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1 Features and Benefits

- Wide operating voltage range: from 3.3V to 18V
- Flexible magnetic thresholds and temperature coefficient
- Integrated self-diagnostic functions activating dedicated Safe Mode
- Reverse supply voltage protection
- Under-Voltage Reset protection
- Thermal protection
- Optional IMC integration for lateral sensing
- Developed according to ISO26262-10, 9 as safety HW element out of context with ASIL-B level

2 Application Examples

- Automotive, Consumer and Industrial
- Brake light wake-up switch
- Electronic Steering Column Lock
- Door latch system
- Seat positioning
- Sunroof/Tailgate opener
- Transmission applications
- Electrical power steering

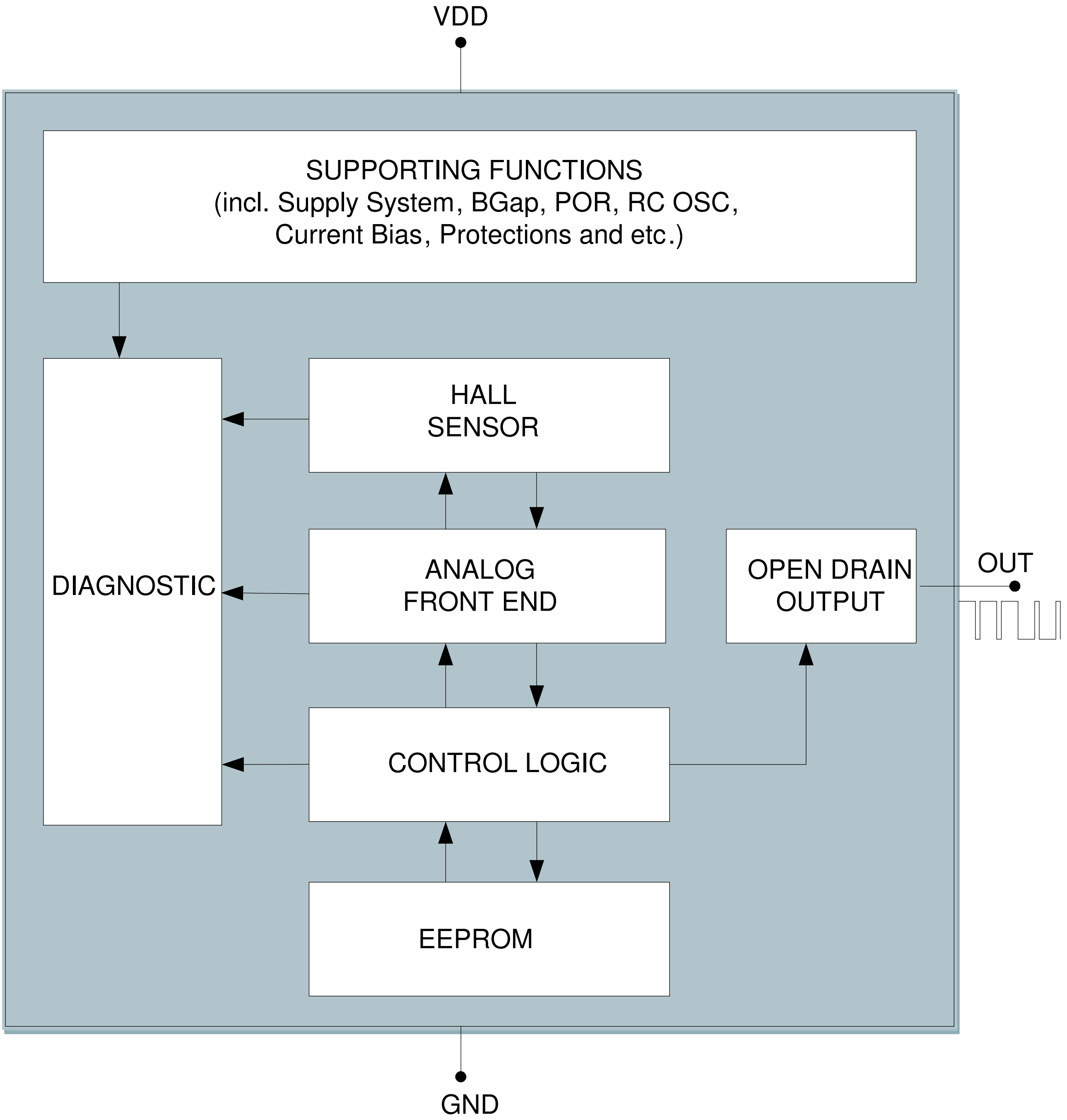
3 Ordering Information

Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
MLX92292	L	SE	AAA-001	RE
MLX92291	L	SE	AAA-200	RE

