1 Features and Benefits

- Wide operating voltage range: from 2.7V to 24V
- Accurate switching thresholds
- Reverse Supply Voltage Protection
- Output Current Limit with Auto-Shutoff
- Under-Voltage Lockout Protection
- Thermal Protection
- Traceability with integrated unique ID
- High ESD rating / Excellent EMC performance

2 Application Examples

- Automotive, Consumer and Industrial
- Solid-state switch
- Brake sensor
- Clutch sensor
- Sunroof/Tailgate opener
- Steering Column Lock
- Open/Close detection

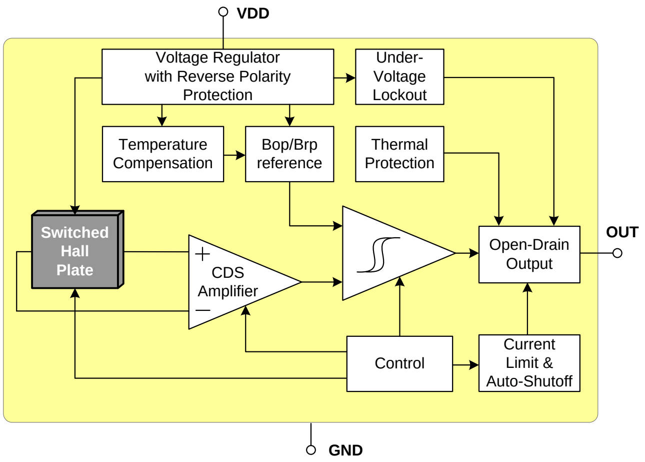
3 Ordering Information

Product Code	Temperature Code	Package Code	Option Code	Packing from Code
MLX92211	L	SE	BAA-0xx	RE
MLX92211	L	UA	BAA-0xx	BU
MLX92211	L	SE	BAA-2xx	RE

Legend:

Temperature Code: L (-40°C to 150°C)
Package Code: SE = TSOT-3L / UA = TO92-3L
Option Code: 0xx => 3 wire Hall Effect Latch
2xx => IMC version
Packing Form: RE = Reel | BU=Bulk
Ordering Example: MLX92211LSE-BAA-001-RE

4 Functional Diagram



5 General Description

The Melexis MLX92211 is a Hall-effect latch designed in mixed signal CMOS technology.

The device integrates a voltage regulator, Hall sensor with advanced offset cancellation system, automotive qualified EEPROM and an open-drain output driver, all in a single package.

Based on the existing robust 922xx platform, the magnetic core has been equipped with a non-volatile memory that is used to accurately trim the switching thresholds and define the needed output magnetic characteristics (TC, B_{OP}, B_{RP}, Output pole functionality).

In addition to that an ID has been integrated on the IC to have a complete traceability throughout the process flow.

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 the 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 state is therefore only updated based on a proper and accurate magnetic measurement result.

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 open drain output is fully protected against short-circuit with a built-in current limit. An additional automatic output shut-off is activated in case of a prolonged short-circuit condition. A self-check is then periodically performed to switch back to normal operation if the short-circuit condition is released. 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.

Table of Contents

6 Glossary of Terms

Tesla	Units for the magnetic flux density, 1 mT = 10 Gauss
TC	Temperature Coefficient in ppm/°C
IMC	Integrated Magnetic Concentrator
POR	Power on Reset

7 Absolute Maximum Ratings

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

Parameter	Symbol	Value	Units
Supply Voltage (1, 2)	V_{DD}	+27	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
Output Voltage (1, 2)	V_{OUT}	+27	V
Output Current (1, 2, 5)	I_{OUT}	+20	mA
Output Current (1, 4, 6)	I_{OUT}	+75	mA
Reverse Output Voltage (1)	V_{OUTREV}	-0.5	V
Reverse Output Current (1, 2)	I_{OUTREV}	-100	mA
Maximum Junction Temperature (7)	T_J	+165	°C
Storage Temperature Range	Ts	-55 to +165	°C
ESD Sensitivity – HBM (8)	-	4000	V
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 V_{OUT}≤27V
7 For 1000 hours
8 Human Model according AEC-Q100-002 standard
9 Charged Device Model according AEC-Q100-011 standard

