

Product Abstract

MLX81150

LIN-Slave for relay and DC motor control

Features

Microcontroller: MLX16x8 RISC CPU

- 16 bit RISC-CPU
- Co-processor for fast multiplication and division
- In-circuit debug and emulation

Memories

- 32 kByte Flash with ECC
- 2 kByte RAM
- 380 Byte EEPROM with separate RAM (also called NVRAM), with ECC, for customer purposes

Supported bus interface

- LIN-Interface with integrated LIN transceiver supporting LIN 2.x and SAE J2602, certified LIN protocol software provided by Melexis
- In-Module-Programming (Flash and EE) via pin LIN using a special Melexis fast protocol
- PWM-Interface
- Full duplex SPI, Master/Slave, double-buffered, speed programmable

Voltage regulator

- Internal voltage regulator, direct powered from 12V battery supply
- Operating voltage $V_S = 5.5V$ to 18V, IC will work down to 3.9V
- Possibility to put an external bypass transistor for high temperature requirements
- Very low SLEEP MODE current $< 30\mu A$, Wake up by LIN traffic or local sources

Periphery

- 4 programmable 16bit PWM modules for external transistor full bridge applications
- Timer unit 16 bit with 4 capture and 4 compare
- 25 MHz $\pm 5\%$ internal RC-oscillator with PLL, optional crystal resonator
- Load dump and brown out interrupt function
- Digital watchdog for software flow tracking
- System-Clock-independent fully integrated watchdog
- On-chip temperature sensor with $\pm 10K$ accuracy
- 10 bit ADC with $< 6 \mu s$ conversion time with multiple channels and different ADC references, DMA access to RAM
- 8 multiple purpose I/Os
- 2 integrated relay drivers with free wheel function
- 2 inputs for relay contact or shunt current monitoring
- Over current detection, shunt current sense
- 1 switch-able supply output for external Hall sensor connection

Additional features

- Direct access to pin LIN possible
- Temperature range $-40^\circ C$ up to $150^\circ C$ ambient
- 28V jump start and 45V load dump protected
- Monolithic solution: Single chip in single package realization
- Small QFN32 5x5

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Applications

LIN slaves for all kind of high current DC and 1 / 2 phase BLDC motor control, like

- Window lifter
- DC oil, water and fuel pumps
- Automatic head lean
- Sun roof
- Throttle valves
- DC/DC converters

Ordering Information

| Order Code ^[1] | Temperature Range | Package | Delivery | Remark |
|---------------------------|-------------------|-----------|----------|-----------|
| MLX81150 LLW-DAA-000-RE | -40 - 150 °C | QFN32 5x5 | Reel | MLX81150D |

Table 1 – Ordering Information

^[1].See Marking/Order Code.