Legend:

Temperature Code:	L (-40°C to 150°C)
Package Code:	SE = TSOT-23L
Option Code:	000 => 3 wire hall effect Switch
	200 => IMC version
Packing Form:	BU=Bulk | RE = Reel | CA = Ammopack
Ordering example:	MLX92292LSE-AAA-001-RE

4 Functional Diagram



5 General Description

Melexis has made a major advance in magnetic sensing technology that will have widespread implications for modern automobile design the MLX92292 - effectively represents a whole new way of sensing. This device delivers switch functions, but unlike existing products on the market it can determine the presence of magnetic fields that are lateral, not just orthogonal, to it. The uniqueness of this offering is taken further by the fact that the MLX92292 switch is supporting an ASIL B safety integrity level (in accordance with ISO 26262), with an array of built-in diagnostic mechanisms available.

Flexibility is a key attribute of the MLX92292. OEM customers can chose straightforward pre-programmed units, or alternatively they can benefit from the end-of-line (EoL) programming capacity. Through this each device may be configured (via its output pin) during the OEM production process, so system optimization is fully realized. The programming facility also enables setting of both magnetic operating points to small increments across a range spanning -90mT to +90mT (-40mT to +40mT for lateral sensing versions).

The MLX92292 can be specified with standard orthogonal sensitivity or the lateral sensitivity option. The upshot of lateral sensitivity being that there is potential to replace multiple devices with a single surface mount unit, thereby saving valuable board space and lowering bill-of-materials costs. This stems directly from Melexis' proprietary Integrated Magnetic Concentrator (IMC™) technology, which enables substantial heightening of signal-to-noise ratios in magnetic field measurement. In addition, the capacity of this technology to sense laterally allows lower profile system implementations, as the magnet can move alongside the device rather than having to be above it.

Safeguarding the MLX92292 are reverse supply voltage, thermal, electro-static discharge (ESD) and over-voltage protections, plus Under-Voltage Reset features. With the capacity to deal with a 40V load dump, it can be connected directly to the vehicle battery. In order to achieve ASIL B compliance, numerous diagnostic/monitoring functions have been incorporated, including Hall sensor and analog frontend diagnostics. The device comprises a full set of programmable reporting features, giving it compatibility with any existing electronic control unit (ECU) interface. Only the normal application pins are required for this - without need of additional diagnostic pins and thus simplifying the design concept considerably.

Table of Contents

6 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply voltage[1, 2]	V_{DD}	+28V	V
Supply voltage (Load Dump)[1, 4]	V_{DD}	+ 45V	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}	-40	mA
Output voltage[1, 2]	V_{OUT}	+28	V
Output current[1, 2, 5]	I_{OUT}	+20	mA
Reverse output voltage[1]	V_{OUTREV}	-0.5	V
Reverse output current[1, 2]	I_{OUTREV}	-50	mA
Maximum junction temperature[6]	T_J	+165	°C
ESD sensitivity – HBM[7]	-	8	kV
ESD sensitivity – CDM[8]	-	1000	V

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

[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 Body Model according AEC-Q100-002 standard*
[8] *Charged Device Model according AEC-Q100-011 standard*

