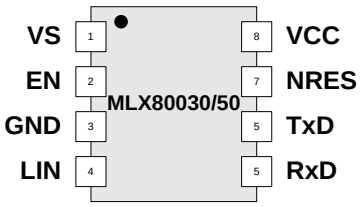
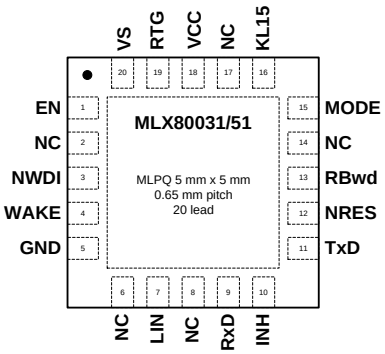
# MLX80050/51/30/31

## *LIN System Basis ICs*




## *Features*

- LIN 2.x / SAE J2602 compliant
- Operating voltage $V_{SUP}$ = 5 ... 27 V
- 3 modes: Normal, Silent and Sleep
- Linear low drop voltage regulator:
  MLX80030/31:
  - Normal mode 3.3V/70mA ±2%
  - Silent mode 3.3V/20mA ±2%

  MLX80050/51:
  - Normal mode 5V/70mA ±2%
  - Silent mode 5V/20mA ±2%
- Low current consumption (typ)
  - Sleep mode 20 µA
  - Silent mode "noload" 45 µA
- Output current limitation
- LIN-Bus Transceiver
  - Baud rate up to 20 kBaud
  - Slew rate control for best EME behaviour
  - Low slew mode for optimized SAE J2602 transmission
  - High impedance LIN pin in case of loss of ground or battery
  - Bus input voltages -24V to 30V independent from VBat
- Remote and local wake up source recognition
- VCC undervoltage detection at NRES output (start-up delay 4ms)
  - Vres threshold 3.0 V (MLX80030/31); Vres threshold 4.1V (MLX80050/51)
- Programmable Window Watchdog (only MLX80031/51)
- VSUP undervoltage detection (POR), Over temperature shutdown
- TxD dominant time out function, Standby mode time out after 350ms
- Automotive temperature range of –40°C to 125°C
- Interface I/O's independent from voltage regulator output
- Enhanced ESD robustness according to IEC 61000-4-2
  - Direct discharge for pin LIN >20kV (only Lin cap connected) and for pin VBAT >15kV
  - Indirect discharge for pin LIN >15kV
- Load dump protected (40V)

| *Order Code* | *Temp. Range* | *Package* | *Delivery* | *Remark* |
|---|---|---|---|---|
| MLX80050 KDC-BAA-000-RE | -40 - 125 °C | SOIC8 | Reel | |
| MLX80051 KLW-BAA-000-RE | -40 - 125 °C | QFN_WF20/5x5 | Reel | Wettable Flanks |
| MLX80030 KDC-BAA-000-RE | -40 - 125 °C | SOIC8 | Reel | |
| MLX80031 KLW-BAA-000-RE | -40 - 125 °C | QFN_WF20/5x5 | Reel | Wettable Flanks |

## *Short Description*

The MLX8005x/3x consist of a low-drop voltage regulator 5V/3.3V/70mA combined with a Reset/Watchdog unit and a LIN bus transceiver. The LIN transceiver is suitable for LIN bus systems conform to LIN specification revision 2.x and SAE J2602. The watchdog times of the integrated window watchdog can be adapted on application needs via external resistors. With the help of an external bipolar transistor it is possible to extend the output current of the integrated voltage regulator. The combination of voltage regulator and bus transceiver as well as watchdog unit makes it possible to develop simple, but powerful and cheap slave nodes in LIN Bus systems.

# Contents

## List of Tables



## List of Figures

# 1. Electrical Specification

All voltages are referenced to ground (GND), positive currents flow into the IC.

## Absolute Maximum Ratings

### Table 1: Absolute maximum ratings

| Parameter | Symbol | Condition | Min | Max | Unit |
|---|---|---|---|---|---|
| Supply voltage at VS | $V_S$ | Respective to GND | -0.3 | 40 | V |
| Transient voltage ISO 7637/2 | | pulse 1, 2 | -100 | 100 | V |
| Transient voltage ISO 7637/2 | | pulse 3A; 3B, coupling 1nF | -150 | 100 | V |
| DC voltage LIN | $V_{LIN\_DC}$ | Respective to GND and VS<br>Loss of Ground (VGND = VS) | -20<br>-30 | 40<br>40 | V |
| DC voltage WAKE | $V_{WAKE\_DC}$ | Respective to GND and VS<br>Loss of Ground (VGND = VS) | -20<br>-30 | 40<br>40 | V |
| DC voltage INH | $V_{INH\_DC}$ | | -0.3 | $V_S$+0.3 | V |
| DC voltage VCC | $V_{VCC\_DC}$ | | -0.3 | 7 | V |
| DC voltage RTG | $V_{RTG\_DC}$ | | -0.3 | 7 | V |
| Input voltage at low voltage I/O's (EN, TxD, RxD, NRES, WDI, $RB_{WD}$) | $V_{IN}$ | | -0.3 | 7 | V |
| ESD voltage | $V_{ESDIEC}$ | IEC 61000-4-2, direct ESD<br>Pin LIN with LIN cap 220pF<br>Pin VS to GND | 20<br>15 | | kV |
| | $V_{ESDIECind}$ | IEC 61000-4-2, indirect ESD<br>Pin LIN with LIN cap 220pF | 15 | | kV |
| | $V_{ESDHBM}$ | HBM (CDF-AEC-Q100-002)<br>Pin LIN<br>Pin WAKE, KL15, VS<br>Other pins | <br>±6<br>±4<br>±2 | | <br>kV<br>kV<br>kV |
| | $V_{ESDCDM}$ | CDM (AEC-Q100-011) | ±500 | | V |
| Power dissipation | $P_0$ | | Internal limited, see also chapter 9.1 | | |
| Thermal resistance from junction to ambient | $R_{THJA\_SOIC8}$ | JEDEC 1s0p board, no air flow | | 150 | K/W |
| | $R_{THJA\_QFN20}$ | JEDEC 1s0p board, no air flow | | 50 | K/W |
| Junction temperature | $T_J$ | | -40 | 150 | °C |
| Storage temperature | $T_{STG}$ | | -55 | 150 | °C |

## 1.1. *DC Characteristics*

Unless otherwise specified all values in the following tables are valid for $V_S$ = 5 to 27V and $T_{AMB}$ = -40 to 125°C. All voltages are referenced to ground (GND), positive currents flow into the IC.
For MLX80031/51 apply: RTG connected to VCC.

**Table 2: Voltage Regulator and Reset Unit**

| | Parameter | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **Supply Voltage Pin VS** | | | | | | | | |
| | Nominal DC operating voltage | $V_S$ | | 5 | | 27 | V | A |
| 1.01 | $V_S$ under voltage reset | $V_{SUVR\_OFF}$ | $V_S$ ramp up | 2.9 | | 4.6 | V | A |
| 1.02 | $V_S$ under voltage reset | $V_{SUVR\_ON}$ | $V_S$ ramp down | 2.4 | | 4.2 | V | A |
| 1.03 | $V_S$ under voltage reset hysteresis | $V_{SUVR\_HYS}$ | $V_{SUVR\_OFF}$ - $V_{SUVR\_ON}$ | 0.04 | 0.3 | 0.7 | V | A |
| ***Supply currents MLX80030, MLX80050*** | | | | | | | | |
| 2.00 | Supply current, normal mode | $I_{VS\_nor}$ | $V_S \leq$ 14V, $V_{EN}$ > 2V, LIN recessive, no load at VCC | 400 | 750 | 1500 | µA | A |
| 2.01 | Supply current, sleep mode | $I_{VS\_sleep}$ | $V_S \leq$ 14V<br>$T_A$ = 25 °C<br>-40 °C ≤ $T_A$ ≤ 125 °C | | <br>20 | <br>20<br>30 | µA | A |
| 2.02 | Supply current, silent mode | $I_{VS\_sil}$ | $V_S \leq$ 14V, LIN recessive no load at VCC<br>$T_A$ = 25 °C<br>-40 °C ≤ $T_A$ ≤ 125 °C | <br><br>20 | <br><br>45 | <br>65<br>85 | µA | A |
| ***Supply currents MLX80031, MLX80051*** | | | | | | | | |
| 2.00 | Supply current, normal mode [2] | $I_{VS\_nor}$ | $V_S \leq$ 14V, $V_{EN}$ > 2V, $RB_{WD}$ = 60k LIN recessive, no load at VCC | 400 | 750 | 1500 | µA | A |
| 2.01 | Supply current, sleep mode | $I_{VS\_sleep}$ | $V_S \leq$ 14V<br>$T_A$ = 25 °C<br>-40 °C ≤ $T_A$ ≤ 125 °C | | <br>20 | <br>20<br>30 | µA | A |
| 2.02 | Supply current, silent mode | $I_{VS\_sil}$ | $V_S \leq$ 14V, LIN recessive no load at VCC<br>$T_A$ = 25 °C<br>-40 °C ≤ $T_A$ ≤ 125 °C | <br><br>20 | <br><br>45 | <br>65<br>85 | µA | A |

| | Parameter | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator Pin VCC** | | | | | | | | |
| ***MLX80050, MLX80051 (RTG connected to VCC)*** | | | | | | | | |
| 3.01 | Output voltage VCC | $V_{CCn5}$ | $6V \le V_S \le 18V$<br>$1mA \le I_{LOAD} \le 70mA$<br>$T_A$ = 25°C<br>$T_A$ = -40°C to 125°C | 4.90<br>4.85 | 5.0 | 5.10<br>5.15 | V | A |
| | Output voltage VCC under disturbances to fulfil functional state A | $V_{CCndis5}$ | $6V \le V_S \le 18V$, $T_A$ = 25°C<br>$R_{LOAD}$ = 330 Ω | 4.75 | | 5.25 | V | C |
| 3.02 | Drop-out voltage [3] | $V_{D10\_5}$ | $V_S > 4V$ , $I_{VCC}$ = 10mA | | 75 | 120 | mV | A |
| 3.03 | | $V_{D30\_5}$ | $V_S > 4V$ , $I_{VCC}$ = 30mA | | 220 | 350 | mV | A |
| 3.04 | | $V_{D70\_5}$ | $V_S > 4V$ , $I_{VCC}$ = 70mA | | 500 | 800 | mV | A |
| 3.05 | Line regulation | $V_{LNR5}$ | $6V \le V_S \le 18V$ | | | 20 | mV | C |
| 3.06 | Load regulation | $V_{LDR10\_5}$ | 1 mA < $I_{LOAD}$ < 10 mA | | | 50 | mV | A |
| 3.07 | | $V_{LDR30\_5}$ | 1 mA < $I_{LOAD}$ < 30 mA | | | 90 | mV | A |
| 3.08 | | $V_{LDR70\_5}$ | 1 mA < $I_{LOAD}$ < 70 mA | | | 150 | mV | A |
| 3.09 | Output current limitation | $I_{VCCLIM\_5}$ | $V_S$ > 6V<br>$T_A$ = -40 °C<br>25 °C ≤ $T_A$ ≤ 125 °C | -135<br>-150 | -110 | -75<br>-80 | mA | A |
| 3.10 | Load capacity | $C_{LOAD}$ | | 2.2 | 22 | | µF | D |
| ***MLX80030, MLX80031 (RTG connected to VCC)*** | | | | | | | | |
| 3.01 | Output voltage VCC | $V_{CCn3}$ | 4 V ≤ $V_S$ ≤ 18 V<br>1m A ≤ $I_{LOAD}$ ≤ 70 mA<br>$T_A$ = 25 °C<br>$T_A$ = -40 °C to 125 °C | 3.234<br>3.201 | 3.3 | 3.366<br>3.399 | V | A |
| | Output voltage VCC under disturbances to fulfil functional state A | $V_{CCndis3}$ | 6 V ≤ $V_S$ ≤ 18 V, $T_A$ = 25 °C<br>$R_{LOAD}$ = 330 Ω | 3.135 | | 3.465 | V | C |
| 3.02 | Drop-out voltage [3] | $V_{D10\_3}$ | $V_S$ > 3 V , $I_{VCC}$ = 10 mA | | | 100 | mV | A |
| 3.03 | | $V_{D30\_3}$ | $V_S$ > 3 V , $I_{VCC}$ = 30 mA | | | 300 | mV | A |
| 3.04 | | $V_{D70\_3}$ | $V_S$ > 3 V , $I_{VCC}$ = 70 mA | | | 700 | mV | A |
| 3.05 | Line regulation | $V_{LNR\_3}$ | 5 V ≤ $V_S$ ≤ 18 V | | | 20 | mV | A |
| 3.06 | Load regulation | $V_{LDR10\_3}$ | 1 mA < $I_{LOAD}$ < 10 mA | | | 50 | mV | A |
| 3.07 | | $V_{LDR30\_3}$ | 1 mA < $I_{LOAD}$ < 30 mA | | | 90 | mV | A |
| 3.08 | | $V_{LDR70\_3}$ | 1 mA < $I_{LOAD}$ < 70 mA | | | 150 | mV | A |
| 3.09 | Output current limitation | $I_{VCCLIM\_3}$ | $V_S$ > 4 V<br>$T_A$ = -40 °C<br>25 °C ≤ $T_A$ ≤ 125 °C | -135<br>-150 | -110 | -75<br>-80 | mA | A |
| 3.10 | Load capacity | $C_{LOAD}$ | | 2.2 | 22 | | µF | D |

| | Parameter | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **Output Pin NRES** | | | | | | | | |
| 4.01 | Output voltage low | $V_{OL\_NRES}$ | $I_{NRES}$ = 2 mA | | | 0.4 | V | A |
| 4.02 | Leakage current low | $I_{leak\_RxD}$ | $V_{NRES}$ = 0 V | -5 | | 5 | µA | A |
| 4.03 | Leakage current high | $I_{leak\_RxD}$ | $V_{NRES}$ = $V_{CC}$ | -5 | | 5 | µA | A |
| | Output voltage high NRES under disturbances to fulfil functional state A [4] | $V_{OH\_NRES}$ | $R_{load}$ = 2.7 k to VCC | $V_{CC}$ -1 | | | V | C |
| ***MLX80050, MLX80051*** | | | | | | | | |
| 5.01 | VCC reset threshold on NRES pin | $V_{RES5V}$ | t > $t_{rr}$ | 3.9 | 4.10 | 4.3 | V | A |
| 5.02 | $V_{RES}$ Hysteresis $V_{RESHYS}$ = \|$V_{RES(ON)}$ – $V_{RES(OFF)}$\| | $V_{RESHYS5V}$ | | | | 200 | mV | C |
| ***MLX80030, MLX80031*** | | | | | | | | |
| 5.01 | VCC reset threshold on NRES pin | $V_{RES3V}$ | t > $t_{rr}$ | 2.75 | 2.95 | 3.15 | V | A |
| 5.02 | $V_{RES}$ Hysteresis $V_{RESHYS}$ = \|$V_{RES(ON)}$ – $V_{RES(OFF)}$\| | $V_{RESHYS3V}$ | | | | 100 | mV | C |
| **Input Pin EN** | | | | | | | | |
| 6.01 | Input voltage low | $V_{IL\_EN}$ | | | | 0.8 | V | A |
| 6.02 | Input voltage high | $V_{IH\_EN}$ | | 2.0 | | | V | A |
| 6.03 | Hysteresis | $V_{HYS\_EN}$ | | 50 | 100 | 700 | mV | C |
| 6.04 | Pull-down resistor | $R_{pd\_EN}$ | $V_{EN}$ =VCC | 50 | 125 | 250 | kΩ | A |
| **Input Pin WAKE (MLX80031, MLX80051)** | | | | | | | | |
| 7.01 | High level input voltage | $V_{IH\_WAKE}$ | Sleep mode | $V_S$-1V | | | V | A |
| 7.02 | Low level input voltage | $V_{IL\_WAKE}$ | Sleep mode | | | $V_S$-3.3V | V | A |
| 7.03 | Pull up current WAKE | $I_{WAKE\_PU}$ | Normal & sleep | -30 | -15 | -1 | µA | A |
| 7.04 | Leakage current WAKE high | $I_{WAKE\_lk}$ | $V_S$ = 18V | -5 | | 5 | µA | A |
| **Input Pin KL15 (MLX80031, MLX80051)** | | | | | | | | |
| 8.01 | High level input voltage | $V_{IH\_KL15}$ | Rv = 50kΩ | 4 | | $V_S$+0.3V | V | A |
| 8.02 | Low level input voltage | $V_{IL\_KL15}$ | Rv = 50kΩ | -1 | | 2 | V | A |
| 8.03 | Pull down current KL15 | $I_{KL15\_PD}$ | | | 30 | 65 | µA | A |
| **Input Pin MODE (MLX80031, MLX80051)** | | | | | | | | |
| 23.01 | Input voltage low | $V_{IL\_MODE}$ | | | | 0.8 | V | A |
| 23.02 | Input voltage high | $V_{IH\_MODE}$ | | 2.0 | | | V | A |
| 23.03 | Hysteresis | $V_{HYS\_MODE}$ | | 50 | 100 | 700 | mV | C |
| 23.04 | Pull-down resistor | $R_{pd\_MODE}$ | $V_{MODE}$ =VCC | 200 | | 250 | kΩ | A |