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1. Functional Diagram

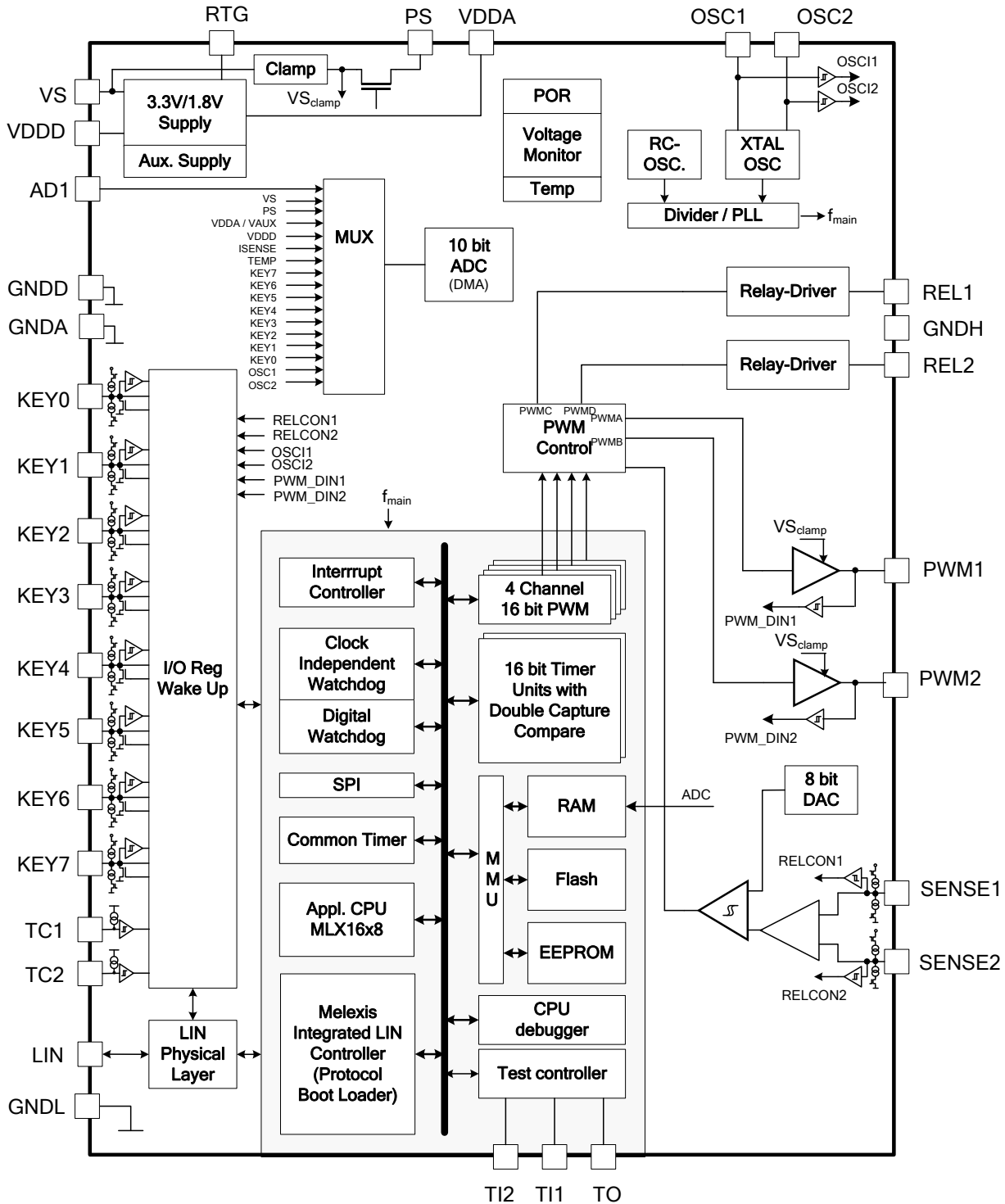


Figure 1: Block Diagram

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2. Pin Description

| Pin No. | Pad count | Pin name | voltage range | remarks and description |
|---------|-----------|------------|-------------------|--|
| 30 | 1 | VS | Pwr HV | Battery supply voltage; external protection against reverse polarity needed, external blocking capacitors |
| 29 | 2 | GNDD | Pwr | Ground pin for Digital part |
| 27 | 2 | GNDA | Pwr | Ground pin for Analogue part |
| 12 | 2 | GNDH | Pwr | Ground pin for Relay Driver |
| 15 | 1 | GNDL | Pwr | Ground pin for LIN |
| 25 | 2 | VDDA | Pwr LV | Regulator output (~3.3 V), external blocking capacitors |
| 28 | 2 | VDDD | Pwr LV | Regulator output (~1.8 V), external blocking capacitors |
| 26 | 1 | RTG | Ana LV | Output for external bipolar transistor in case of HT applications |
| 32 | 1 | PS | Ana HV | High-side switch with Ron < 40 Ohm at 20mA, Switch-able supply (<15 V) for external components |
| [3:10] | 8 | KEY[7:0] | Multi-function HV | High voltage I/O port with wake-up function, Input for high or low active switches, ADC input, Low-side driver output 2mA (15mA), Weak current sources for pin diagnosis and WAKE UP in SLEEP MODE SPI Interface Pins (valid for KEY[3:0], DI, DO, CLK, CS) |
| 31 | 1 | AD1 | Ana HV | High voltage ADC input (for VBAT measurement), Low side driver 30 mA (only for test purposes) |
| 13, 11 | 2, 2 | REL[2:1] | Ana HV | Low-side switch with Ron < 7 Ohm at 150 mA @150°C, Relay driver with free wheel function, PWM controlled output |
| 23, 24 | 2 | SENSE[2:1] | Ana HV | High voltage input for read out the status of relay contacts, Current sense function for shunt current |
| 2, 1 | 2 | PWM[2:1] | Ana HV | Push pull output with Ron < 50 Ohm at 20mA, high output level is supply related but max approx. 14V, PWM controlled output |
| 21, 22 | 2 | TC[2:1] | Ana LV | Input for timer capture unit, Low voltage input |
| 18, 19 | 2 | OSC[2:1] | Ana LV | Crystal oscillator pin, Low voltage input, load capacitors external, ADC input |
| 14 | 1 | LIN | Ana HV | LIN 2.x transceiver BUS pin, slave only, High voltage I/O |

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| Pin No. | Pad count | Pin name | voltage range | remarks and description |
|---------|-----------|---------------|---------------|--|
| 17, 16 | 1 | TI[2:1] | Dig input | Test inputs for Melexis, debug interface - connect via resistor to GND in application mode, so that Flashing via these test pins is possible |
| 20 | 1 | TO | Dig output | Test output for Melexis, debug interface, unconnected in application mode |
| - | - | not connected | - | not connected pins |

| | |
|---------------|--|
| Dig | digital input or output or bidirectional |
| Ana | analogue pin |
| Pwr | power/supply pin |
| Multifunction | multifunctional pin (configurable pin) |
| Test | pin for test purposes |
| LV | low voltage, VDDA or VDDD related |
| HV | high voltage, VBAT or VS related |

Top view of the package QFN32

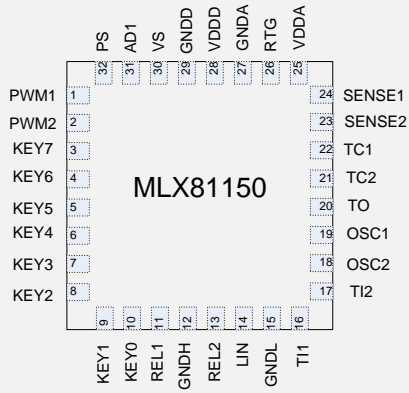


Table 3 – Ordering Information

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3. Electrical Characteristics

All voltages are referenced to ground (GND). Positive currents flow into the IC. The absolute maximum ratings given in the table below are limiting values that do not lead to a permanent damage of the device but exceeding any of these limits may do so. Long term exposure to limiting values may affect the reliability of the device. Reliable operation of the device is only specified within the limits shown in Operating Conditions.

3.1. Operating Conditions

The IC can have 6 different hardware modes. The exact functionality of these modes depends on the hardware and software configuration:

- **Reset:**
 - triggered by hardware. When VS or VDDA or VDDD drop below a critical level, the complete chip is powered down.
 - The analogue and digital supply regulators are disabled. No functionality is available in this mode.
- **Normal mode. Main application running**
 - Microcontroller fully functional
 - Analogue fully functional
- **Under voltage: triggered by the hardware under voltage detection interrupt. (VS_UV)**
 - Microcontroller fully functional.
 - Analogue functionality under software control.
 - Reduced current capability on VDDA below VS=5.5V.
- **Over voltage: triggered by the hardware over voltage detection interrupt. (VS_OV)**
 - Microcontroller fully functional
 - Analogue functionality powered down by hardware or software.
- **Sleep Mode: Triggered by the software.**
 - Microcontroller powered down
 - Digital and analogue supply powered down.
 - Sleep Mode and wake-up functionality running on help supply Vaux

| Parameter | Symbol | Conditions | Limit | | Unit |
|----------------------|--------|------------|-----------------|-----|-----------------------|
| | | | Min | Typ | |
| Supply Voltage Range | VS | | 5.5 (3.9[1]) | | 18 V |
| Ambient Temperature | Ta | | -40 | | 105 (150[2]) °C |

Table 1: Operational conditions

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- [1] IC will work down to 3.9V with reduced analogue characteristics, Digital part still works, Memories will keep their content. Some analogue parameter will drift out of limits, but chip function can be guaranteed.
Before going down to 3.9V the VS has to be at the startup of the IC for a certain time > 6V to guarantee a correct reset!
Evaluation will only be done on sample basis in the preproduction phase; no production test; no life time test
- [2] With temperature applications at $T_A > 105^{\circ}\text{C}$ a reduction of chip internal power dissipation with external supply transistor is obligatory. The extended temperature range is only allowed for a limited periods of time, customers mission profile has to be agreed by Melexis as an obligatory part of the Part Submission Warrant (PSW).
Some analogue parameter may drift out of limits, but chip function can be guaranteed.

