

Features and Benefits

- ❑ Low voltage supply : from 2.5V to 5.5V
- ❑ Chopper-stabilized amplifier stage
- ❑ Low power switch: 2.1mA
- ❑ Wide temperature range: -40°C to 150°C
- ❑ Automotive qualified: AEC-Q100
- ❑ Optimized ESD performance: 8kV
- ❑ Designed for standalone PCB applications
- ❑ Thin SOT23 3L Green Compliant package

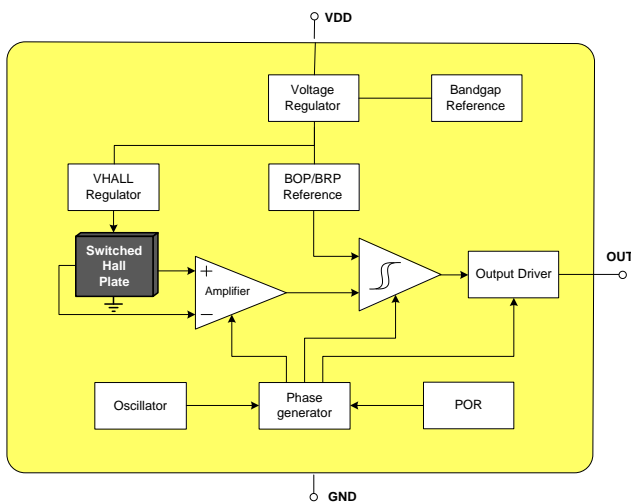
Application Examples

- ❑ Automotive, Consumer and Industrial
- ❑ BLDC motor commutation
- ❑ Solid-state Latch
- ❑ Low power applications
- ❑ Index counting
- ❑ Electrical power steering

Ordering Information

| Part No. | Temperature Code | Package Code | Comment |
|------------------------|--------------------|--------------|----------------------|
| MLX92212LSE-AAA-000-RE | L (-40°C to 150°C) | SE (TSOT-3L) | Very sensitive Latch |
| MLX92212LSE-ABA-000-RE | L (-40°C to 150°C) | SE (TSOT-3L) | Unipolar switch |

1 Functional Diagram



2 General Description

The Melexis MLX92212 is a low voltage Hall-effect switch designed in mixed signal CMOS technology. The device integrates a voltage regulator, Hall sensor with advanced offset cancellation system and an open-drain output driver, all in a single package.

The device features a low voltage regulator with optimized performances targetting low power consumption at low voltage levels.

It is suitable for use in automotive applications thanks to its wide temperature range and extensive qualification according to automotive standards.

The MLX92212 is delivered in a Green compliant 3-pin Thin Small Outline Transistor (TSOT) for surface-mount process.

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3 Glossary of Terms

| | |
|------------------------|---|
| MilliTesla (mT), Gauss | Units of magnetic flux density: 1mT = 10 Gauss |
| RoHS | Restriction of Hazardous Substances |
| TSOT | Thin Small Outline Transistor (TSOT package) – also referred with the Melexis package code “SE” |
| ESD | Electro-Static Discharge |
| BLDC | Brush-Less Direct-Current |

4 Absolute Maximum Ratings

| Parameter | Symbol | Value | Units |
|-------------------------------|-----------|---------------------|-------|
| Supply Voltage | V_{DD} | -0.5 to 6 | V |
| Supply Current ⁽¹⁾ | I_{DD} | ± 20 | mA |
| Output Voltage | V_{OUT} | -0.5 to 6 | V |
| Output Current ⁽¹⁾ | I_{OUT} | ± 20 | mA |
| Operating Temperature Range | T_A | -40 to 150 | °C |
| Storage Temperature Range | T_S | -50 to 165 | °C |
| Maximum Junction Temperature | T_J | 165 | °C |
| ESD Sensitivity – HBM | - | 8000 ⁽²⁾ | V |
| ESD Sensitivity – CDM | - | 750 | V |

Table 1: Absolute maximum ratings

Note 1: Including current through the protection structure. Max Power dissipation should be also considered.

