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MLX92242

2-Wire EOL programmable Hall Effect Latch/Switch

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_{DD} 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

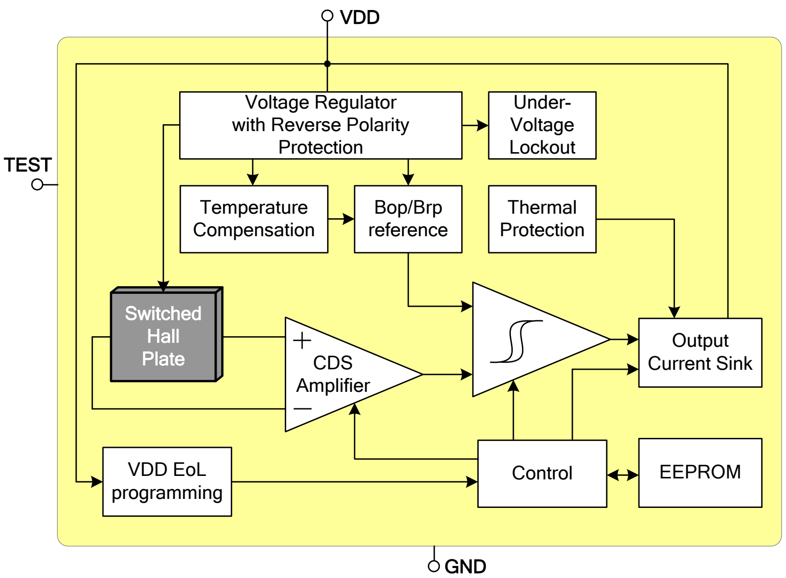
Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
MLX92242	L	UA	AAA-x00	BU
MLX92242	L	SE	AAA-x00	RE

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.

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.

Contents

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 (1, 2)	V_{DD}	+28	V
Supply Voltage (Load Dump) (1, 4)	V_{DD}	+32	V
Supply Current (1, 2, 3)	I_{DD}	+20	mA
Supply Current (1, 3, 4)	I_{DD}	+50	mA
Reverse Supply Voltage (1, 2)	V_{DDREV}	-24	V
Reverse Supply Voltage (1, 4)	V_{DDREV}	-30	V
Reverse Supply Current (1, 2, 5)	I_{DDREV}	-20	mA
Reverse Supply Current (1, 4, 5)	I_{DDREV}	-50	mA
Maximum Junction Temperature (6)	T_J	+165	°C
ESD Sensitivity – HBM (7)	-	8	kV
ESD Sensitivity – System level (8)	-	15	kV
ESD Sensitivity – CDM (9)	-	1000	V
Magnetic Flux Density	B	Unlimited	mT

Table 1: Absolute maximum ratings

[1] *The maximum junction temperature should not be exceeded*
[2] *For maximum 1 hour*
[3] *Including current through protection device*
[4] *For maximum 500ms*
[5] *Through protection device*
[6] *For 1000 hours.*
[7] *Human Model according AEC-Q100-002 standard*
[8] *Indirect discharge according VW TL82466 standard, typical value, only for option MLX92242LUA-AAA-1xx*
[9] *Charged Device Model according AEC-Q100-011 standard*

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°C to 165°C (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ[10]	Max	Units
OFF Supply Current (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 [11]	t_R/t_F	V_{DD} = 12V, C_{LOAD} = 50pF to GND	0.1	0.3	1	µs
Power-On Time [12, 13]	t_{ON}	V_{DD} = 5V, dV_{DD}/dt > 2V/us, activated output with >1mT overdrive	-	40	70	µs
Chopping Frequency	f_{CHOP}		-	350	-	kHz
Delay Time [11, 14]	t_D	Average over 1000 successive switching events @10kHz, Latch, B_{OP} set to 5mT, square wave magnetic field with B > ±20mT, $t_{RISE} = t_{FALL} \leq$ 20µs	-	7.5	-	µs
Output Jitter (p-p) [11, 15]	t_{JITTER}	Over 1000 successive switching events @ 1kHz, Latch, B_{OP} set to 5mT, square wave magnetic field with B > ±20mT, $t_{RISE} = t_{FALL}$ ≤ 20µs	-	±4	-	µs
Maximum Switching Frequency [11, 16]	f_{SW}	Latch, B_{OP} set to 5mT, square wave magnetic field with B > ±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 [11]	t_{UVL}		-	1	-	µs
Integrated capacitor	C_{INT}	Only for option MLX92242LUA-AAA-1xx	-	68	-	nF