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3.2. Absolute maximum ratings

| Parameter | Symbol | Condition | Limit Min | Limit Max | Unit |
|------------------------|-----------------|---|-----------|-------------------------|------|
| Supply voltage | VS | t < 5 min | -0.3 | 28 | V |
| | | t < 500 ms | -0.3 | 45 | |
| | VS.tr1 | ISO 7637-2 pulse 1 [1] VS=13.5V, TA=(23 ± 5)°C | -100 | | |
| | VS.tr2 | ISO 7637-2 pulse 2 [1] VS=13.5V, TA=(23 ± 5)°C | | +50 | |
| | VS.tr3 | ISO 7637-2 pulses 3A, 3B [1] VS=13.5V, TA=(23 ± 5)°C | -150 | +100 | |
| | VS.tr5 | ISO 7637-2 pulses 5b [1] VS=13.5V, TA=(23 ± 5)°C | +65 | +87 | |
| Output voltage | VDDA | | -0.3 | 3.6 | |
| Output voltage | VDDD | | -0.3 | 1.95 | |
| LIN Bus | VLIN | T < 500ms | -22 | 40 | |
| | VLIN.tr1 | ISO 7637-2 pulse 1 [2] VS=13.5V, TA=(23 ± 5)°C | -100 | | |
| | VLIN.tr2 | ISO 7637-2 pulse 2 [2] VS=13.5V, TA=(23 ± 5)°C | | +75 | |
| | VLIN.tr3 | ISO 7637-2 pulses 3A, 3B [2] VS=13.5V, TA=(23 ± 5)°C | -150 | +100 | |
| Voltage on Analogue HV | VANA_HV | Without external resistor; Pins KEY[7:0], AD1 Pin PWM[2:1] | -0.3 | VS+0.3 V(PS) +0.3 | |
| | | With external resistor of 47 kΩ; Pins KEY[7:0], AD1 | | VBAT | |
| | VmaxPS | Pin PS | | 15 | |
| | VmaxSENSE [2:1] | Pins SENSE[2:1] | | VS+0.3 | |
| | VmaxREL[2:1] | Pins REL[2:1] | | Vclrel[2:1] | |
| Voltage on Analogue LV | VANA_LV | Pins RTG, TC[2:1], OSC[2:1] RTG (in case of external bipolar transistor) | -0.3 | VDDA +0.3 | |

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| Parameter | Symbol | Condition | Limit Min | Limit Max | Unit |
|---|------------|---|-----------|-----------|------|
| | | | | 5 | |
| Digital Output Voltage | VOUT_DIG | Pin TO | -0.3 | VDDA +0.3 | |
| Digital Input Voltage | VIN_DIG | Pins TI[2:1] | -0.3 | VDDA +0.3 | |
| Digital Input Current | IIN_DIG | Pins TI[2:1] | -10 | 10 | mA |
| Maximum latch-up free current at any pin | ILATCH | according to JEDEC JESD78, AEC-Q100-004 | -250 | 250 | |
| ESD capability of pin LIN | ESDHBM_LIN | Human body model [4] | -6 | +6 | kV |
| ESD capability of pin LIN | ESDIEC_LIN | Acc. To IEC 61000-4-2 [5] | -6 | +6 | kV |
| ESD capability of any other pin, except LIN | ESDHBM | Human body model [4] | -2 | +2 | kV |
| ESD capability at any pin | ESDCDM | Charge Device Model [6] | -500 | +500 | V |
| Storage temperature | Tstg | | -55 | 150 | °C |
| Junction Temperature | TJ | | -40 | 155 | °C |
| Thermal resistance QFN32 [3] | Rth | in free air, air flow 0m/s | ~ 32 | | K/W |

Table 2: Absolute maximum ratings

- [1] ISO 7637 test pulses are applied to VS via a reverse polarity diode and >1μF blocking capacitor;
- [2] ISO 7637 test pulses are applied to LIN via a coupling capacitance of 1nF;
- [3] Simulated value for low conductance board (JEDEC).
- [4] Equivalent to discharging a 100pF capacitor through a 1.5kΩ resistor conform to AEC-Q100-002 or ESDA/JEDEC JDS-001.
- [5] Equivalent to discharging a 150pF capacitor through a 330Ω resistor.
- [6] ESD CDM Test confirm to AEC-Q100-011 or JEDEC22-C101.

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4. Application Examples

The following sections show typical application examples ^[1].

4.1. Single DC-Motor Drive

In this sample application the IC can realize the driving of a DC motor via an external relay bridge. Speed, position sensing and anti trap or block detection are done by means of external Hall latches connected to a timer capture unit. The Hall sensors are switched off during standby mode via a switch-able battery voltage output. Additionally Relay contact monitoring can be done by checking the voltages over it.