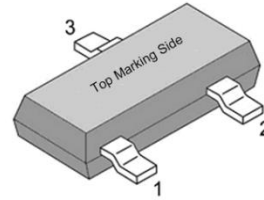
Note 2: Human Body Model according AEC-Q100-002 standard

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

5 Pin Definitions and Descriptions

| Pin № | Name | Type | Function |
|-------|------|--------|-----------------------|
| 1 | VDD | Supply | Supply Voltage pin |
| 2 | OUT | Output | Open Drain output pin |
| 3 | GND | Ground | Ground pin |

Table 2: SE Package pinout



6 General Electrical Specifications

DC Operating Parameters $T_A = -40$ to 150°C , $V_{DD} = 2.5\text{V}$ to 5.5V (unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|--|------------|---|------|------|-----|---------------------------|
| Supply Voltage | V_{DD} | Operating | 2.5 | | 5.5 | V |
| Supply Current | I_{DD} | | 1.3 | 2.1 | 3.2 | mA |
| Output Saturation Voltage | V_{DSON} | $I_{OUT} = 5\text{mA}$, $B > B_{OP}$ | | | 0.5 | V |
| Output Leakage Current | I_{OFF} | $B < B_{RP}$, $V_{OUT} = 5.5\text{V}$ | | 0.01 | 10 | μA |
| Output Rise Time ⁽¹⁾ | t_r | $R_L = 1\text{k}\Omega$, $C_L = 50\text{pF}$ | | 0.25 | | μs |
| Output Fall Time ⁽¹⁾ | t_f | $R_L = 1\text{k}\Omega$, $C_L = 50\text{pF}$ | | 0.25 | | μs |
| Power-On Time ⁽²⁾ | t_{PON} | $dV_{DD}/dt > 2\text{V}/\mu\text{s}$ | | 38 | 70 | μs |
| Power-On Reset Voltage ⁽³⁾ | V_{POR} | | | 1.95 | 2.1 | V |
| Power-On State | - | | High | | | - |
| Maximum Switching Frequency ⁽¹⁾ | F_{SW} | $B \geq \pm 40\text{mT}$ and square wave magnetic field | 10 | | | KHz |
| SE Package Thermal Resistance | R_{TH} | Single layer (1S) Jedec board | | 300 | | $^\circ\text{C}/\text{W}$ |

Table 3: Electrical specifications

¹ Guaranteed by design and verified by characterization, not production tested.

² The Power-On time represents the time from reaching $V_{DD} = 2.5\text{V}$ to the first refresh of the output.

³ If V_{DD} drops below V_{POR} the output is reset to High state.

7 Magnetic Specification

7.1 MLX92212LSE-AAA-000-RE

DC Operating Parameters $T_A = -40$ upto 150 °C, $V_{DD} = 2.5V$ to $5.5V$ (unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|-----------------|------------|---------------------|------|------|------|-------|
| Operating Point | B_{OP} | $T_A = -40^\circ C$ | 0.6 | 2.1 | 3.8 | mT |
| | | $T_A = 25^\circ C$ | 0.6 | 2.0 | 3.8 | mT |
| | | $T_A = 150^\circ C$ | 0.6 | 1.9 | 3.8 | mT |
| Release Point | B_{RP} | $T_A = -40^\circ C$ | -3.8 | -2.1 | -0.6 | mT |
| | | $T_A = 25^\circ C$ | -3.8 | -2.0 | -0.6 | mT |
| | | $T_A = 150^\circ C$ | -3.8 | -1.9 | -0.6 | mT |
| Hysteresis | B_{HYST} | $T_A = -40^\circ C$ | 1.7 | 4.2 | 6.8 | mT |
| | | $T_A = 25^\circ C$ | 1.7 | 4 | 6.8 | mT |
| | | $T_A = 150^\circ C$ | 1.7 | 3.8 | 6.8 | mT |