| | Parameter | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **Input Pin NWDI (MLX80031, MLX80051)** | | | | | | | | |
| 9.01 | Input voltage low | $V_{IL\_NWDI}$ | | | | 0.8 | V | A |
| 9.02 | Input voltage high | $V_{IH\_NWDI}$ | | 2.0 | | | V | A |
| 9.03 | Hysteresis | $V_{HYS\_NWDI}$ | | 50 | 100 | 600 | mV | C |
| 9.04 | Pull-up resistor to VCC | $R_{pu\_NWDI}$ | $VN_{WDI}$ = 0V | 125 | 250 | 375 | kΩ | A |
| **Watchdog Oscillator pin $RB_{WD}$ (MLX80031, MLX80051)** | | | | | | | | |
| 10.01 | Voltage at $RB_{WD}$ | $V_{RBwd}$ | $I_{OUT}$ = -50 µA | | 1.2 | | V | A |
| 10.02 | Range of $RB_{WD}$ resistance | $RB_{WD}$ | | 20 | | 150 | kΩ | B |
| 10.03 | $RB_{WD}$ short resistance to disable Watchdog | $RB_{WDSH}$ | Watchdog disabled | 0 | | 330 | Ω | B |
| **Output INH (MLX80031, MLX80051)** | | | | | | | | |
| 11.01 | ON Resistance | $R_{ON\_INH}$ | $V_S$ = 12V | | 20 | 50 | Ω | A |
| 11.02 | Leakage current INH high | $I_{leakH\_INH}$ | Sleep Mode, $V_{INH}$ = 18V, $V_S$ = 18V | -5 | | 5 | µA | A |
| 11.03 | Leakage current INH low | $I_{leakL\_INH}$ | Sleep Mode, $V_{INH}$ = 0V, $V_S$ = 18V | -5 | | 5 | µA | A |
| **Thermal Protection** | | | | | | | | |
| | Thermal shutdown | $T_{JSHD}$ | | 155 | 170 | 190 | °C | D |
| | Thermal hysteresis | $T_{JHYS}$ | | | 10 | 30 | °C | D |

**Table 3: LIN DC Characteristics**

| Parameter | | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **General** | | | | | | | | |
| 12.01 | Pull up current LIN (recessive) | $I_{INLINpu}$ | $V_{LIN}$ = 18 V, $V_S$ = 6V | | | 80 | µA | A |
| 12.02 | Pull up resistor LIN | $R_{LINpu}$ | $V_S$ = 12V, $V_{LIN}$ = 0V | 20 | 30 | 60 | kΩ | A |
| 12.03 | Reverse current LIN (dominant) | $I_{INLINdom}$ | $V_S$ = 12V, $V_{LIN}$ = 0V | -400 | | | µA | A |
| 12.04 | Reverse current LIN (recessive) | $I_{INLINrec}$ | $V_{LIN} \geq V_S$, 8V ≤ $V_{LIN}$ ≤ 18V, 8V ≤ $V_S$ ≤ 18V | 0 | | 23 | µA | A |
| 12.05 | Reverse current LIN (loss of battery) | $I_{INLIN\_lob}$ | $V_S$ = 0V, 0V ≤ $V_{LIN}$ ≤ 18V | 0 | | 23 | µA | A |
| 12.06 | Reverse current LIN (loss of ground) | $I_{INLIN\_log}$ | $V_S$= 12V, 0V ≤ $V_{LIN}$ ≤ 18V | -10 | | 50 | µA | A |
| | Voltage drop serial Diode | $V_{SerDiode}$ | | 0.4 | 0.7 | 1.0 | V | D |
| | Battery Shift | $V_{Shift\_BAT}$ | | 0 | | 11.5 | % | D |
| | Ground Shift | $V_{Shift\_GND}$ | | 0 | | 11.5 | % | D |
| | Ground-Battery shift difference | $V_{Shift\_diff}$ | | 0 | | 8 | % | D |
| **Receiver** | | | | | | | | |
| 12.07 | Receiver dominant voltage | $V_{BUSdom}$ | 7.0 V ≤ $V_S$ ≤ 18 V | | | 0.4*$V_S$ | V | A |
| | Receiver recessive voltage | $V_{BUSrec}$ | | 0.6*$V_S$ | | | | A |
| 12.08 | Centre point of receiver threshold $V_{thr\_cnt}$ = ($V_{thr\_rec}$+$V_{thr\_dom}$)/2 | $V_{thr\_cnt}$ | | 0.475*$V_S$ | 0.5*$V_S$ | 0.525*$V_S$ | | A |
| 12.09 | Receiver Hysteresis $V_{hys}$ = $V_{thr\_rec}$-$V_{thr\_dom}$ | $V_{hys}$ | | | 0.15*$V_S$ | 0.175*$V_S$ | | A |
| **Transmitter** | | | | | | | | |
| 12.10 | Transmitter dominant voltage | $Vol_{bus}$ | $R_{load}$ = 500Ω, $V_S$ = 5V | 0 | | 1.2 | V | D |
| | | | $R_{load}$ = 500Ω, $V_S$ >= 7V | 0 | | 0.2*$V_S$ | | A |
| 12.11 | Current limitation LIN | $I_{LIM}$ | $V_{LIN}$ = $V_S$, TxD = 0V | 40 | 120 | 200 | mA | A |
| 12.12 | Transmitter recessive voltage | $Voh_{BUS}$ | No load, $V_{EN}$ = 0/5V, VTxD = 5V | 0,8*$V_S$ | | $V_S$ | V | A |

| Parameter | | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **Input/Output Pin TxD** | | | | | | | | |
| 13.01 | Input voltage low TxD | $V_{IL\_TxD}$ | rising | | | 0.8 | V | A |
| 13.02 | Input voltage high TxD | $V_{IH\_TxD}$ | | 2 | | | V | A |
| 13.03 | Hysteresis | $V_{HYS\_TxD}$ | | 50 | | 700 | mV | C |
| 13.04 | Pull-up resistor to VCC | $R_{pu\_TxD}$ | $V_{TxD}$ = 0V | 125 | 250 | 375 | kΩ | A |
| 13.06 | Low level output current | $I_{OL\_TxD}$ | local wake-up request; standby mode; $V_{TxD}$ = 0.4V | 1.5 | | | mA | A |
| **Output Pin RxD** | | | | | | | | |
| 14.01 | Output voltage low RxD | $V_{OL\_RxD}$ | $I_{RxD}$ = 2 mA | | | 0.6 | V | A |
| 14.02 | Pull-up resistor to VCC | $R_{pu\_RxD}$ | $V_{RxD}$ = 0V | 3 | 5 | 7 | kΩ | A |
| 14.03 | Leakage current high | $I_{leak\_RxD}$ | $V_{RxD}$ = VCC | -5 | | 5 | µA | A |
| | Output voltage high RxD under disturbances to fulfil functional state A [4] | $V_{OH\_RxD}$ | $R_{load}$ = 2.7k to VCC | $V_{CC}$ -1 | | | V | C |

Notes:

[1] A = 100% serial test, B = Operating parameter, C = only used for data characterization (cpk), D = Value guaranteed by design

[2] No watchdog reset; Watchdog trigger time on WDI = t.b.d.ms; Measurement of the average current of 10 watchdog periods.

[3] The nominal $V_{CC}$ voltage is measured at $V_{SUP}$ =12V. If the $V_{CC}$ voltage is 100mV below its nominal value then the voltage drop is $V_D = V_{SUP} - V_{CC}$

[4] Functionality range of current limitation at silent mode is limited by reset threshold $V_{RES}$. Below them the IC change to normal mode.

Validity for $I_{VCC\_MAXsil}$ : VCCn (min) ≤ VCC ≤ $V_{RES}$

## 1.2. *AC Characteristics*

6V ≤ $V_S$ ≤ 27V, -40°C ≤ $T_A$ ≤ 125°C, RTG connected to VCC, unless otherwise specified

**Table 4: AC Characteristics**

| Parameter | | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| **Reset parameter on NRES** | | | | | | | | |
| 16.01 | Reset time | $t_{Res}$ | $V_S$ = 14V | 2.5 | 4 | 5.5 | ms | A |
| 16.02 | Reset rising time | $t_{rr}$ | $V_S$ = 14V | *3.0* | *6.5* | *12* | µs | A |
| **Watchdog parameter on NRES (MLX80031, MLX80051)** | | | | | | | | |
| 17.01 | Watchdog-Oscillator Period (on TM9) | $t_{WDOSC20}$ | $RB_{WD}$ = 20kΩ ±1% | 6.87 | 8.09 | 9.30 | µs | A |
| 17.02 | | $t_{WDOSC60}$ | $RB_{WD}$ = 51kΩ ±1% | 16.06 | 18.90 | 21.73 | µs | A |
| 17.03 | | $t_{WDOSC100}$ | $RB_{WD}$ = 100kΩ ±1% | 30.58 | 35.98 | 41.37 | µs | A |

| Parameter | | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| 17.04 | | $t_{WDOSC150}$ | $RB_{WD}$ = 150kΩ ±1% | 45.40 | 53.41 | 61.42 | µs | A |
| | Watchdog Close Window | $t_{CW}$ | $t_{WDOSC}$ | | 1053 | | cy-cles | D |
| | Watchdog Open Window | $t_{OW}$ | $t_{WDOSC}$ | | 1105 | | cy-cles | D |
| 17.05 | Watchdog Reset Low Time | $t_{WDres}$ | | 3 | 4 | 5 | ms | A |
| | Watchdog Lead Window | $t_{LDT}$ | * $t_{WDOSC}$ | | 7895 | | cy-cles | D |
| 17.06 | Watchdog Safety Oscillator | $t_{WDsafety}$ | $RB_{WD}$ gnd | *30* | 50 | *75* | µs | A |
| **Wake-up and Mode Control** | | | | | | | | |
| 18.01 | Remote Wake-up filter time | $t_{wu\_remote}$ | | 30 | 70 | 150 | µs | A |
| 18.02 | Wake-up filter time on WAKE (only MLX80051,MLX80031) | $t_{wu\_WAKE}$ | Sleep or Silent Mode, WAKE falling edge | 10 | | 50 | µs | A |
| 18.03 | Wake-up filter time on KL15 (only MLX80051,MLX80031) | $t_{wu\_KL15}$ | Sleep or Silent Mode, KL15 rising edge | 80 | 168 | 250 | µs | A |
| 18.04 | Propagation delay from Normal Mode to Sleep Mode via EN | $t_{pd\_sleep}$ | $V_{EN}$ = 0V | 5 | 15 | 20 | µs | A |
| 18.05 | Propagation delay from Standby Mode to Normal Mode via EN | $t_{pd\_norm}$ | $V_{EN}$ = 5V | 5 | 15 | 20 | µs | A |
| 18.06 | Propagation delay from Silent Mode to Normal Mode via EN | $t_{pd\_sil\_n}$ | $V_{EN}$ = 5V | 5 | 15 | 40 | µs | A |
| 18.07 | Propagation delay: go to silent mode after EN=H/L[3] | $t_{pd\_sil}$ | check falling edge on RBwd EN = 0V | | | 20 | µs | A |
| | Setup time TxD to EN for low slew mode | $t_{set\_TxD\_EN}$ | | 5 | | | µs | B |
| | Hold time TxD after EN for low slew mode | $t_{hold\_TxD\_EN}$ | | 20 | | | µs | B |
| 18.08 | Debouncing time EN | $t_{deb\_EN}$ | | 2 | 5 | 20 | µs | A |
| 18.09 | TxD dominant time out | $t_{TxD\_to}$ | Normal Mode, $V_{TxD}$ = 0V | 27 | | 60 | ms | A |
| 18.10 | Standby time out | $t_{sby\_to}$ | Standby Mode, $V_{EN}$= 0V | 150 | | 500 | ms | A |
| **General LIN Parameter** | | | | | | | | |
| 19.01 | Receiver propagation delay LIN -> RxD | $t_{dr\_RxD}$ $t_{df\_RxD}$ | $C_{L(RXD)}$ = 50 pF | | | 6 | µs | A |
| 19.02 | Symmetry prop. delay LIN->RxD | $t_{dsym\_RxD}$ | $t_{dr\_RXD}$ - $t_{df\_RXD}$ | -2 | | 2 | µs | A |
| 19.03 | Receiver debouncing time | $t_{deb\_LIN}$ | | 1.5 | 2.8 | 4.0 | µs | D |

| | Parameter | Symbol | Condition | Min | Typ | Max | Unit | T[1] |
|---|---|---|---|---|---|---|---|---|
| 19.04 | slew rate rising edge LIN | dV/dTrise | Normal Mode LIN-Load: 1k / 1nF | 1.0 | 1.5 | 2.5 | V/µs | C |
| 19.05 | slew rate falling edge LIN | dV/dTfall | | -2.5 | -1.5 | -1.0 | V/µs | C |
| 19.06 | slew rate rising edge LIN | dV/dTrise | Low Slew Mode LIN-Load: 1k / 1nF | 0.3 | 0.8 | 1.3 | V/µs | C |
| 19.07 | slew rate falling edge LIN | dV/dTfall | | -1.3 | -0.8 | -0.3 | V/µs | C |
| | Internal capacity | $C_{LIN}$ | Pulse at LIN via 10kOhm with 0/10 V; VS = open | | 25 | 35 | pF | D |
| **LIN transceiver parameter according to LIN Physical Layer Spec. rev. 2.0, table 3.4 (20kbit/s)** | | | | | | | | |
| Conditions: | Normal slew mode; $V_S$ =7.0V to 18V; LIN loads: 1kΩ/1nF; 660Ω/6.8nF; 500Ω/10nF<br>TxD signal: $t_{Bit}$ = 50µs, $t_{wH}$ = $T_{wL}$ = $t_{Bit}$; $t_{rise}$ = $t_{fall}$ < 100ns | | | | | | | |
| | Minimal recessive bit time [2] | $t_{rec(min)}$ | | 40 | 50 | 58 | µs | |
| | Maximum recessive bit time [2] | $t_{rec(max)}$ | | 40 | 50 | 58 | µs | |
| 20.01 | Duty cycle 1 | $D_1$ | $D_1 = t_{rec(min)} / (2*t_{Bit})$ | 0.396 | | | | A |
| 20.02 | Duty cycle 2 | $D_2$ | $D_2 = t_{rec(max)} / (2*t_{Bit})$ | | | 0.581 | | A |
| **Transceiver parameter according to LIN Physical Layer Spec. rev. 2.0, table 3.4 (10.4kbit/s)** | | | | | | | | |
| Conditions: | Low slew mode; $V_S$ =7.0V to 18V; LIN loads: 1kΩ/1nF; 660Ω/6.8nF; 500Ω/10nF<br>TxD signal: $t_{Bit}$ = 96µs, $t_{wH}$ = $T_{wL}$ = $t_{Bit}$; $t_{rise}$ = $t_{fall}$ < 100ns | | | | | | | |
| | Minimal recessive bit time [2] | $t_{rec(min)}$ | | 80 | 96 | 113 | µs | |
| | Maximum recessive bit time [2] | $t_{rec(max)}$ | | 80 | 96 | 113 | µs | |
| 21.01 | Duty cycle 1 | $D_3$ | $D_3 = t_{rec(min)} / (2*t_{Bit})$ | 0.417 | | | | A |
| 21.02 | Duty cycle 2 | $D_4$ | $D_4 = t_{rec(max)} / (2*t_{Bit})$ | | | 0.590 | | A |
| **LIN transceiver parameter according to SAE J2602 (10.4kbit/s)** | | | | | | | | |
| Conditions: | Low slew mode; $V_S$ =7.0V to 18V; LIN loads: 1kΩ/1nF;660Ω/6.8nF;500Ω/10nF<br>TxD signal: $t_{Bit}$ = 96µs, $t_{wH}$ = $T_{wL}$ = $t_{Bit}$; $t_{rise}$ = $t_{fall}$ < 100ns | | | | | | | |
| 22.01 | Minimal recessive delay TxD -> LIN [2] | $t_{x\_rec\_min}$ | | | | 48 | µs | A |
| 22.02 | Maximum recessive delay TxD -> LIN [2] | $t_{x\_rec\_max}$ | | | | 48 | µs | A |
| 22.03 | Minimal dominant delay TxD -> LIN [2] | $t_{x\_dom\_min}$ | | | | 48 | µs | A |
| 22.04 | Maximum dominant delay TxD -> LIN [2] | $t_{x\_dom\_max}$ | | | | 48 | µs | A |
| 22.05 | Maximum rec. to dom. delay | $T_{r\_d\_max}$ | $t_{x\_rec\_max}$ - $t_{x\_dom\_min}$ | | | 15.9 | µs | A |
| 22.06 | Maximum dom. to rec. delay | $T_{d\_r\_max}$ | $t_{x\_dom\_max}$ - $t_{x\_rec\_min}$ | | | 17.2 | µs | A |