[10] *Typical values are defined at T_A = +25°C and V_{DD} = 12V.*

[11] *Guaranteed by design and verified by characterization, not production tested, without integrated capacitor.*

[12] *The Power-On Time represents the time from reaching V_{DD} = 2.7V to the first refresh of the supply current state.*

[13] *Power-On Slew Rate is not critical for the proper device start-up.*

[14] *The Delay Time is the time from magnetic threshold reached to the start of the output switching.*

[15] *Output jitter is the unpredictable deviation of the Delay time.*

[16] *Maximum switching frequency corresponds to the maximum frequency of the applied magnetic field which is detected without loss of pulses.*

Thermal Protection Activation	T_{PROT}		-	190[17]	-	°C
Thermal Protection Release	T_{REL}		-	180[17]	-	°C
UA Package Thermal Resistance	R_{THJA}		-	200	-	°C/W
SE Package Thermal Resistance	R_{THJA}		-	300	-	°C/W

Table 2: General electrical parameters

[17] *T_{PROT} and T_{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°C to 150°C (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ[18]	Max	Units
Operating Point Programming Range [19]	B_{OP}	V_{DD} = 5V, T_J = 25°C	-100	-	100	mT
Operating Point for programming target 28mT	B_{OP28}	V_{DD} = 5V, T_J = 25°C	26	28	30	mT
B_{OP} Magnitude Programming [20]			-	8	-	bit
B_{OP} Polarity Selection			-	1	-	bit
B_{OP}/B_{RP} Temperature Coefficient Programming Range [21]	TC [22]	V_{DD} = 5V, Latch with B_{OP} = 28mT, B_{RP} = -28mT	-2000	-	0	ppm/°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 [23]			-	5	-	bit
Proportional Hysteresis Ratio Programming Range $HYS_{RATIO} = B_{HYSPR} / B_{OP}$ [4]	HYS_{RATIO}	Programming step 0.025	0.025	-	0.800	-
Absolute Hysteresis Programming Range [4]	B_{HYSABS}	Programming step 0.1mT	0	-	3.1	mT
Absolute Hysteresis tolerance [24]	B_{HYSTOL}	B_{HYSABS} = 0.8mT to 1.6mT, B_{OP} = 3mT, V_{DD} = 3.5 to 14V	-0.6	0	0.6	mT
Absolute Hysteresis tolerance [7]	B_{HYSTOL}	B_{HYSABS} = 1.7mT to 3.1mT, B_{OP} = 3mT, V_{DD} = 3.5 to 14V	-0.7	0	0.7	mT
B_{OP}, B_{RP} and B_{HYSPR} life time drift		HTOL 1000h at T_J = 165°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°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:
$$TC = \frac{(B_{OPT2} - B_{RPT2}) - (B_{OPT1} - B_{RPT1})}{(B_{OPT1} - B_{RPT1}) * (T_2 - T_1)} * 10^6, \text{ppm/°C}; T_1 = 25°C; T_2 = 150°C$$
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°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.

