

## 1. Features and Benefits

- Wide operating voltage range: from 2.7V to 24V
- Maximum application flexibility by re-programming of all sensor functions
- Customer End-Of-Line programming via VDD pin in the application module for system design optimization
- Locking EEPROM after final programming via V<sub>DD</sub> pin
- Wide programmable magnetic Latch/Switch range - from -100mT to +100mT
- Programmable magnetic hysteresis, active pole, output polarity
- Programmable permanent magnet Temperature Coefficient compensation - from 0 to -2000ppm/°C
- Integrated self-diagnostic functions activating dedicated Safe Mode
- Reverse supply voltage protection
- Under-Voltage Lockout protection
- Thermal protection
- Integrated capacitor for PCB less designs
- HW component Qualified according to ISO26262-8:13 for use in safety critical systems

## 2. Application Examples

- Automotive, Consumer and Industrial
- Wiper motor
- Brake light switch
- Window lifter
- Door lock
- Seatbelt buckle
- Seat positioning
- Sunroof/Tailgate opener
- Transmission applications
- Electrical power steering

## 3. Ordering Information

| Product Code | Temperature Code | Package Code | Option Code | Packing Form Code |
|--------------|------------------|--------------|-------------|-------------------|
| MLX92242     | L                | UA           | AAA-x00     | BU                |
| MLX92242     | L                | SE           | AAA-x00     | RE                |

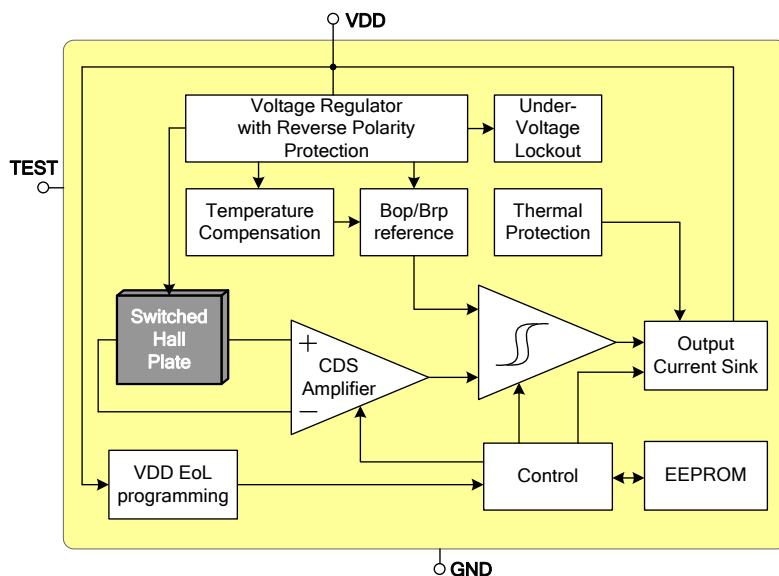
### Legend:

Temperature Code: L(-40°C to 150°C)  
Package Code: UA=TO-92-3L | SE = TSOT-23L

Option Code:                      000 => 2 wire hall effect Switch  
   100 => 2 wire hall effect Switch with Integrated capacitor (UA only)  
   200 => 2 wire hall effect Switch with Integrated Magnetic Concentrator (IMC)  
   300 => 2 wire hall effect Switch with Integrated capacitor and IMC (UA only)

Packing Form:                      BU=Bulk | RE = Reel | CA = Ammopack  
Ordering example:                  MLX92242LUA-AAA-x00-BU

## 4. Functional Diagram



## 5. General Description

The Melexis MLX92242 is based on the Melexis Hall-effect switch latest platform, designed in mixed signal submicron CMOS technology.

The device integrates a voltage regulator, Hall sensor with advanced offset cancellation system and a current sink-configured output driver and integrated capacitor all in a single package.

Based on the proven in use platform, the magnetic core is using an improved offset cancellation system allowing faster and more accurate processing while being temperature insensitive and stress independent. In addition a pre-programmable temperature coefficient is implemented to compensate the natural behavior of certain types of magnets becoming weaker with rise in temperature.

The included voltage regulator operates from 2.7 to 24V, hence covering a wide range of applications. With the built-in reverse voltage protection, a serial resistor or diode on the supply line is not required so that even remote sensors can be specified for low voltage operation down to 2.7V while being reverse voltage tolerant.