7 General Electrical Specifications

DC Operating Parameters V_{DD} = 3.3V to 18V, T_A = -40°C to 150°C (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ[1]	Max	Units
Under-Voltage Reset threshold	V_{UVR}	V_{DD} monitoring during Active phase	1.8	2.5	3	V
UVR reaction time[2]	t_{UVR}	V_{DD} monitoring during Active phase, V_{DD} = V_{UVR} - 0.3V	—	1	—	µs
Minimum supply voltage for defined output state[2]	V_{DD1}	R_{PU} = 2.2kΩ, V_{PU} = 5V	—	1	1.2	V
Output leakage[8]	I_{OFF}	V_{OUT} =18V, T_A= -40..85°C	—	0.1	1	µA
Output leakage	I_{OFF}	V_{OUT} =18V	—	—	5	µA
Output saturation voltage	V_{OL}	Fast Mode, I_{OL} =20mA	0.1	0.25	0.7	V
Output saturation voltage	V_{OL}	µ-Power Mode, I_{OL} =10mA	—	0.15	0.5	V
Output Rise Time[2,5] (R_{PU} dependent)	t_R	R_{PU} =2.2kΩ, V_{DD} =12V, V_{PU} =5V C_{LOAD} =50pF to GND	0.3	0.6	1	µs
Output Fall Time[2,5] (On-chip controlled)	t_F	R_{PU} =2.2kΩ, V_{DD} =12V, V_{PU} =5V C_{LOAD} =50pF to GND	0.3	0.6	1	µs
Power-On time[3, 4]	t_{ON}	V_{DD} =5V, dV_{DD}/dt > 2V/us	—	0.5	1	ms
Power-On state	-	Output state during t_{ON}		High		—
Output update period	T_{UPD}	Fast Mode	—	40	45	µs
Programmable operating (output update) period	T_{OP}	µ-Power Mode, typical range	0.16[1]	—	260[1]	ms
Operating period 1 (1st ref. value)	T_{OP1}	µ-Power Mode	196	222	246	ms
Operating period 2 (2nd ref. value)	T_{OP2}	µ-Power Mode	40	45	50	ms
Programmable diagnostic period in Fail Safe state	T_{DP}	Fast Mode, typical range	0.13[1]	—	260[1]	ms
Programmable "Output Ticking" repetition period	T_{TICK}	Equal to (multiple of) T_{OP}, typical range	0.6[1]	—	260[1]	ms
Programmable "Output Ticking" duration	t_{TICK}	Typical range	4	—	128	µs
Active phase duration, diagnostic On	t_{ACT_Don}	µ-Power Mode, defined at I_{DD} > 0.7mA	—	40	—	µs
Active phase duration, diagnostic Off	t_{ACT_Doff}	µ-Power Mode, defined at I_{DD} > 0.7mA	—	24	—	µs
Tolerance of operating period ratio t_{ACT}/T_{OP}	R_{TOL}	µ-Power Mode	-5	0	5	%
Active phase supply current, diagnostic On (average value)	I_{DDACT_Don}	µ-Power Mode	1.8	2.4	2.9	mA
Active phase supply current, diagnostic Off (average value)	I_{DDACT_Doff}	µ-Power Mode	2.2	3	3.5	mA
Standby phase supply current[8]	I_{DDSTBY}	V_{DD} ≤ 16V, T_A = -40..85°C	—	6	9	µA
Standby phase supply current	I_{DDSTBY}	V_{DD} ≤ 16V	—	6	27	µA
Average supply current[8,9]	I_{DDAVG1}	V_{DD} ≤ 16V, T_A = -40..85°C, T_{OP} =T_{OP1}	—	6.4	9.5	µA
Average supply current[8,9]	I_{DDAVG2}	V_{DD} ≤ 16V, T_A = -40..85°C, T_{OP} =T_{OP2}	—	8.1	11.7	µA
Step response time[2]	t_{RESP}	Fast Mode, B_{OP} = 1mT, B_{RP} = -1mT, square wave magnetic field with B > ±4mT, t_{RISE}=t_{FALL}≤ 5µs	15	40	65	µs
Signal bandwidth[2,6]	BW	Fast Mode, B_{OP} = 1mT, B_{RP} = -1mT, sine wave magnetic field with amplitude 5mT	6	8	—	kHz
Peak supply current[2]	I_{DDPEAK}	For peak duration ≥ 5µs	—	2.9	3.6	mA
Fast Mode supply current	I_{DDFAST}		2.2	2.9	3.5	mA
Fast Mode fail supply current	I_{DDFAIL}		0.1	0.3	0.6	mA

Reverse supply current	I_{DDREV}	V_{DD} = -16V	-1	—	—	mA
Thermal Protection Activation	T_{PROT}		—	185(7)	—	°C
Thermal Protection Release	T_{REL}		—	175(7)	—	°C
UA package thermal resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards, still air (LFPM=0)	—	200	—	°C/W
SE package thermal resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards, still air (LFPM=0)	—	300	—	°C/W

1 Unless otherwise specified the typical values are defined at T_A = +25°C and V_{DD} = 12V
2 Guaranteed by design and verified by characterization, not production tested
3 The Power-On Time represents the time from reaching V_{DD} = 3.3V to the first refresh of the output state.
4 Power-On Slew Rate is not critical for the proper device start-up.
5 R_{PU} and V_{PU} are respectively the external pull-up resistor and pull-up power supply
6 OUT switching should track magnetic field frequency without missing pulses
7 T_{PROT} and T_{REL} are the corresponding junction temperature values
8 Guaranteed by correlation with production test at T_A=150°C and verified by characterization
9 Average current consumption for µ-Power Mode

$$I_{DDAVG} = \frac{I_{DDACT} * t_{ACT} * (1 + R_{TOL}/100) + I_{DDSTBY} * (T_{OP} - t_{ACT} * (1 + R_{TOL}/100))}{T_{OP}},$$

where t_{ACT} and T_{OP} are always typical values. The maximum I_{DDACT}, I_{DDSTBY} and R_{TOL} spec values should be used for the maximum I_{DDAVG} calculation.