8 General Electrical Specifications

DC Operating Parameters V_{DD} = 2.7V to 24V, T_A = -40°C to 150°C (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ[1]	Max	Units
Supply Voltage	V_{DD}	Operating	2.7	-	24	V
Supply Current	I_{DD}		1.5	3.0	4.5	mA
Reverse supply current	I_{DDREV}	V_{DD} = -16V	-1	-	-	mA
Output Saturation Voltage	V_{DSON}	V_{DD} = 3.5 to 24V, I_{OUT} = 20mA	-	0.3	0.5	V
Output Leakage	I_{OFF}	V_{OUT} = 12V, V_{DD} = 12V	-	-	10	µA
Output Rise Time [2, 6] (R_{PU} dependent)	t_R	R_{PU} = 1kΩ, V_{DD} = 12V, V_{PU} = 5V C_{LOAD} = 50pF to GND	0.1	0.3	1	µs
Output Fall Time [2, 6] (On-chip controlled)	t_F	R_{PU} = 1kΩ, V_{DD} = 12V, V_{PU} = 5V C_{LOAD} = 50pF to GND	0.1	0.3	1	µs
Power-On Time [3,4,7]	t_{ON}	V_{DD} = 5V, dV_{DD}/dt > 2V/us	-	40	70	µs
Power-On Output State	-	t < t_{ON}		High (V_{PU})		-
Output Current Limit	I_{CL}	V_{DD}=3.5 to 24V, V_{OUT} = 12V	25	40	70	mA
Output ON Time under Current Limit conditions[8]	t_{CLON}	V_{PU} = 12V, R_{PU} = 100Ω	150	240		µs
Output OFF Time under Current Limit conditions[8]	t_{CLOFF}	V_{PU} = 12V, R_{PU} = 100Ω	-	3.5	-	ms
Chopping Frequency	f_{CHOP}		-	340	-	kHz
Refresh Period	t_{PER}		-	6	-	µs
Output Jitter (p-p) [2]	t_{JITTER}	Over 1000 successive switching events @10kHz triangle wave magnetic field, B > ±(B_{OPMAX} +20mT)	-	±3.2	-	µs
Maximum Switching Frequency [2, 5]	f_{SW}	B > ±3(B_{OPMAX} +1mT), triangle wave magnetic field	30	65	-	kHz
Under-voltage Lockout Threshold	V_{UVL}		-	-	2.7	V
Under-voltage Lockout Reaction time [2]	t_{UVL}		-	1	-	µs
Thermal Protection Threshold	T_{PROT}	Junction temperature	-	190[9]	-	°C
Thermal Protection Release	T_{REL}	Junction temperature	-	180[9]	-	°C
SE Package Thermal Resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards		300		°C/W
UA package Thermal Resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards		200		°C/W

Table 2: General Electrical parameters

1 *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} = 2.7V to the first refresh of the output*
4 *Power-On Slew Rate is not critical for the proper device start-up.*
5 *Maximum switching frequency corresponds to the maximum frequency of the applied magnetic field which is detected without loss of pulses*
6 *R_{PU} and V_{PU} are respectively the external pull-up resistor and pull-up power supply*
7 *Activated output with 1 mT overdrive*
8 *If the Output is in Current Limitation longer than t_{CLON} the Output is switched off in high-impedance state. The Output returns back in active state at next reaching of B_{OP} or after t_{CLOFF} time interval*
9 *T_{PROT} and T_{REL} are the corresponding junction temperature values*