## 2-Wire EOL programmable Hall Effect Latch/Switch

In an event of a drop below the minimum supply voltage during operation, the under-voltage lock-out protection will automatically freeze the device, preventing the electrical perturbation to affect the magnetic measurement circuitry. The output current state is therefore only updated based on a proper and accurate magnetic measurement result.

The two-wire interface not only saves one wire, but also allows implementation of diagnostic functions as reverse polarity connection and malfunction detection.

The on-chip thermal protection also switches off the output if the junction temperature increases above an abnormally high threshold. It will automatically recover once the temperature decreases below a safe value.

The MLX92242 is delivered in a Green and RoHS compliant Plastic Single-in-Line (TO-92 flat) for through-hole mount, or PCB-less design with integrated capacitor or in 3-pin Thin Small Outline Transistor (TSOT) for surface mount process.

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## 6. Glossary of Terms

|       |  |
|-------|--|
| Tesla | Units for the magnetic flux density, 1 mT = 10 Gauss |
| TC    | Temperature Coefficient in ppm/°C                    |
| NC    | Not Connected  |
| ADC   | Analog-to-Digital Converter                          |
| PTC   | Programming Through Connector                        |
| POR   | Power on Reset                                       |
| INL   | Integral Non Linearity                               |
| DNL   | Differential Non Linearity                           |
| PWM   | Pulse Width Modulation                               |

## 7. Absolute Maximum Ratings

| Parameter                                     | Symbol             | Value     | Units |
|---|--------------------|-----------|-------|
| Supply Voltage <sup>(1, 2)</sup>              | V <sub>DD</sub>    | +28       | V     |
| Supply Voltage (Load Dump) <sup>(1, 4)</sup>  | V <sub>DD</sub>    | +32       | V     |
| Supply Current <sup>(1, 2, 3)</sup>           | I <sub>DD</sub>    | +20       | mA    |
| Supply Current <sup>(1, 3, 4)</sup>           | I <sub>DD</sub>    | +50       | mA    |
| Reverse Supply Voltage <sup>(1, 2)</sup>      | V <sub>DDREV</sub> | -24       | V     |
| Reverse Supply Voltage <sup>(1, 4)</sup>      | V <sub>DDREV</sub> | -30       | V     |
| Reverse Supply Current <sup>(1, 2, 5)</sup>   | I <sub>DDREV</sub> | -20       | mA    |
| Reverse Supply Current <sup>(1, 4, 5)</sup>   | I <sub>DDREV</sub> | -50       | mA    |
| Maximum Junction Temperature <sup>(6)</sup>   | T <sub>J</sub>     | +165      | °C    |
| ESD Sensitivity – HBM <sup>(7)</sup>          | -                  | 8         | kV    |
| ESD Sensitivity – System level <sup>(8)</sup> | -                  | 15        | kV    |
| ESD Sensitivity – CDM <sup>(9)</sup>          | -                  | 1000      | V     |
| Magnetic Flux Density                         | B                  | Unlimited | mT    |

Table 1: Absolute maximum ratings

<sup>1</sup> The maximum junction temperature should not be exceeded

<sup>2</sup> For maximum 1 hour

<sup>3</sup> Including current through protection device

<sup>4</sup> For maximum 500ms

<sup>5</sup> Through protection device

<sup>6</sup> For 1000 hours.

<sup>7</sup> Human Model according AEC-Q100-002 standard

<sup>8</sup> Indirect discharge according VW TL82466 standard, typical value, only for option MLX92242LUA-AAA-1xx

<sup>9</sup> Charged Device Model according AEC-Q100-011 standard

# MLX92242

2-Wire EOL programmable Hall Effect Latch/Switch

Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

## 8. General Electrical Specifications

DC Operating Parameters  $V_{DD} = 2.7V$  to  $24V$ ,  $T_J = -40^{\circ}C$  to  $165^{\circ}C$  (unless otherwise specified)