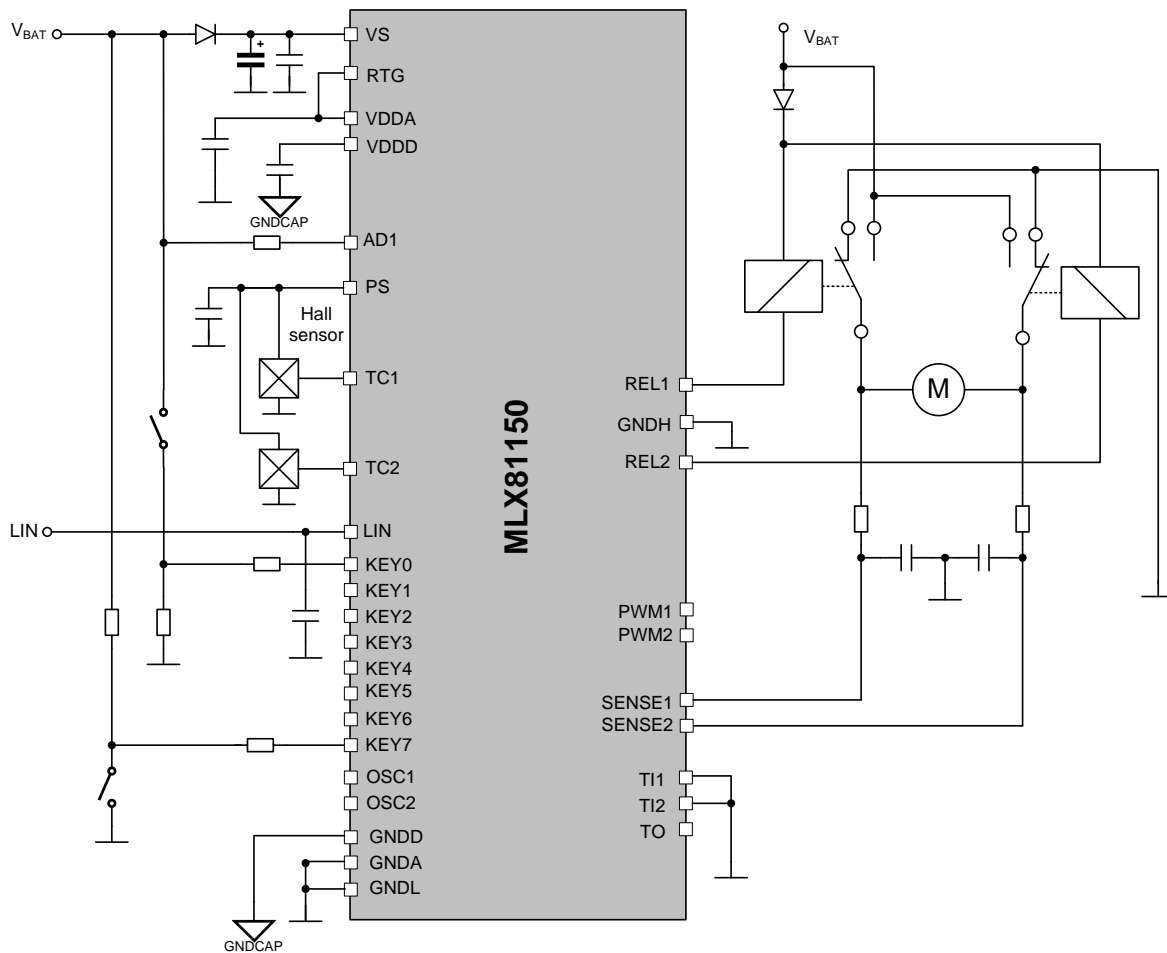


Figure 1- Principle application diagram showing a common relay driver controlled by external switches and LIN bus

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4.2. Single DC Motor Drive with soft start / stop

For some applications it might be necessary:

- To control the motor speed especially during start / stop,
- To have an independent switching channel in case the relay “hangs”,
- To switch the power via the power transistor and to increase with this the life time of the relay contacts
- To monitor the motor current (current sensing and over current shut off).

This application requires then also a reverse polarity protection in the power path.

Following application diagram shows the practical realization in principle:

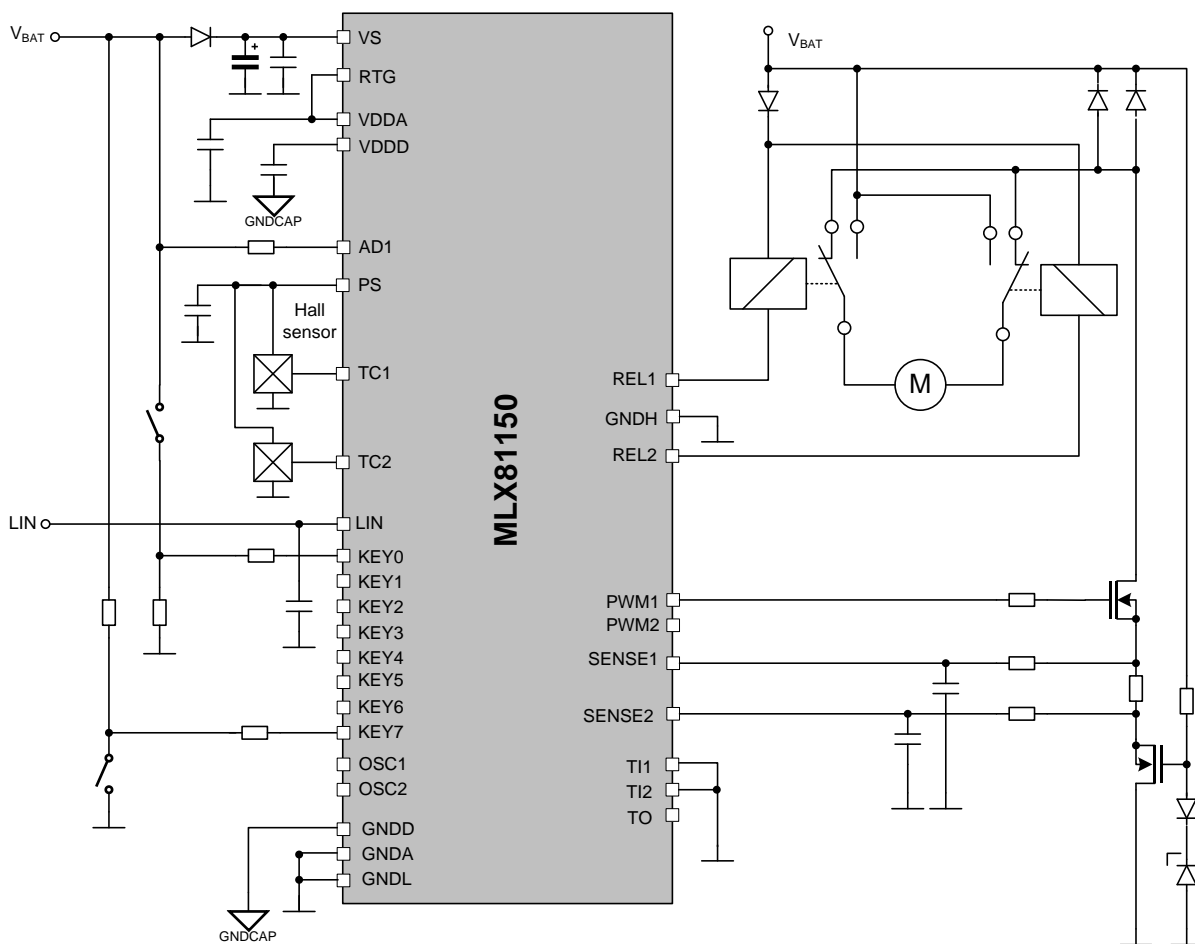


Figure 2- Principle application diagram showing a common relay driver controlled by external switches and LIN bus, with soft start / stop and motor current sense