Table 4: Magnetic specifications

7.2 MLX92212LSE-ABA-000-RE

DC Operating Parameters, $T_A = -40$ upto 150 °C, $V_{DD} = 2.5V$ to $5.5V$ (unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|-----------------|----------|---------------------|-----|------|------|-------|
| Operating Point | B_{OP} | $T_A = -40^\circ C$ | 9.2 | 12.7 | 16.6 | mT |
| | | $T_A = 25^\circ C$ | 9.4 | 12.2 | 15.4 | mT |
| | | $T_A = 85^\circ C$ | 9.2 | 12.3 | 15.4 | mT |
| | | $T_A = 125^\circ C$ | 8.8 | 12.4 | 16.0 | mT |
| | | $T_A = 150^\circ C$ | 8.2 | 12.5 | 16.8 | mT |
| Release Point | B_{RP} | $T_A = -40^\circ C$ | 7.6 | 11 | 14.4 | mT |
| | | $T_A = 25^\circ C$ | 7.8 | 10.5 | 13.4 | mT |
| | | $T_A = 85^\circ C$ | 7.8 | 10.6 | 13.4 | mT |
| | | $T_A = 125^\circ C$ | 7.4 | 10.7 | 13.9 | mT |
| | | $T_A = 150^\circ C$ | 6.8 | 10.8 | 14.8 | mT |

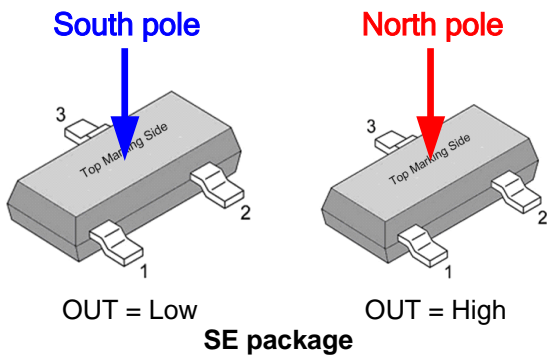
Table 5: Magnetic specifications

8 Output behaviour versus Magnetic Field

8.1 Latch sensor: MLX92212LSE-AAA-000

| Parameter | Test Conditions | OUT |
|------------|-----------------|------|
| South pole | $B > B_{OP}$ | Low |
| North pole | $B < B_{RP}$ | High |

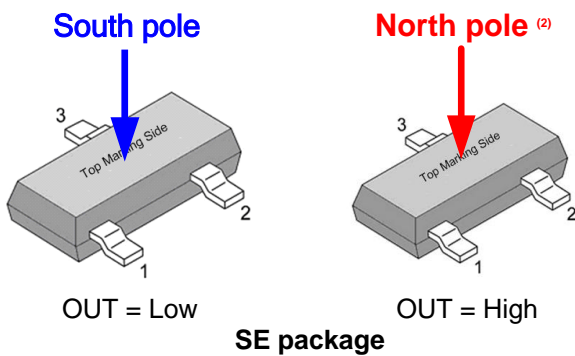
Table 6: Output behaviour versus magnetic pole ⁽¹⁾



8.2 Switch sensor: MLX92212LSE-ABA-000

| Parameter | Test Conditions | OUT |
|---------------------------|-----------------|------|
| South pole | $B > B_{OP}$ | Low |
| North pole ⁽²⁾ | $B < B_{RP}$ | High |

Table 7: Output behaviour versus magnetic pole ⁽¹⁾



¹ Magnetic pole facing the branded / top side of the package

² North pole or absence of field or South field lower than B_{RP}

9 Detailed General Description

Based on mixed signal CMOS technology, Melexis MLX92212LSE-AAA-000 is a Hall-effect device with very high magnetic sensitivity. Melexis MLX92212LSE-ABA-000 is a Hall-effect device with a low hysteresis covering higher magnetic fields. Both versions are allowing the use of generic magnets, weak magnets or larger air gap.