| Parameter   | Symbol       | Test Conditions   | Min | Typ <sup>(10)</sup> | Max | Units   |
|---|--------------|---|-----|---------------------|-----|---------|
| OFF Supply Current<br>(selectable by a dedicated bit) | $I_{OFF}$    | $V_{DD} = 3.5$ to $24V$   | 2   | -                   | 5   | mA      |
|   |              |   | 5   | -                   | 6.9 | mA      |
| ON Supply Current                                     | $I_{ON}$     | $V_{DD} = 3.5$ to $24V$   | 12  | -                   | 17  | mA      |
| Reverse Supply current                                | $I_{DDREV}$  | $V_{DD} = -16V$   | -1  | -                   | -   | mA      |
| Safe Mode Supply Current                              | $I_{SAFE}$   |   | -   | -                   | 1   | mA      |
| Supply Current Rise/Fall Time <sup>(11)</sup>         | $t_R/t_F$    | $V_{DD} = 12V$ , $C_{LOAD} = 50pF$ to GND   | 0.1 | 0.3                 | 1   | $\mu s$ |
| Power-On Time <sup>(12, 13)</sup>                     | $t_{ON}$     | $V_{DD} = 5V$ , $dV_{DD}/dt > 2V/\mu s$ , activated output with $>1mT$ overdrive  | -   | 40                  | 70  | $\mu s$ |
| Chopping Frequency                                    | $f_{CHOP}$   |   | -   | 350                 | -   | kHz     |
| Delay Time <sup>(11, 14)</sup>                        | $t_D$        | Average over 1000 successive switching events @10kHz, Latch, $B_{OP}$ set to 5mT, square wave magnetic field with $B > \pm 20mT$ , $t_{RISE} = t_{FALL} \leq 20\mu s$ | -   | 7.5                 | -   | $\mu s$ |
| Output Jitter (p-p) <sup>(11, 15)</sup>               | $t_{JITTER}$ | Over 1000 successive switching events @ 1kHz, Latch, $B_{OP}$ set to 5mT, square wave magnetic field with $B > \pm 20mT$ , $t_{RISE} = t_{FALL} \leq 20\mu s$         | -   | $\pm 4$             | -   | $\mu s$ |
| Maximum Switching Frequency <sup>(11, 16)</sup>       | $f_{SW}$     | Latch, $B_{OP}$ set to 5mT, square wave magnetic field with $B > \pm 20mT$  | -   | 50                  | -   | kHz     |
| Under-voltage Lockout Threshold                       | $V_{UVL}$    |   | -   | -                   | 2.7 | V       |
| Max Programming Supply Voltage                        | $V_{DDprog}$ |   | -   | 22                  | 28  | V       |
| Under-voltage Lockout Reaction time <sup>(11)</sup>   | $t_{UVL}$    |   | -   | 1                   | -   | $\mu s$ |
| Integrated capacitor                                  | $C_{INT}$    | Only for option MLX92242LUA-AAA-1xx   | -   | 68                  | -   | nF      |

<sup>10</sup> Typical values are defined at  $T_A = +25^{\circ}C$  and  $V_{DD} = 12V$ .

<sup>11</sup> Guaranteed by design and verified by characterization, not production tested, without integrated capacitor.

<sup>12</sup> The Power-On Time represents the time from reaching  $V_{DD} = 2.7V$  to the first refresh of the supply current state.

<sup>13</sup> Power-On Slew Rate is not critical for the proper device start-up.

<sup>14</sup> The Delay Time is the time from magnetic threshold reached to the start of the output switching.

<sup>15</sup> Output jitter is the unpredictable deviation of the Delay time.

<sup>16</sup> Maximum switching frequency corresponds to the maximum frequency of the applied magnetic field which is detected without loss of pulses.

|                               |                   |  |   |                     |   |      |
|-------------------------------|-------------------|--|---|---------------------|---|------|
| Thermal Protection Activation | $T_{\text{PROT}}$ |  | - | 190 <sup>(17)</sup> | - | °C   |
| Thermal Protection Release    | $T_{\text{REL}}$  |  | - | 180 <sup>(17)</sup> | - | °C   |
| UA Package Thermal Resistance | $R_{\text{THJA}}$ |  | - | 200                 | - | °C/W |
| SE Package Thermal Resistance | $R_{\text{THJA}}$ |  | - | 300                 | - | °C/W |

*Table 2: General electrical parameters*

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<sup>17</sup>  $T_{\text{PROT}}$  and  $T_{\text{REL}}$  are the corresponding junction temperature values.