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4.3. Single DC motor drive in FET controlled full bridge applications

By adding some external additional circuitry, the IC will also allow to drive DC motors in full bridge applications. Position, speed and direction sensing is done via external Hall latches.

By having one PWM on the low side path of the half bridge and the inverse PWM (with programmable interlock delay in the high side path) the p channel can be actively switched on in case the current wheels out.

Same is for the n-channel Transistor.

The other side of the full bridge is then statically switched on or off.

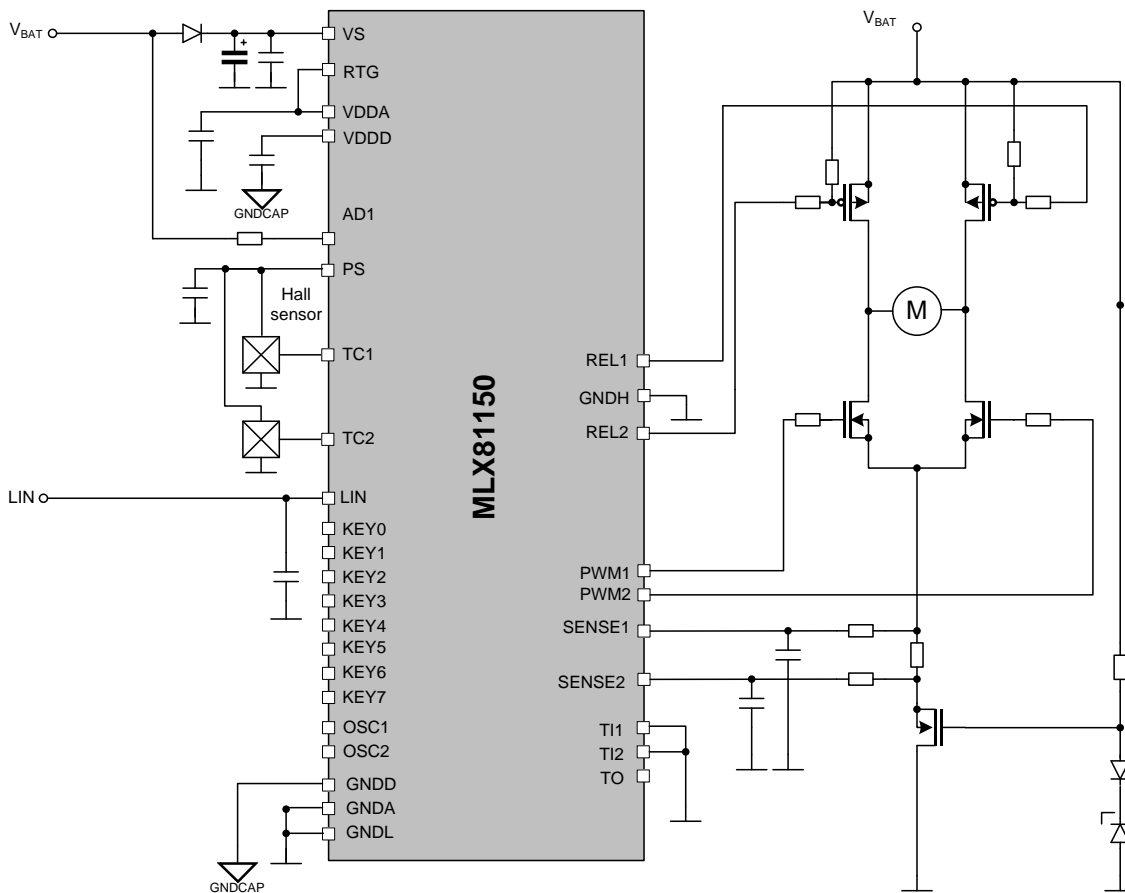


Figure 3- Single DC Motor drive; full bridge

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4.4. LED-Lamp driver, switch mode power supply

In this application the MLX81150 drives a LED lamp with several high power LEDs in a DC-DC converter configuration. The module itself is controlled via the LIN bus. The current in the LED is regulated to a given value. Adjusting PWM frequency and PWM ratio allows controlling the transformer in a very efficient way from EMC perspective as well as from energy point of view.