8 Version specific parameters

8.1 MLX92292LSE-AAA-001-RE

DC Operating Parameters V_{DD} = 3.3 to 18V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Output behaviour	Active Pole
	Min	Typ[2]	Max	Min	Typ[2]	Max	Typ[2]		
T_A = -40°C	8.7	11	13.5	7.2	9.3	11.7			
T_A = 25°C	8.6	10	11.4	7.2	8.5	9.8	-1100[3]	Inverted switch	South pole
T_A = 150°C	6.7	8.6	10.7	5.6	7.4	9.4			

IMC	Safe message	Operating period, ms	Diagnostic period in Fail Safe state, ms	"Output Ticking" duration, µs	"Output Ticking" repetition period, ms
No	uNoDiag	0.16	-	-	-

8.2 MLX92291LSE-AAA-200-RE

DC Operating Parameters V_{DD} = 3.3 to 18V, T_A = -40°C to 150°C

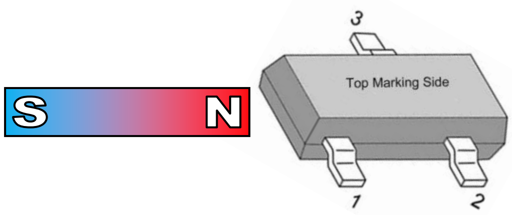
Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Output behaviour	Active Pole
	Min	Typ[2]	Max	Min	Typ[2]	Max	Typ[2]		
T_A = -40°C	7.6	10.5	13.6	5.6	8.1	11			
T_A = 25°C	7	9	11	5.1	7	8.9	-2200[3]	Inverted switch	South pole
T_A = 150°C	4.5	6.6	8.9	3.2	5.2	7.2			

IMC	Safe message	Operating period, ms	Diagnostic period in Fail Safe state, ms	"Output Ticking" duration, µs	"Output Ticking" repetition period, ms
Yes	FlddMsg	-	2	-	-

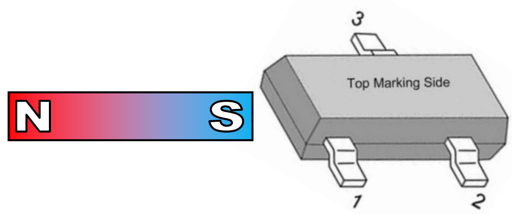
1 Melexis production testing is limited to version specific parameters only
2 Unless otherwise specified the typical values are defined at T_A = +25°C and V_{DD} = 12V
3 The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XPTA2} - B_{XPTA1}}{B_{XPTA1} * (T_{A2} - T_{A1})} * 10^6, \text{ppm/°C}$$

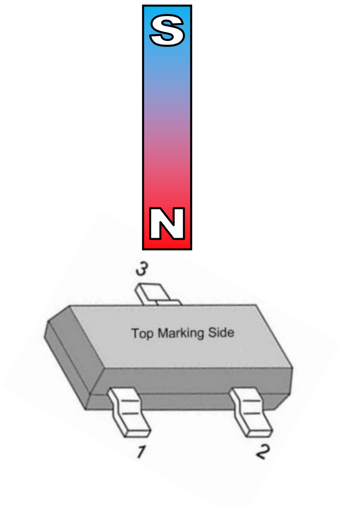
where:
T_{A1} = 25°C, T_{A2} = 150°C,
In case of magnetic Latch application: B_{XPTA1} (B_{XPTA2}) = B_{OP}-B_{RP} at T_{A1} (T_{A2})
In case of magnetic Switch application: B_{XPTA1} (B_{XPTA2}) = B_{OP} or B_{RP} at T_{A1} (T_{A2})