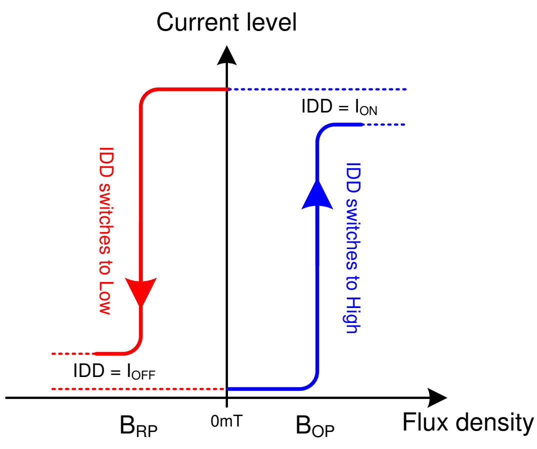


Fig.1 – South Pole Active

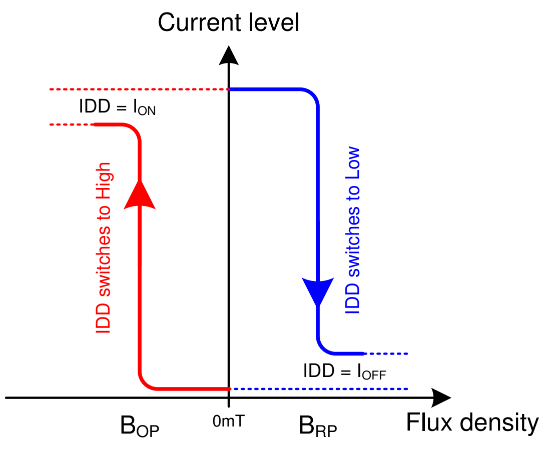


Fig.2 – North Pole Active

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

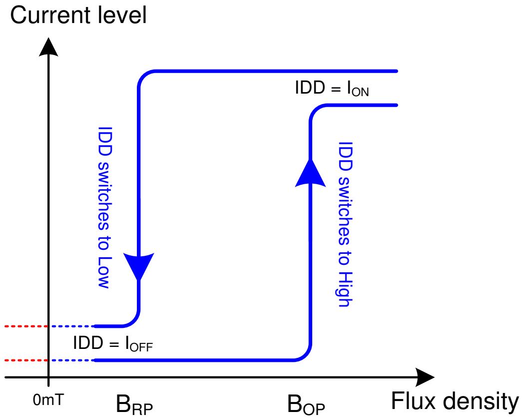


Fig.1 – Direct South Pole Active

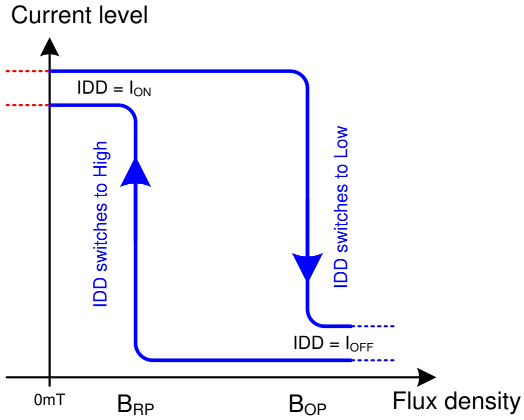


Fig.2 – Inverted South Pole Active

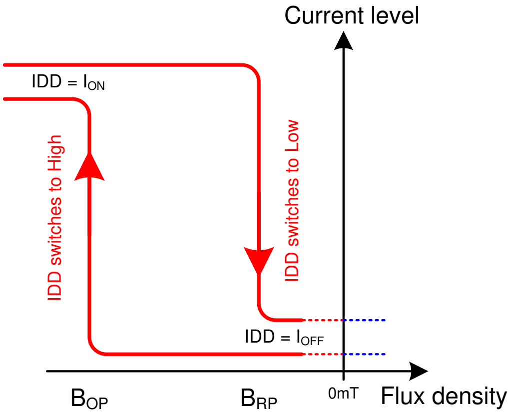


Fig.3 – Direct North Pole Active

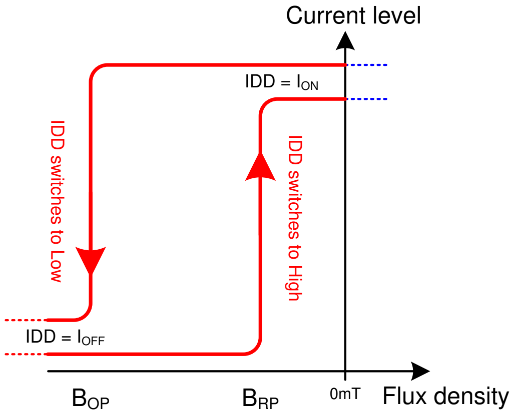
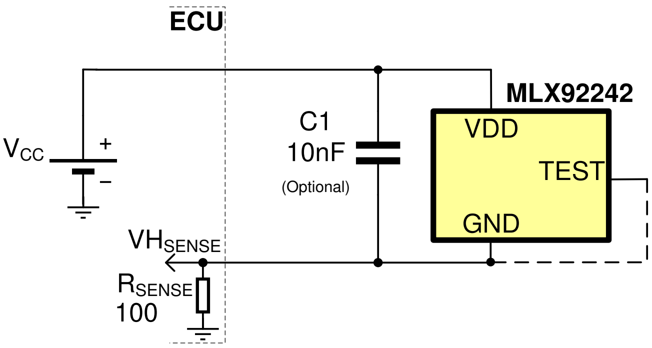