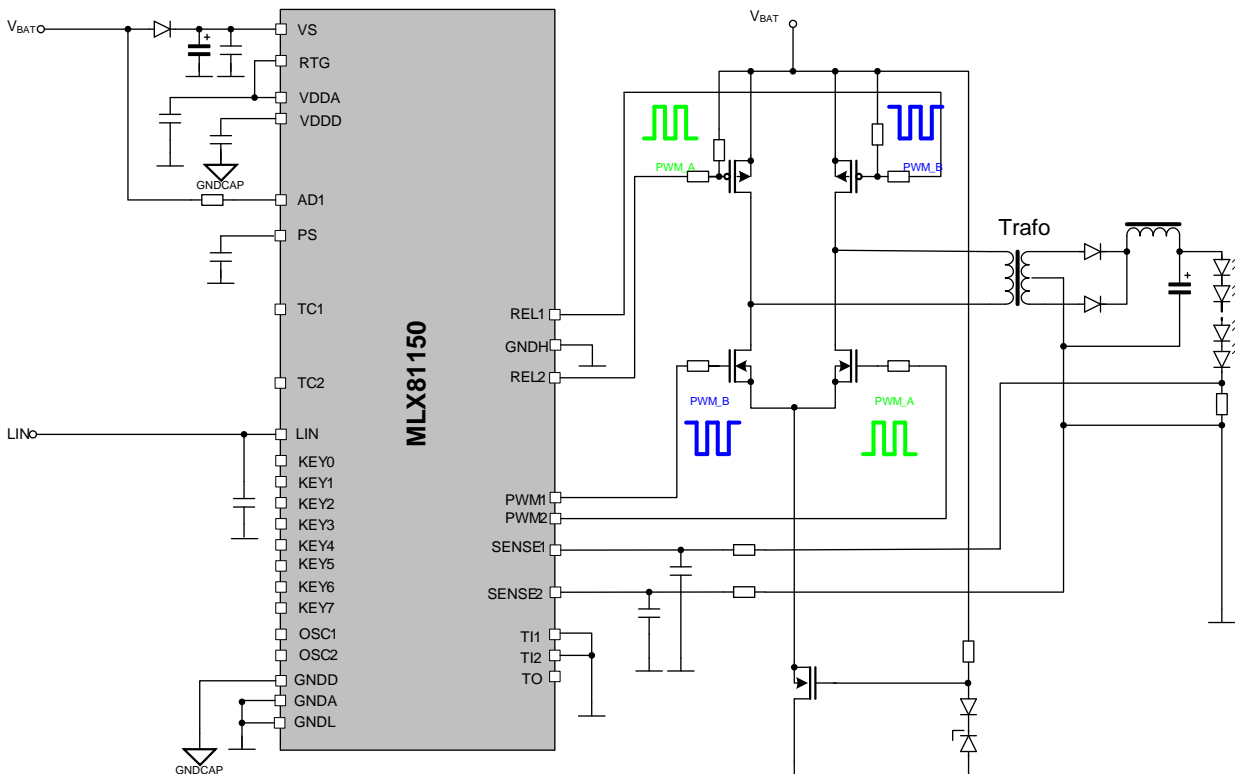


Figure 4- Principle application diagram showing a DC/DC converter for high power LED lamp driving controlled by a LIN bus

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4.5. MLX81150 in 1- and 2- phase BLDC (brush less DC) Motor control applications

BLDC motors are used today in several permanent running automotive applications. 1- and 2-phase BLDC motors are applied in several auxiliary applications as small pumps and blowers. In case these pumps request a LIN or PWM interface connection, the MLX81150 is a perfect solution for that. The commutation information for the brush less DC motors is provided by a hall switch/latch reacting on positive and negative magnet field of the permanent magnet rotor.

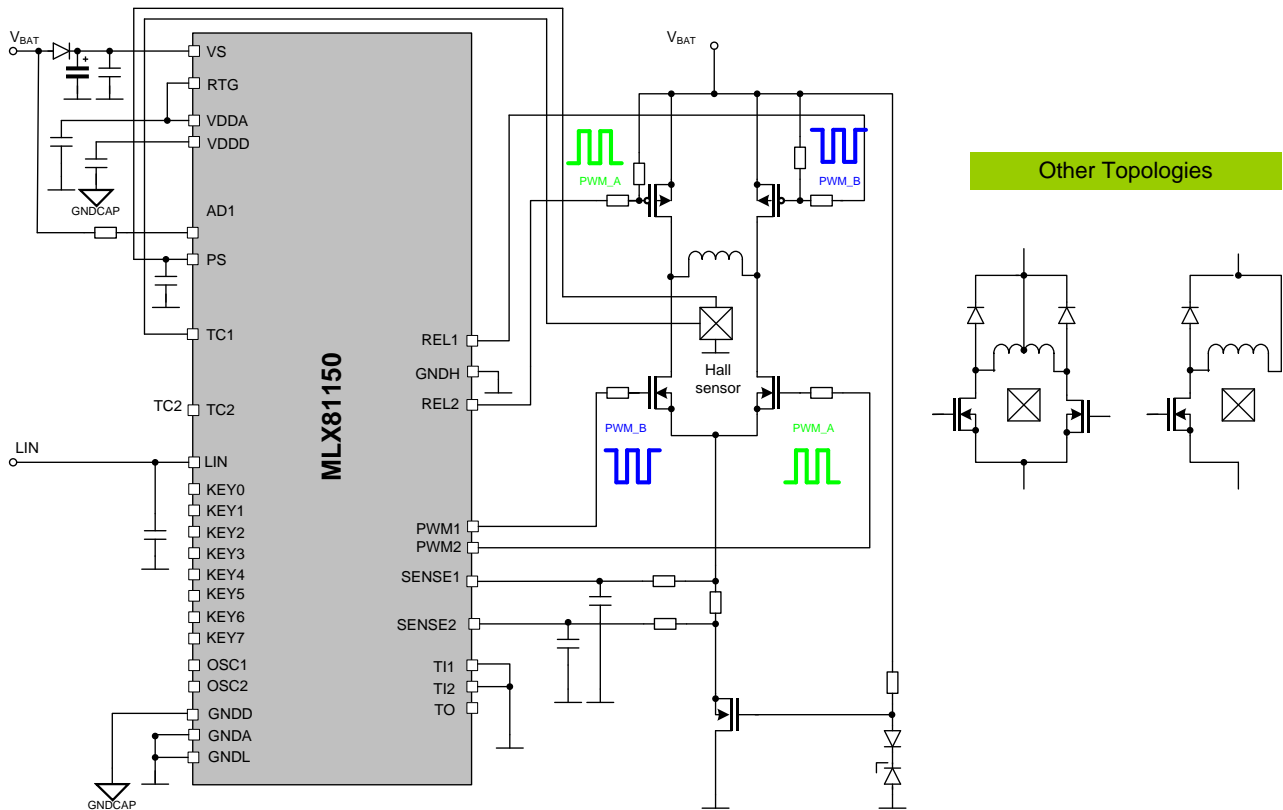


Figure 5- Principle application diagram showing a 1 / 2 phase BLDC motor drive

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4.6. Key inputs with different wetting currents in active and sleep configuration

Depending on different application requests for the key inputs it might be necessary to use in active mode relatively high wetting currents for the external switches. These currents will be provided by external pull up / pull down resistors. The IC will read the switches then with suitable threshold levels.