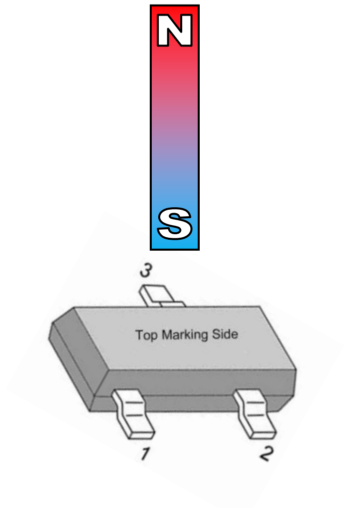
North active pole (IMC version)



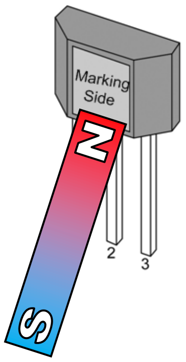
South active pole (IMC version)



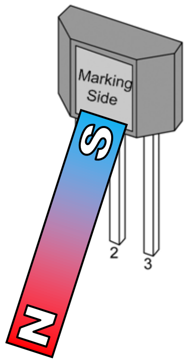
North active pole



South active pole



North active pole



South active pole

9 Magnetic Behaviour

9.1 Latch Sensor

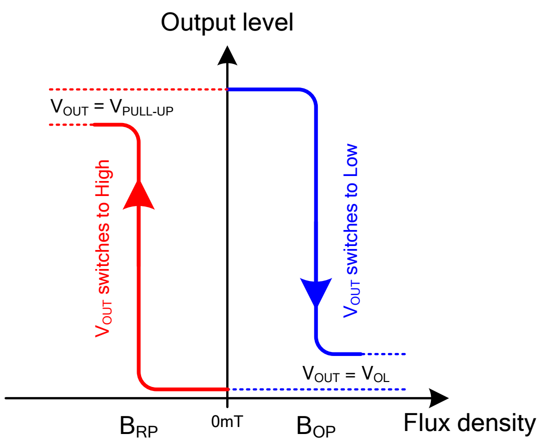


Fig.1 – Direct Output Latch

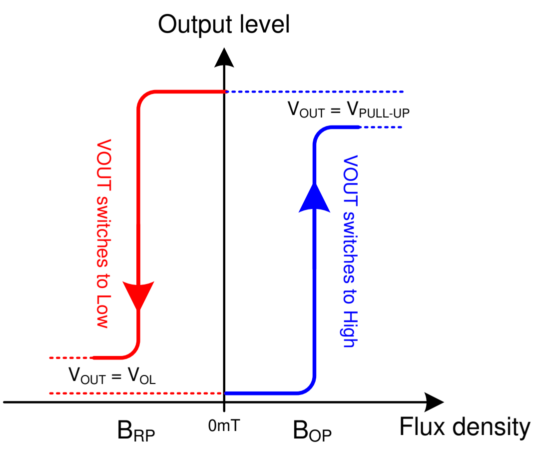


Fig.2 – Inverted Output Latch

9.2 Unipolar Switch Sensor

Magnetic Field	Output Polarity	Remark
South	Direct South Switch	Fig.3
South	Inverted South Switch	Fig.4
North	Direct North Switch	Fig.5
North	Inverted North Switch	Fig.6