[1] A = 100% serial test, B = Operating parameter, C = only used for data characterization (cpk), D = Value guaranteed by design

## 1.3. *Timing diagrams*

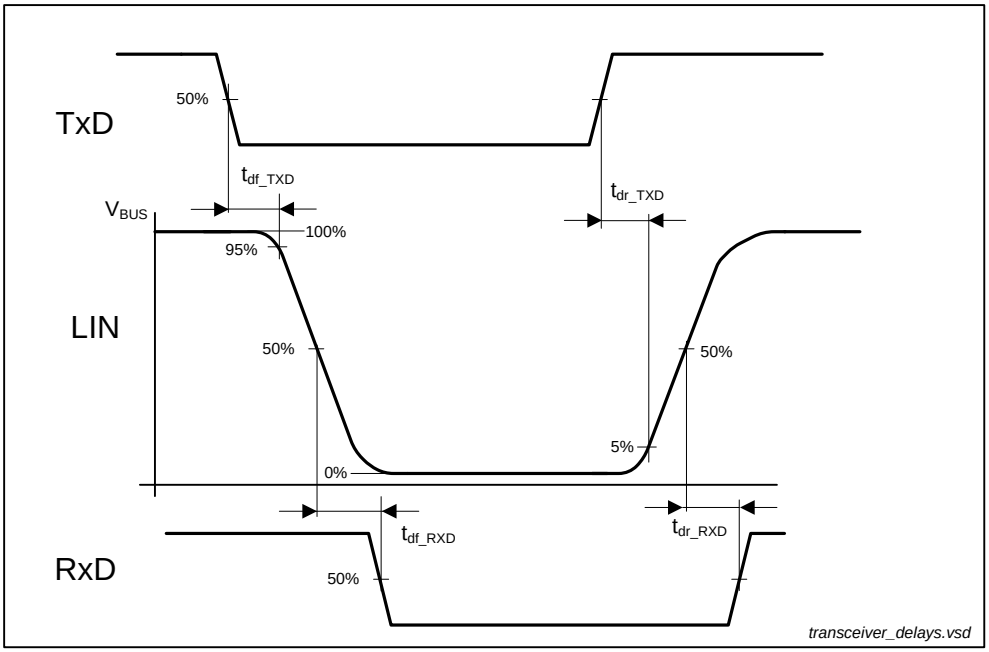



**Figure 1: LIN propagation delays**

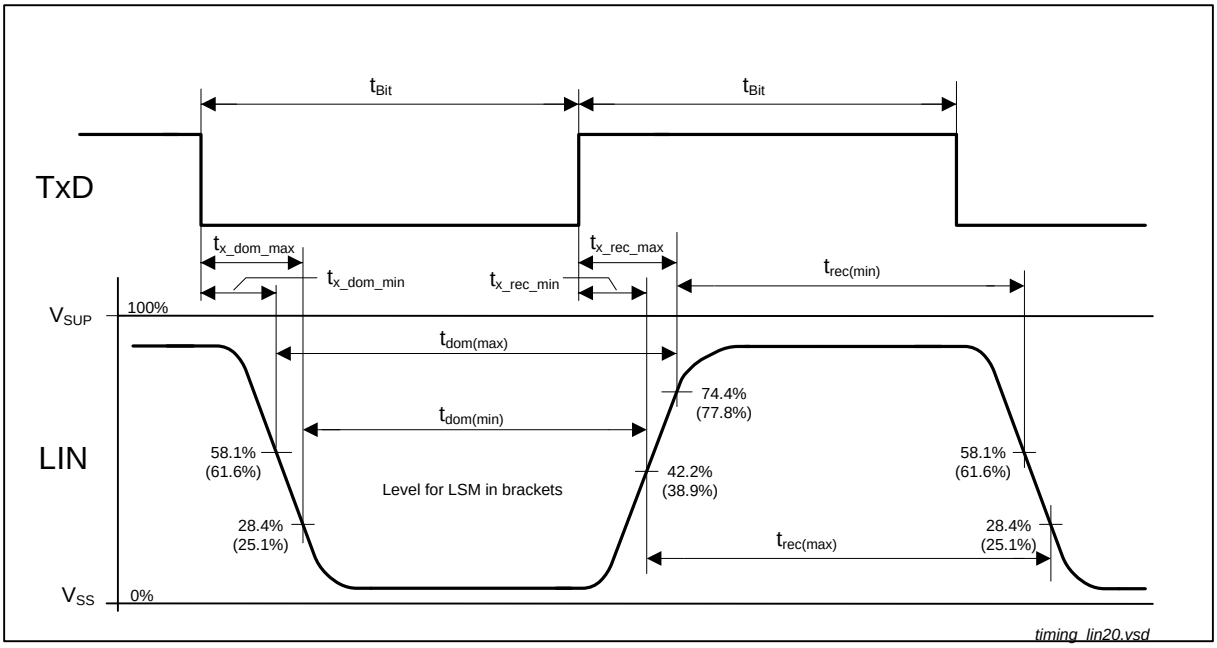



**Figure 2: LIN duty cycles**

# 2. Pin Configuration

## 2.1. *MLX80030 and MLX80050 - SOIC8*

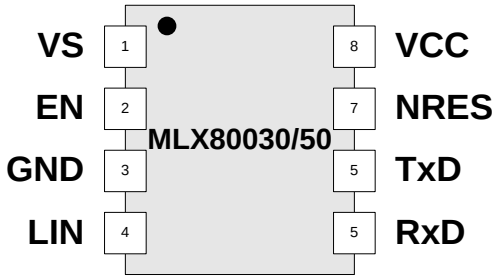



**Table 5: MLX80050/30 pin list in SOIC8**

| Pin | Name | IO-Typ | Description |
|---|---|---|---|
| 1 | VS | P | Battery supply voltage |
| 2 | EN | I | Mode control pin, enables the normal operation mode when HIGH |
| 3 | GND | G | Ground |
| 4 | LIN | I/O | LIN bus transmitter/receiver pin,<br>(low = dominant) |
| 5 | RxD | I/O | Received data from LIN bus, low in dominant state; internal pull-up resistor |
| 6 | TxD | I/O | Transmit data input (low = dominant) |
| 7 | NRES | O | Undervoltage reset output (open drain),<br>low active |
| 8 | VCC | P | Voltage regulator output |

## 2.2. *MLX80031 and MLX80051 in QFN20*

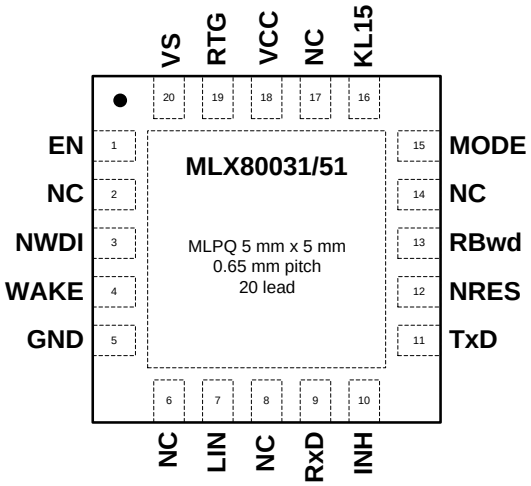



**Table 6: MLX80051/31 pin list in QFN20**

| Pin | Name | IO-Typ | Description |
|---|---|---|---|
| 1 | EN | I | Mode control pin, enables the normal operation mode when HIGH |
| 2 | NC | | not connected |
| 3 | NWDI | I | Watchdog trigger input; negative edge; pull-up |
| 4 | WAKE | I | High voltage input for local wake up, negative edge triggered |
| 5 | GND | G | Ground |
| 6 | NC | | not connected |
| 7 | LIN | I/O | LIN bus transmitter/receiver pin, (low = dominant) |
| 8 | NC | | not connected |
| 9 | RxD | I/O | Received data from LIN bus, low in dominant state; internal pull-up resistor |
| 10 | INH | O | High side switch; High voltage |
| 11 | TxD | I/O | Transmit data input (low = dominant) |
| 12 | NRES | O | Reset output (open drain), low active |
| 13 | $RB_{WD}$ | I/O | Bias resistor for watchdog oscillator |
| 14 | NC | | not connected |
| 15 | MODE | I | Input to control window watchdog; internal pull-down resistor |
| 16 | KL15 | I | High voltage input for local wake up, positive edge triggered |
| 17 | NC | | not connected |
| 18 | VCC | I | Voltage regulator sense input |
| 19 | RTG | P | Voltage regulator output |
| 20 | VS | P | Battery supply voltage |

## 3. Functional Description

The MLX8003x/5x consists of a low drop 3.3V/5V voltage regulator capable to drive 70mA and a LIN bus transceiver, which is a bi-directional bus interface for data transfer between LIN bus and the LIN protocol controller. Additionally integrated is a Window-Watchdog/RESET unit with a fixed power-on-reset delay of 4 ms and an adjustable watchdog time defined by an external bias resistor.

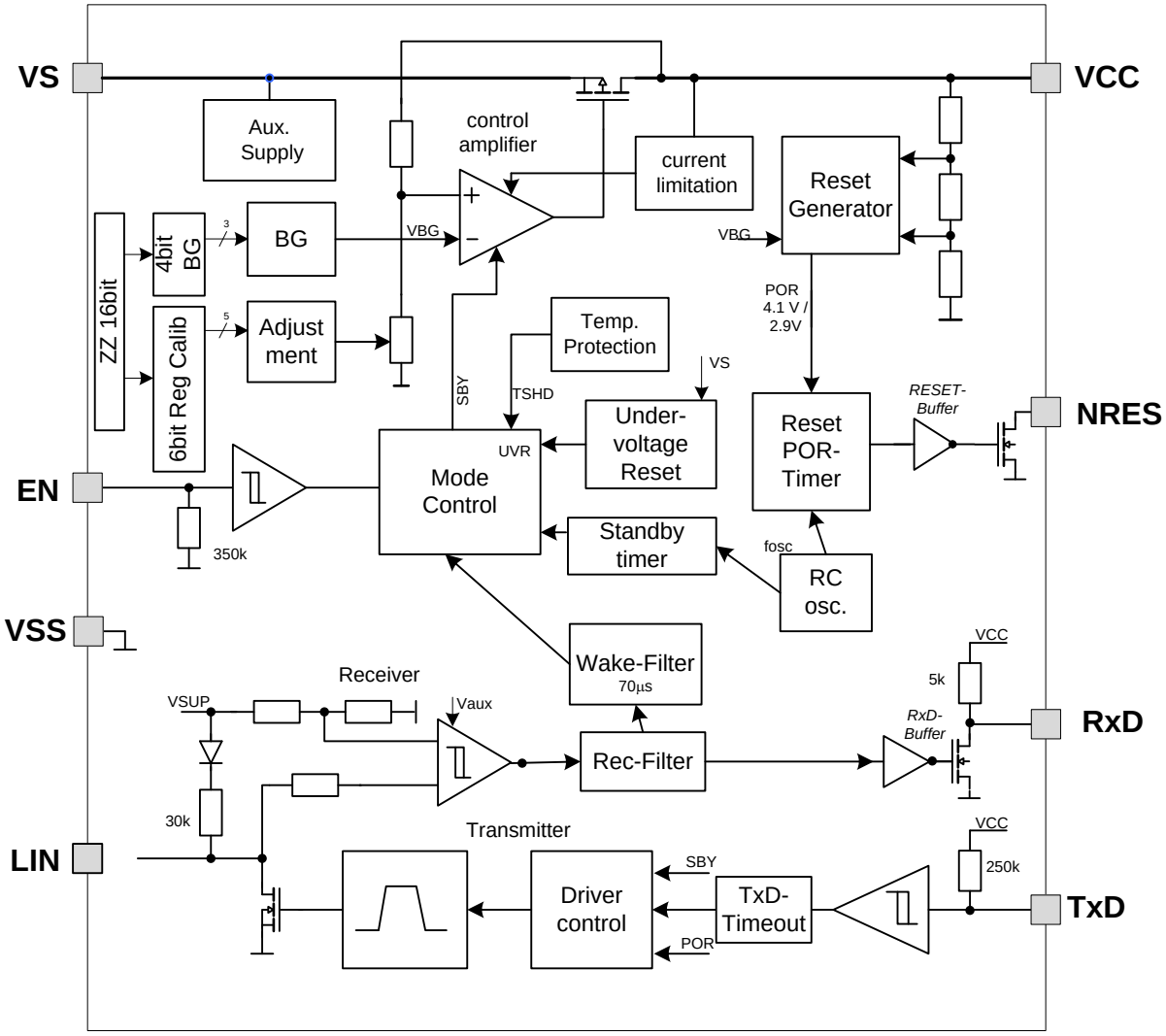



**Figure 3: MLX80050/30 Block Diagram**

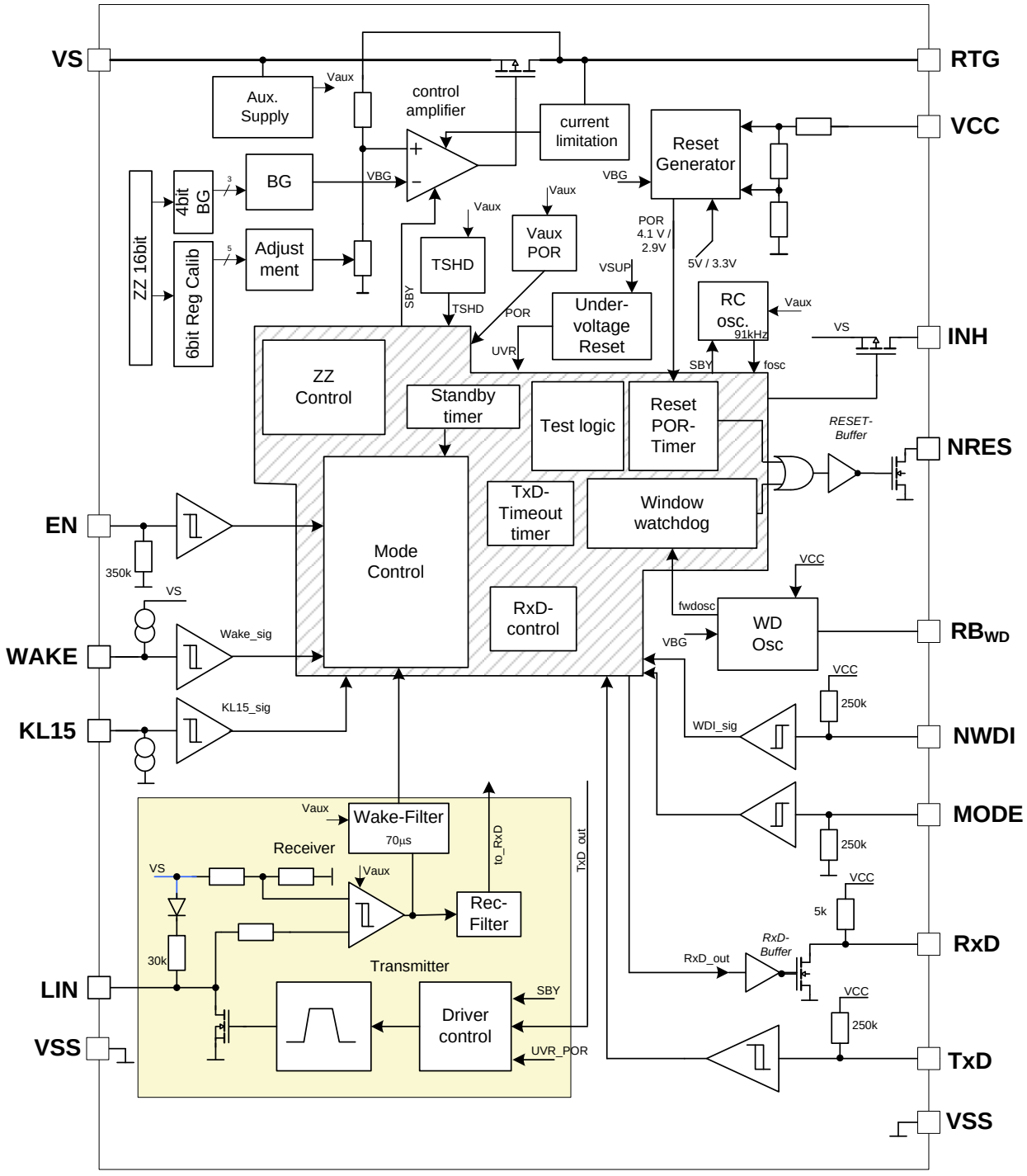



**Figure 4: MLX80051/31 Block Diagram**

## 3.1. *Supply Pin VS*

VS is the operational voltage pin of MLX8005x/3x. The voltage range is VS = 6 to 18V. After switching on VS, the MLX8003x/5x starts at Standby Mode and the VCC voltage regulator ramps up. An undervoltage detection unit prevent an undefined operation for Vs < 4V.