In SLEEP MODE relatively low wetting currents are necessary. These currents will be provided by external pull up / pull down resistors. Wake up will be then just with a rising or falling edge of the incoming signal.

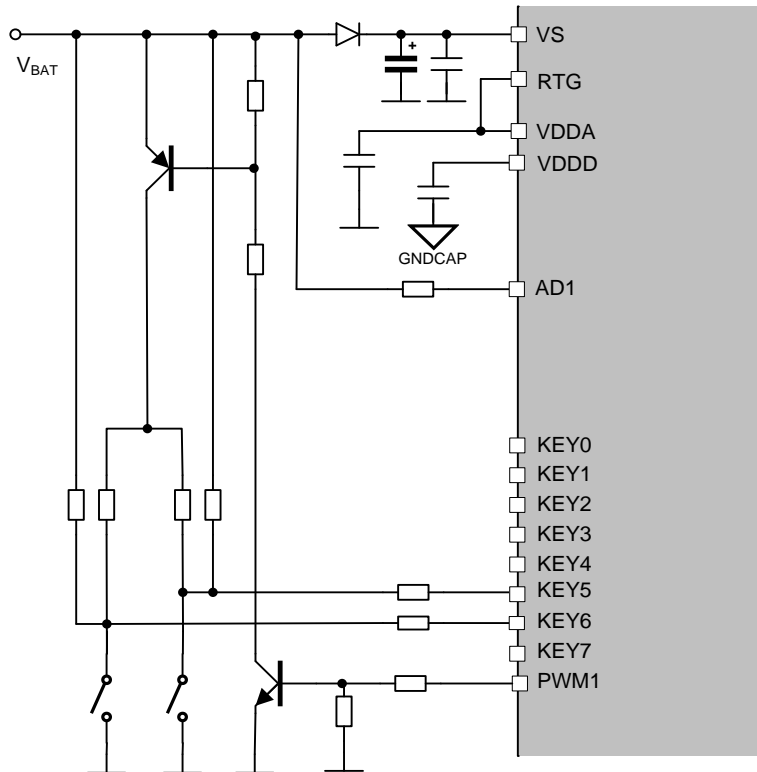


Figure 6 - Principle application diagram using different wetting currents in active and SLEEP MODE configuration, switches are related to GND; PWM1 pin provides steady state voltage level, pull up currents

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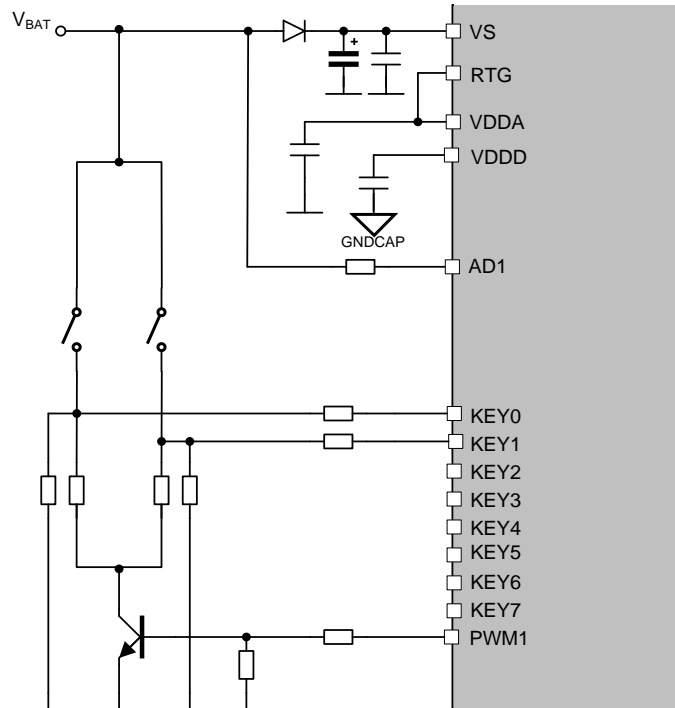


Figure 7 – Principle application diagram using different wetting currents in active and SLEEP MODE configuration, switches are related to supply; PWM1 pin just provides steady state voltage level, pull down currents

Via a 2-stage measurement, first at pin AD1 to check the V_{BAT} and second at pin KEY7, it is possible to check also the status of so called ‘Matrix Switches’. Figure 8 shows the principle of this application.

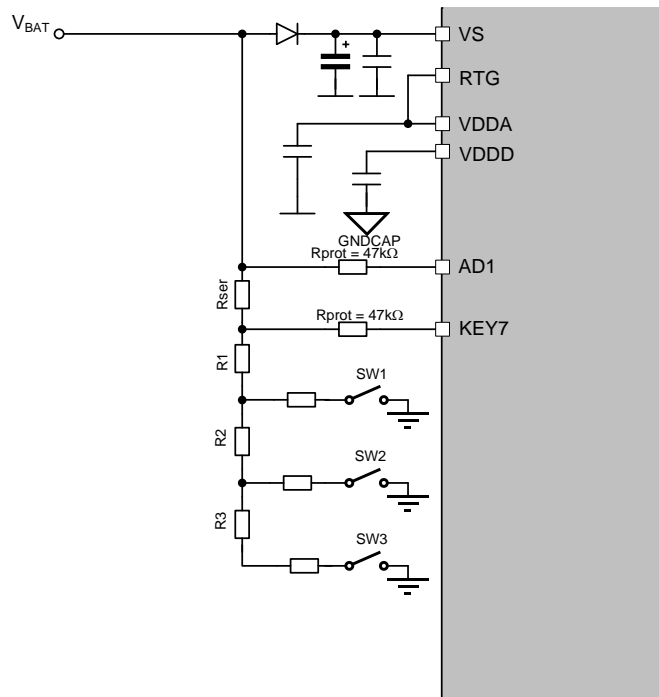


Figure 8 – Principle application diagram with matrix switch detection via KEY7 and AD1