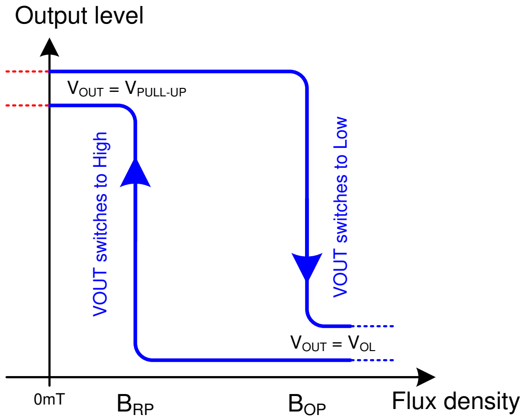


Fig.3 – Direct South Switch

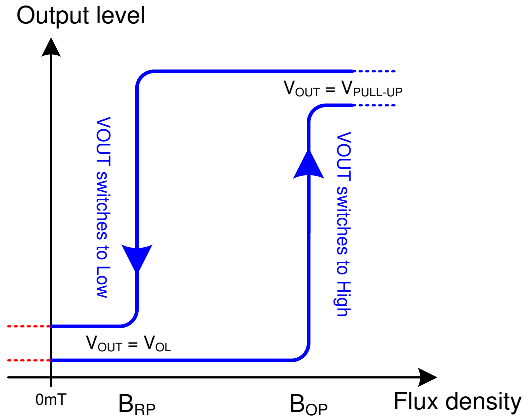


Fig.4 – Inverted South Switch

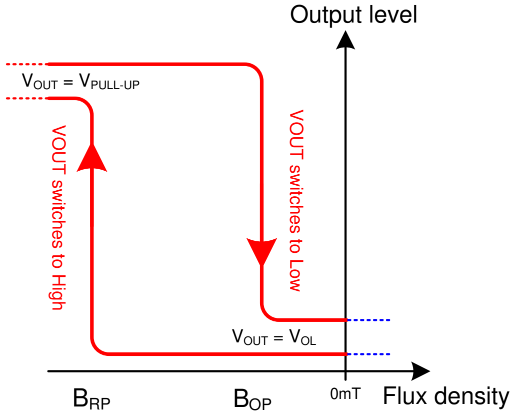


Fig.5 – Direct North Switch

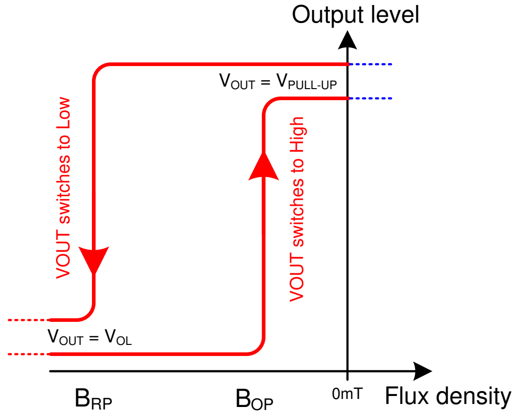


Fig.6 – Inverted North Switch

10 Functional Safety Capability

10.1 Sensor Development

MLX92292 is developed according to the ISO26262 requirements for ASIL B level.

10.2 Technical Safety Requirements

The main (mission) technical safety requirement for MLX92292 is the following:

10.2.1 TS_RQT_Mission

MLX92292 shall detect the presence of magnetic field by comparing it with magnetic thresholds Bop and Brp, each of them being within a Safe Tolerance Interval (STI) defined in mT as ±a*Bxp ±b, where
Bxp is the actual magnetic threshold (Bop or Brp) and a, b are parameters depending on the application temperature range.

Two typical examples of Safe Tolerance Interval are given in section 5 and 6.

10.2.2 TS_RQT_Safe_Message

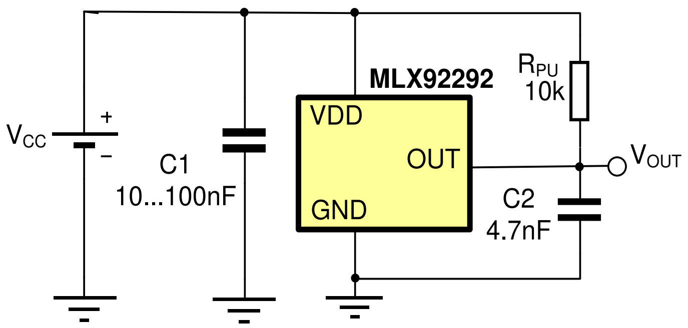
MLX92292 shall report detected failures that could prevent TS_RQT_Mission.
One of the following programmable Safe Message options can be chosen depending on the application:

Message Option	B<Brp Diagnostic OK	B>Bop Diagnostic OK	All B values Diagnostic Failed	Diagnostic Coverage	Safe States
µ-Power Mode				**SPFM**	
TickMsg(1,2)	OUT = Off+Ticking	OUT = On+Ticking	OUT = Off	92%	B_{OP}, B_{RP} within STI ; OUT = On/Off w/o ticking
TickOffMsg(1)	OUT = Off+Ticking	OUT = On	OUT = Off	82%	B_{OP}, B_{RP} within STI ; OUT = Off
TickOnMsg(2)	OUT = Off	OUT = On+Ticking	OUT = On	55%	B_{OP}, B_{RP} within STI ; OUT = On
OutOffMsg	OUT = Off	OUT = On	OUT = Off	82%	B_{OP}, B_{RP} within STI ; OUT = Off
OutOnMsg	OUT = Off	OUT = On	OUT = On	55%	B_{OP}, B_{RP} within STI ; OUT = On
StbyX2Msg(3)	OUT = Off	OUT = On	OUT = Off Twice increased T_{OP}	77%	B_{OP}, B_{RP} within STI ; Twice increased Top
uNoDiag(4)	OUT = Off	OUT = On	-	No diagnostic	B_{OP}, B_{RP} within STI
Fast Mode					
FIddMsg	OUT = Off, I_{DD} = I_{DDFAST}	OUT = On, I_{DD} = I_{DDFAST}	OUT = Off, I_{DD} = I_{DDFAIL}	67%	B_{OP}, B_{RP} within STI ; OUT=Off & I_{DD} below (1..1.6)mA
FNoDiag(4)	OUT = Off	OUT = On	-	No diagnostic	B_{OP}, B_{RP} within STI