## 9. Magnetic Specifications

### 9.1. MLX92242LUA / SE -AAA-000 and MLX92242LUA / SE -AAA-100

DC Operating Parameters  $V_{DD} = 3.5V$  to  $24V$ ,  $T_J = -40^{\circ}C$  to  $150^{\circ}C$  (unless otherwise specified)

| Parameter  | Symbol             | Test Conditions  | Min         | Typ <sup>(18)</sup> | Max      | Units            |
|--|--------------------|--|-------------|---------------------|----------|------------------|
| Operating Point Programming Range <sup>(19)</sup>  | $B_{OP}$           | $V_{DD} = 5V$ , $T_J = 25^{\circ}C$  | -100        | -                   | 100      | mT               |
| Operating Point for programming target 28mT  | $B_{OP28}$         | $V_{DD} = 5V$ , $T_J = 25^{\circ}C$  | 26          | 28                  | 30       | mT               |
| $B_{OP}$ Magnitude Programming <sup>(20)</sup>   |                    |  | -           | 8                   | -        | bit              |
| $B_{OP}$ Polarity Selection  |                    |  | -           | 1                   | -        | bit              |
| $B_{OP}/B_{RP}$ Temperature Coefficient Programming Range <sup>(21)</sup>                            | TC <sup>(22)</sup> | $V_{DD} = 5V$ , Latch with $B_{OP} = 28mT$ , $B_{RP} = -28mT$                    | -2000       | -                   | 0        | ppm/ $^{\circ}C$ |
| $B_{OP}/B_{RP}$ Temperature Coefficient Programming  |                    |  | -           | 5                   | -        | bit              |
| Switch/Latch Function Selection  |                    |  | -           | 1                   | -        | bit              |
| Proportional/Absolute Hysteresis Selection   |                    |  | -           | 1                   | -        | bit              |
| Hysteresis Magnitude Programming <sup>(23)</sup>   |                    |  | -           | 5                   | -        | bit              |
| Proportional Hysteresis Ratio Programming Range<br>$HYS_{RATIO} = B_{HYSRP} / B_{OP}$ <sup>(4)</sup> | $HYS_{RATIO}$      | Programming step 0.025   | 0.025       | -                   | 0.800    | -                |
| Absolute Hysteresis Programming Range <sup>(4)</sup>   | $B_{HYSABS}$       | Programming step 0.1mT   | 0           | -                   | 3.1      | mT               |
| Absolute Hysteresis tolerance <sup>(24)</sup>  | $B_{HYSTOL}$       | $B_{HYSABS} = 0.8mT$ to $1.6mT$ ,<br>$B_{OP} = 3mT$ ,<br>$V_{DD} = 3.5$ to $14V$ | -0.6        | 0                   | 0.6      | mT               |
| Absolute Hysteresis tolerance <sup>(7)</sup>   | $B_{HYSTOL}$       | $B_{HYSABS} = 1.7mT$ to $3.1mT$ ,<br>$B_{OP} = 3mT$ ,<br>$V_{DD} = 3.5$ to $14V$ | -0.7        | 0                   | 0.7      | mT               |
| $B_{OP}$ , $B_{RP}$ and $B_{HYSRP}$ life time drift  |                    | HTOL 1000h at $T_J = 165^{\circ}C$   | -(4%+0.2mT) |                     | 4%+0.2mT |                  |
| Output Polarity Selection  |                    |  | -           | 1                   | -        | bit              |
| $V_{DD}$ Programming Lock  |                    |  | -           | 1                   | -        | bit              |

1. Typical values are defined at  $T_A = +25^{\circ}C$  and  $V_{DD} = 5V$

2. Guaranteed by correlation with production test at  $B = 28mT$  and verified by characterization

3. The programming step is typically from 0.4% to 0.8% of the programmed  $B_{OP}$  value for  $|B_{OP}| \geq 2mT$  and 0.016mT for  $|B_{OP}| \leq 2mT$

4. The minimum and maximum limits are typical values

5. The  $B_{OP}/B_{RP}$  Temperature Coefficient is calculated using the following formula:

$$TC = \frac{(B_{OPT2} - B_{RPT2}) - (B_{OPT1} - B_{RPT1})}{(B_{OPT1} - B_{RPT1}) * (T_2 - T_1)} * 10^6, \text{ ppm}/^{\circ}C; T_1 = 25^{\circ}C; T_2 = 150^{\circ}C$$

6. Programming of very low hysteresis magnitude (<1mT) could lead to output toggling due to noise and mechanical looseness in the magnetic system. As  $T_J = T_A + V_{DD} * I_{DD} * R_{THJA}$  the change in the junction temperature due to  $I_{DD}$  switching between  $I_{ON}$  and  $I_{OFF}$  in combination with the device TC could cause  $B_{OP}$  or  $B_{RP}$  shift. If the chosen magnetic hysteresis is close or below the above shift and inverted output polarity is selected, an output toggling could appear.