Fig.4 – Inverted North Pole Active

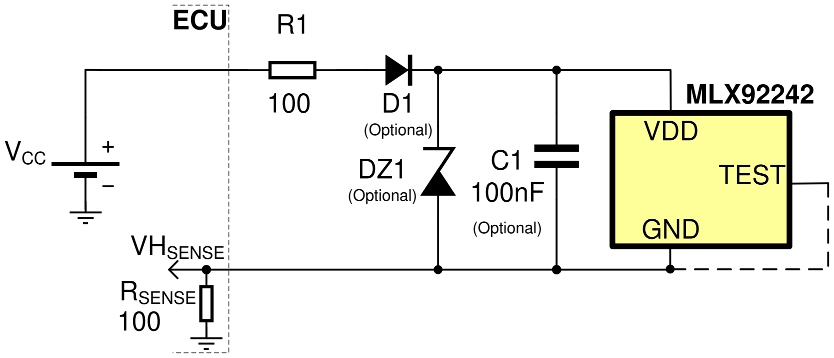
11. Application Information

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_{DD} 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:
1. For proper operation, a 10 to 100nF bypass capacitor should be placed as close as possible to the V_{DD} and ground (GND) pin.
For MLX92242LUA-AAA-1xx and 3 xx C1 is not required.
2. 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) as well as trim&form recommendations (http://www.melexis.com/Assets/Trim-and-form-recommendations-5565.aspx).

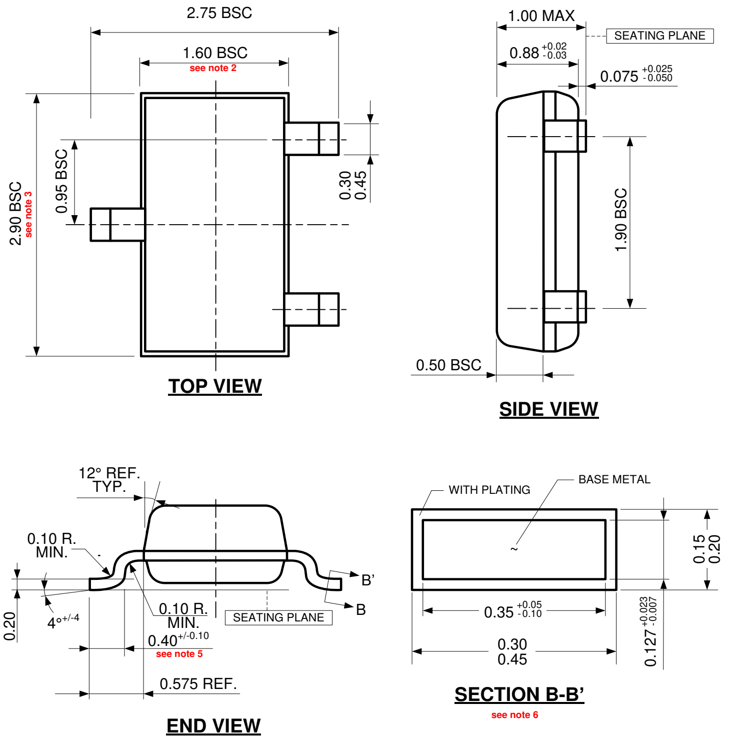
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: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

13. 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

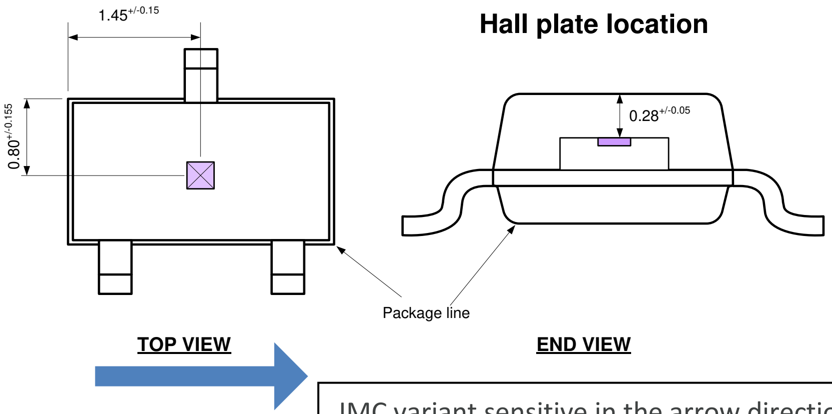
WW: Assembly week

BOTTOM:

YLLL

Y: Assembly Year

LLL: Last 3 digits from lot#



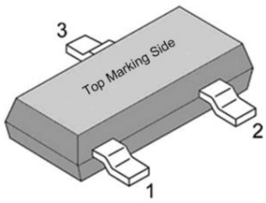
Notes:

1. All dimensions are in millimeters

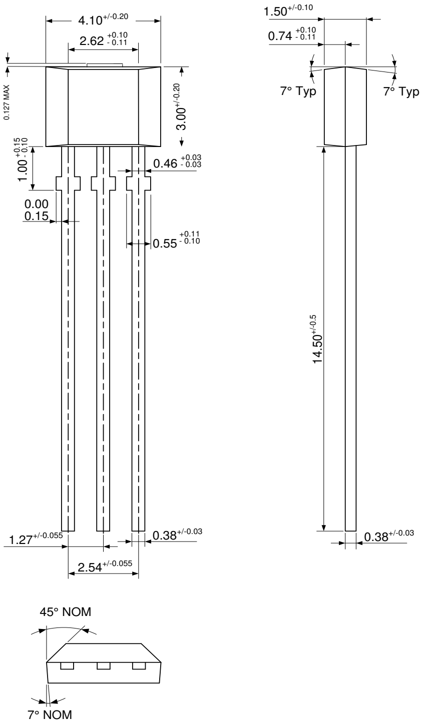
IMC variant sensitive in the arrow direction (Bx instead of Bz)

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:

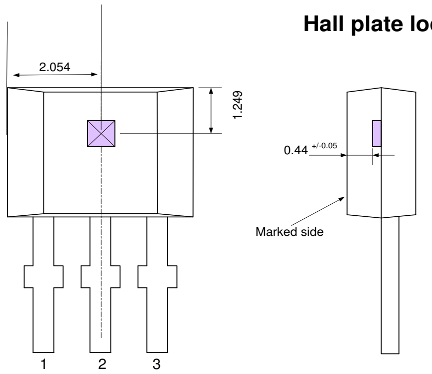
1. All dimensions are in millimeters
2. Package dimension exclusive molding flash.
3. The end flash shall not exceed 0.127 mm on the top side.

Marking:

1st Line : 42WW
WW - calendar week number

2nd Line : YLLL
Y - last digit of year
LLL - last Three digits of lot number

Hall plate location

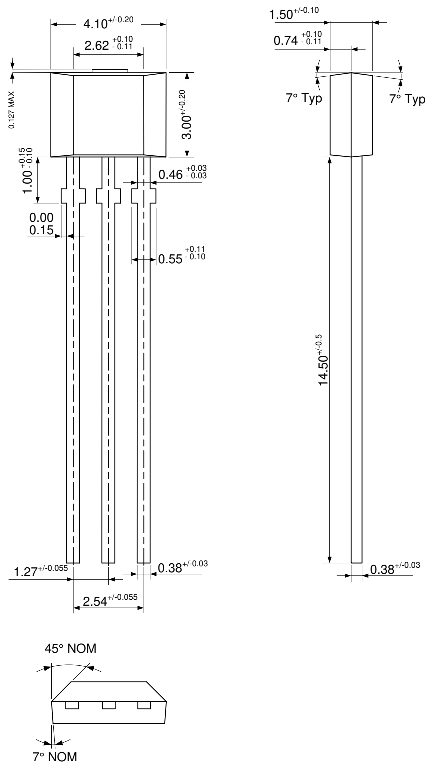


Notes:

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

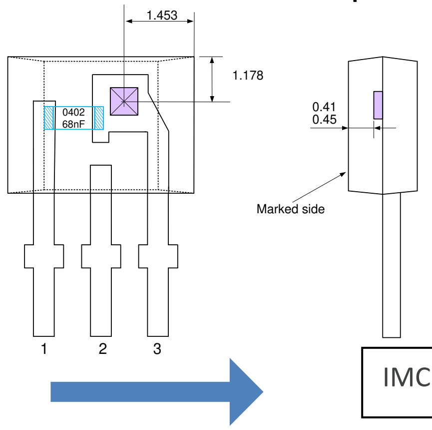


Notes:
1. All dimensions are in millimeters
2. Package dimension exclusive molding flash.
3. The end flash shall not exceed 0.127 mm on the top side.

Marking:
TOP:
1st Line : C1WW – C1 = 68nF, WW = Calendar week number
2nd 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:

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	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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The Product(s) may not be used for the following applications subject to export control regulations: the development, production, processing, operation, maintenance, storage, recognition or proliferation of 1) chemical, biological or nuclear weapons, or for the development, production, maintenance or storage of missiles for such weapons: 2) civil firearms, including spare parts or ammunition for such arms; 3) defense related products, or other material for military use or for law enforcement; 4) any applications that, alone or in combination with other goods, substances or organisms could cause serious harm to persons or goods and that can be used as a means of violence in an armed conflict or any similar violent situation.
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ISO/TS 16949 and ISO14001 Certified