9 Magnetic Specifications

9.1 MLX92211LSE-BAA-003

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	-0.8	0.5	2.0	-2.0	-0.5	0.8	0(2)	Z-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	-0.8	0.5	2.0	-2.0	-0.5	0.8			
T_A = 150°C	-0.8	0.5	2.0	-2.0	-0.5	0.8			

9.2 MLX92211LSE-BAA-006

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	-0.5	1.5	3.5	-3.5	-1.5	0.5	0(2)	Z-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	-0.5	1.5	3.5	-3.5	-1.5	0.5			
T_A = 150°C	-0.5	1.5	3.5	-3.5	-1.5	0.5			

9.3 MLX92211LSE-BAA-008

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	5.7	8.0	10.5	-10.5	-8.0	-5.7	-2000(2)	Z-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	5.4	7.0	8.6	-8.6	-7.0	-5.4			
T_A = 150°C	3.4	5.4	7.6	-7.6	-5.4	-3.4			

1 Typical values are defined at T_A=+25°C and V_{DD}=12V

2 Temperature coefficient is calculated using the following formula:

$$\frac{(B_{OPT2}-B_{RPT2})-(B_{OPT1}-B_{RPT1})}{(B_{OP25^oC}-B_{RP25^oC})\times(T_2-T_1)}*10^6,\ ppm/^oC; T_1=-40^oC; T_2=150^oC$$

9.4 MLX92211LUA-BAA-015

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT) (3)			Release Point B_{RP} (mT) (3)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	-0.8	0.5	2.0	-2.0	-0.5	0.8	0(2)	Z-axis sensitive South pole	UA (TO92-3)
T_A = 25°C	-0.8	0.5	2.0	-2.0	-0.5	0.8			
T_A = 150°C	-0.8	0.5	2.0	-2.0	-0.5	0.8			

9.5 MLX92211LSE-BAA-024

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT) (3)			Release Point B_{RP} (mT) (3)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	3.1	5.0	6.8	-6.8	-5.0	-3.1	0(2)	Z-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	3.1	5.0	6.8	-6.8	-5.0	-3.1			
T_A = 150°C	3.1	5.0	6.8	-6.8	-5.0	-3.1			

9.6 MLX92211LSE-BAA-044

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT) (3)			Release Point B_{RP} (mT) (3)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	-2.0	-0.5	0.8	-0.8	0.5	2.0	0(2)	Z-axis sensitive North pole	SE (TSOT-3L)
T_A = 25°C	-2.0	-0.5	0.8	-0.8	0.5	2.0			
T_A = 150°C	-2.0	-0.5	0.8	-0.8	0.5	2.0			

9.7 MLX92211LSE-BAA-202

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	-0.5	1.5	3.5	-3.5	-1.5	0.5	0(2)	X-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	-0.5	1.5	3.5	-3.5	-1.5	0.5			
T_A = 150°C	-0.5	1.5	3.5	-3.5	-1.5	0.5			

1 Typical values are defined at T_A=+25°C and V_{DD}=12V

2 Temperature coefficient is calculated using the following formula:

$$\frac{(B_{OPT2}-B_{RPT2})-(B_{OPT1}-B_{RPT1})}{(B_{OP25^\circ C}-B_{RP25^\circ C})\times(T_2-T_1)}*10^6,\ ppm/^\circ C; T_1=-40^\circ C; T_2=150^\circ C$$

3 Final magnetic parameters will be covered in the PPAP documentation set, the table below is based on theoretical calculations

9.8 MLX92211LSE-BAA-203

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

Test Condition	Operating Point B_{OP} (mT) (3)			Release Point B_{RP} (mT) (3)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	0.8	3.0	5.2	-5.2	-3.0	-0.8	0(2)	X-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	0.8	3.0	5.2	-5.2	-3.0	-0.8			
T_A = 150°C	0.8	3.0	5.2	-5.2	-3.0	-0.8			