7. Including life time drift. Guaranteed by correlation with production test at  $B = 3mT$ ,  $T_J = +25^{\circ}C$  and verified by characterization.

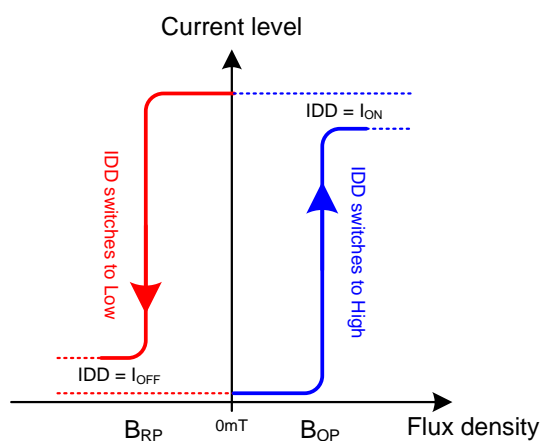
*Table 3: Magnetic specification*

## 10. Magnetic Behavior

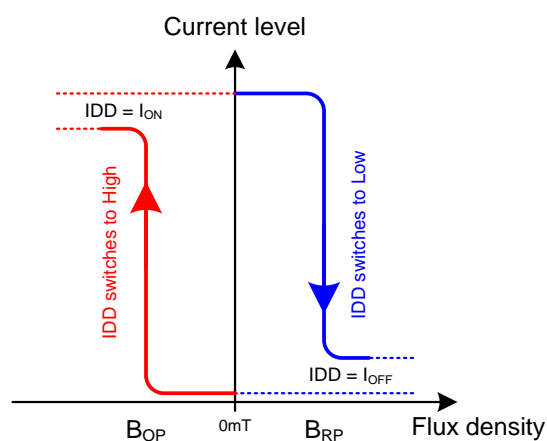
### 10.1. Latch sensor

| Pole Active | Remark |
|-------------|--------|
| South       | Fig.1  |
| North       | Fig.2  |

Note: Latch sensors are inherently Direct South or Direct North Pole Active only.



*Fig.1 – South Pole Active*



*Fig.2 – North Pole Active*

### 10.2. Unipolar Switch sensor

| Pole Active | Output Polarity | Remark |
|-------------|-----------------|--------|
| South       | Direct          | Fig.1  |
| South       | Inverted        | Fig.2  |
| North       | Direct          | Fig.3  |
| North       | Inverted        | Fig.4  |