Note (1) Off+Ticking signal means that the Off state duration lasts significantly longer than the On state duration.
Note (2) On+Ticking signal means that the On state duration lasts significantly longer than the Off state duration.
Note (3) If T_{OP} is set <5ms then T_{OP} increases less than twice in case of diagnostic fail.
Note (4) This message option do not offer integrated diagnostic

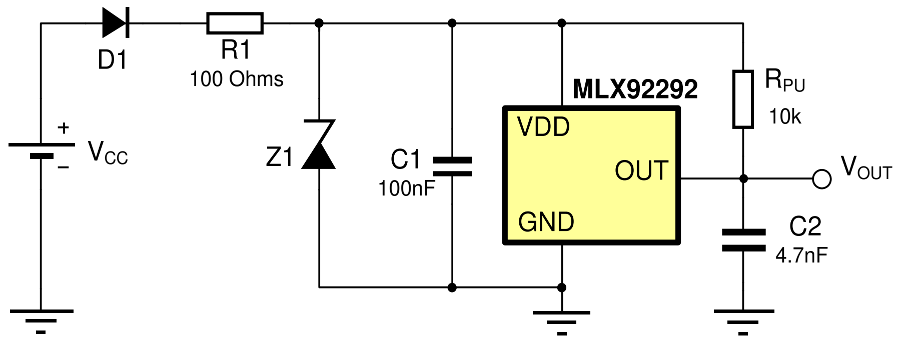
11 Application Information

11.1 Typical Automotive 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 will improve the EMC performance

11.2 Automotive and Harsh, Noisy Environments Application Circuit

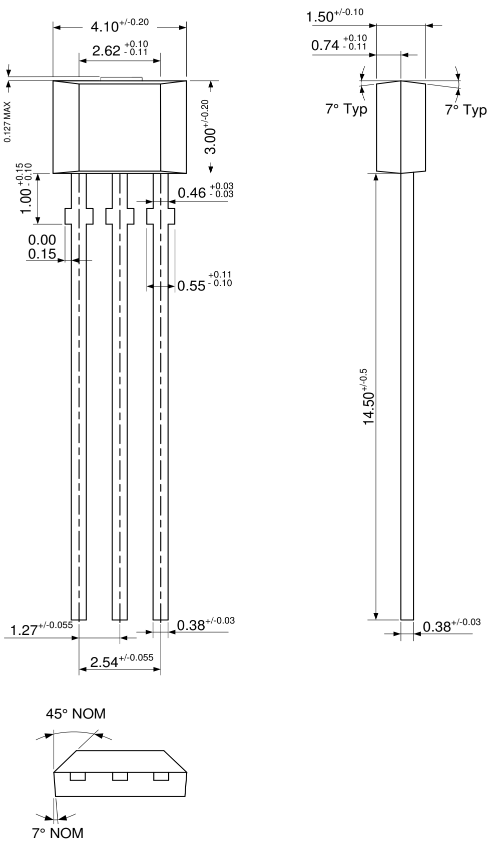


Notes:
1. For proper operation the bypass capacitor C1 should be placed as close as possible to the VDD and GND pins.
2. If negative transients over supply line V_{PEAK}< -30V are expected, usage of the diode D1 is recommended. Otherwise only R1 is sufficient. When selecting the resistor R1, three points 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 ($V_{DD} = V_{CC} – R1.I_{DD}$)

3. If positive transients over supply line with V_{PEAK}> 40V are expected, usage of Zener diode Z1 is recommended. The R1-Z1 network should be sized to limit the voltage over the device below the maximum allowed.