The chopper-stabilized amplifier uses switched capacitor techniques to suppress the offset generally observed with Hall sensors and amplifiers. The CMOS technology makes this advanced technique possible and contributes to smaller chip size and lower current consumption than bipolar technology. The small chip size is also an important factor to minimize the effect of physical stress.

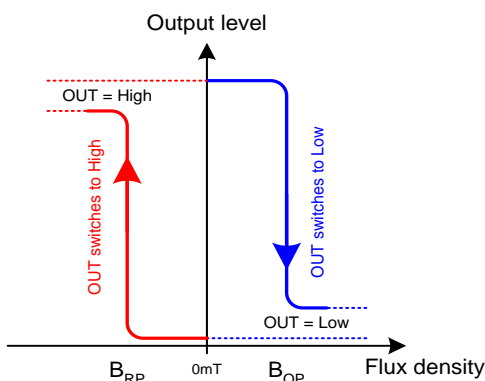
This combination results in more stable magnetic characteristics and enables faster and more precise design.

The operating voltage from 2.5V to 5.5V, low current consumption and large choice of operating temperature range according to "L" specification make this device suitable for automotive, industrial and consumer low voltage applications.

The output signal is open-drain type. Such output allows simple connectivity with TTL or CMOS logic by using a pull-up resistor tied between a pull-up voltage and the device output

10 Latching characteristic

The MLX92212-AAA exhibits magnetic latching characteristics.

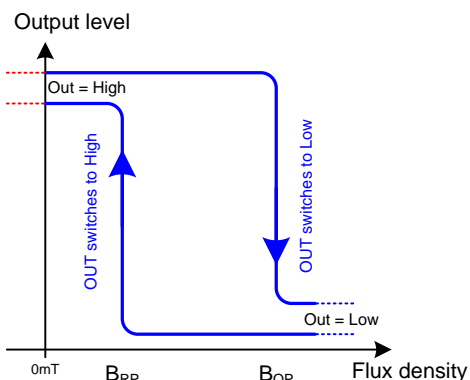


Latch characteristic

Typically, the device behaves as a latch with symmetric operating and release switching points ($B_{OP}=|B_{RP}|$). This means magnetic fields with equivalent strength and opposite direction drive the output high and low.

Removing the magnetic field ($B \rightarrow 0$) keeps the output in its previous state. This latching property defines the device as a magnetic memory.

The MLX92212LSE-ABA exhibits magnetic switching characteristics.