9.9 MLX92211LSE-BAA-205

DC Operating Parameters V_{DD} = 3.5V to 24V, T_A = -40°C to 150°C

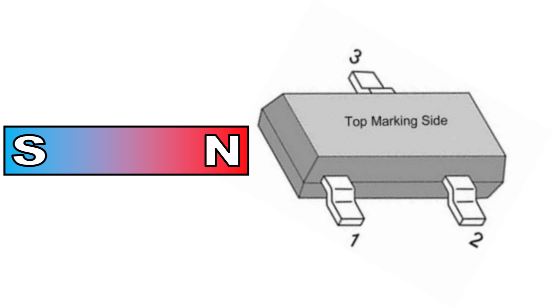
Test Condition	Operating Point B_{OP} (mT) (3)			Release Point B_{RP} (mT) (3)			TC (ppm/°C)	Active Pole	Package Information
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C	6.3	9.4	12.6	-12.6	-9.4	-6.3	-1100(2)	X-axis sensitive South pole	SE (TSOT-3L)
T_A = 25°C	6.1	8.8	11.6	-11.6	-8.8	-6.1			
T_A = 150°C	4.6	7.4	10.5	-10.5	-7.4	-4.6			

1 *Typical values are defined at T_A=+25°C and V_{DD}=12V*

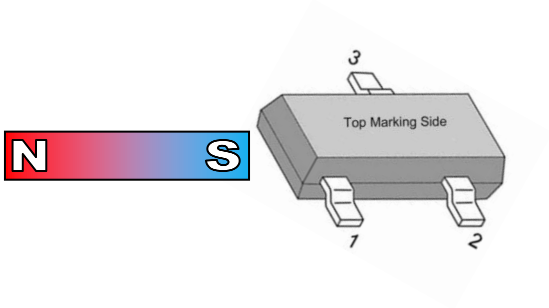
2 *Temperature coefficient is calculated using the following formula:*

$$\frac{(B_{OPT2}-B_{RPT2})-(B_{OPT1}-B_{RPT1})}{(B_{OP25^oC}-B_{RP25^oC})\times(T_2-T_1)}*10^6, ppm/^oC; T_1=-40^oC; T_2=150^oC$$

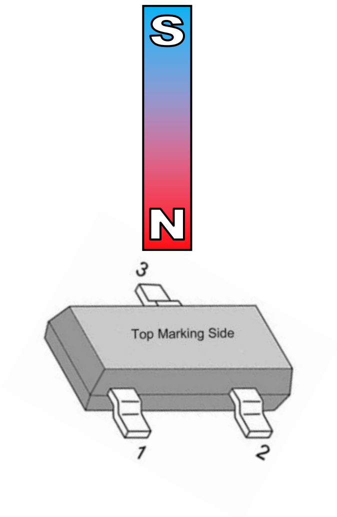
3 *Final magnetic parameters will be covered in the PPAP documentation set, the table below is based on theoretical calculations*



