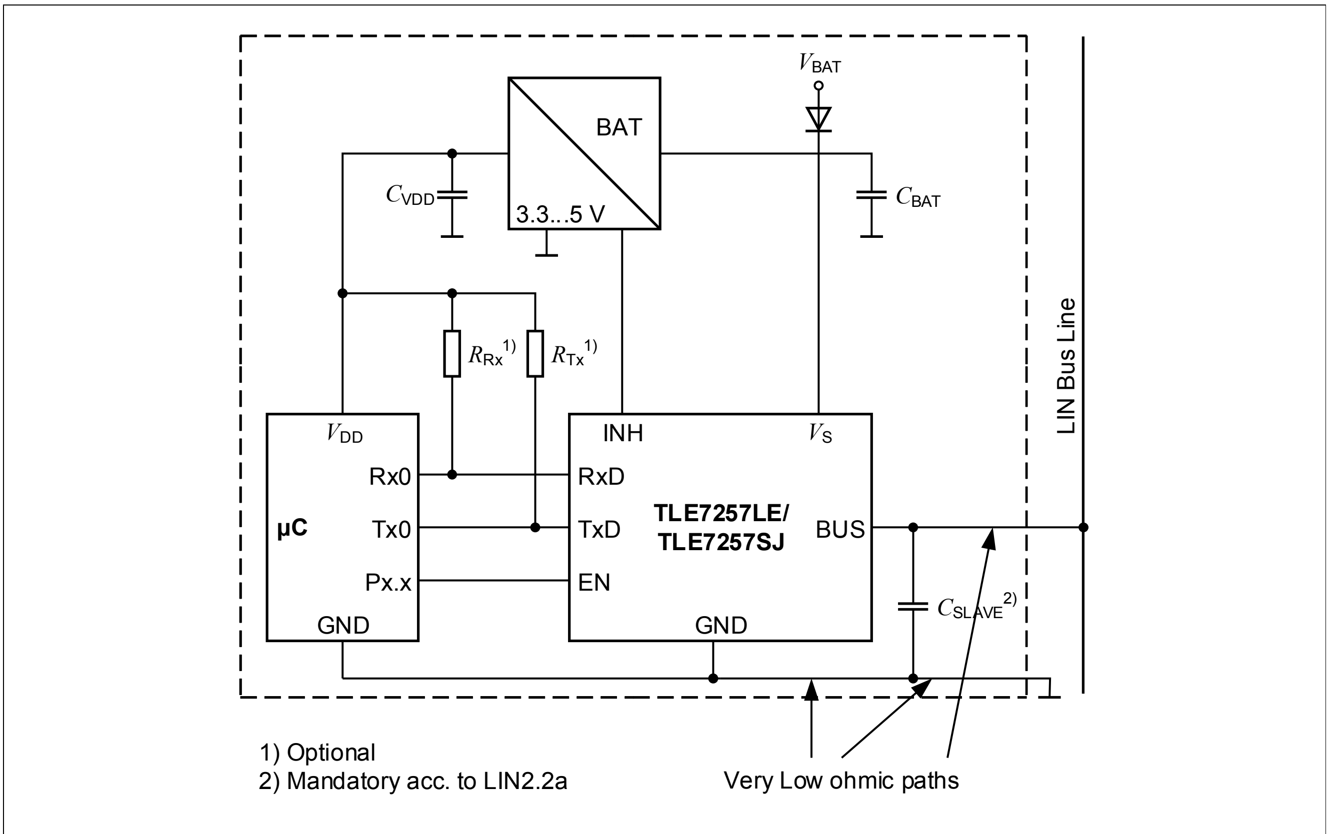


Figure 17 Proposal for an ESD Performance Application Circuit

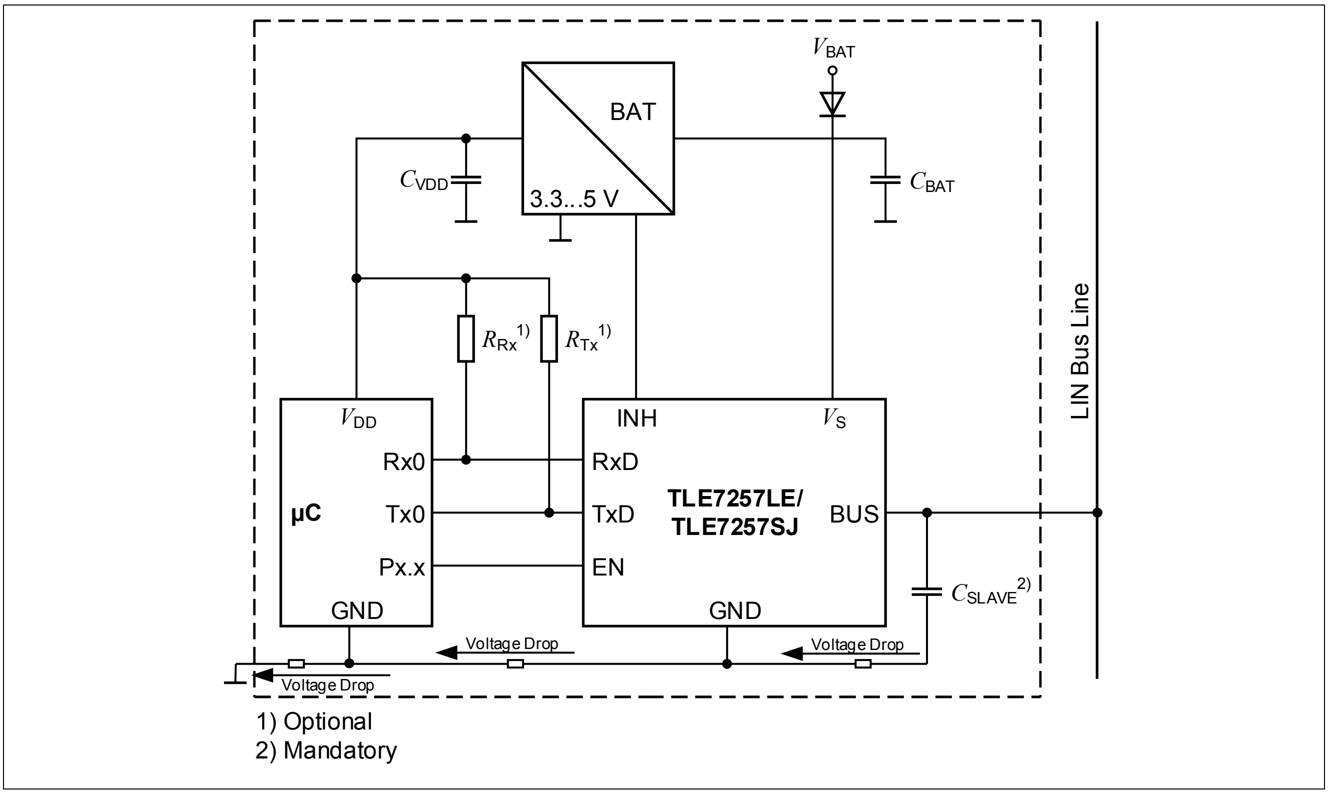


Figure 18 Critical Problem in Case of ESD

11 References

[1] Data Sheet TLE7257LE/TLE7257SJ, LIN Transceiver, Infineon Technologies AG

[2] LIN Specification Package, LIN Protocol Specification - Revision 2.2a, LIN Consortium; ISO 17987-4

[3] International Standard ISO 9141, Road Vehicles - Diagnostic Systems - Requirement for Interchange of Digital Information, International Standardization Organization, 1989

12 Revision History

Revision	Date	Changes
1.0	2016-05-18	Application Note created

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