Unipolar switch characteristic

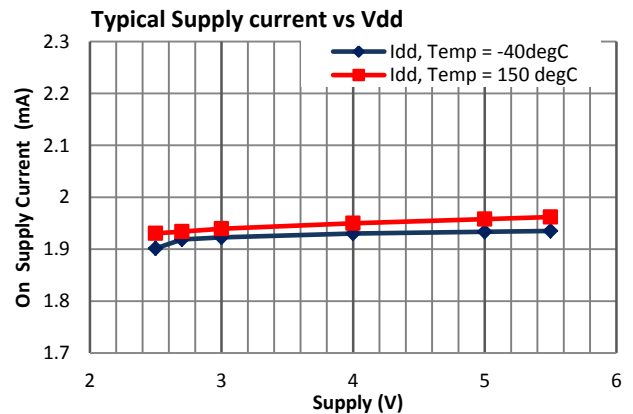
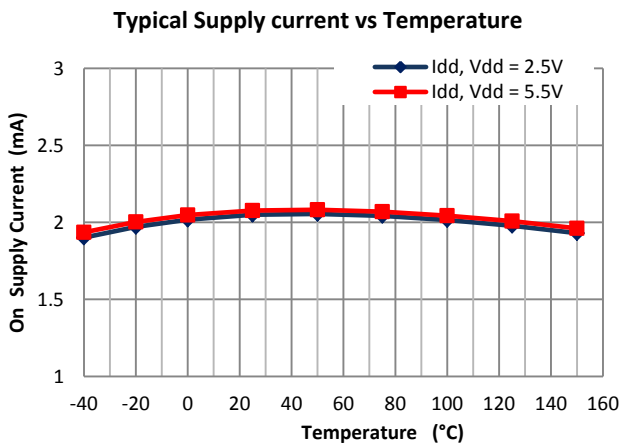
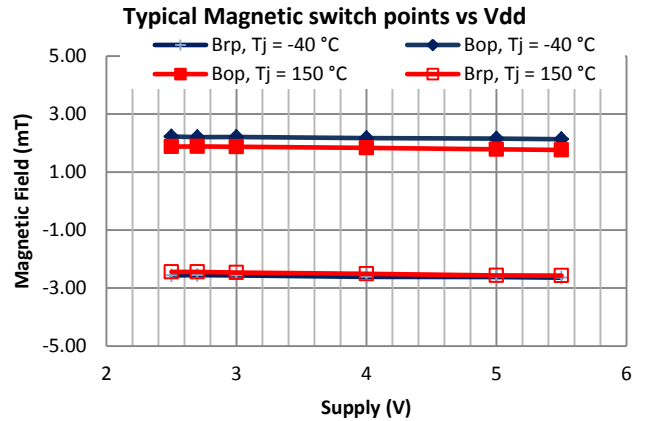
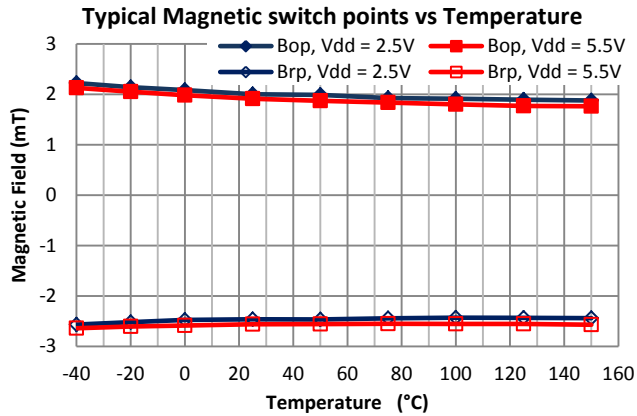
The device is south pole active:

Applying a south magnetic pole greater than B_{OP} facing the branded side of the package switches the output low.

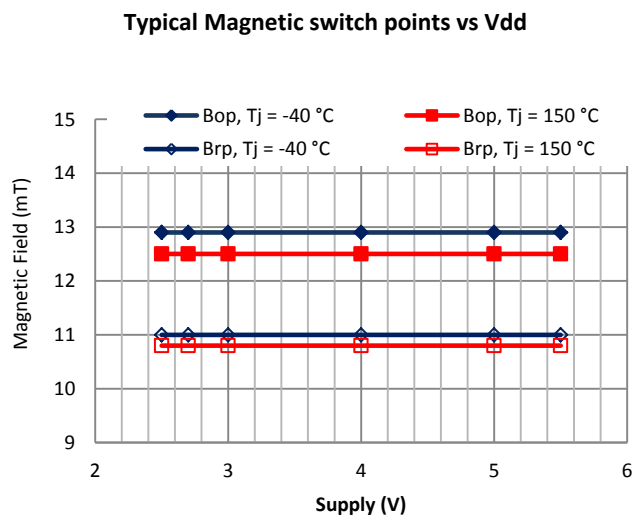
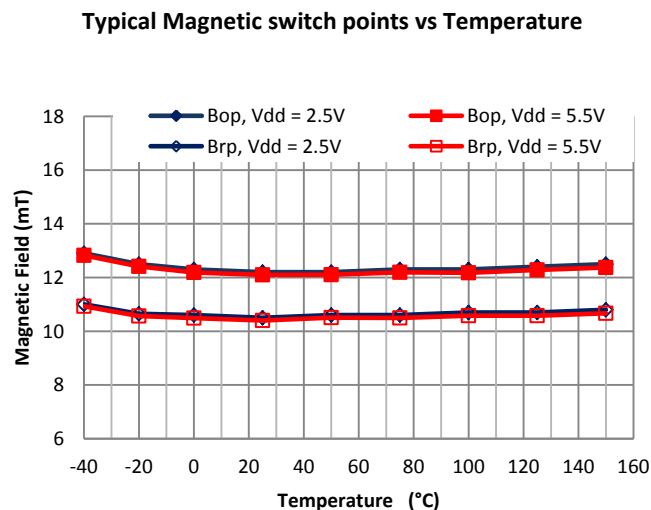
Removing the magnetic field ($B \rightarrow 0$) switches the output high. The use of the opposite magnetic pole facing the branded side does not affect the output state.