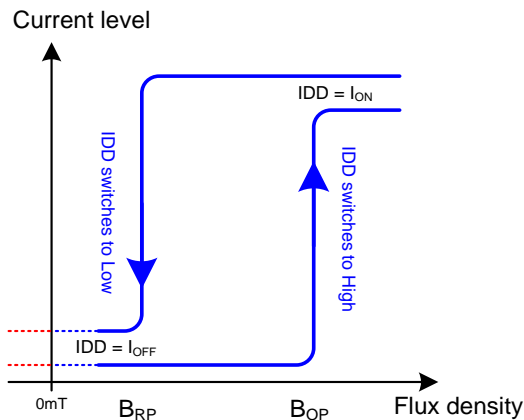


Fig.1 – Direct South Pole Active

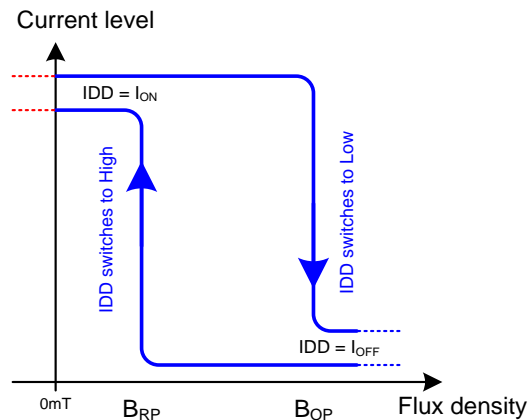


Fig.2 – Inverted South Pole Active

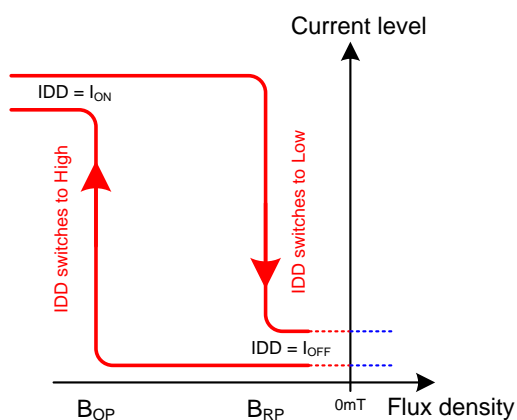


Fig.3 – Direct North Pole Active

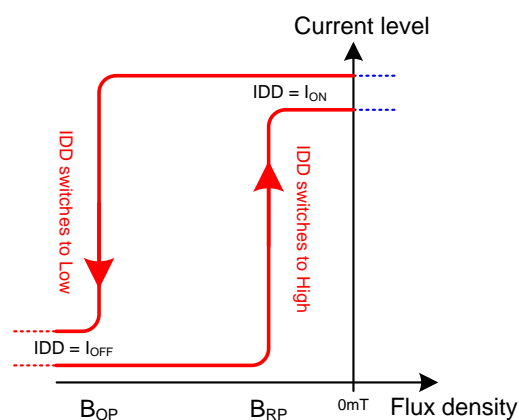
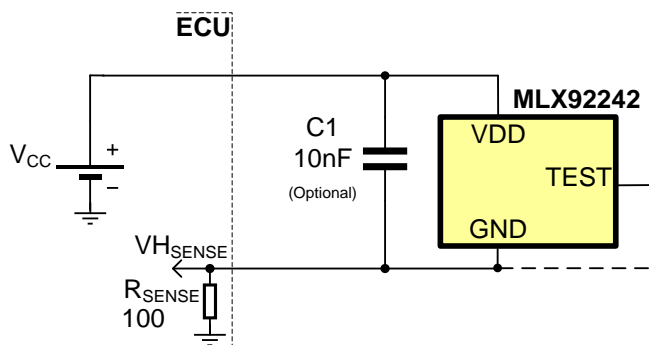


Fig.4 – Inverted North Pole Active

## 11. Application Information

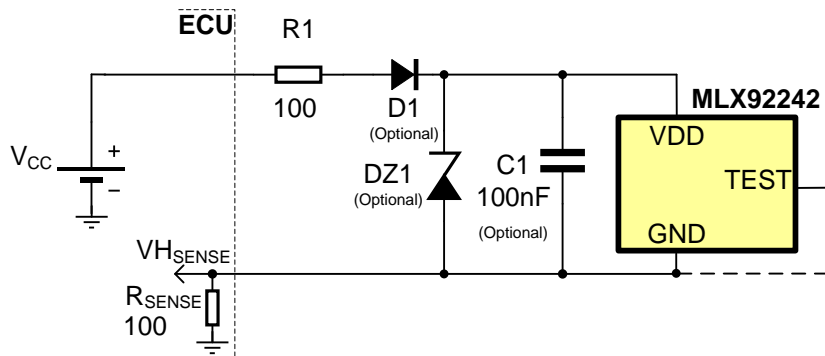
### 11.1. Typical Automotive Application Circuit



#### Notes:

1. For proper operation, a 10 to 100nF bypass capacitor should be placed as close as possible to the V<sub>DD</sub> and ground (GND) pin. For MLX92242LUA-AAA-1xx and 3xx C1 is not required.
2. The TEST pin is to be connected to GND or left open.

## 11.2. Automotive and Harsh, Noisy Environments Application Circuit



### Notes:

- For proper operation, a 10 to 100nF bypass capacitor should be placed as close as possible to the V<sub>DD</sub> and ground (GND) pin. For MLX92242LUA-AAA-1xx and 3 xx C1 is not required.
- The device can tolerate positive voltages up to +28 (+32)V and negative voltages down to -24 (-30)V. If bigger transients over the supply line are expected the usage of D1 and DZ1 (24...27V) is recommended. The series resistor R1 is used to limit the current through DZ1 and to improve the EMC performance.