**VS- Power-ON**

If VS is switched on, the MLX8003x/5x starts in Standby Mode. A combination of dynamic POR and under voltage reset circuitry generates a POR signal, which switches the MLX8003x/5x on. This power on behaviour is independent from the status of the EN-pin.

Power-on reset and under-voltage reset operate independent from each other, which secures the independence from the rise time of VS.

## 3.2. *EN input pin*

The ENable input is the mode control pin of MLX8003x/5x in combination with the TxD input.

The MLX8003x/5x is switched into the Sleep Mode with a falling edge and into normal mode with a rising edge at the EN pin. The state machine goes to Normal Mode after $t_{Res}$ (see also Table 4: AC Characteristics). The Normal Mode will be kept as long as EN remains high.

The Normal Mode can be entered from Standby Mode, when the pin EN is driven HIGH. To prevent unwanted mode transitions, the EN input contains a debounce filter as specified ($t_{EN\_deb}$).

The pin EN contains a weak pull down resistor. The input thresholds are compatible to 3.3V and 5V supply systems.

MLX80031/51:

Additionally the positive edge on pin EN results in an immediate reset of the active low interrupt on pin RxD as well as the wake-up source recognition flag on pin TxD.

## 3.3. *Ground pin GND*

This is the reference pin of the IC. The absence of GND connection will not influence or disturb the communication between other LIN bus nodes.

## 3.4. *LIN*

This bidirectional pin consists of a low side driver in the output path and a high-voltage comparator in the input path. Furthermore is integrated a LIN pull-up resistor between LIN and VS pin. Low side driver consist a current limitation.

## 3.5. *Receiver Output RxD*

The pin RxD is a buffered open drain output. Output signals can be shifted by the external pull up resistor to 3.3V and 5V supply systems.

## 3.6. *Transmit Input TxD*

The transmit data stream of the LIN protocol controller applied to the pin TxD is converted into the LIN bus signal with slew rate control in order to minimize electromagnetic emissions.

The pin TxD contains a weak pull up resistor. The input thresholds are compatible to 3.3V and 5V supply systems. To enable the transmit path, the TxD pin has to be driven recessive (HIGH) after or during the normal mode has been entered.

### *3.6.1. TxD dominant time-out feature*

With the first dominant level on pin TxD after the transmit path has been enabled, the dominant time-out counter is started. In case of a faulty blocked permanent dominant level on pin TxD the transmit path will be disabled after the specified time $t_{TxD\_to}$. The time-out counter is reset by the first negative edge on pin TxD.

## 3.7. *Output NRES*

The NRES pin outputs the reset state as well as the watchdog condition in MLX80031 and MLX80051.

## 3.8. *Voltage regulator pins VCC and RTG*

The MLX80030/50 has an integrated low drop linear regulator with a p-channel-MOSFET as driving transistor. This regulator outputs a voltage of 5V ±2% (MLX80050/51) or 3.3V ±2% (MLX80030/31) with a load current of max. 70mA. The current limitation unit limits the output current for short circuits or overload to 130mA by decreasing the VCC voltage. This way the power dissipation is held constant at a maximum value.

The voltage regulator has two pins, output pin RTG and sense input pin VCC. For MLX80030/50 both, RTG and VCC, are commonly bonded to pin VCC on the package.

Devices MLX80031/51 has both pins bonded and provides the possibility to use an external npn transistor to boost the maximum load current. In this case the basis of the npn transistor has to be connected to the RTG pin and the emitter to the VCC pin. In case of using the internal voltage regulator, both pins have to be connected to each other.

## 3.9. *INH Output (only MLX80031/51)*

INH switches to high (VS connected to INH) in case of Standby or Normal Mode. INH is switched off at Silent and Sleep Mode. The pin will be used for switch on an external power supply or for switch off the external 1k master resistor in master node applications.

## 3.10. *WAKE Input (only MLX80031/51)*

High voltage input pin for local wake-up functionality. With a falling edge on WAKE the IC wakes-up from Silent Mode or Sleep Mode to Standby Mode.

The pin WAKE provides a weak pull up current source towards Vs which provides a HIGH level on the pin in case of open circuit failures or if no local wake-up feature is required. In such applications it is recommended to connect the pin WAKE directly to pin Vs in order to prevent influences due to EMI.

## 3.11. *KL15 Input (only MLX80031/51)*

High voltage input pin for local wake-up functionality. With a rising edge on KL15 the IC wakes-up from Silent Mode or Sleep Mode to Standby Mode.

The pin KL15 provides a weak current sink towards GND which provides a LOW level on the pin in case of open circuit failures or if no local wake-up feature is required. In such applications it is recommended to connect the pin KL15 directly to GND in order to prevent influences due to EMI. KL15 is typically connected to the ignition terminal and generates a local wake-up at start of ignition.

## 3.12. *Watchdog Trigger Input NWDI (only MLX80031/51)*

This input is used to trigger the integrated window watchdog in MLX80031/51. Every falling edge on NWDI in watchdog open window is used to reset the watchdog timer. An internal pull up resistor of 250k secures a stable high condition if this pin is open. The NWDI input is a low voltage CMOS input.

## 3.13. *Watchdog Oscillator Resistor $RB_{WD}$ (only MLX80031/51)*

A resistor between $RB_{WD}$ and GND defines the window watchdog times as trigger time and reset time.

## 3.14. *Mode Input MODE (only MLX80031/51)*

Special pin for to disable the window watchdog function. For normal watchdog operation connect the MODE pin to GND directly or via external resistor. With MODE pin on 3.3V/5V the window watchdog is switched off.

# 4. Operational Modes

The MLX8003x/5x provides four main operating modes “Standby”, “Normal”, “Silent” and “Sleep”. The main modes are fixed states defined by basic actions (VS start, EN or wake-up).

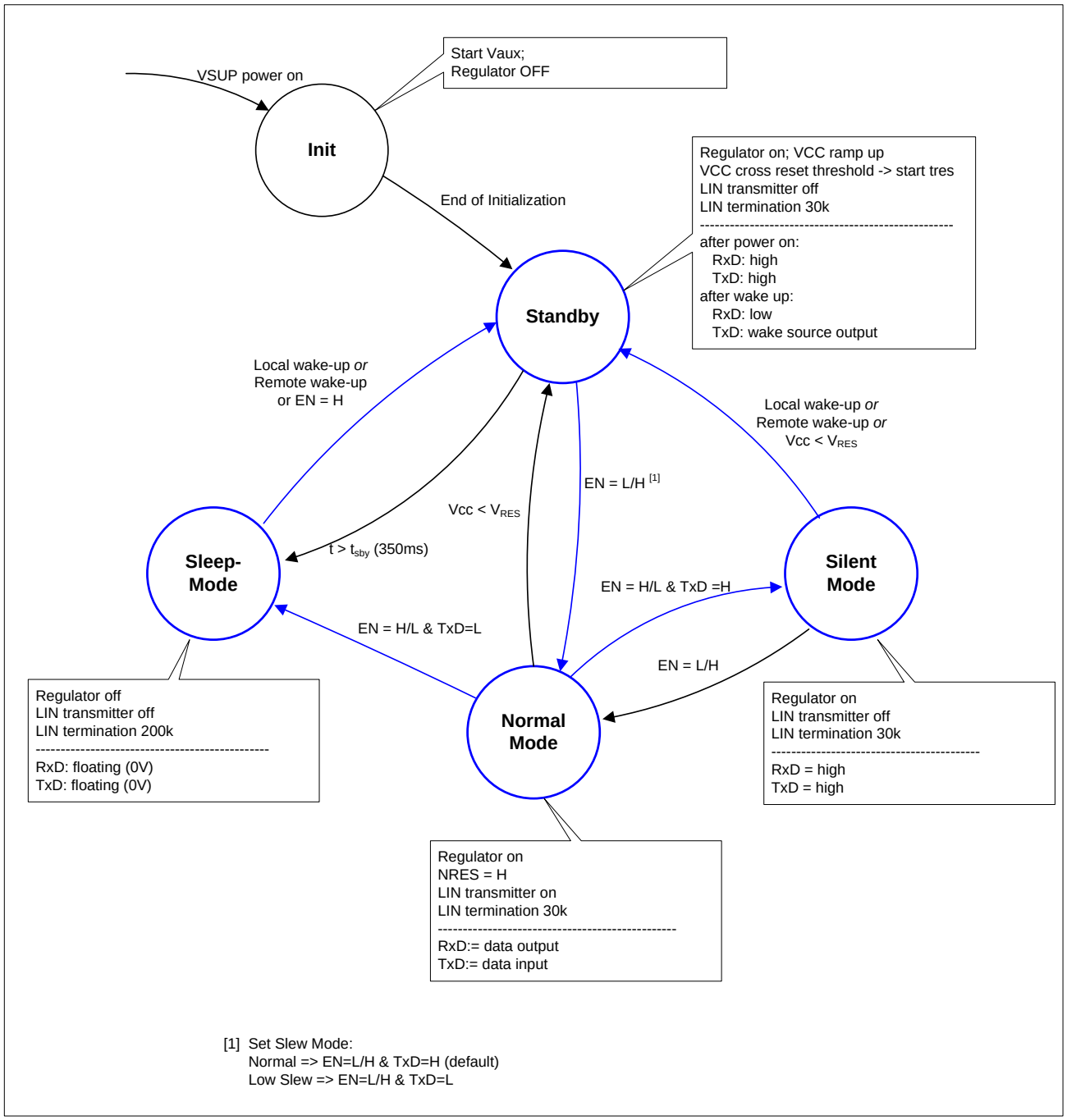



**Figure 5: MLX8005x3x state diagram of modes of operation**

## 4.1. *Modes Overview*

**Table 7: MLX80050/30 Operation Modes**

| Mode | VCC | TxD | RxD | LIN | remarks |
|---|---|---|---|---|---|
| Standby | 3.3V/5V | high | high | recessive | entered after power on or wake up |
| Normal | 3.3V/5V | input for transmit data stream | output for LIN data stream | follows TxD | [1] |
| Silent | 3.3V/5V | high | high | recessive | high = 3.3V/5V |
| Sleep | 0 | floating | floating | recessive | remote wake up to enter Standby Mode, EN = H to go to Normal Mode |

[1] Normal mode will be entered form Standby Mode by a low -> high transition on pin EN and from Sleep Mode by EN = H after startup of the regulator. When recessive level (high) on pin TxD is present the transmit path will be enabled

**Table 8: MLX80051/31 Operation Modes**

| Mode | VCC | TxD | RxD | LIN | INH | Watchdog | remarks |
|---|---|---|---|---|---|---|---|
| Standby | 3.3V/5V | High/ active low[1] | high/ active low[2] | recessive | ON | ON | entered after power on or wake up |
| Normal | 3.3V/5V | input for transmit data stream | output for LIN data stream | follows TxD | ON | ON | [3] [4] [5] |
| Silent | 3.3V/5V | high | high | recessive | OFF | OFF | |
| Sleep | 0 | floating | floating | recessive | OFF | OFF | Local or re-mote wake up to enter Standby Mode, EN = H to go to Normal Mode |

[1] Indicates the wake up flag in case of local wake up
[2] After power on RxD is going high via pull-up to Vcc. If any wake up(local or remote) occurs it will be indicated by active low
[3] Active low interrupt at pin RxD will be removed when entering normal mode
[4] Wake up source flag at pin TxD will be removed when entering normal mode
[5] Normal mode will be entered from Standby Mode by a low -> high transition on pin EN and from Sleep Mode by EN = H after startup of the regulator. When recessive level (high) on pin TxD is present the transmit path will be enabled

## 4.2. *Initialisation and Standby mode*

When the battery supply voltage VS exceeds the specified threshold $V_{SUVR\_OFF}$, the MLX8003x/5x automatically enters the Standby Mode. Following internal procedure is running:

**First:**

- Start of internal supply Vaux and POR of Vaux
- Start of internal RC oscillator

**Second** and parallel after POR:

- Start of voltage regulator

The output voltage $V_{CC}$ ramps up to nominal value. The pin RxD is floating and the integrated slave pull up resistor with decoupling diode pulls the pin LIN. The transmitter as well as the receiver is disabled.

If there occurs no mode change to Normal Mode via an EN LOW to HIGH transition within the time stated (typically 350ms), the IC enters the most power saving Sleep Mode.

Furthermore the standby mode will be entered after a valid local or remote wake up event, when the MLX8003x/5x is in Sleep or Silent mode. The entering of the standby mode after wake up will be indicated by an active LOW interrupt on pin RxD.

## 4.3. *Normal Mode*

This mode is the base mode. The bus transceiver is able to send with a max baud rate of 20kbit/s.

The whole MLX8003x/5x is active. The incoming bus traffic is detected by the receiver and transferred via the RxD output pin to the microcontroller.

To exit the Normal Mode with on of the following condition:

1. High-to-low edge on EN pin with TxD = H -> switch to Silent Mode
2. High-to-low edge on EN pin with TxD = L -> switch to Sleep Mode
3. Undervoltage monitor on VCC detects a low voltage reset condition (VCC < $V_{RES}$) -> switch back to stand-by mode.

### *Low Slew Mode*

The first rising edge on EN after power-on defines the slew rate of the device. With TxD = High at this point works the MLX8003x/5x with normal slew rate (default state). TxD = Low activates the Low Slew Mode, as long as VS > $V_{SUVR\_OFF}$.

In this mode the slew rate is switched from the normal value of typ. 1.6V/µs to a low value of typ. 0.8V/µs. This mode is optimized to send with a maximum baud rate of 10.4kbit/s (acc. to SAE J2602). Because of this reduction of the slew rate the EME behaviour is improved especially in the frequency range of 100 kHz to 10MHz.

## 4.4. *Silent Mode*

The Silent Mode is a special mode for application with active Sleep Mode on LIN, but the connected MCU still needs to be supplied with VCC.

With a falling edge on EN input in combination with TxD=high switches the MLX8003x/5x from Normal Mode to the Silent Mode with reduced internal current consumption.

In Silent Mode the voltage regulator is on with a 2% tolerance. The transmitter is disabled and the pin RxD is disconnected from the receive path and is floating. The slave termination resistor (LIN pull up resistor with decoupling diode between pins LIN and VS) is disconnected; only a weak curernt source is applied to the LIN bus. Value is typical -75uA, limits -20…-100uA.

To exit the silent mode with on of the following condition:

1. Low-to-high edge on the EN pin -> switch back to normal mode
2. Remote wake up (all versions) or local wake up request (MLX80031/51 only) -> switch to standby mode
3. Undervoltage monitor on VCC detects a low voltage reset condition (VCC < $V_{RES}$) -> switch back to stand-by mode.