11 Performance graphs

11.1 MLX92212LSE -AAA-000

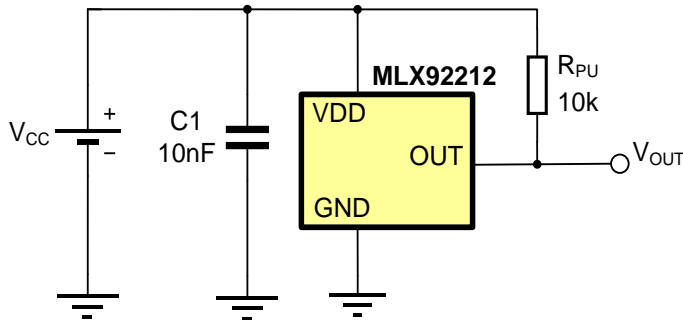


11.2 MLX92212LSE -ABA-000



12 Application Information

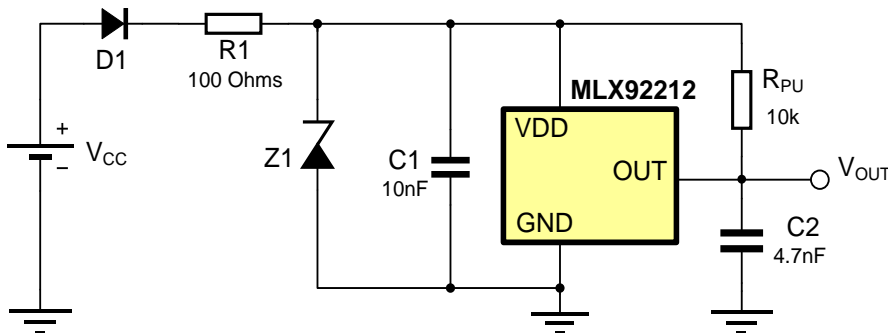
12.1 Typical Three-Wire Application Circuit



Notes:

1. For proper operation, a 10nF to 100nF bypass capacitor should be placed as close as possible to the V_{DD} and ground pin.
2. A capacitor connected to the output is not obligatory, because the output slope is generated internally.

12.2 Automotive and Harsh, Noisy Environments Three-Wire Circuit



Notes:

1. For proper operation, a 10nF to 100nF bypass capacitor should be placed as close as possible to the V_{DD} and ground pin.
2. The device could tolerate negative voltage down to -0.5 V, so if negative transients over supply line $V_{PEAK} < -32V$ are expected, usage of the diode D1 is recommended. Otherwise only R1 is sufficient.

When selecting the resistor R1, three points are important:

- the resistor has to limit I_{DD}/I_{DDREV} to 40mA maximum
- the resistor has to withstand the power dissipated in both over voltage conditions ($V_{R1}^2/R1$)
- the resulting device supply voltage V_{DD} has to be higher than V_{DD min} ($V_{DD} = V_{CC} - R1 \cdot I_{DD}$)

3. The device could tolerate positive supply voltage up to +6V (until the maximum power dissipation is not exceeded), so if positive transients over supply line with $V_{PEAK} > 6V$ are expected, usage a zener diode Z1 is recommended. The R1-Z1 network should be sized to limit the voltage over the device below the maximum allowed.