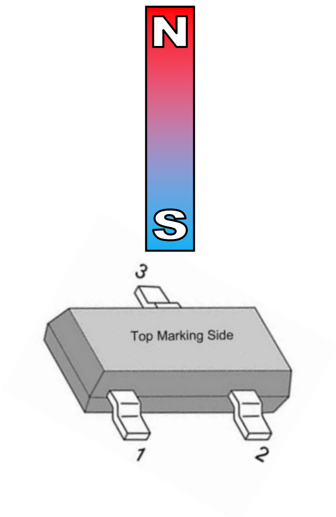
X-axis Sensitive
North Active Pole



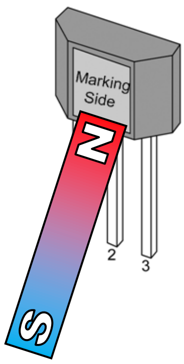
X-axis Sensitive
South Active Pole



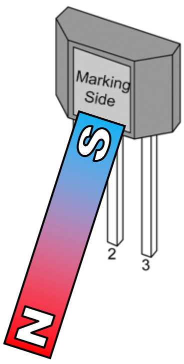
Z-axis Sensitive
North Active Pole



Z-axis Sensitive
South Active Pole

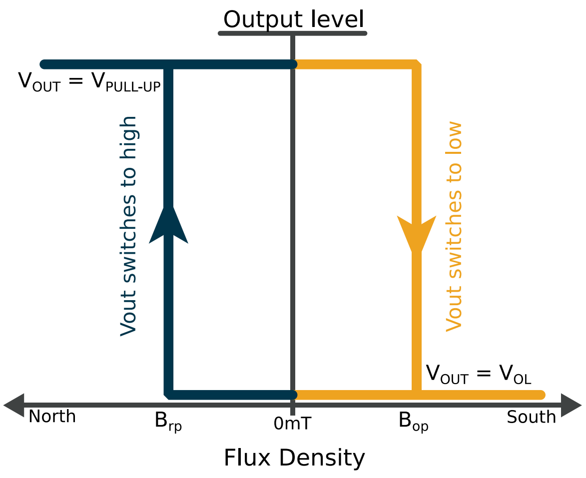


Z-axis Sensitive
North Active Pole

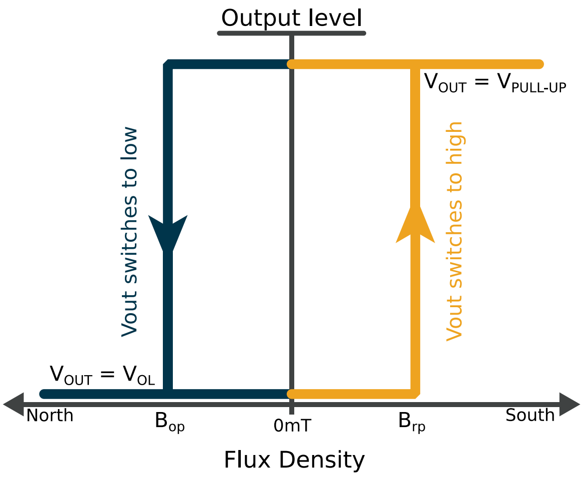


Z-axis Sensitive
South Active Pole

10 Magnetic Behaviour



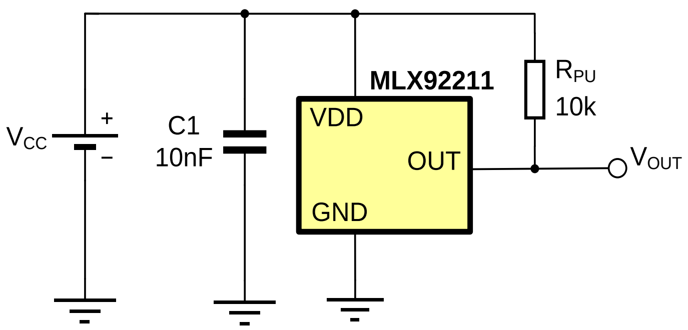
South Active Pole



North Active Pole

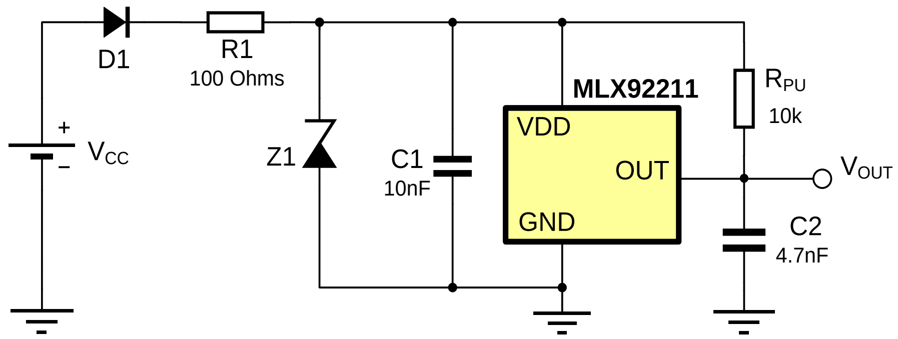
11 Application Information

11.1 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. The pull-up resistor R_{PU} value should be chosen in to limit the current through the output pin below the maximum allowed continuous current for the device.
3. A capacitor connected to the output is not needed, because the output slope is generated internally.

