1. Features and Benefits

- Motor driver
  - 3x PreDriver for DC or BLDC motor
  - Up to 200nC NFETs (12V-48V supply)
    - $0.7\ \text{Apk typ. charge current}$
    - $1.5\ \text{Apk typ. discharge current}$
  - charge-pump for top-NFETs
  - $V_{DS}$ protection for all NFETs
- Microcontroller:
  - MLX16-FX, application CPU
  - MLX4, communication CPU
  - Programmable digital watch-dog
  - Interrupt controller
  - Common purpose timer
- Memories split per CPU
  - MLX16-FX memories:
    - MLX81346: 64 KB Flash with ECC
    - 20 KB ROM
    - 4 KB RAM
    - 576 Byte EEPROM
  - MLX4 memories:
    - 6 KB ROM
    - 512 Byte RAM
- Fast end-of-line programming via LIN pin (64kB Flash in < 4sec)
- Pin-compatible Predriver family in QFN32
  - MLX81340: 58 KB Flash+ROM
  - MLX81344: 90 KB Flash+ROM
  - MLX81346: 90 KB Flash+ROM

- Periphery
  - Configurable RC-clock 12..32MHz
  - 12x general purpose IO’s, digital, analog, 5x high-voltage IO’s, 2x UART, SPI, I²C-slave
  - 2x high-side supply <50mA
  - 5x 16-bit motor PWM timers
  - 2x 16-bit timers
  - 12-bit ADC with < 1.2μs conversion time with 64 channels
  - Differential current sense amplifier with 8-bit programmable overcurrent
  - Temperature sensor, over-temperature detection
  - Over-current detection, over-voltage and under-voltage protection

- Voltage regulators
  - operating motor voltage $V_{SM}= 5.5V-60V$
  - operating supply voltage $V_S= 5.5V-32V^*$ (*operating voltage up to 36V limited to 24h over lifetime)
  - Internal voltage regulators, directly powered from VS supply
  - Operation down to 3.5V with reduced analog characteristics, down to 3.0V without losing register content, down to 1.6V with intact RAM memory
  - Low standby current consumption of typ 25µA in sleep mode
  - Wake-up possible via LIN, external pins or internal wake-up timer

- Bus interface
  - LIN 2.x/SAE J2602 and ISO17987-4 compliant LIN slave

- Automotive AEC-Q100 Qualified
2. Application Examples

- 12V-48V DC/BLDC Engine Cooling Fans, Pumps, Compressors
- 12V-48V DC/BLDC Positioning applications

3. Ordering Information

<table>
<thead>
<tr>
<th>Order Code</th>
<th>Temp. Range</th>
<th>Package</th>
<th>Delivery</th>
<th>Remark</th>
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<tr>
<td>MLX81346 LLW-BMT-003-RE</td>
<td>-40 - 150 °C</td>
<td>QFN32_WF 5x5</td>
<td>Reel</td>
<td></td>
</tr>
<tr>
<td>MLX81346 LPF-BMA-003-RE</td>
<td>-40 - 150 °C</td>
<td>TQFP48 7x7 eP</td>
<td>Reel</td>
<td></td>
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*Table 1 – Ordering Information*
4. Family Concept

<table>
<thead>
<tr>
<th></th>
<th>MLX81340</th>
<th>MLX81344</th>
<th>MLX81346</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCU Memory</td>
<td>32 KB Flash + 26 KB ROM</td>
<td>64 KB Flash + 26 KB ROM</td>
<td>64 KB Flash + 26 KB ROM</td>
</tr>
<tr>
<td>MCU EEPROM</td>
<td>64x8 Byte</td>
<td>64x8 Byte</td>
<td>64x8 Byte</td>
</tr>
<tr>
<td>MCU RAM</td>
<td>2.5 KB</td>
<td>4.5 KB</td>
<td>4.5 KB</td>
</tr>
<tr>
<td>Pre-Driver</td>
<td>3x Predrivers 60nC gate charge</td>
<td>3x Predrivers 60nC gate charge</td>
<td>3x Predrivers 200nC gate charge</td>
</tr>
<tr>
<td>Motor Power range</td>
<td>typ. 10..500W</td>
<td>typ. 10..500W</td>
<td>typ. 10..2000W</td>
</tr>
<tr>
<td>Motor Voltage range</td>
<td>5.5V...36V</td>
<td>5.5V...36V</td>
<td>5.5V...60V</td>
</tr>
<tr>
<td>IO pins (analog, digital)</td>
<td>9x LV + 3x HV/LV</td>
<td>9x LV + 3x HV/LV</td>
<td>9x LV + 3x HV/LV</td>
</tr>
<tr>
<td>Motor current sensing</td>
<td>Low side shunt, differential</td>
<td>Low side shunt, differential</td>
<td>Low side shunt, differential</td>
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<tr>
<td>Sensor interface (3V/5V supply)</td>
<td>analog, pwm, spi, sent, I²C, uart</td>
<td>analog, pwm, spi, sent, I²C, uart</td>
<td>analog, pwm, spi, sent, I²C, uart</td>
</tr>
<tr>
<td>Sensorless FOC support</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LIN auto-address support (AA)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Maximum IC Temperature (with validated mission profile)</td>
<td>( T_j = 175°C )</td>
<td>( T_j = 175°C )</td>
<td>( T_j = 175°C )</td>
</tr>
<tr>
<td>Package</td>
<td>QFN32, 5x5 QFN24, 4x4</td>
<td>QFN32, 5x5 QFN24, 4x4</td>
<td>QFN32, 5x5 TQFP48, 7x7</td>
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<tr>
<td>Automotive AECQ-100</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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Table 2 – Family Overview

5. Revision history

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Description</th>
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<tr>
<td>1.0</td>
<td>01/04/2022</td>
<td>Initial MLX81346 product abstract</td>
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Table 3 – Revision history
# Contents

1. Features and Benefits .................................................................................................................. 1
2. Application Examples .................................................................................................................... 2
3. Ordering Information ..................................................................................................................... 2
4. Family Concept ............................................................................................................................ 3
5. Revision history ............................................................................................................................. 3
6. Contents ........................................................................................................................................ 4
7. System block diagram and system functions ............................................................................... 5
8. Functional safety ........................................................................................................................... 7
9. IC Block diagram .......................................................................................................................... 7
10. Technical description .................................................................................................................... 8
    10.1. Package data QFN32 .............................................................................................................. 8
    10.2. Package Data – TQFP48 ....................................................................................................... 9
    10.3. Package Pin-out .................................................................................................................... 10
    10.4. Pin out description .............................................................................................................. 11
    10.5. Marking Instruction ............................................................................................................. 15
11. Typical application schematic ...................................................................................................... 16
    11.1. BLDC Application 12-24V .................................................................................................. 16
    11.2. BLDC Applications 48V ..................................................................................................... 17
12. Electrical characteristics ............................................................................................................... 19
    12.1. Absolute maximum ratings ............................................................................................... 19
    12.2. Operating range ................................................................................................................... 21
    12.3. Electrical specifications ......................................................................................................... 22
        12.3.1. Current consumption .................................................................................................... 22
        12.3.2. Supply system ............................................................................................................. 22
        12.3.3. Clock generation ........................................................................................................... 25
        12.3.4. PowerFET Pre-driver ................................................................................................ 26
        12.3.5. Over-temperature detection ......................................................................................... 29
        12.3.6. ADC ............................................................................................................................. 29
        12.3.7. IOs ................................................................................................................................. 31
        12.3.8. LIN ............................................................................................................................... 33
13. Disclaimer .................................................................................................................................... 38
7. System block diagram and system functions

The system block diagram is shown in Figure 1, where the key system functions of MLX81346 are illustrated, i.e. the capability to drive the phases of a motor over N-FET halfbridges, to read data from sensors and to communicate with the engine control unit (ECU) over a LIN compliant interface.