13 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) 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>).

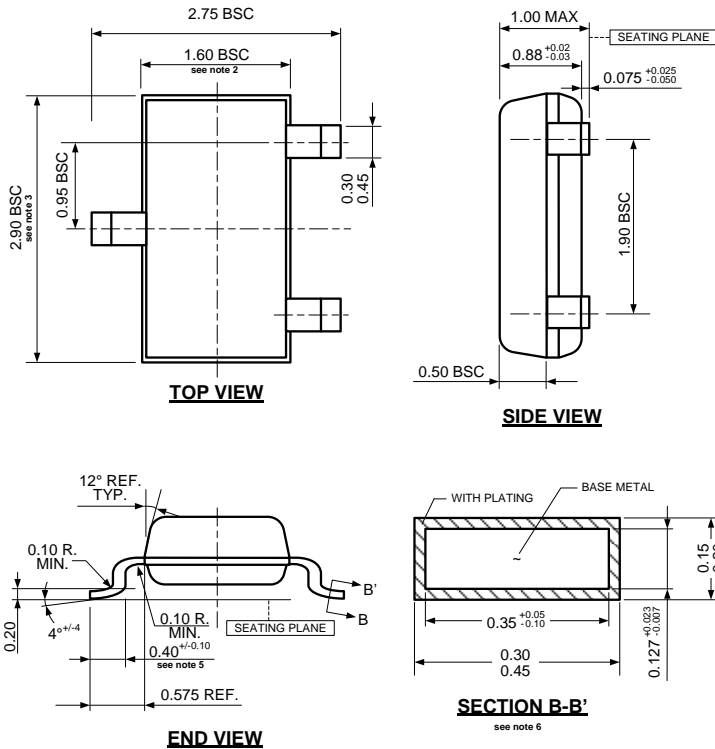
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: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

14 ESD Precautions

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

15 Package Information

15.1 SE (TSOT-3L) Package Information



Notes:

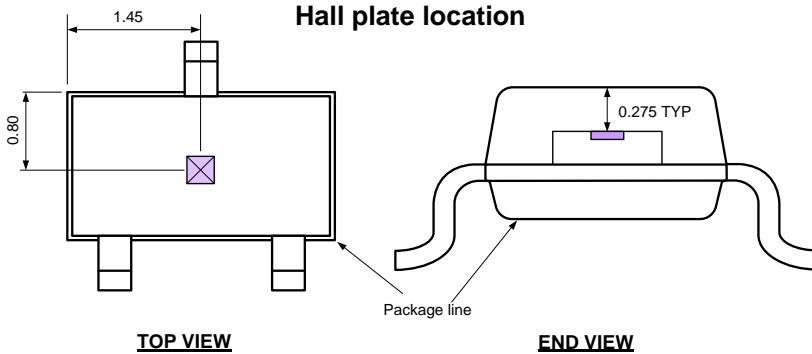
1. All dimensions are in millimeters
2. Outermost plastic extreme width does not include mold flash or protrusions. Mold flash and protrusions shall not exceed 0.15mm per side.
3. Outermost plastic extreme length does not include mold flash or protrusions. Mold flash and protrusions shall not exceed 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 side : MLX92212LSE-AAA-000 = 12YY (YY = year code)
 MLX92212LSE-ABA-000 = 12BY (Y = year code)

Bottom side: LLLL= last 4 digits from lot#

Hall plate location



Notes:

1. All dimensions are in millimeters

| Pin № | Name | Type | Function |
|-------|------|--------|-----------------------|
| 1 | VDD | Supply | Supply Voltage pin |
| 2 | OUT | Output | Open Drain output pin |
| 3 | GND | Ground | Ground pin |

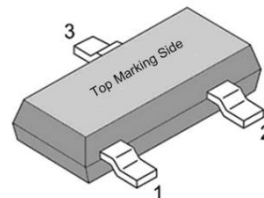


Table 8:Package pinout

16 Disclaimer

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