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5. Mechanical Specification

5.1. Package QFN32 5x5

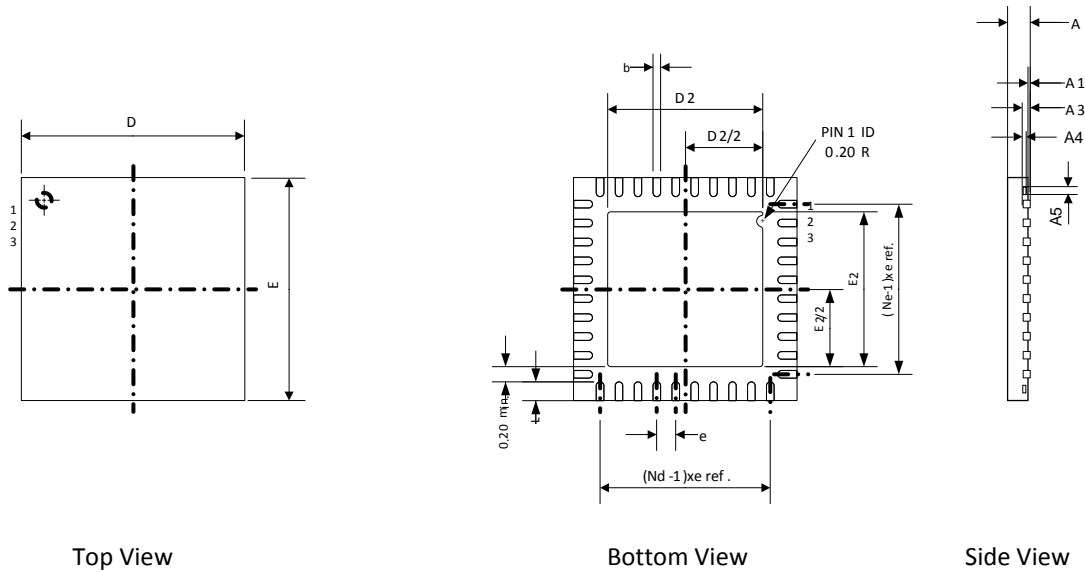


Figure 4: Package Drawing

5.2. Package QFN32 5x5 Dimensions

| [1] [2] | A | A1 | A3 | A4 | A5 | b | D | D2 | E | E2 | e | L | N [3] | ND [4] | NE [4] |
|------------|------|------|------|-----|------|------|------|------|------|------|------|-----|----------|-----------|-----------|
| min | 0.80 | 0.00 | 0.20 | | | 0.18 | 5.00 | 3.50 | 5.00 | 3.50 | 0.50 | 0.3 | 32 | 8 | 8 |
| nom | 0.85 | 0.02 | | 0.1 | 0.16 | 0.25 | | 3.60 | | 3.60 | | 0.4 | | | |
| max | 1.00 | 0.05 | | | | 0.30 | | 3.70 | | 3.70 | | 0.5 | | | |

- [1] Dimensions and tolerances conform to ASME Y14.5M-1994
- [2] All dimensions are in Millimeters. All angles 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

Table 6 – Package QFN32 5x5 Dimensions

-
- [1] Dimensions and tolerances conform to ASME Y14.5M-1994
 - [2] All dimensions are in Millimeters. All angles 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

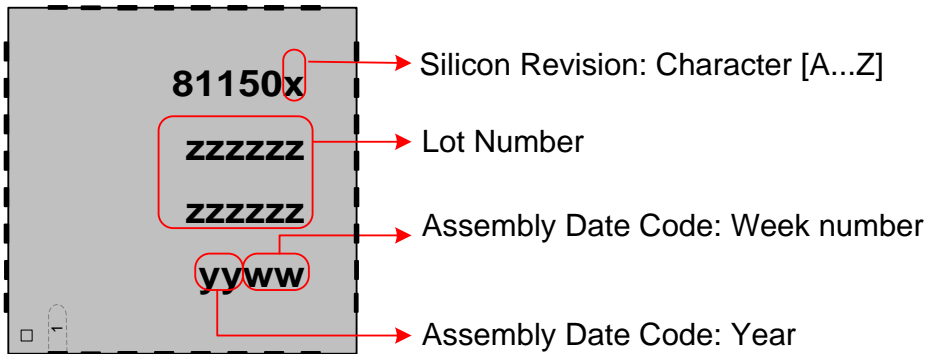
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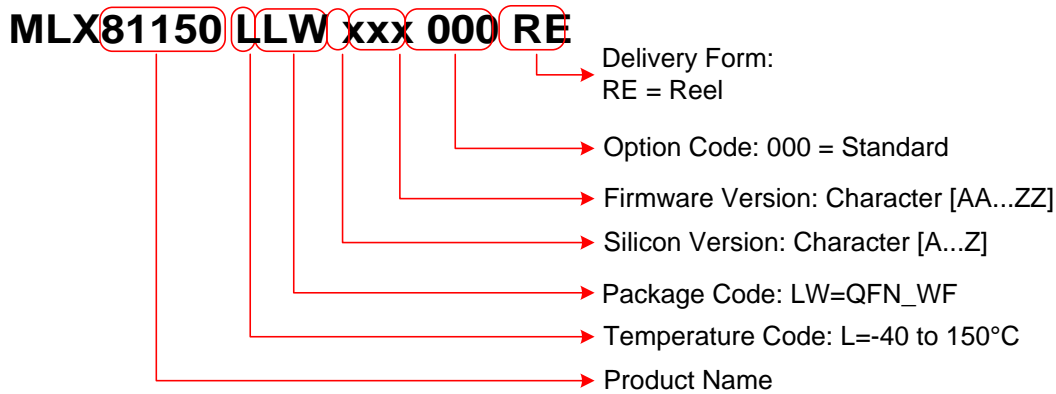
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6. Marking/Order Code

6.1. Marking MLX81150



6.2. Order Code MLX81150



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7. Assembly Information

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) (http://www.melexis.com/Quality_soldering.aspx) as well as [trim&form recommendations](http://www.melexis.com/Assets/Trim-and-form-recommendations-5565.aspx) (<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>

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8. Contact

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

For additional information, please contact our Direct Sales team and get help for your specific needs:

| | |
|----------------|----------------------------------|
| Europe, Africa | Telephone: +32 13 67 04 95 |
| | Email : sales_europe@melexis.com |
| Americas | Telephone: +1 603 223 2362 |
| | Email : sales_usa@melexis.com |
| Asia | Email : sales_asia@melexis.com |

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