![Figure 1 System block diagram]

The system functions of MLX81346 are:

- **Motor driving:**
  - The IC can drive up to 3 half-bridges consisting of 6 N-FETs with max 200nC gate charge to support motors ranging from 10W - 1200W
    - 3-phase BLDC motor
  - The IC can process standard or complex motor drive algorithms
    - Sensor-less FOC (field-oriented control)
    - Sensoresd FOC (field-oriented control)

- **Sensing:**
  - The IC senses the motor current over an external shunt
  - The IC can read up to 12 analog outputs of external sensors
The IC can read up to 12 digital outputs of external sensors

The IC can receive as SPI master the output of an external sensor

The IC can receive the SENT output of an external sensor

The IC can supply external sensors, limited by maximum supply current < 25mA

The IC can sense the motor supply and phase voltages

**Communication:**

- The IC supports LIN 2.x, SAE J2602 and ISO17987-4 standards as a slave node
- The IC supports I^2^C Standard-mode, Fast-mode and Fast-mode Plus as a slave node
- The IC supports the SPI standard
- The IC can transmit a digital SENT signal
- The IC can read up to 3 high-voltage analog levels
- The IC can read up to 3 high-voltage digital signals
- The IC supports receiving and transmitting a PWM communication signal at the LIN pin
- The IC supports receiving and transmitting up to 2 UART signals

The diagnostic functions of the IC are covered in the safety manual.
8. Functional safety

The MLX81346 is an ASSP and developed as SEooC [ISO 26262] with assumed technical safety requirements with ASIL-B capability targets. The technical safety concept is described in the MLX81346 Safety manual.

9. IC Block diagram

![IC Block diagram](image-url)

*Figure 2 – 81346 IC Block diagram with external power bridge (BLDC)*
10. Technical description

10.1. Package data QFN32

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Minimum</th>
<th>Nominal</th>
<th>Maximum</th>
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<tr>
<td>A</td>
<td>0.83</td>
<td>0.85</td>
<td>1.00</td>
</tr>
<tr>
<td>A1</td>
<td>0</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>A2</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>B</td>
<td>3.90</td>
<td>3.85</td>
<td>3.85</td>
</tr>
<tr>
<td>C</td>
<td>4.60</td>
<td>4.60</td>
<td>4.60</td>
</tr>
<tr>
<td>E2</td>
<td>3.40</td>
<td>3.40</td>
<td>3.40</td>
</tr>
<tr>
<td>L</td>
<td>0.35</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>W</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Note:
1. Exposed tie bar should be kept free from solder.
2. Side wall thickness tin plating min. 1um thick.

Figure 3 – Package data QFN32
10.2. Package Data – TQFP48

Figure 4 – Package data TQFP48 7x7 eP
10.3. Package Pin-out

![Figure 5 – Pin-out diagram QFN32 (-LLW variant)](image)

![Figure 6 – Pin-out diagram TQFP48 (LPF variant)](image)
## 10.4. Pin out description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin name</th>
<th>Description</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HS_W</td>
<td>High-Side FET Predriver for W</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>W</td>
<td>W-phase</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>HS_V</td>
<td>High-Side FET Predriver for V</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>V</td>
<td>V-phase</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>HS_U</td>
<td>High-Side FET Predriver for U</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>U</td>
<td>U-phase</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>LS_W</td>
<td>Low-Side FET Predriver for W</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>LS_V</td>
<td>Low-Side FET Predriver for V</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>LS_U</td>
<td>Low-Side FET Predriver for U</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>IS_P</td>
<td>Current sense input (+)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>IS_N</td>
<td>Current sense input (-)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>GNDM</td>
<td>GND Motor</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>LIN</td>
<td>LIN interface pin</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>nc</td>
<td>not connected</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>IO9</td>
<td>LVIO</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>IO8</td>
<td>LVIO</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>IO7</td>
<td>LVIO</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; test interface output TDO</td>
</tr>
<tr>
<td>18</td>
<td>IO6</td>
<td>LVIO</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; test interface input TDI</td>
</tr>
<tr>
<td>19</td>
<td>IO5</td>
<td>LVIO</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>IO4</td>
<td>LVIO + HVS (high-voltage supply &lt;50mA)</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>IO3</td>
<td>LVIO + HVS (high-voltage supply &lt;50mA)</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>IO2</td>
<td>LVIO + HVIO (high-voltage in/out)</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Test interface output TDO</td>
</tr>
<tr>
<td>23</td>
<td>IO1</td>
<td>LVIO + HVIO (high-voltage in/out)</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Test interface input TDI</td>
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<td>24</td>
<td>IO0</td>
<td>LVIO + HVIO (high-voltage in/out)</td>
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<tr>
<td>25</td>
<td>IO11</td>
<td>LVIO</td>
<td></td>
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<td>26</td>
<td>IO10</td>
<td>LVIO</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>VDDA</td>
<td>3.3V</td>
<td>3.3V IO supply, option for external sensors ≤</td>
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<tr>
<td>Pin</td>
<td>Pin name</td>
<td>Description</td>
<td>Comment</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>----------------------</td>
<td>------------------------------------------</td>
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<tr>
<td>28</td>
<td>GND</td>
<td>GND IC</td>
<td></td>
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<tr>
<td>29</td>
<td>VS</td>
<td>Supply IC</td>
<td>For 48V : connect 12V external supply to VS</td>
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<tr>
<td>30</td>
<td>CPDRV</td>
<td>Driver for charge pump</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>VSM</td>
<td>Supply Motor</td>
<td></td>
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<td>32</td>
<td>VBOOST</td>
<td>Boost voltage to drive High-Side FETs</td>
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Table 4 – Pin-out description for QFN32
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<thead>
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<th>#</th>
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<th>Description</th>
<th>Comment</th>
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<tr>
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<td>HS_W</td>
<td>High-Side FET Predriver for W</td>
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<tr>
<td>4</td>
<td>W</td>
<td>W phase</td>
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<td>5</td>
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<tr>
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<td>HS_V</td>
<td>High-Side FET Predriver for V</td>
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</tr>
<tr>
<td>7</td>
<td>V</td>
<td>V phase</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>NC</td>
<td>Not connected</td>
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<td>9</td>
<td>HS_U</td>
<td>High-Side FET Predriver for U</td>
<td></td>
</tr>
<tr>
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<td>U phase</td>
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<td>GND W phase</td>
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<td>17</td>
<td>LSS_V</td>
<td>GND V phase</td>
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<td>LS_U</td>
<td>Low-Side FET Predriver for U</td>
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<tr>
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<td>LSS_U</td>
<td>GND U phase</td>
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<tr>
<td>20</td>
<td>IS_P</td>
<td>Current sense input (+)</td>
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</tr>
<tr>
<td>21</td>
<td>IS_N</td>
<td>Current sense input (-)</td>
<td></td>
</tr>
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<td>22</td>
<td>GNDM</td>
<td>GND Motor</td>
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</tr>
<tr>
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<td>LIN</td>
<td>LIN interface pin</td>
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<td></td>
</tr>
<tr>
<td>25</td>
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<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>IO9</td>
<td>LVIO</td>
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</tr>
<tr>
<td>27</td>
<td>IO8</td>
<td>LVIO</td>
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</tr>
<tr>
<td>28</td>
<td>IO7</td>
<td>LVIO</td>
<td>1st test interface output TDO</td>
</tr>
<tr>
<td>29</td>
<td>IO6</td>
<td>LVIO</td>
<td>1st test interface input TDI</td>
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<td>IO5</td>
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<tr>
<td>#</td>
<td>Pin name</td>
<td>Description</td>
<td>Comment</td>
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<td>--------------------------------------------------</td>
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<td>31</td>
<td>IO4</td>
<td>LVIO + HVS (high-voltage supply &lt;50mA)</td>
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<td>LVIO + HVS (high-voltage supply &lt;50mA)</td>
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<tr>
<td>33</td>
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<td>LVIO + HVIO (high-voltage in/out)</td>
<td>2nd Test interface output TDO</td>
</tr>
<tr>
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<td>IO1</td>
<td>LVIO + HVIO (high-voltage in/out)</td>
<td>2nd Test interface input TDI</td>
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<td>IO0</td>
<td>LVIO + HVIO (high-voltage in/out)</td>
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</tr>
<tr>
<td>37</td>
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</tr>
<tr>
<td>38</td>
<td>IO11</td>
<td>LVIO</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>IO10</td>
<td>LVIO</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>VDDA</td>
<td>3.3V</td>
<td>3.3V IO supply, option for external sensors</td>
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<td>&lt;25mA</td>
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<td>GND IC</td>
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</tr>
<tr>
<td>43</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>VS</td>
<td>Supply IC</td>
<td>For 48V: connect 12V external supply to VS</td>
</tr>
<tr>
<td>45</td>
<td>CPDRV</td>
<td>Driver for charge pump</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>VSM</td>
<td>Supply Motor</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>VBOOST</td>
<td>Boost voltage to drive High-Side FETs</td>
<td></td>
</tr>
</tbody>
</table>

*Table 5 – Pin-out description for TQFP48*
10.5. Marking Instruction

**Figure 7 – Marking example on IC package QFN32 5x5**

**Figure 8 – Marking example on IC package TQFP48**
11. Typical application schematic

In the following schematic examples, external components are indicated that may be needed to protect the IC against EMC/ESD pulses. Depending on ECU conditioned power, over-voltage and reverse polarity discretes may be needed. Capacitor discretes or capacitor values will depend on specific OEM ESD/EMC requirements.