## 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) ([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>).

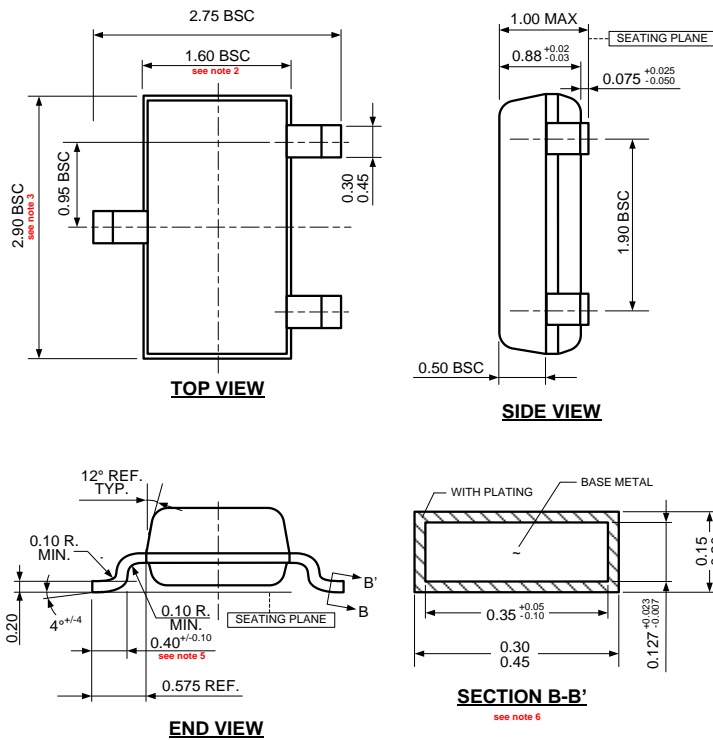
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: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

### 13. ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).  
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

## 14. Package Information

### 14.1. SE (TSOT-3L) Package Information



#### Notes:

1. All dimensions are in millimeters
2. Outermost plastic extreme width does not include mold flash or protrusions. Mold flash and protrusions shall not exceed 0.15mm per side.
3. Outermost plastic extreme length does not include mold flash or protrusions. Mold flash and protrusions shall not exceed 0.25mm per side.
4. The lead width dimension does not include dambar protrusion. Allowable dambar protrusion shall be 0.07mm total in excess of the lead width dimension at maximum material condition.
5. Dimension is the length of terminal for soldering to a substrate.
6. Dimension on SECTION B-B' applies to the flat section of the lead between 0.08mm and 0.15mm from the lead tip.
7. Formed lead shall be planar with respect to one another with 0.076mm at seating plane.

#### Marking:

##### TOP:

42WW

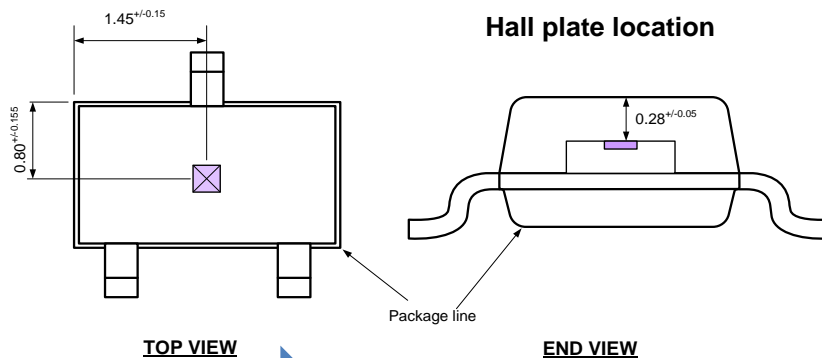
WW: Assembly week

##### BOTTOM:

YLLL

Y: Assembly Year

LLL: Last 3 digits from lot#



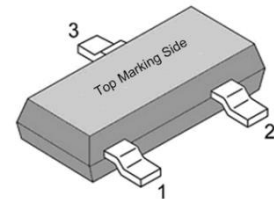
#### Notes:

1. All dimensions are in millimeters

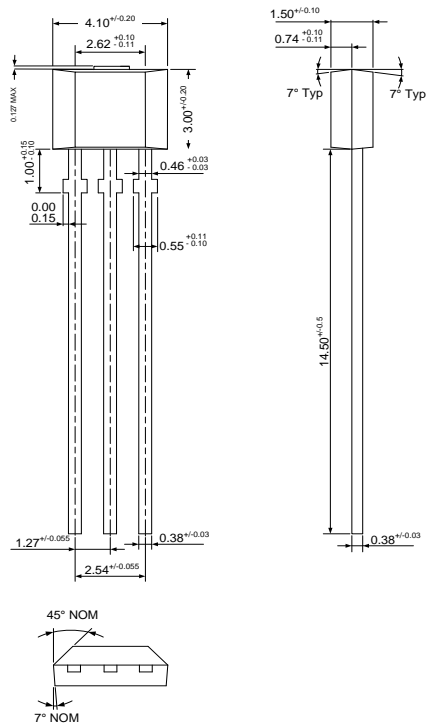
IMC variant sensitive in the arrow direction (Bx instead of Bz)

| SE Pin № | Name | Type   | Function             |
|----------|------|--------|----------------------|
| 1        | VDD  | Supply | Supply Voltage pin   |
| 2        | TEST | I/O    | For Melexis use only |
| 3        | GND  | Ground | Ground pin           |

Table 4: SE Package pinout



## 14.2. UA (TO92 - 3L) Package Information



### Notes:

1. All dimensions are in millimeters
2. Package dimension exclusive molding flash.
3. The end flash shall not exceed 0.127 mm on the top side.