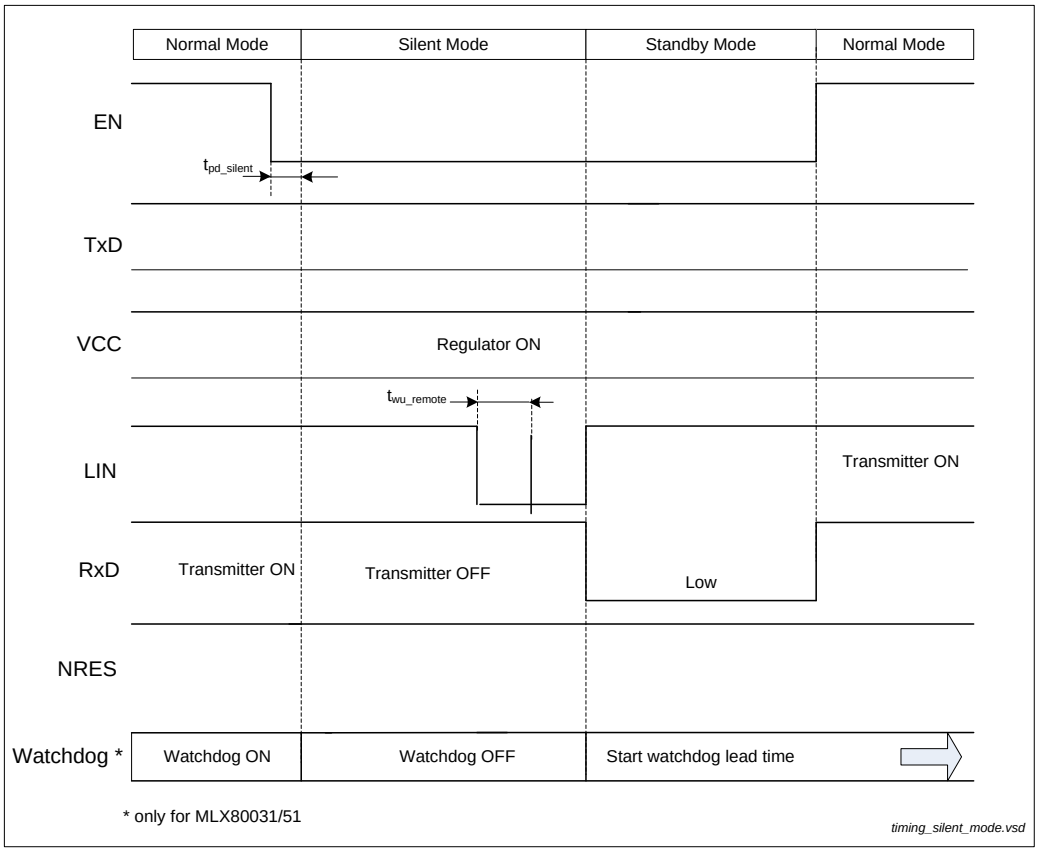



**Figure 6: LIN wake-up from Silent Mode**

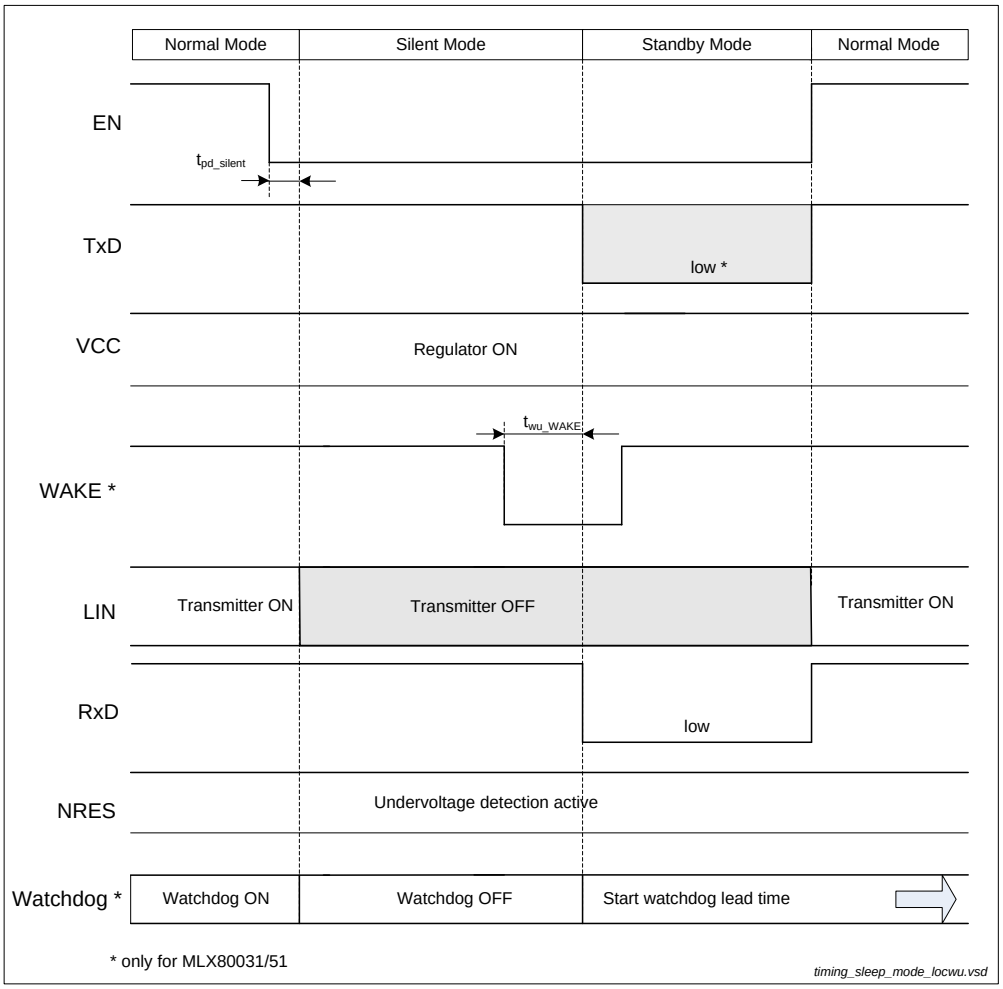



**Figure 7 Local Wake-up from Silent Mode via WAKE**

## 4.5. *Sleep Mode*

The most power saving mode of the MLX8003x/5x is the Sleep Mode. The MLX8003x/5x offers two procedures to enter the sleep mode:

- The mode is selected from normal mode with a falling edge on EN in combination with TxD = L.
- If the MLX8003x/5x is in Standby Mode after power-on or wake-up, a sleep counter is started and switches the transceiver into Sleep Mode after the specified time (typ. 350ms) even when the microcontroller of the ECU will not confirm the normal operation by setting the EN pin to logic HIGH. This new feature allows faulty blocked LIN nodes to reach always the most power saving mode.

Being in Sleep Mode the voltage regulator switched off in order to minimize the current consumption of the complete LIN node. The transmitter is disabled and the pin RxD is disconnected from the receive path and is low (follows VCC). The slave termination resistor (LIN pull up resistor with decoupling diode between pins LIN and VS) is disconnected, only a weak current source is applied to the LIN bus (see chapter 8 fail-safe features)

To exit the Sleep Mode with one of the following condition(s):

1. Remote (all versions) or local wake up request (MLX80031/51 only) -> Switch to Standby Mode

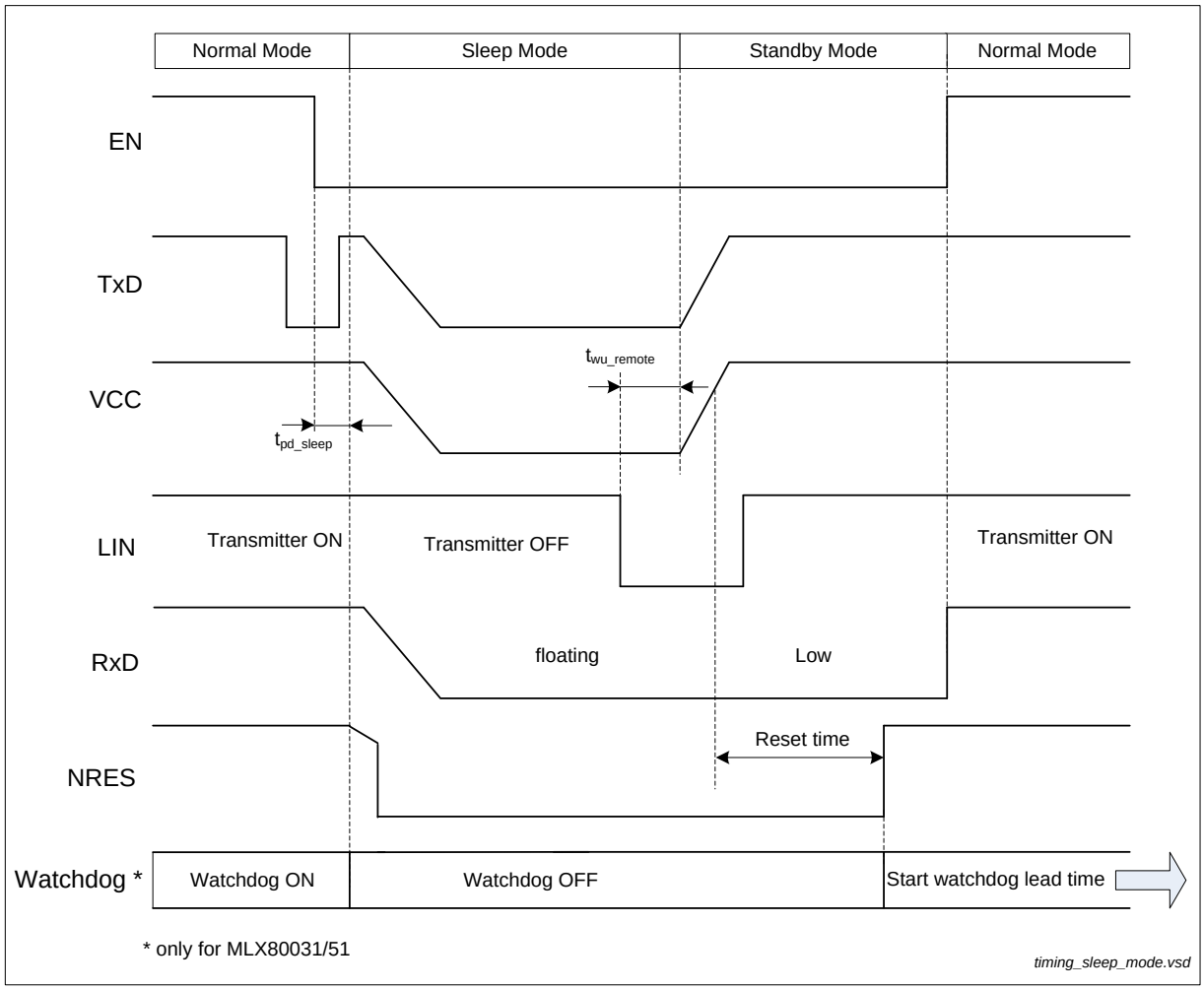



**Figure 8: Remote wake-up from Sleep Mode**

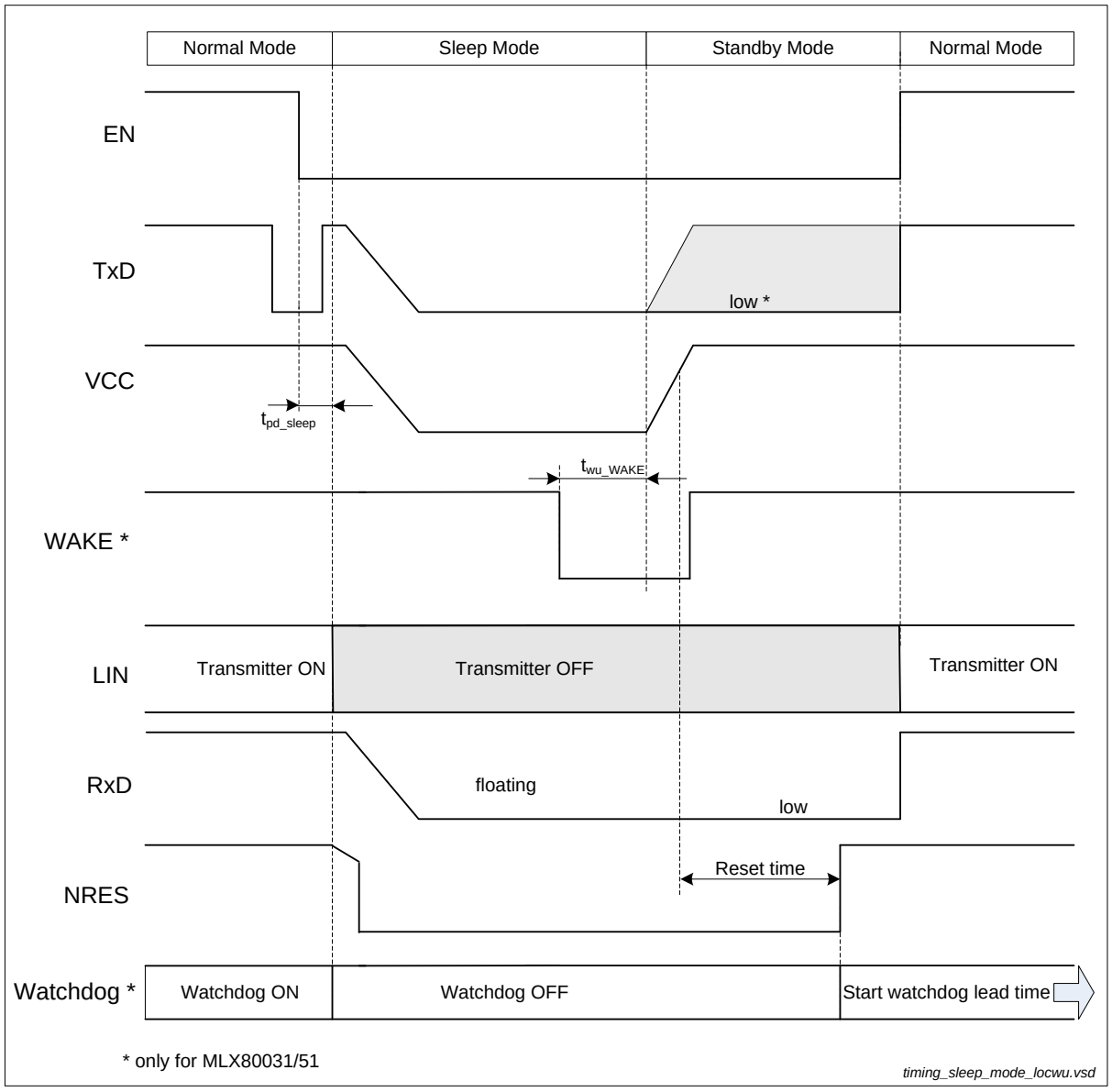



**Figure 9: Local wake-up from Sleep Mode**

## 4.6. *Init-State*

This is an intermediate state, which will pass through after switch on of VS or after undervoltage detection VS with VS < $V_{SUVR\_ON}$. The internal supply voltage Vaux ramp up and the initial readout procedure off zenerzap storage are started. On the end off this phase the VCC voltage definition and the definition of MLX8003x5x version is established. This Init-State changes to Standby Mode with the start of VCC regulator.

# 5. Wake Up Procedures

The MLX80030/50 versions offer only remote wake-up:

- After a falling edge on the LIN bus followed by a dominant voltage level for longer than the specified value ($t_{wu\_remote}$) and a rising edge on pin LIN will cause a remote wake up. The device switches to Standby Mode and the wake-up request is indicated by an active LOW on pin RxD.

The MLX80031/51 versions offer three wake-up procedures:

- In applications with continuously powered ECU a wake up via mode transition to normal mode is possible (see chapter 4.3 Normal Mode)
- Remote wake-up via LIN bus traffic
  After a falling edge on the LIN bus followed by a dominant voltage level for longer than the specified value($t_{wu\_remote}$) and a rising edge on pin LIN will cause a remote wake up (see)
- Local wake-up via a negative edge on pin WAKE
  A negative edge on the pin WAKE and a dominant voltage level for longer than the specified time ($t_{wu\_WAKE}$) will cause a local wake-up. The current for an external switch has to be provided by an external pull up resistor $R_{WK}$. For a reverse current limitation in case of a closed external switch and a negative ground shift or an ECU loss of ground a protection resistor $R_{WK\_prot}$ between pin WAKE and the switch is recommended.
- Local wake-up via a positive edge on pin KL15
  A positive edge on the pin KL15 followed by a high voltage level for a time period $t_{wu\_KL15}$ > 250µs results in a local wake-up request. The MLX80031/51 switches to the Standby Mode. The long debouncing time on KL15 suppress unintentional transients in a certainly way. A high level on KL15 has no influence of switching between modes with EN input. Before a new local wake-up request via KL15 can be started, KL15 have to be switched to low level for a time > 250µs.

## 5.1. *Wake Up Source Recognition in MLX80031/51*

The device can distinguish between a local wake-up event (pin WAKE or pin KL15) and a remote wake-up event. The wake-up source flag is set after a local wake-up event and is indicated by an active LOW on pin TxD.
The wake-up flag can be read if an external pull up resistor towards the microcontroller supply voltage has been added and the MLX80031/51 is still in standby mode:

- LOW level indicates a local wake-up event
- HIGH level indicates a remote wake up event

The wake-up request is indicated by an active LOW on pin RxD and can be used for an interrupt.
When the microcontroller confirms a normal mode operation by setting the pin EN to HIGH, both the wake-up request on pin RxD as well as the wake-up source flag on pin TxD are reset immediately.