11.1. BLDC Application 12-24V

![Typical motor schematic with MLX81346](image)

* Supply filter (CLC) may be needed to comply with OEM EMC specs

Figure 9 – Typical motor schematic with MLX81346
11.2. BLDC Applications 48V

For 48V automotive applications, 2 changes are needed versus the normal 12V application:

- VS pin is supplied by external 12V regulator to reduce IC heating (linear regulator or DC/DC)
- ECU – Peripheral communication is achieved via capacitive or optical coupling to enable isolation

The concept is shown in below figure:

*Figure 10 – Principle block diagram for MLX81346 in an isolated 48V application*
**Figure 11 – Principle block diagram for MLX81346 in a 48V application**

* Supply filter (CLC) may be needed to comply with OEM EMC specs
12. Electrical characteristics

12.1. Absolute maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage IC</td>
<td>VS</td>
<td>-0.5</td>
<td>32</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Supply voltage IC</td>
<td>VS</td>
<td>-0.5</td>
<td>36 1</td>
<td>V</td>
<td>t &lt; 500ms</td>
</tr>
<tr>
<td>Supply voltage Motor</td>
<td>VSM</td>
<td>-0.5</td>
<td>45</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Supply voltage Motor</td>
<td>VSM</td>
<td>-0.5</td>
<td>60</td>
<td>V</td>
<td>t &lt; 500ms</td>
</tr>
<tr>
<td>Supply voltage transient</td>
<td>VS.tr1</td>
<td>-100</td>
<td></td>
<td>V</td>
<td>ISO 7637-2 pulse 1 2</td>
</tr>
<tr>
<td>Supply voltage transient</td>
<td>VS.tr2</td>
<td>75</td>
<td></td>
<td>V</td>
<td>ISO 7637-2 pulse 2 2</td>
</tr>
<tr>
<td>Supply voltage transient</td>
<td>VS.tr3</td>
<td>-150</td>
<td>100</td>
<td>V</td>
<td>ISO 7637-2 pulses 3a, 3b 2</td>
</tr>
<tr>
<td>Output voltage</td>
<td>VDDA</td>
<td>-0.3</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>LIN bus voltage</td>
<td>VLIN</td>
<td>-40</td>
<td>40</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>LIN bus voltage transient</td>
<td>VLIN.tr1</td>
<td>-30</td>
<td></td>
<td>V</td>
<td>ISO 7637-3 DCC slow - 3</td>
</tr>
<tr>
<td>LIN bus voltage transient</td>
<td>VLIN.tr2</td>
<td>30</td>
<td></td>
<td>V</td>
<td>ISO 7637-3 DCC slow + 3</td>
</tr>
<tr>
<td>LIN bus voltage transient</td>
<td>VLIN.tr3</td>
<td>-150</td>
<td>100</td>
<td>V</td>
<td>ISO 7637-2 pulses 3a, 3b 3</td>
</tr>
<tr>
<td>Analog HV voltage</td>
<td>VAN_HS_U(V,W)</td>
<td>-0.3</td>
<td>VBOOST</td>
<td>V</td>
<td>HS_U, HS_V, HS_W</td>
</tr>
<tr>
<td>Analog HV voltage</td>
<td>VAN_U(V,W)</td>
<td>-0.3</td>
<td>VBOOST</td>
<td>V</td>
<td>U, V, W</td>
</tr>
<tr>
<td>Analog HV voltage</td>
<td>VAN_LSx</td>
<td>-0.3</td>
<td>10</td>
<td>V</td>
<td>LS_U, LS_V, LS_W</td>
</tr>
<tr>
<td>VBOOST voltage</td>
<td>VAN_</td>
<td>70  5</td>
<td></td>
<td>V</td>
<td>Switching transients at 60V</td>
</tr>
</tbody>
</table>

1 36V operation is limited to maximum 24 hours over life; 28...36V motor driving may require a 100Ω resistor at VBOOST pin for protection reasons in case of PCB switching transients >45V.
2 ISO 7637 test pulses are applied to VS via a reverse polarity diode and blocking capacitor.
3 ISO 7637 test pulses are applied to LIN via a coupling capacitance of 1nF.
4 Target for production version – value will be fixed after final qualification.
# Parameter Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBOOST</td>
<td>VBOOST</td>
<td></td>
<td></td>
<td></td>
<td>motor drive</td>
</tr>
<tr>
<td>IS_P, IS_N voltage</td>
<td>VAN_ISx</td>
<td>-0.3</td>
<td>VDDA+0.3</td>
<td>V</td>
<td>I00, IO1, IO2, IO3, IO4 (HV input mode)</td>
</tr>
<tr>
<td>Analog HV voltage</td>
<td>VAN_HV</td>
<td>-0.3</td>
<td>VS+0.3</td>
<td>V</td>
<td>IO0..IO11</td>
</tr>
<tr>
<td>Analog LV voltage</td>
<td>VAN_LV</td>
<td>-0.3</td>
<td>VDDA+0.3</td>
<td>V</td>
<td>IO0..IO11</td>
</tr>
<tr>
<td>Digital input voltage</td>
<td>VIN_DIG</td>
<td>-0.3</td>
<td>VDDA+0.3</td>
<td>V</td>
<td>IO0..IO11</td>
</tr>
<tr>
<td>Digital output voltage</td>
<td>VOUT_DIG</td>
<td>-0.3</td>
<td>VDDA+0.3</td>
<td>V</td>
<td>IO0..IO11</td>
</tr>
<tr>
<td>Reverse current into any IO</td>
<td>IREV_IO</td>
<td></td>
<td>1</td>
<td>mA</td>
<td>IO0..IO11</td>
</tr>
<tr>
<td>Reverse current into all IO</td>
<td>IREV_IO_TOT</td>
<td>10</td>
<td></td>
<td>mA</td>
<td>IO0..IO11</td>
</tr>
<tr>
<td>ESD HBM capability</td>
<td>ESD_HBM</td>
<td>-2</td>
<td>2</td>
<td>kV</td>
<td>All pins</td>
</tr>
<tr>
<td>ESD HBM capability, LIN</td>
<td>ESD_HBM_LIN</td>
<td>-6</td>
<td>6</td>
<td>kV</td>
<td>Pin LIN. ESD applied on LIN pin versus shorted GND pins</td>
</tr>
<tr>
<td>ESD CDM capability</td>
<td>ESD_CDM</td>
<td>-500</td>
<td>500</td>
<td>V</td>
<td>All pins</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>TJ</td>
<td>-55</td>
<td>175</td>
<td>ºC</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance QFN32 5x5</td>
<td>Rth_ja</td>
<td>~32</td>
<td></td>
<td>K/W</td>
<td>in free air</td>
</tr>
<tr>
<td>Thermal resistance TQFP48</td>
<td>Rth_ja</td>
<td>~28</td>
<td></td>
<td>K/W</td>
<td>in free air</td>
</tr>
</tbody>
</table>

*80V for <200ms (target for production version 80V for <500ms; will be fixed after final Qualification)