12 Package Information

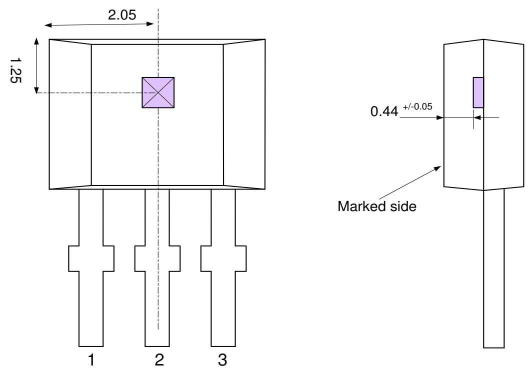
12.1 UA (TO92-3L) Package Information



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 : 92WW
92: referring to design number
WW: Calender week number
2nd Line : YLLL
Y - last digit of year
LLL – Last three digits of lot number

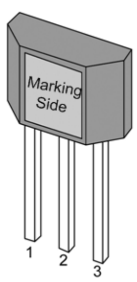
Hall plate location



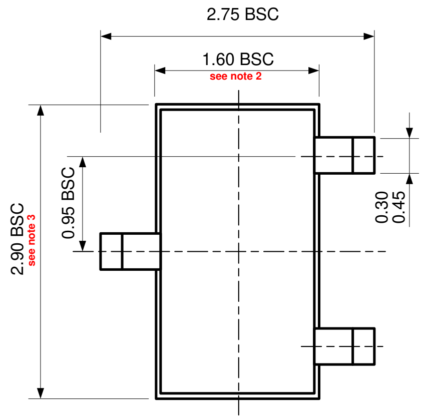
Notes:
1. All dimensions are in millimeters

UA Pin №	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	GND	Ground	Ground pin
3	OUT	I/O	Output&Test I/O

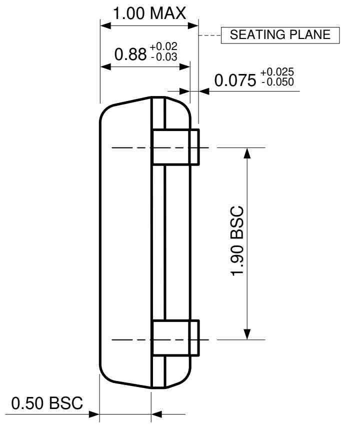
Table 1: UA Package pinout



12.2 SE (TSOT-3L) Package Information



TOP VIEW



SIDE VIEW

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:

92WW – Normal sensitivity version

93WW – Lateral sensitivity version

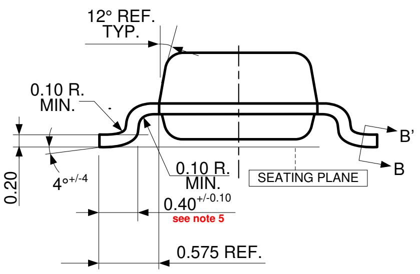
WW: Assembly week

BOTTOM:

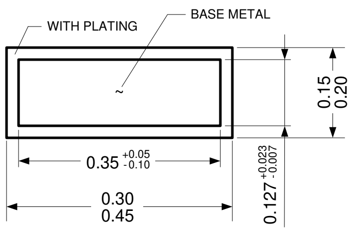
YLLL

Y: Assembly Year

LLL: Last 3 digits from lot#

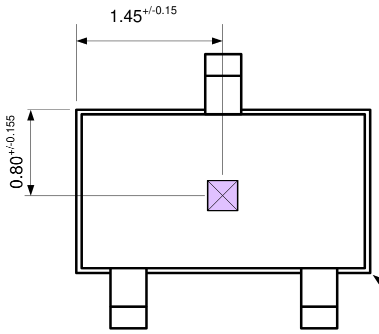


END VIEW



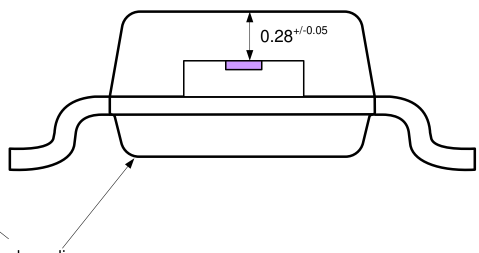
SECTION B-B'
see note 6

Hall plate location



TOP VIEW

Package line



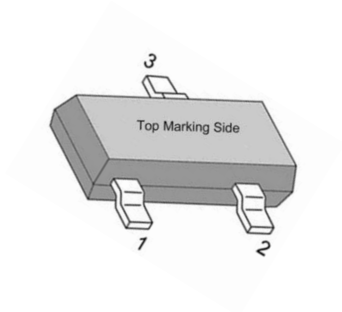
END VIEW

Notes:

1. All dimensions are in millimeters

SE Pin №	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	OUT	I/O	Output&Test I/O
3	GND	Ground	Ground pin

Table 2: SE Package pinout



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 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 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:

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