# 6. Functionality

## 6.1. RESET behaviour of MLX8003x/5x

The MLX8003x/5x contains a reset unit which secures the correct initialization and generation of the reset signal. The *NRES* pin outputs the reset state of the MLX8003x/5x. The POR timer will be started if $V_S$ is switched on and $V_{CC} > V_{RES}$ threshold. After the time $t_{Res}$ the *NRES* output is switched from low to high.
The reset unit combines a VCC low voltage detection unit with fixed reset timer. This output is switched from low to high if $V_S$ is switched on and after the time $t_{Res}$ is $V_{CC} > V_{RES}$ .
All conditions which cause a drop of the $V_{CC}$ voltage will be detected from the low voltage reset unit which generates a reset signal. The MLX8003x/5x will be reinitialized if the $V_{CC}$ voltage rises above the low voltage limit.
If the voltage $V_{CC}$ drops below $V_{RES}$ then the *NRES* output is switched from high to low after the time $t_{rr}$ has been reached. For these reason short breaks of the $V_{CC}$ voltage and uncontrolled reset generations will be inhibited.

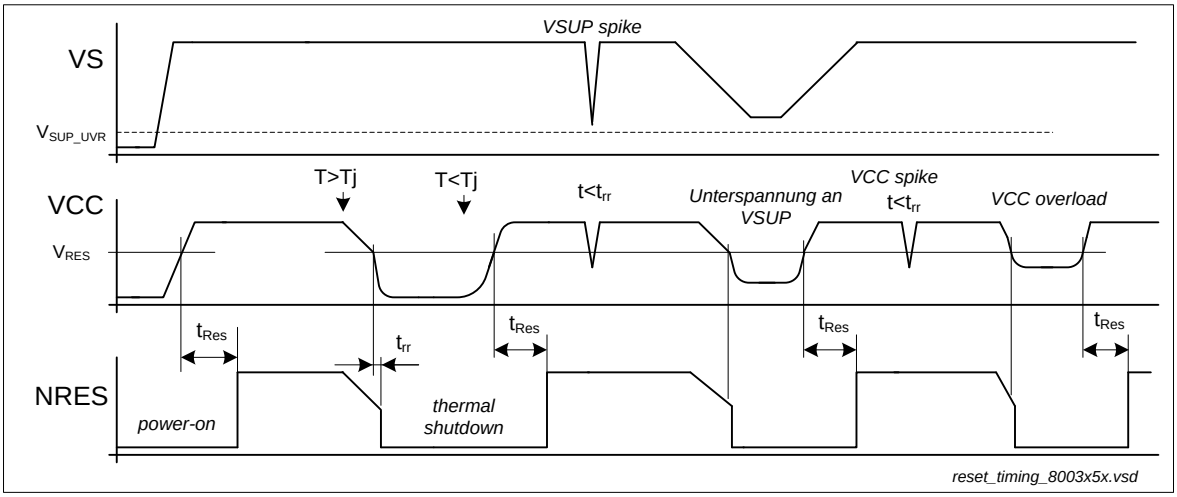



**Figure 10: VCC reset behavior**

The MLX80031/51 version combines the reset behaviour described at point above with a window-watchdog unit.
The NRES pin outputs the reset state as well as the watchdog condition. The POR timer will be started if $V_{SUP}$ is switched on and $V_{CC}$ > POR threshold. After the time $t_{Res}$ the RESET output is switched from low to high. The watchdog is disabled during this POR procedure. After the POR delay the NRES output is switched from low to high and the watchdog starts. In normal mode the NRES pin outputs the status of the window watchdog.

## 6.2. Thermal Shutdown

If the junction temperature $T_J$ is higher than $T_{JSHD}$, the MLX8003x/5x will be switched from any mode into Standby Mode. During TSD all functions are switched-off. The transceiver is completely disabled; no wake-up functionality is available.
If $T_J$ falls below the thermal recovery temperature $T_{JREC}$, the MLX8003x/5x will resume operation starting from Standby Mode. If EN=H at recovery, chip switches to NORMAL after VCC>VRES and tres. SBY-timeout timer is disabled during TSD.

## 6.3. *VS under voltage reset*

The under voltage detection unit prevents an undefined behaviour of the MLX8003x/5x under low voltage condition (VS < $V_{SUVR\_ON}$). If VS drops below $V_{SUVR\_ON}$, the under voltage detection becomes active and the IC will be switched from every state to Init-State followed by Standby Mode with the same behaviour like after VS power-on. With the following increase of VS above $V_{SUVR\_OFF}$ the MLX8003x5x remains in Standby Mode and the voltage regulator starts with the initialization sequence (Vcc available). If EN=H at power-up, the chip switches to NORMAL after VCC>VRES and tres.

**Remark:** In case Vs drops below 5V but still remains above $V_{SUVR\_ON}$ , Vcc follows Vs. Vcc is switched off during Vs Undervoltage reset.

## 6.4. *LIN-Transceiver*

The MLX8003x/5x has an integrated bi-directional bus interface device for data transfer between LIN bus and the LIN protocol controller.
The transceiver consists of a driver with slew rate control, wave shaping and current limitation and a receiver with high voltage comparator followed by a debouncing unit.

### *Transmit Mode*

During transmission the data at the pin TxD will be transferred to the LIN driver to generate a bus signal. To minimize the electromagnetic emission of the bus line, the LIN driver has an integrated slew rate control and wave shaping unit.
Transmitting will be interrupted in the following cases:

- Sleep Mode
- Silent Mode
- Thermal Shutdown active
- Power on Reset

The recessive LIN bus level is generated from the integrated 30k pull up resistor in serial with an active diode This diode prevents the reverse current of $V_{LIN}$ during differential voltage between VS and LIN ($V_{LIN}$>$V_S$).
No additional termination resistor is necessary to use the MLX8003x/5x in LIN slave nodes. If this ICs are used for LIN master nodes it is necessary that the LIN pin is terminated via an external 1kΩ resistor in series with a diode to VBAT.

### *Receive Mode*

The data signals from the LIN pin will be transferred continuously to the pin RxD. Short spikes on the bus signal are suppressed by the implemented debouncing circuit.

### *Slew Modes and Data rates*

The MLX8003x/5x consists a ***constant slew rate*** transceiver which means that the bus driver works with a mode depended slew rate. In normal mode the slew rate is typical 1.6 V/µs (max. baud rate 20kbit/s) and in low slew mode typical 0.8 V/µs. The lower slew rate in low slew mode associated with a baud rate of 10.4kbit/s improves the EME behaviour.
The LIN transceiver of MLX8003x/5x is compatible to the physical layer specification according to LIN 2.x specification for data rates up to 20kbit/s and the SAE specification J2602 for data rates up to 10.4kbit/s.
The constant slew rate principle is very robust against voltage drops and can operate with RC- oscillator systems with a clock tolerance up to ±2% between 2 nodes.

### *Low Slew Mode*

In this mode the slew rate is switched from the normal value of typical 1.6V/µs to a low value of typical 0.8V/µs. This mode is optimized to send with a maximum baud rate of 10.4kbit/s (acc. to SAE J2602). Because of this reduction of the slew rate the EME behaviour is improved especially in the frequency range of 100 kHz to 10MHz.

## 6.5. *Voltage Regulator*

The MLX8003x/5x has an integrated low drop linear regulator with a p-channel-MOSFET as driving transistor. This regulator outputs a voltage of 3.3V/5V ±2% and a current of ≤70mA within an input voltage range of 6V ≤ $V_{SUP}$ ≤ 18V. The current limitation unit limits the output current for short circuits or overload to 130mA respectively drop-down of the $V_{CC}$ voltage.

# 7. Window-Watchdog (only MLX80031/51)

The integrated window watchdog unit observes the correct function of the connected Microcontroller. The required timing can be programmed with an external resistor connected to the pin $RB_{WD}$. This resistor defines together with an internal capacitor the watchdog oscillator frequency. The watchdog is re-triggered by the Microcontroller via the NWDI input. The watchdog status is represented by the NRES pin.
Negative edges on NWDI reset the watchdog timer. If no pulse is received at NWDI, the MLX80051/31 generates low pulses on the NRES output with a pulse width of $t_{WDres}$ and a period of $t_{WDper}$.

## 7.1. *MLX80031/51 Watchdog Behaviour*

After power-on and elapsed reset time $t_{res}$, the window watchdog starts operation with a rising edge on pin NRES. This start is independent from Standby or Normal Mode.

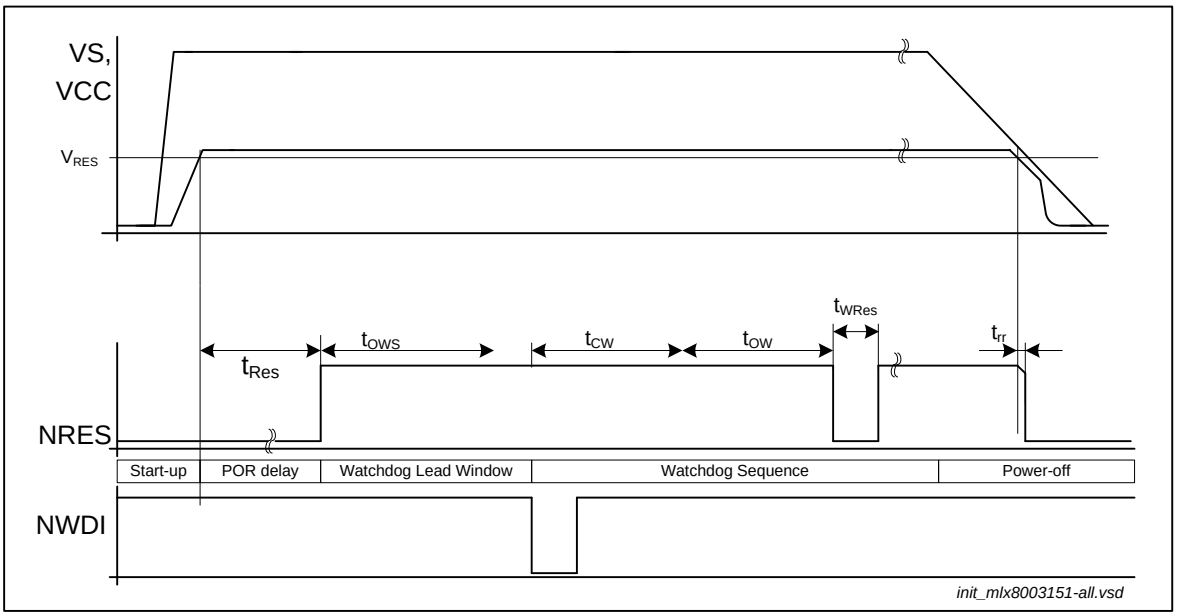



**Figure 11: MLX80031/51 Watchdog behavior**

In case of Silent or Sleep Mode are left via remote wake-up (LIN) or local wake-up (WAKE or KL15), the window watchdog starts immediately after entering Standby Mode.

After $t_{res}$ the window watchdog unit starts with the Lead Time State. At this state the watchdog clock periods ($1/f_{wdosc}$) are counted 7895(=nlead) times. A negative edge on NWDI pin within this lead time stops the lead counter and activates the Close Window State with ncw=1053. Thereafter follows the Open Window State with counter start value of now=1105. In case the lead counter elapses, the watchdog enters the Reset State and starts the reset timer with time tres.

Close Window State and Open Window State are the normal states of the window watchdog. At each of these states runs a counter with the watchdog clock signal. The CWT counter runs always to the end. The watchdog will only trigger correctly if the NWDI trigger signal arrives within the Open Window State.
A NWDI trigger pulse outside the open window generates a reset condition and the NRES output switches to low for the time $t_{WDres}$ (see Figure 12).

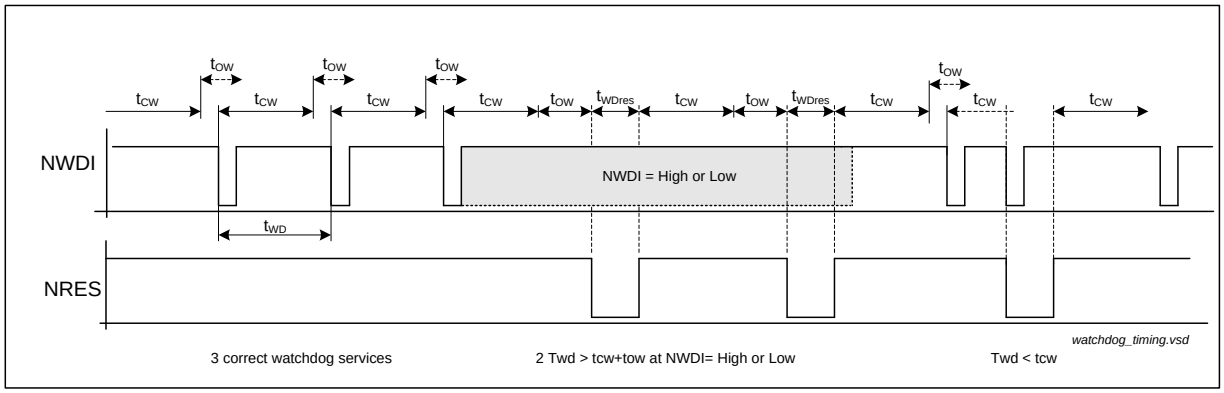



**Figure 12: Watchdog timing**

## 7.2. *All watchdog start-up scenarios*

### *7.2.1. After power-on and initialization*

Watchdog started after VCC ramp up and the finishing of reset timer (typ. 4ms) with Lead Time State. MLX80031/51 is in Standby or Normal Mode

### *7.2.2. Wake up indicated transition to Standby Mode from Sleep or Silent Mode*

Watchdog started immediately with activating of Standby Mode (SBY_MODE = 1). By transition from Sleep Mode the VCC regulator ramps up also and the reset timer starts. The reset timer has in this case no influence for the watchdog start.

### *7.2.3. Undervoltage reset on VCC on Normal Mode or Silent Mode*

MLX80031/51 goes to Standby Mode. Running watchdog process is stopped and cleared. With active undervoltage reset the signal the output pin NRES goes to low. With leaving of undervoltage reset start the reset timer (4ms) and after them start a new watchdog procedure.

### *7.2.4. EN indicated transition from Silent Mode to Normal Mode*

Mode control goes from Silent Mode to Normal Mode. Watchdog started immediately with activating of Normal Mode with Close Window State.

## 7.3. *Calculation of Watchdog Period*

The RC-oscillator of MLX80031/51 which generates the responsible timing of the watchdog has a tolerance of ±15%. This has the consequence that also the watchdog window times $t_{CW}$ and $t_{OW}$ variants with this tolerance.

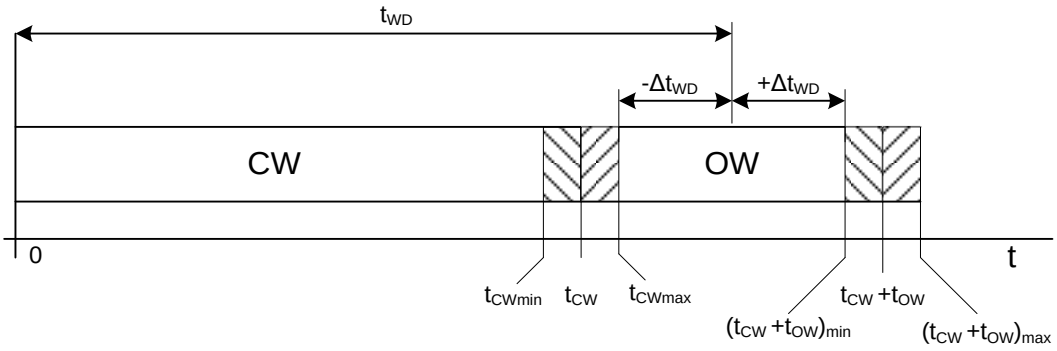



**Figure 13: Watchdog open and close window tolerances**

The ideal watchdog period can be calculated with:

$$t_{WD\_id} = t_{cw} + \frac{1}{2} * t_{ow}$$

The average value $t_{WD}$ of the real usable watchdog trigger time under consideration of the oscillator tolerance is:

$$t_{WD} = (t_{CW\,min} + t_{OW\,min} + t_{CW\,max})/2 \qquad \text{[EQ1]}$$

The allowed tolerance $\Delta t_{WD}$ is:

$$\Delta t_{WD} = (t_{CW\,min} + t_{OW\,min} - t_{CW\,max})/2 \qquad \text{[EQ2]}$$

With the definition of $t_{CW}$ = ncw * (1± TOL) * $t_{WDOSC}$ and $t_{OW}$ = now * (1± TOL) * $t_{WDOSC}$ from [EQ1] $t_{WD}$ can be calculated with:

$$t_{WD} = t_{WDOSC}(2 \cdot ncw + now \cdot (1 - TOL))/2 \qquad \text{[EQ3]}$$

and with [EQ2]:

$$\Delta t_{WD} = t_{WDOSC}(now \cdot (1 - TOL) - 2 \cdot TOL \cdot ncw)/2 \qquad \text{[EQ4]}$$

The variation $\Delta t_{WD}$ will be normalized to the mean value $t_{WD}$ and both counter values set in a relationship of a=now/ncw, then follows for the relative deviation:

$$t_{WDTOL} = \frac{a \cdot (1 - TOL) - 2 \cdot TOL}{2 + a \cdot (1 - TOL)} \qquad \text{[EQ5]}$$

The watchdog trigger time as well as the tolerance depends only on the oscillator frequency respectively the period $t_{WDOSC}$, if the there are fixed values for both counters (ncw and now) and oscillator tolerance.