* Simulated value for low conductance board (JEDEC).
12.2. Operating range

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>4</td>
<td>12</td>
<td>32</td>
<td>V</td>
<td>Analog full performance</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>3.5</td>
<td>4</td>
<td>V</td>
<td>V</td>
<td>Analog reduced performance</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>32</td>
<td>36</td>
<td>V</td>
<td>V</td>
<td>Analog reduced performance</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>3.0</td>
<td>32</td>
<td>36</td>
<td>V</td>
<td>Digital functional</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>1.6</td>
<td>32</td>
<td></td>
<td>V</td>
<td>SRAM content valid</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>10</td>
<td>32</td>
<td>36</td>
<td>V</td>
<td>Pre-driver full performance</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>VS</td>
<td>5.5</td>
<td>10</td>
<td>V</td>
<td>V</td>
<td>Pre-driver reduced performance</td>
</tr>
<tr>
<td>Motor Supply voltage</td>
<td>VSM</td>
<td>10</td>
<td>12/24/48</td>
<td>60</td>
<td>V</td>
<td>Operational motor driving</td>
</tr>
<tr>
<td>Motor Supply voltage</td>
<td>VSM</td>
<td>5.5</td>
<td>10</td>
<td>V</td>
<td>V</td>
<td>Operational motor driving reduced performance</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;</td>
<td>-40</td>
<td>175</td>
<td>°C</td>
<td>Limited time at T&lt;sub&gt;j&lt;/sub&gt;=175 °C</td>
<td></td>
</tr>
</tbody>
</table>

Table 7 – Operating range

---

7 IC is functional down to 3.5V with reduced analog performance. VDDA short detection may trigger. During IC start-up, VS needs to be >5.5V for a certain time to guarantee a correct reset.

8 IC is functional up to 36V with reduced analog performance. 36V operation is limited to maximum 24 hours over life; 28..36V motor driving may require a 1000Ω resistor at VBOOST pin to protect in case of PCB switching transients >45V.

9 Pre-driver module is functional with reduced performance (lower gate drive voltage), VBOOST UV may trigger.

10 Extended temperature range with T<sub>j</sub>=175 °C is only allowed for a limited time, customer's mission profile has to be agreed by Melexis as an obligatory part of the Part Submission Warrant (PSW).
12.3. Electrical specifications

12.3.1. Current consumption

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal working current</td>
<td>INOM</td>
<td>10</td>
<td>15</td>
<td>mA</td>
<td>all IO pins are inputs; trimmed to 32 MHz; no external loads; no LIN communication; no ADC conversion</td>
<td></td>
</tr>
<tr>
<td>Sleep mode current</td>
<td>ISLEEP</td>
<td>25</td>
<td>50</td>
<td>μA</td>
<td>VS ≤ 18V, VSM ≤18V, Tj ≤ 150°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop mode current</td>
<td>ISTOP</td>
<td>250</td>
<td>500</td>
<td>μA</td>
<td>VS ≤ 32V, VSM ≤60V, Tj ≤ 150°C</td>
<td></td>
</tr>
<tr>
<td>Holding mode current</td>
<td>IHOLD</td>
<td>7</td>
<td></td>
<td>mA</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Table 8 – Electrical specifications: current consumption

12.3.2. Supply system

12.3.2.1. VDDA 3.3V regulator (including 5V option, external C: 0 ... 220nF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3V analog supply voltage</td>
<td>VDDA</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
<td>V</td>
<td>Bandgap and VDDA regulator trimmed</td>
</tr>
<tr>
<td>3.3V external current capability</td>
<td>IDDEXT_VDDA</td>
<td></td>
<td></td>
<td>25</td>
<td>mA</td>
<td>VS ≥ 4V, external supply for sensors</td>
</tr>
<tr>
<td>3.3V under-voltage detection threshold</td>
<td>VTH_UV_VDDA</td>
<td>2.75</td>
<td>2.85</td>
<td>2.95</td>
<td>V</td>
<td>VDDA ramping down</td>
</tr>
<tr>
<td>3.3V under-voltage detection hysteresis</td>
<td>VHYST_UV_VDDA</td>
<td>0.1</td>
<td>0.175</td>
<td>0.25</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Under-voltage debouncing time</td>
<td>TUV_VDDA</td>
<td>1.0</td>
<td>3.0</td>
<td>10</td>
<td>μs</td>
<td>11</td>
</tr>
<tr>
<td>3.3V over-voltage detection threshold</td>
<td>VTH_OV_VDDA</td>
<td>3.85</td>
<td>4.0</td>
<td>4.15</td>
<td>V</td>
<td>VDDA ramping up</td>
</tr>
<tr>
<td>3.3V over-voltage detection hysteresis</td>
<td>VHYST_OV_VDDA</td>
<td>0.1</td>
<td>0.175</td>
<td>0.25</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>5V analog supply voltage (option)</td>
<td>VDDA5V</td>
<td>4.85</td>
<td>5</td>
<td>5.15</td>
<td>V</td>
<td>Bandgap and VDDA regulator trimmed,</td>
</tr>
</tbody>
</table>
### 12.3.2.2. VDDD 1.8V regulator

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8V digital supply voltage</td>
<td>VDDD</td>
<td>1.80</td>
<td>1.875</td>
<td>1.95</td>
<td>V</td>
<td>Bandgap and VDDD regulator trimmed</td>
</tr>
<tr>
<td>1.8V current capability</td>
<td>IDDINT$_{\text{VDDD}}$</td>
<td>15</td>
<td></td>
<td></td>
<td>mA</td>
<td>Internal supply only, no external load; for information only</td>
</tr>
</tbody>
</table>

### 12.3.2.3. VSM under-voltage and VSM over-voltage detection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSM under-voltage detection threshold</td>
<td>VUV$<em>{\text{LH}</em>\text{VS}_0}$</td>
<td>3.5</td>
<td>4</td>
<td>4.5</td>
<td>V</td>
<td>Under-voltage detection on, PRUV$_{\text{VS}}$=0</td>
</tr>
<tr>
<td>VSM under-voltage detection threshold</td>
<td>VUV$<em>{\text{LH}</em>\text{VS}_1}$</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
<td>Under-voltage detection on, PRUV$_{\text{VS}}$=1</td>
</tr>
<tr>
<td>VSM under-voltage detection threshold</td>
<td>VUV$<em>{\text{LH}</em>\text{VS}_2}$</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>V</td>
<td>Under-voltage detection on, PRUV$_{\text{VS}}$=2</td>
</tr>
</tbody>
</table>
### Parameter Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VSM under-voltage detection threshold</strong></td>
<td>VUV_LH_VS_3</td>
<td>6.5</td>
<td>7</td>
<td>7.5</td>
<td>V</td>
<td>Under-voltage detection on, PRUV_VS=3</td>
</tr>
<tr>
<td><strong>VSM under-voltage detection threshold</strong></td>
<td>VUV_LH_VS_4</td>
<td>7.5</td>
<td>8</td>
<td>8.5</td>
<td>V</td>
<td>Under-voltage detection on, PRUV_VS=4</td>
</tr>
<tr>
<td><strong>VSM under-voltage detection threshold</strong></td>
<td>VUV_LH_VS_5</td>
<td>8.5</td>
<td>9</td>
<td>9.5</td>
<td>V</td>
<td>Under-voltage detection on, PRUV_VS=5</td>
</tr>
<tr>
<td><strong>VSM under-voltage detection hysteresis</strong></td>
<td>VHYST_UV_VS</td>
<td>0.1</td>
<td>0.5</td>
<td>1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td><strong>VSM under-voltage debouncing time</strong></td>
<td>TUV_VS</td>
<td>1.0</td>
<td>3.0</td>
<td>10</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td><strong>VSM over-voltage detection threshold</strong></td>
<td>VOV_LH_VS_0</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>V</td>
<td>Over-voltage detection on, PROV_VS=0</td>
</tr>
<tr>
<td><strong>VSM over-voltage detection threshold</strong></td>
<td>VOV_LH_VS_1</td>
<td>22</td>
<td>24</td>
<td>26</td>
<td>V</td>
<td>Over-voltage detection on, PROV_VS=1</td>
</tr>
<tr>
<td><strong>VSM over-voltage detection threshold</strong></td>
<td>VOV_LH_VS_2</td>
<td>38</td>
<td>40</td>
<td>42</td>
<td>V</td>
<td>Over-voltage detection on, PROV_VS=2</td>
</tr>
<tr>
<td><strong>VSM over-voltage detection threshold</strong></td>
<td>VOV_LH_VS_3</td>
<td>61</td>
<td>64</td>
<td>67</td>
<td>V</td>
<td>Over-voltage detection on, PROV_VS=3</td>
</tr>
<tr>
<td><strong>VSM over-voltage detection hysteresis</strong></td>
<td>VHY_OV_VS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td><strong>VSM over-voltage debouncing time</strong></td>
<td>TOV_VS</td>
<td>1.0</td>
<td>3.0</td>
<td>10</td>
<td>µs</td>
<td></td>
</tr>
</tbody>
</table>