### Marking:

1<sup>st</sup> Line : 42WW

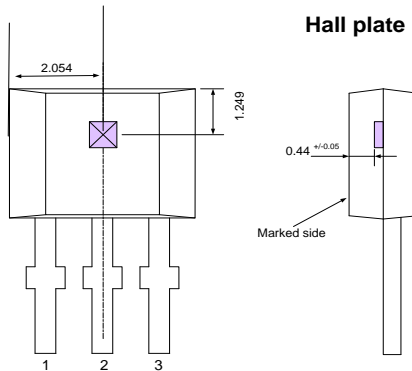
WW - calendar week number

2<sup>nd</sup> Line : YLLL

Y - last digit of year

LLL - last Three digits of lot number

### Hall plate location

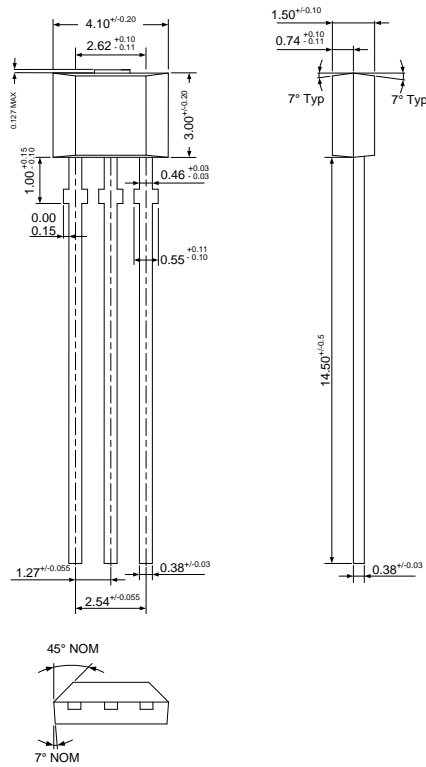


### Notes:

1. All dimensions are in millimeters

| Pin № | Name | Type   | Function             |
|-------|------|--------|----------------------|
| 1     | VDD  | Supply | Supply Voltage pin   |
| 2     | GND  | Ground | Ground pin           |
| 3     | TEST | I/O    | For Melexis use only |

### 14.3. UA (TO92 - 3L) with integrated capacitor Package Information



#### Notes:

1. All dimensions are in millimeters
2. Package dimension exclusive molding flash.
3. The end flash shall not exceed 0.127 mm on the top side.

#### Marking:

##### TOP:

1<sup>st</sup> Line : C1WW – C1 = 68nF, WW = Calendar week number

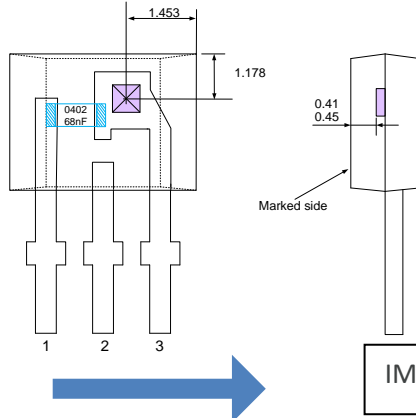
2<sup>nd</sup> Line : YLLL – Y=Last digit calendar year

LLL = Last three digits of lot number

##### Bottom:

T7 or M7

#### Hall plate location



#### Notes:

1. All dimensions are in millimeters

IMC variant sensitive in the arrow direction (Bx instead of Bz)

| Pin № | Name | Type   | Function             |
|-------|------|--------|----------------------|
| 1     | VDD  | Supply | Supply Voltage pin   |
| 2     | TEST | I/O    | For Melexis use only |
| 3     | GND  | Ground | Ground pin           |



## 15. Contact

For the latest version of this document, go to our website at [www.melexis.com](http://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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