Implemented in MLX80031/51 is a precision RC oscillator with a tolerance of TOL = ±15%. Combined with the relation of counter values a=1.04 reached them a tolerance of trigger time of ±20%.

**Table 9: Parameters of Window Watchdog**

| Symbol | Parameter | Value |
|---|---|---|
| TOL | Tolerance WD oscillator | ±15% |
| ncw | Close window counter | 1053 |
| now | Open window counter | 1105 |
| $t_{WDTOL}$ | Tolerance WD-trigger time | ±20% |
| | | |

With the predefined counter values (ncw and now) and the oscillator tolerance TOL are the trigger time of watchdog and them tolerance only be calculated by the selection of oscillator frequency, or their period $t_{WDOSC}$.

Fort the used precision RC-oscillator the oscillator period is shown as a linear function of the external resistor $RB_{WD}$.

$$t_{WDOSC}[\mu s] = 0.3486 \cdot RB_{WD}[k\Omega] + 1.117 \qquad \text{[EQ6]}$$

The trigger period can be calculated with the help of EQ3 together with Table 9 – Parameter of Window Watchdog

$$t_{WD}[ms] = 0.53078 \cdot RB_{WD}[k\Omega] + 1.70 \qquad \text{[EQ7]}$$

Or convert to $RB_{WD}$:

$$RB_{WD}[k\Omega] = 1.883 \cdot tWD[ms] - 3.20 \qquad \text{[EQ8]}$$

Some samples of different $RD_{WD}$ values and the corresponding watchdog times:

**Table 10: Window Watchdog Timing Selection**

| $RB_{WD}$ [kΩ] | $t_{WDOSC}$ [µs] | Lead Time $t_{LEAD}$ [ms] | Close Window $t_{CW}$ [ms] | Open Window $t_{OW}$ [ms] | Trigger Period $t_{WD}$ [ms] |
|---|---|---|---|---|---|
| 20 | 8.09 | 63.9 | 8.52 | 8.94 | 12.32 |
| 30 | 11.58 | 91.4 | 12.19 | 12.79 | 17.62 |
| 51 | 18.90 | 149.2 | 19.90 | 20.88 | 28.77 |
| 75 | 27.26 | 215.2 | 28.71 | 30.12 | 41.51 |
| 100 | 35.98 | 284.0 | 37.88 | 39.75 | 54.78 |
| 120 | 42.95 | 339.1 | 45.23 | 47.46 | 65.40 |
| 150 | 53.41 | 421.6 | 56.24 | 59.01 | 81.32 |

***Short or open circuit on $RB_{WD}$***

The MLX80031/51 can detect a short circuit against GND on the $RB_{WD}$ pin or an open $RB_{WD}$ pin. If on pin a resistor $RB_{WD}$ <330Ω or $RB_{WD}$ >10MΩ detected, then the MLX80031/51 checks during the initialization phase a fail-safe state. The watchdog oscillator will be set in a fail-safe mode with an oscillator period of about 50µs.

# 8. Fail-safe features

***Loss of battery***

If the ECU is disconnected from the battery, the LIN bus pin is in high impedance state. There is no impact to the bus traffic and to the ECU itself. Reverse current is limited to < 20µA

***Loss of Ground***

In case of an interrupted ECU ground connection there is no influence to the bus line. The current from the ECU to the LIN bus is limited by the weak pull up resistor of the pin LIN. The slave termination resistor is disconnected in order to fulfil the SAE J2602 requirements for the loss of ground current (<100µA @12V).

***Short circuit to battery***

The transmitter output current is limited to the specified value in case of short circuit to battery in order to prevent high current densities and thermal hot spots in the LIN driver.

***Short circuit to ground***

If the LIN bus wiring is shorted to negative shifted ground levels, there is no current flow from the ECU ground to the bus and no distortion of the bus traffic occurs.

If the controller detects a short circuit of the LIN bus to ground the transceiver can be set into sleep mode. Additionally the internal slave termination resistor is switched off and only a weak pull up termination is applied to the LIN bus (typ. 50µA). If the failure disappears, the bus level will become recessive again and will wake up the system even if no local wake up occurs or is possible.

***Thermal overload***

All MLX8003x/5x versions are protected against thermal overloads. If the chip temperature exceeds the specified value, the transmitter is disabled until thermal recovery and the following recessive to dominant transition on pin TxD. The receiver is still working while thermal shutdown.

***Undervoltage lock out***

If the battery supply voltage is missing or decreases below the specified value (VS_UV), the transmitter is disabled to prevent undefined bus traffic. While in sleep mode, the MLX8003x/5x enters the Standby Mode if Vs drops below the internal power on reset threshold.

***Open Circuit protection***

- The pin TxD provides a pull up resistor to VCC. The transmitter can not be enabled.
- The pin EN provides a pull down resistor to prevent undefined normal mode transitions.
- The pin NWDI provides a pull up resistor to VCC. The window watchdog generates NRES pulse.
- The pin MODE provides a pull down resistor to GND. No influence on window watchdog.
- If the battery supply voltage is disconnected, the pin RxD is floating.
- The pin WAKE provides a weak pull up current towards supply voltage Vs to prevent local wake-up requests.
- The pin KL15 provides a weak pull down current towards GND to prevent local wake-up requests.

***Short circuit RxD, NRES against GND or VCC***

Both outputs are short circuit proof to VCC and ground.

***RBWD short circuit against GND or open***

The watchdog oscillator runs with an internal controlled frequency and guarantees a reset.

# 9. Application Hints

## 9.1. Safe Operating Area

The linear regulator of the MLX8003x/5x operates with input voltages up to 27 V and can output a current of 70 mA. The maximum power dissipation limits the maximum output current at high input voltages and high ambient temperatures. The output current of 70 mA at an ambient temperature of $T_A$ = 125°C is only possible with small voltage differences between $V_S$ and $V_{CC}$.

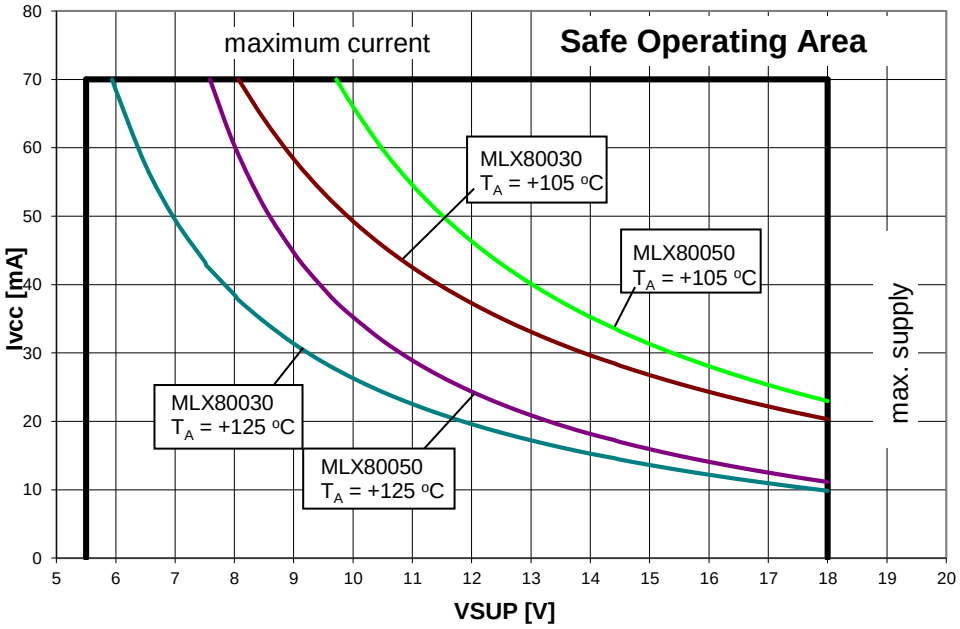



**Figure 14: Safe operating area for MLX80030/50 in SOIC-8 for Vsup up to 18V**

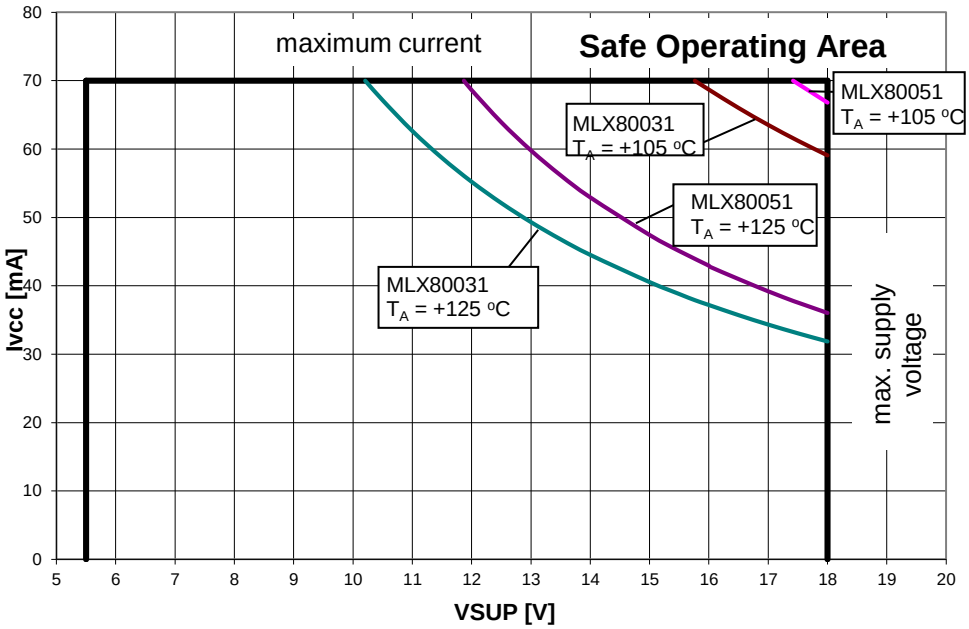



**Figure 15: Safe operating area for MLX80031/51 in QFN20 for Vsup up to 18V**

## 9.2. *Application Circuitry*

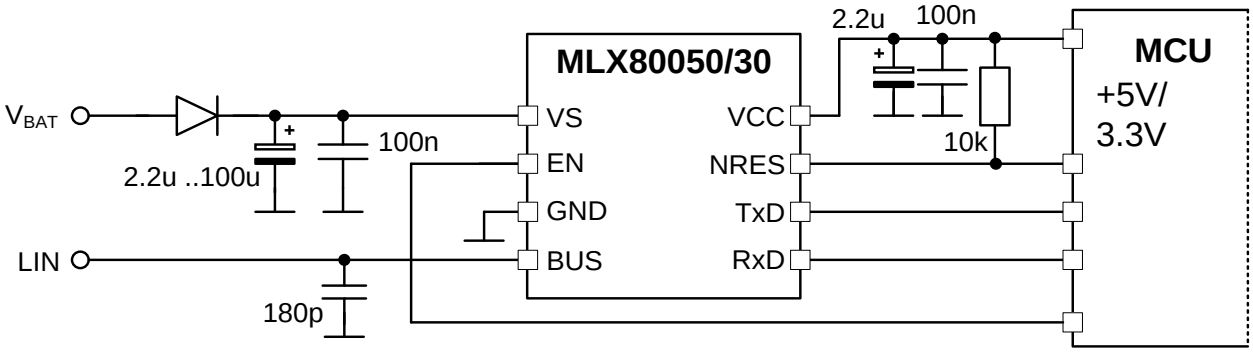



**Figure 16: Application circuit with MLX80050 or MLX80030 (slave node)**

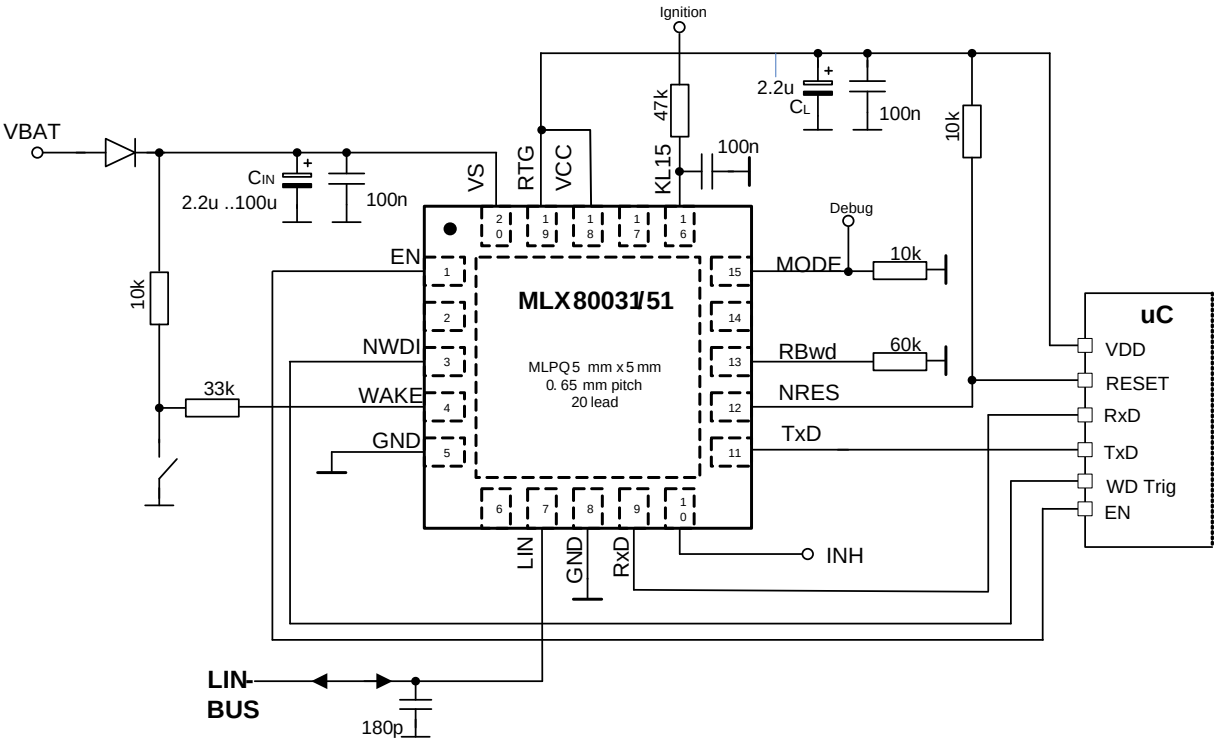



**Figure 17: Application circuit with MLX80031 or MLX80051 (slave node)**

### *9.2.1. EMI Suppressing*

To minimize the influence of EMI on the bus line an 180pF capacitor should be connected directly to the LIN pin (see 0). This EMI-Filter assures that the RF injection into the IC from the LIN bus line has no effect or will be limited.
It is also possible to use LC- or RC-filters. The dimensions of C-L or R-L depend on the corner frequency, the maximum LIN bus capacitance (10nF) and the compliance with the DC- and AC LIN bus parameters.

### *9.2.2. EMC disturbances using the example of MLX80030/50*

The MLX80030/50 complies with the standards ISO 7637 part1 and 2 (immunity against transients) and IEC 62132 part 1 and 4 (immunity against RF). The check bases on the document: “Hardware Requirements for LIN, CAN and FlexRay Interfaces in Automotive Applications” V1.0 from 2008-12-10, chapter 5 “EMC Requirements”. The tests will be performed on a common test PCB.