Table 11 – Electrical specifications: VSM over- and under-voltage detection

#### 12.3.2.4. Wake-up circuit

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wake-up filter time IO pins</td>
<td>TWU_IO</td>
<td>15</td>
<td></td>
<td></td>
<td>80</td>
<td>µs</td>
</tr>
<tr>
<td>Wake-up filter time LIN pin</td>
<td>TWU_LIN</td>
<td>28</td>
<td></td>
<td></td>
<td>145</td>
<td>µs</td>
</tr>
<tr>
<td>Wake-up time internal timer</td>
<td>TWU_INT_0</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Wake-up time internal timer</td>
<td>TWU_INT_1</td>
<td></td>
<td></td>
<td></td>
<td>4096</td>
<td>FRC_10K</td>
</tr>
<tr>
<td>Wake-up time internal timer</td>
<td>TWU_INT_2</td>
<td></td>
<td></td>
<td></td>
<td>8192</td>
<td>FRC_10K</td>
</tr>
<tr>
<td>Parameter</td>
<td>Symbol</td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Unit</td>
<td>Condition</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>Wake-up time internal timer</td>
<td>TWU_INT_3</td>
<td></td>
<td>16384</td>
<td></td>
<td></td>
<td>WUI=11 (~1.6s)</td>
</tr>
</tbody>
</table>

Table 12 – Electrical specifications: wake-up circuit

### 12.3.2.5. Bandgap

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandgap voltage</td>
<td>VBG</td>
<td>1.15</td>
<td>1.185</td>
<td>1.22</td>
<td>V</td>
<td>Trimmed</td>
</tr>
<tr>
<td>Bandgap voltage temperature coeff.</td>
<td>TC_VBG</td>
<td>0</td>
<td>200</td>
<td></td>
<td>ppm/K</td>
<td></td>
</tr>
</tbody>
</table>

Table 13 – Electrical specifications: bandgap

### 12.3.3. Clock generation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency 1MHz oscillator</td>
<td>FRC_1M</td>
<td>-5%</td>
<td>1</td>
<td>+5%</td>
<td>MHz</td>
<td>MCU clock: MCU_CLK info: 32MHz results in ~25 MIPS</td>
</tr>
<tr>
<td>Frequency 32MHz oscillator</td>
<td>FRC_32M</td>
<td>-5%</td>
<td>32</td>
<td>+5%</td>
<td>MHz</td>
<td>MCU clock: MCU_CLK info: 32MHz results in ~25 MIPS</td>
</tr>
<tr>
<td>Frequency 10kHz oscillator</td>
<td>FRC_10K</td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td>Timing accuracy</td>
<td>TIMING_ACC</td>
<td>-1.5</td>
<td>1.5</td>
<td></td>
<td>%</td>
<td>Timing accuracy after sw correction using EEPROM calibration values</td>
</tr>
</tbody>
</table>

Table 14 – Electrical specifications: clock generation
12.3.4. PowerFET Pre-driver

12.3.4.1. Charge Pump and Boost voltage

The charge pump parameters are measured for $C_{fly} = 680 \text{nF}$, $C_{tank} = 3.3 \mu\text{F}$. Voltages (except hysteresis) are specified relative to $V_S$.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge pump clock</td>
<td>FRC_60K</td>
<td>50</td>
<td>60</td>
<td>75</td>
<td>KHz</td>
<td></td>
</tr>
<tr>
<td>VBOOST Charge pump voltage</td>
<td>VBOOST_VS_HI</td>
<td>7.5</td>
<td>9</td>
<td>10</td>
<td>V</td>
<td>$V_S \geq 10\text{V}$, $I_{LOAD} \leq 15\text{mA}$</td>
</tr>
<tr>
<td>VBOOST Charge pump voltage</td>
<td>VBOOST_VS_NOM</td>
<td>5.5</td>
<td>$V_S$ -1</td>
<td>9.5</td>
<td>V</td>
<td>$8\text{V} &lt; V_S &lt; 10\text{V}$, $I_{LOAD} \leq 15\text{mA}$</td>
</tr>
<tr>
<td>VBOOST Charge pump voltage</td>
<td>VBOOST_VS_LO</td>
<td>3.5</td>
<td>$V_S$ -1</td>
<td>8</td>
<td>V</td>
<td>$5.5\text{V} &lt; V_S &lt; 8\text{V}$, $I_{LOAD} \leq 5\text{mA}$</td>
</tr>
<tr>
<td>VBOOST Output resistance</td>
<td>RBOOST_OUT</td>
<td>5</td>
<td>20</td>
<td></td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>VBOOST under-voltage level</td>
<td>VUV_HL_VBOOST</td>
<td>6.1</td>
<td>6.4</td>
<td>6.7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VBOOST under-voltage hysteresis</td>
<td>VHYST_UV_VBOOST</td>
<td>0.2</td>
<td>0.25</td>
<td>0.35</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VBOOST Over-voltage level</td>
<td>VOV_LH_VBOOST</td>
<td>9.5</td>
<td>10.0</td>
<td>10.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VBOOST Over-voltage hysteresis</td>
<td>VHYST_OV_VBOOST</td>
<td>0.2</td>
<td>0.25</td>
<td>0.3</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

*Table 15 – Electrical specifications: charge pump*

12.3.4.2. Predriver stage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predriver charge resistance</td>
<td>R_HIGH</td>
<td>8</td>
<td>16</td>
<td></td>
<td>Ω</td>
<td>$V_{SM} = 10\text{V}... 60\text{V}$ $V_S \geq 10\text{V}$</td>
</tr>
<tr>
<td>Predriver discharge resistance</td>
<td>R_LOW</td>
<td>4</td>
<td>8</td>
<td></td>
<td>Ω</td>
<td>$V_{SM} = 10\text{V}... 60\text{V}$ $V_S \geq 10\text{V}$</td>
</tr>
<tr>
<td>Predriver peak charge-current</td>
<td>I_ON</td>
<td>700</td>
<td></td>
<td>mA</td>
<td></td>
<td>5Ω $R_{gate}$ at FET (200nC)¹¹</td>
</tr>
</tbody>
</table>

¹² Values are valid for BAT54S and similar low forward voltage Schottky diodes with $T_j \leq 150\text{ºC}$

¹³ with BAT54S and estimated 0.4V@$I_{LOAD}=10\text{mA}$ at 35°C
### 12.3.4.3. Current sense amplifier

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input range</td>
<td>V_CSL_IR</td>
<td>-125</td>
<td>125</td>
<td></td>
<td>mV</td>
<td>Current sense range for CSA_HIGHGAIN = 0</td>
</tr>
<tr>
<td>Input range</td>
<td>V_CSH_IR</td>
<td>-60</td>
<td>60</td>
<td></td>
<td>mV</td>
<td>Current sense range for CSA_HIGHGAIN = 1</td>
</tr>
<tr>
<td>Amplifier low gain</td>
<td>A_CSL</td>
<td>9.5</td>
<td>10</td>
<td>10.5</td>
<td></td>
<td>CSA_HIGHGAIN = 0</td>
</tr>
<tr>
<td>Amplifier high gain</td>
<td>A_CSH</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td></td>
<td>CSA_HIGHGAIN = 1</td>
</tr>
<tr>
<td>Low-pass filter time</td>
<td></td>
<td>0.25</td>
<td>0.5</td>
<td>1.0</td>
<td>µs</td>
<td>guaranteed by design</td>
</tr>
<tr>
<td>Over-current detection level</td>
<td>VTH_OC</td>
<td>10</td>
<td>300</td>
<td></td>
<td>mV</td>
<td>programmable 8-bit DAC</td>
</tr>
<tr>
<td>Over-current detection accuracy</td>
<td></td>
<td>-10</td>
<td>10</td>
<td></td>
<td>%</td>
<td>FullScale VTH_OC range</td>
</tr>
<tr>
<td>Over-current detection accuracy</td>
<td></td>
<td>-10</td>
<td>10</td>
<td></td>
<td>mV</td>
<td>@VTH_OC 10mV...300mV for Tj=85°C and</td>
</tr>
<tr>
<td>Over-current detection accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>@VTH_OC 200mV...300mV for Tj=(85..150)°C</td>
</tr>
<tr>
<td>Over-current debounce time</td>
<td>TDEB_OC</td>
<td>1</td>
<td>16</td>
<td></td>
<td>µs</td>
<td>programmable 7-bit timer</td>
</tr>
</tbody>
</table>

Table 17 – Electrical specifications: current sense amplifier
12.3.4.4. FET VDS monitor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS over-voltage level</td>
<td>VTH_OV_VDS_0</td>
<td>0.3</td>
<td>0.5</td>
<td>0.7</td>
<td>V</td>
<td>VDSMON_VTH_SEL = 00</td>
</tr>
<tr>
<td></td>
<td>VTH_OV_VDS_1</td>
<td>0.8</td>
<td>1.0</td>
<td>1.2</td>
<td>V</td>
<td>VDSMON_VTH_SEL = 01</td>
</tr>
<tr>
<td></td>
<td>VTH_OV_VDS_2</td>
<td>1.3</td>
<td>1.5</td>
<td>1.7</td>
<td>V</td>
<td>VDSMON_VTH_SEL = 10</td>
</tr>
<tr>
<td></td>
<td>VTH_OV_VDS_3</td>
<td>1.8</td>
<td>2.0</td>
<td>2.2</td>
<td>V</td>
<td>VDSMON_VTH_SEL = 11</td>
</tr>
<tr>
<td>VDS over-voltage hysteresis</td>
<td>VHY_OV_VDS</td>
<td>0.05</td>
<td>0.2</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VDS over-voltage debounce time</td>
<td>TDEB_OV_VDS</td>
<td>1</td>
<td></td>
<td></td>
<td>µs</td>
<td>programmable 7-bit timer</td>
</tr>
</tbody>
</table>

*Table 18 – Electrical specifications: FET VDS monitor*

12.3.4.5. OSD (off-state-diagnostics)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSD Pull up current</td>
<td>I_OSD</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>OSD Pull down resistance</td>
<td>R_OSD</td>
<td>25</td>
<td>35</td>
<td>50</td>
<td>kΩ</td>
<td></td>
</tr>
</tbody>
</table>

*Table 19 – Electrical specifications: OSD*

12.3.4.6. Active CDI (Current-Direction-Indicator)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparator threshold</td>
<td>VTH_CDI</td>
<td>-7.5</td>
<td>0</td>
<td>7.5</td>
<td>mV</td>
<td>ACTIVE_CDI_CLOCK ≤ 2MHz</td>
</tr>
</tbody>
</table>

*Table 20 – Electrical specifications: Active CDI*
12.3.4.7. VSM supply sensor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage range for ADC measurement</td>
<td></td>
<td>36</td>
<td>70</td>
<td></td>
<td>V</td>
<td>Measurement of VSM/26 (VSM_LOWGAIN = 0) Measurement of VSM/52 (VSM_LOWGAIN = 1)</td>
</tr>
<tr>
<td>VSM filter cut-off frequency</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>kHz</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 21 – Electrical specifications: VSM supply sensor

12.3.5. Over-temperature detection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTD threshold</td>
<td>TTH_OT_LH</td>
<td>175</td>
<td>185</td>
<td>195</td>
<td>°C</td>
<td>Temperature ramping up</td>
</tr>
<tr>
<td>OTD threshold</td>
<td>TTH_OT_HL</td>
<td>160</td>
<td></td>
<td></td>
<td>°C</td>
<td>Temperature ramping down</td>
</tr>
<tr>
<td>OTD hysteresis</td>
<td>THY_OT</td>
<td>25</td>
<td></td>
<td></td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

Table 22 – Electrical specifications: over-temperature detection

12.3.6. ADC

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference voltage</td>
<td>VREF_ADC_C</td>
<td></td>
<td>1.48</td>
<td></td>
<td>V</td>
<td>Trimmed and calibrated</td>
</tr>
<tr>
<td>Resolution</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
<td>bit</td>
<td>ADC cyclic mode for differential input from -VREF_ADC to +VREF_ADC</td>
</tr>
<tr>
<td>Sample &amp; Hold time</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>µs</td>
<td>ADC_CLK= 16MHz</td>
</tr>
<tr>
<td>Conversion time</td>
<td>TCONV</td>
<td>1.125</td>
<td>1.18</td>
<td></td>
<td>µs</td>
<td>ADC_CLK= 16MHz</td>
</tr>
<tr>
<td>DNL</td>
<td></td>
<td>-1</td>
<td></td>
<td>1</td>
<td>LSB</td>
<td>11</td>
</tr>
<tr>
<td>INL</td>
<td></td>
<td>-3</td>
<td></td>
<td>3</td>
<td>LSB</td>
<td>14</td>
</tr>
<tr>
<td>ADC channel accuracy - LV channels (with 1/2.5)</td>
<td></td>
<td>-45</td>
<td></td>
<td>45</td>
<td>mV</td>
<td>0V – 3.3V input, calibrated acc. calibration document</td>
</tr>
</tbody>
</table>

14 VS >= 4.5V for HVIO ADC LV channels (IO[4:0])
### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>divider)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - HV channels $^{15}$ (with 1/26 divider)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - HV channels $^{15}$ (with 1/26 divider)</td>
<td></td>
<td>-0.30</td>
<td>0.30</td>
<td>V</td>
<td>&lt;5V input, calibrated acc. calibration document</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - HV channels $^{15}$ (with 1/26 divider)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - HV channels $^{15}$ (with 1/26 divider)</td>
<td></td>
<td>-0.60</td>
<td>0.60</td>
<td>V</td>
<td>&lt;20V input, calibrated acc. calibration document</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - U,V,W (with 1/52 divider) and VBOOST (with 1/64 divider)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - U,V,W (with 1/52 divider) and VBOOST (with 1/64 divider)</td>
<td></td>
<td>-1.2</td>
<td>1.2</td>
<td>V</td>
<td>&lt;60V input, calibrated acc. calibration document</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - VSMF channel (with 1/26 divider)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - VSMF channel (with 1/26 divider)</td>
<td></td>
<td>-0.20</td>
<td>0.20</td>
<td>V</td>
<td>&lt;5V input, calibrated acc. calibration document</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - VSMF channel (with 1/26 divider)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - VSMF channel (with 1/26 divider)</td>
<td></td>
<td>-0.30</td>
<td>0.30</td>
<td>V</td>
<td>&lt;20V input, calibrated acc. calibration document</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - VSMF channel (with 1/52 divider)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - VSMF channel (with 1/52 divider)</td>
<td></td>
<td>-0.75</td>
<td>0.75</td>
<td>V</td>
<td>&lt;60V input, calibrated acc. calibration document (w/ and w/o OCD and CSA)</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel accuracy - temperature channel

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel accuracy - temperature channel</td>
<td></td>
<td>-10</td>
<td>10</td>
<td>°C</td>
<td>Calibrated acc. calibration document</td>
<td></td>
</tr>
</tbody>
</table>

ADC channel selection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC channel selection</td>
<td></td>
<td>0</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 23 – Electrical specifications: ADC