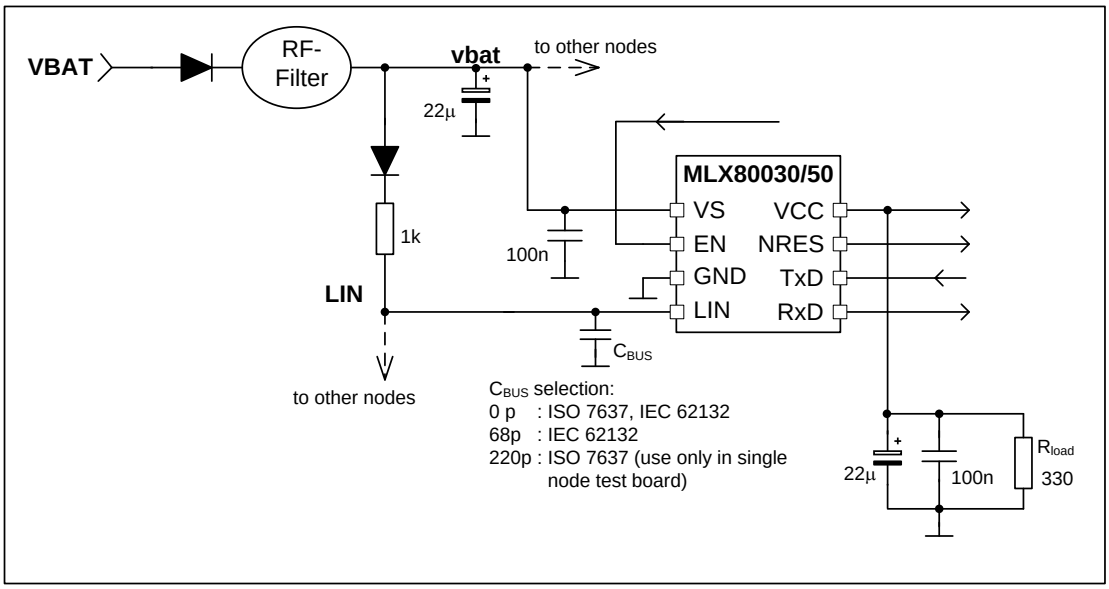



**Figure 18: Part of test circuitry for EMC tests with MLX80030/50**

The standard test board includes 3 LIN nodes with MLX80030/50. The load condition at VCC pin is a compromise between the requirements described in the document named before and the use of MLX80030/50 in practical applications.
The demand of 80% of max load condition means at Normal Mode and Silent Mode 56mA (max. 70mA). In practical application both modes will be used under consideration of save operating area. This leads to a max load value of 15mA or 330 Ohm for Rload.
Failure criterion for all EMC tests is functional status class A. The following table defines the parameter ranges for the pins RxD (dig out), NRES (dig out), VCC (supply out) to fulfil the functional state A at each operating mode.

**Table 11: Parameter ranges for function state A (MLX80050)**

| Mode | Transmitter | VCC | RxD | NRES |
|---|---|---|---|---|
| Normal | ON | Supply ON:<br>4.75V .. 5.25V | High and Low state<br>with Vcc ±0.9V | High state:<br>min level: Vcc – 1V |
| Silent | OFF | Supply ON with reduced load<br>4.75V .. 5.25V | High state:<br>min level: Vcc – 1V | High state:<br>min level: Vcc – 1V |
| Sleep | OFF | Supply OFF:<br>0V .. 0.9V | no evaluation | no evaluation |

# 10. Mechanical Specification

## 10.1. *SOIC8 package*

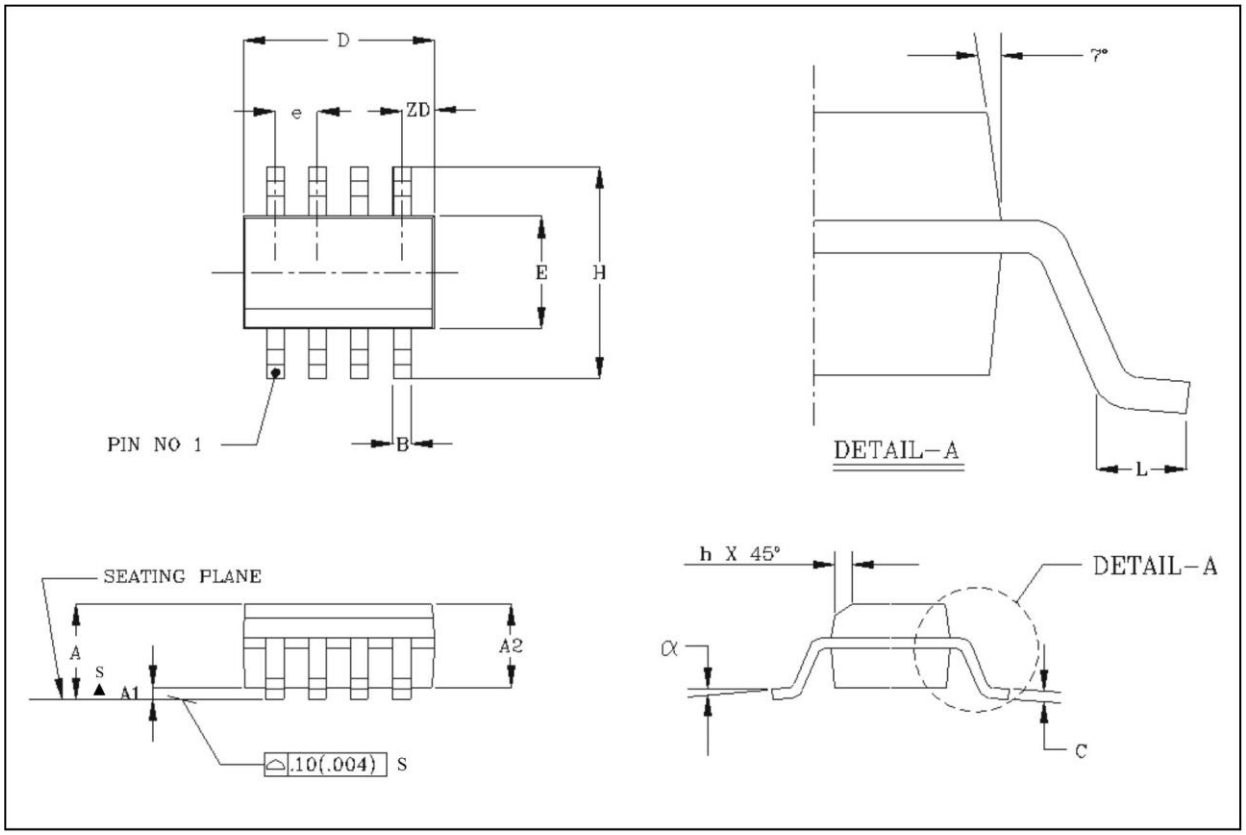



**Figure 19: SOIC8 Drawing**

**Table 12: SOIC8 dimensions**

Small Outline Integrated Circiut (SOIC), SOIC 8, 150 mil

| | A1 | B | C | D | E | e | H | h | L | A | α | ZD | A2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All Dimension in mm, coplanarity < 0.1 mm | | | | | | | | | | | | | |
| min | 0.10 | 0.36 | 0.19 | 4.80 | 3.81 | 1.27 | 5.80 | 0.25 | 0.41 | 1.52 | 0° | 0.53 | 1.37 |
| max | 0.25 | 0.46 | 0.25 | 4.98 | 3.99 | | 6.20 | 0.50 | 1.27 | 1.72 | 8° | | 1.57 |

## 10.2. *QFN20 5x5 package*

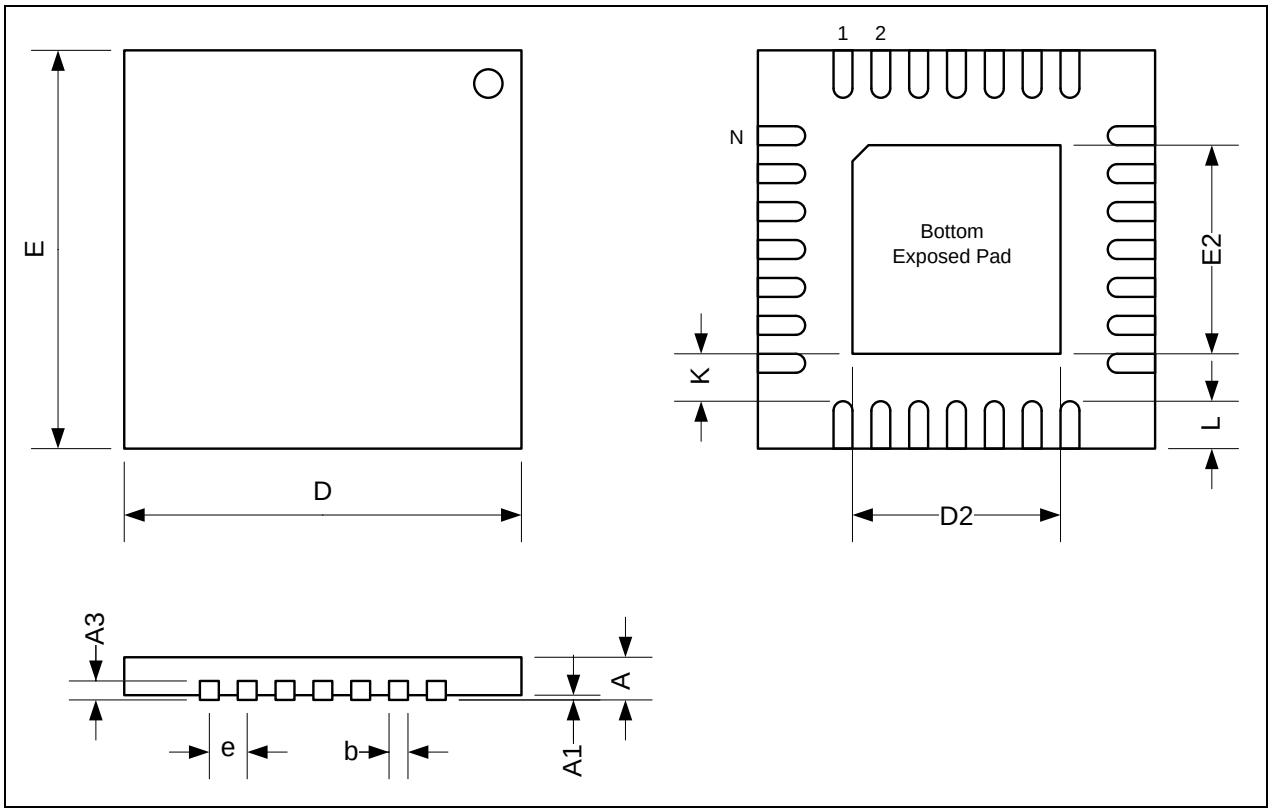



**Figure 20: QFN20 Drawing**

**Table 13: QFN20 Package Dimensions**

| Symbol | A | A1 | A3 | b | D | D2 | E | E2 | e | K | L | N [3] | ND [4] | NE [4] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| min | 0.80 | 0 | 0.20 | 0.25 | 5.00 | 3.00 | 5.00 | 3.00 | 0.65 | 0.20 | 0.45 | 20 | 5 | 5 | [1] [2] |
| max | 1.00 | 0.05 | | 0.35 | | 3.25 | | 3.25 | | | 0.65 | | | | |

[1] Dimensions and tolerances conform to ASME Y14.5M-1994
[2] All dimensions are in Millimeters. All angels are in degrees
[3] N is the total number of terminals
[4] ND and NE refer to the number of terminals on each D and E side respectively

# 11. Revision History

| Version | Changes | Remark | Date |
|---|---|---|---|
| 001 | First Release | 1st Release | April 2012 |
| 002 | • For TSD added: "If EN=H at recovery, chip switches to NORMAL after VCC>VRES and tres" and "SBY-timeout timer is disabled during TSD"<br>• For TSD removed explicit values and kept parameter name only.<br>• For Vs_uvr added: "If EN=H at power-up, chip switches to NORMAL after VCC>VRES and tres"<br>• Changed state diagram: sleep mode can be left with EN = H (was a L-H transition in A version of the device), refers to Errata 80050AA-07. | | June 2012 |
| 003 | • ESD robustness level adapted to Conformance Test Report<br>• Static Characteristics adapted to CPK-Values<br>• Block Diagram updated<br>• Corrected short description of product | | Dec 2012 |
| 004 | • Removed 06.05, 09.05, 13.05<br>• Changed 05.02 to 200mV (5V) and 100mV (3.3V)<br>• Changed 06.03 and 13.03 to 700mV<br>• Changed 09.03 to 600mV<br>• Added MODE pin to parameter list<br>• Changed 15.05 to LL = 2.7V and UL to 3.3V<br>• Changed 14.01 to 0.6V at 2mA<br>• Changed 08.03 to LL = 30<br>• Changed 02.00 to LL = 400 and UL to 1500<br>• Changed Tjshd to 155/170/190°C<br>• Changed 12.04 and 12.05 UL to 20uA<br>• Changed 03.05 to relevance “C” (only for characterization)<br>• Added 17.06 Watchdog safety oscillator<br>• Changed 3.01 for 80030/31 to UL = 3.201 and UL = 3.399 | | Mar 2013 |
| 005 | • Corrected value “e” of QFN package data to “0.65” | | Apr 2013 |
| 006 | • Changed 15.01<br>• Changed 1.03 LL to 40mV<br>• Changed 3.09 LL to -135mA and UL to -75mA<br>• Changed ESD capability of LIN pin to +/-6kV | | July 2013 |
| 007 | • Changed operating voltage to max. 27V<br>• Changed table 2, nominal operating voltage, max to 27V<br>• Update 3.09: split temperature ranges<br>• Changed 12.03 to min: -400µA<br>• Changed 12.06 to min: -10µA, max: 50µA<br>• Changed 6.04 to typ: 125 kΩ, max: 250 kΩ<br>• Changed 12.01 to 80µA | | Feb 2014 |
| 008 | • Added condition for thermal resistance | | April 2014 |

| | | | |
|---|---|---|---|
| | • Updated chapter 4.1, tables 7 and 8 for TxD and RxD values depending on the mode and EN = H transition from Sleep Mode to Normal Mode<br>• Changed operating voltage to 27V max in application hints 9.1<br>• Re-phrased information to EMC compliance in 9.2.2<br>• LIN: Changed parameter 12.10 and added parameter 12.12 to Lin spec 2.x and compatible to SAE J2602, split parameter 12.07 into dominant and recessive | | |
| 009 | • Updated product codes to “wettable flanks” | | Nov 2014 |

# 12. Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

**Reflow Soldering SMD's (Surface Mount Devices)**

- IPC/JEDEC J-STD-020
  Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
  (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113
  Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing
  (reflow profiles according to table 2)

**Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)**

- EN60749-20
  Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

**Iron Soldering THD's (Through Hole Devices)**

- EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

**Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)**

- EIA/JEDEC JESD22-B102 and EN60749-21
  Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

Melexis recommends reviewing on our web site the General Guidelines soldering recommendation (http://www.melexis.com/Quality_soldering.aspx) as well as trim&form recommendations (http://www.melexis.com/Assets/Trim-and-form-recommendations-5565.aspx).

Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: http://www.melexis.com/quality.aspx

## 13. Disclaimer

Devices sold by Melexis are covered by the warranty and patent indemnification provisions appearing in its Term of Sale. Melexis makes no warranty, express, statutory, implied, or by description regarding the information set forth herein or regarding the freedom of the described devices from patent infringement. Melexis reserves the right to change specifications and prices at any time and without notice. Therefore, prior to designing this product into a system, it is necessary to check with Melexis for current information. This product is intended for use in normal commercial applications. Applications requiring extended temperature range, unusual environmental requirements, or high reliability applications, such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional processing by Melexis for each application.

The information furnished by Melexis is believed to be correct and accurate. However, Melexis shall not be liable to recipient or any third party for any damages, including but not limited to personal injury, property damage, loss of profits, loss of use, interrupt of business or indirect, special incidental or consequential damages, of any kind, in connection with or arising out of the furnishing, performance or use of the technical data herein. No obligation or liability to recipient or any third party shall arise or flow out of Melexis' rendering of technical or other services.



For the latest version of this document, go to our website at
**www.melexis.com**

Or for additional information contact Melexis Direct:

Europe, Africa, Asia:
Phone: +32 1367 0495
E-mail: sales_europe@melexis.com

America:
Phone: +1 248 306 5400
E-mail: sales_usa@melexis.com

ISO/TS 16949 and ISO14001 Certified