---

$^{15}$ HV channels are U, V, W, VBOOST, VS, IO0..IO4
### 12.3.7. IOs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input level L→H</td>
<td>VTH_LH</td>
<td></td>
<td></td>
<td>2.4</td>
<td>V</td>
<td>IO[11:0]</td>
</tr>
<tr>
<td>Input level H→L</td>
<td>VTH_HL</td>
<td>1</td>
<td></td>
<td></td>
<td>V</td>
<td>IO[11:0]</td>
</tr>
<tr>
<td>Input hysteresis</td>
<td>VHY</td>
<td>0.1</td>
<td></td>
<td></td>
<td>V</td>
<td>IO[11:0]</td>
</tr>
<tr>
<td>LV output voltage L</td>
<td>VOL</td>
<td></td>
<td>0.4</td>
<td></td>
<td>V</td>
<td>IO[11:0] (LV-mode) ILOAD = 3mA</td>
</tr>
<tr>
<td>LV output voltage H</td>
<td>VOH</td>
<td>VDDA-0.4</td>
<td></td>
<td></td>
<td>V</td>
<td>IO[11:0] (LV-mode) ILOAD = 3mA</td>
</tr>
<tr>
<td>HV output voltage L</td>
<td>VOL_HV</td>
<td></td>
<td>1.0</td>
<td></td>
<td>V</td>
<td>IO0, IO1, IO2, IO3, IO4 (HV-mode) ILOAD = 5mA</td>
</tr>
<tr>
<td>HV output voltage H</td>
<td>VOH_HV</td>
<td>VS-1.0</td>
<td></td>
<td></td>
<td>V</td>
<td>IO0, IO1, IO2, IO3, IO4 (HV-mode) ILOAD = 5mA</td>
</tr>
<tr>
<td>HV input range for ADC measurement</td>
<td></td>
<td></td>
<td>0</td>
<td>36</td>
<td>V</td>
<td>IO0, IO1, IO2, IO3, IO4 (HV-mode) Measurement of IOx/26</td>
</tr>
<tr>
<td>HS output current</td>
<td></td>
<td></td>
<td>50</td>
<td>mA</td>
<td></td>
<td>IO3, IO4 (HS-mode)</td>
</tr>
<tr>
<td>HS output resistance</td>
<td></td>
<td></td>
<td>10</td>
<td>25</td>
<td>Ω</td>
<td>IO3, IO4 (HS-mode)</td>
</tr>
<tr>
<td>I2C SDA hold time</td>
<td>TH_SDA</td>
<td>-50</td>
<td>0</td>
<td>50</td>
<td>ns</td>
<td>Referenced to SCL; TRIM_SDAFILT_IO = 00</td>
</tr>
<tr>
<td>I2C SDA hold time</td>
<td>TH_SDA</td>
<td>150</td>
<td>260</td>
<td>340</td>
<td>ns</td>
<td>Referenced to SCL; TRIM_SDAFILT_IO = 01</td>
</tr>
<tr>
<td>I2C SDA hold time</td>
<td>TH_SDA</td>
<td>200</td>
<td>320</td>
<td>420</td>
<td>ns</td>
<td>Referenced to SCL; TRIM_SDAFILT_IO = 10</td>
</tr>
<tr>
<td>I2C SDA hold time</td>
<td>TH_SDA</td>
<td>360</td>
<td>500</td>
<td>640</td>
<td>ns</td>
<td>Referenced to SCL; TRIM_SDAFILT_IO = 11</td>
</tr>
</tbody>
</table>

Table 24 – Electrical specifications: IO

---

If IO is connected to an external harness, EMC protection circuitry has to be applied according to paragraph Error! Reference source not found.
12.3.7.1. VDS monitor IO3 and IO4

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS monitor level</td>
<td>VTH__VDS_IO</td>
<td>70</td>
<td>100</td>
<td>130</td>
<td>mA</td>
<td>VS&gt;=4.5V</td>
</tr>
<tr>
<td>VDS monitor hysteresis</td>
<td></td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>VDS debounce time</td>
<td>TDEB_OV__VDS_IO</td>
<td>0.032</td>
<td>16000</td>
<td>µs</td>
<td>programmable 4-bit timer with 4 bit prescaler</td>
<td></td>
</tr>
</tbody>
</table>

Table 25 – Electrical specifications: VDS monitor IO
### 12.3.8. LIN

#### 12.3.8.1. LIN transceiver – static

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter internal capacitance</td>
<td>CLIN</td>
<td>30</td>
<td>40</td>
<td>pF</td>
<td>Response on 14V pulse via 1K</td>
<td></td>
</tr>
<tr>
<td>Bus short circuit current</td>
<td>IBUS_LIM</td>
<td>40</td>
<td>200</td>
<td>mA</td>
<td>VLIN = VS = 18V, VTxD = 0V</td>
<td></td>
</tr>
<tr>
<td>Pull up resistance bus</td>
<td>RSLAVE</td>
<td>20</td>
<td>35</td>
<td>60</td>
<td>kΩ</td>
<td>VDISTERM = 0</td>
</tr>
<tr>
<td>Pull up current bus, sleep mode</td>
<td>ISLAVE_SLEEP</td>
<td>-50</td>
<td>-20</td>
<td>-5</td>
<td>μA</td>
<td>VLIN = 0V, VSBY = VAUX, VEN = 0</td>
</tr>
<tr>
<td>Dominant input leakage current including pull up resistor</td>
<td>IBUS_PAS_dom</td>
<td>-1</td>
<td></td>
<td>mA</td>
<td>VLIN = 0V, VS = 12V, VTxD = VDDD, VDISTERM = 0 VEN = VDDD, VSBY = 0</td>
<td></td>
</tr>
<tr>
<td>Recessive input leakage current</td>
<td>IBUS_PAS_rec</td>
<td>0.25</td>
<td>20</td>
<td>μA</td>
<td>VEN = VDDD, VSBY = 0, VTxD = VDDD</td>
<td></td>
</tr>
<tr>
<td>Bus reverse current loss of battery</td>
<td>IBUS_NO_BAT</td>
<td>0.25</td>
<td>23</td>
<td>μA</td>
<td>VS = 0V, 0V &lt; VLIN ≤ 18V</td>
<td></td>
</tr>
<tr>
<td>Bus current during loss of ground</td>
<td>IBUS_NO_GND</td>
<td>-100</td>
<td>1</td>
<td>μA</td>
<td>VS = VGND = 12V, 0 &lt; VLIN ≤ 18V</td>
<td></td>
</tr>
<tr>
<td>Transmitter dominant output voltage</td>
<td>VolBUS</td>
<td>0</td>
<td>0.2×VS</td>
<td>V</td>
<td>Rload = 500Ω</td>
<td></td>
</tr>
<tr>
<td>Transmitter recessive output voltage</td>
<td>VohBUS</td>
<td>0.8×VS</td>
<td>1×VS</td>
<td>V</td>
<td>VEN = VDDD, VSBY = 0, VTxD = VDDD or sleep mode</td>
<td></td>
</tr>
<tr>
<td>Receiver dominant voltage</td>
<td>VBUSdom</td>
<td>0.4×VS</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver recessive voltage</td>
<td>VBUSrec</td>
<td>0.6×VS</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center point of receiver threshold</td>
<td>VBUS_CNT</td>
<td>0.475×VS</td>
<td>0.5×VS</td>
<td>0.525×VS</td>
<td>V</td>
<td>VBUS_cnt = (Vth_dom+Vth_rec)/2</td>
</tr>
<tr>
<td>Receiver hysteresis</td>
<td>VHYS</td>
<td>0.175×VS</td>
<td>V</td>
<td>VHYS = (Vth_rec – Vth_dom)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 26 – Electrical specifications: LIN transceiver – static (7 ≤ VS ≤ 18V)

---

17 The parameter in are according to ISO17987-4, SAE J2602-1. For 5.5V < VS < 7V Reduced performance.
### Parameter Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter internal capacitance</td>
<td>CLIN</td>
<td>30</td>
<td>40</td>
<td></td>
<td>pF</td>
<td>Response on 14V pulse via 1K</td>
</tr>
<tr>
<td>Bus short circuit current</td>
<td>IBUS_LIM</td>
<td>40</td>
<td>300</td>
<td></td>
<td>mA</td>
<td>VLIN = VS = 36V, VTxD = 0V</td>
</tr>
<tr>
<td>Pull up resistance bus</td>
<td>RSLAVE</td>
<td>20</td>
<td>35</td>
<td>60</td>
<td>kΩ</td>
<td>VDISTTERM = 0</td>
</tr>
<tr>
<td>Pull up current, sleep mode</td>
<td>ISLAVE_SLEEP</td>
<td>-50</td>
<td>-20</td>
<td>-5</td>
<td>µA</td>
<td>VLIN = 0V, VSBY = VAUX, VEN =0</td>
</tr>
<tr>
<td>Dominant input leakage current including pull up resistor</td>
<td>IBUS_PAS_dom</td>
<td>-2</td>
<td></td>
<td></td>
<td>mA</td>
<td>VLIN =0V, VS =24V, VTxD = VDDD, VDISTTERM = 0 VEN = VDDD, VSBY = 0</td>
</tr>
<tr>
<td>Recessive input leakage current</td>
<td>IBUS_PAS_rec</td>
<td>0.5</td>
<td>20</td>
<td></td>
<td>µA</td>
<td>VEN = VDDD, VSBY = 0, VTxD = VDDD, VLIN &gt; VS</td>
</tr>
<tr>
<td>Bus reverse current loss of battery</td>
<td>IBUS_NO_BAT</td>
<td>0.5</td>
<td>23</td>
<td></td>
<td>µA</td>
<td>VS = 0V, 0V &lt; VLIN ≤ 36V</td>
</tr>
<tr>
<td>Bus current during loss of ground</td>
<td>IBUS_NO_GND</td>
<td>-200</td>
<td>2</td>
<td></td>
<td>µA</td>
<td>VS = VGND = 12V, 0 &lt; VLIN ≤ 36V</td>
</tr>
<tr>
<td>Transmitter dominant output voltage</td>
<td>VolBUS</td>
<td>0</td>
<td></td>
<td>0.2×VS</td>
<td>V</td>
<td>Rload = 500Ω</td>
</tr>
<tr>
<td>Transmitter recessive output voltage</td>
<td>VohBUS</td>
<td></td>
<td>0.8×VS</td>
<td>1×VS</td>
<td>V</td>
<td>VEN = VDDD, VSBY = 0, VTxD = VDDD or sleep mode</td>
</tr>
<tr>
<td>Receiver dominant voltage</td>
<td>VBUSdom</td>
<td></td>
<td>0.4×VS</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Receiver recessive voltage</td>
<td>VBUSrec</td>
<td></td>
<td>0.6×VS</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Center point of receiver threshold</td>
<td>VBUS_CNT</td>
<td>0.475×VS</td>
<td>0.5×VS</td>
<td>0.525×VS</td>
<td>V</td>
<td>VBUS_cnt = (Vth_dom+Vth_rec)/2</td>
</tr>
<tr>
<td>Receiver hysteresis</td>
<td>VHYS</td>
<td></td>
<td>0.175×VS</td>
<td></td>
<td>V</td>
<td>VHYS = (Vth_rec – Vth_dom)</td>
</tr>
</tbody>
</table>

*Table 27 – Electrical specifications: LIN transceiver – static (18V < VS ≤ 36V)*

---

**In accordance to SAE J2602**
12.3.8.2. LIN transceiver – dynamic

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propagation delay receiver</td>
<td>trx_pdf</td>
<td>6</td>
<td>6</td>
<td>µs</td>
<td></td>
<td>CRxD =25pF falling edge</td>
</tr>
<tr>
<td>Propagation delay receiver</td>
<td>trx_pdr</td>
<td>6</td>
<td>6</td>
<td>µs</td>
<td></td>
<td>CRxD =25pF rising edge</td>
</tr>
<tr>
<td>Propagation delay receiver symmetry</td>
<td>trx_sym</td>
<td>-2</td>
<td>2</td>
<td>µs</td>
<td></td>
<td>Calculate trx_pdf - trx_pdr</td>
</tr>
<tr>
<td>Receiver debounce time</td>
<td>trx_deb</td>
<td>0.5</td>
<td>4</td>
<td>µs</td>
<td></td>
<td>LIN rising &amp; falling edge</td>
</tr>
<tr>
<td>LIN duty cycle 1</td>
<td>D1</td>
<td>0.396</td>
<td></td>
<td></td>
<td></td>
<td>20kbps operation, normal mode</td>
</tr>
<tr>
<td>LIN duty cycle 2</td>
<td>D2</td>
<td>0.581</td>
<td></td>
<td></td>
<td></td>
<td>20kbps operation, normal mode</td>
</tr>
<tr>
<td>LIN duty cycle 3</td>
<td>D3</td>
<td>0.417</td>
<td></td>
<td></td>
<td></td>
<td>10.4kbs operation, low speed mode</td>
</tr>
<tr>
<td>LIN duty cycle 4</td>
<td>D4</td>
<td>0.590</td>
<td></td>
<td></td>
<td></td>
<td>10.4kbs operation, low speed mode</td>
</tr>
<tr>
<td>tREC(MAX) – tDOM(MIN)</td>
<td>Δt3</td>
<td>15.9</td>
<td>µs</td>
<td></td>
<td></td>
<td>10.4kbs operation, low speed mode</td>
</tr>
<tr>
<td>tDOM(MAX) – tREC(MIN)</td>
<td>Δt4</td>
<td>17.28</td>
<td>µs</td>
<td></td>
<td></td>
<td>10.4kbs operation, low speed mode</td>
</tr>
<tr>
<td>Slew rate on pin LIN normal mode, trimmed</td>
<td></td>
<td>1.2</td>
<td>V/µs</td>
<td></td>
<td></td>
<td>dV/dt between duty cycle measurement points, VS=12V</td>
</tr>
<tr>
<td>Slew rate on pin LIN low speed mode, trimmed</td>
<td></td>
<td>0.6</td>
<td>V/µs</td>
<td></td>
<td></td>
<td>dV/dt between duty cycle measurement points, VS=12V</td>
</tr>
<tr>
<td>TxD dominant timeout</td>
<td>ttXD_to</td>
<td>15</td>
<td>ms</td>
<td></td>
<td></td>
<td>Normal mode, vTxD=0V</td>
</tr>
</tbody>
</table>

Table 28 – Electrical specifications: LIN transceiver – dynamic (7 ≤ VS ≤ 18V)
### Table 29 – Electrical specifications: LIN transceiver – dynamic (18V < VS ≤ 36V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propagation delay receiver</td>
<td>trx_pdf</td>
<td>19 20</td>
<td>6 μs</td>
<td>CRxD = 25pF falling edge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation delay receiver</td>
<td>trx_pdr</td>
<td>19 20</td>
<td>6 μs</td>
<td>CRxD = 25pF rising edge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation delay receiver symmetry</td>
<td>trx_sym</td>
<td>-2 2</td>
<td>2 μs</td>
<td>Calculate trx_pdf - trx_pdr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver debounce time</td>
<td>trx_deb</td>
<td>0.5 4</td>
<td>μs</td>
<td>LIN rising &amp; falling edge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIN duty cycle 1</td>
<td>D1</td>
<td>0.330</td>
<td>20kbps operation, normal mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIN duty cycle 2</td>
<td>D2</td>
<td>0.642</td>
<td>20kbps operation, normal mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIN duty cycle 3</td>
<td>D3</td>
<td>0.386</td>
<td>10.4kbps operation, low speed mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIN duty cycle 4</td>
<td>D4</td>
<td>0.591</td>
<td>10.4kbps operation, low speed mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tREC(MAX) – tDOM(MIN)</td>
<td>Δt3</td>
<td>21.89 μs</td>
<td>10.4kbps operation, low speed mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tDOM(MAX) – tREC(MIN)</td>
<td>Δt4</td>
<td>17.47 μs</td>
<td>10.4kbps operation, low speed mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slew rate on pin LIN normal mode, trimmed</td>
<td>2.4 V/μs</td>
<td>dV/dt between duty cycle measurement points, VS=24V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slew rate on pin LIN low speed mode, trimmed</td>
<td>1.2 V/μs</td>
<td>dV/dt between duty cycle measurement points, VS=24V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TxD dominant timeout</td>
<td>ttxd_to</td>
<td>15 ms</td>
<td>Normal mode, vTxD=0V</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

19 This parameter is tested by applying a square wave signal to the LIN. The minimum slew rate for the LIN rising and falling edges is 50V/μs.
20 See Figure 12
21 Standard loads for duty cycle measurements are 1kΩ/1nF, 660Ω/6.8nF, 500Ω/10nF, internal master termination disabled.
22 In accordance to SAE J2602, see Figure 13
23 Parameter in relation to internal signal TxD.
Figure 12 – LIN timing diagram (reference LIN2.1 specification)

Figure 13 – LIN timing diagram, relation between propagation delay and duty cycle

(Reference SAE J2602 specification)
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