11.2 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 -24V, so 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 50mA 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. The device could tolerate positive supply voltage up to +27V (until the maximum power dissipation is not exceeded), so if positive transients over supply line with V_{PEAK}> 32V 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.

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.

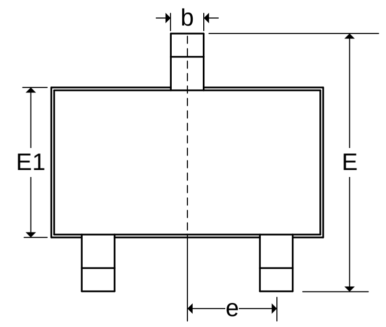
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: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

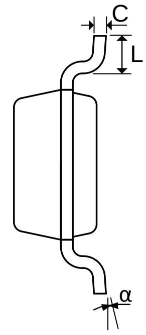
13 ESD Precautions

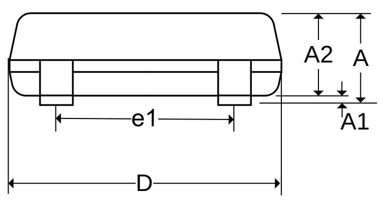
Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

14 Package Information

14.1 SE (TSOT-3L) Package Information







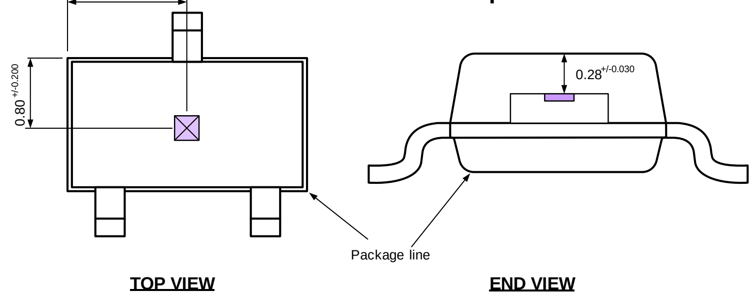
Marking:

Top mark: 31ww ==> ww; assembly week

IMC version: 33ww ==> ww; assembly week

Bottom mark: YLLL ==> Y; last digit of year LLL= last 3 digits of lot number

Hall plate location



Notes:

1. All dimensions are in millimeters
2. XY Hall plate position tolerances do not include the mold flashes and protrusions described in the package drawing

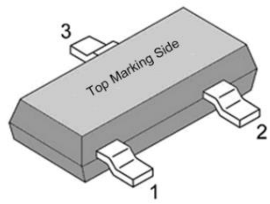
All dimensions are in mm:

	A	A1	A2	D	E	E1	L	b	c	e	e1	α
min	–	0.025	0.85	2.80	2.60	1.50	0.30	0.30	0.10	0.95	1.90	0°
max	1.00	0.10	0.90	3.00	3.00	1.70	0.50	0.45	0.20	BSC	BSC	8°

Notes:

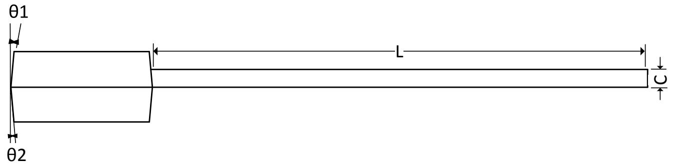
1. Dimension "D" and "E1" do not include mold flash or protrusions. Mold flash or protrusion shall not exceed 0.15mm on "D" and 0.25mm on "E" per side.
2. Dimension "b" does not include dambar protrusion.

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

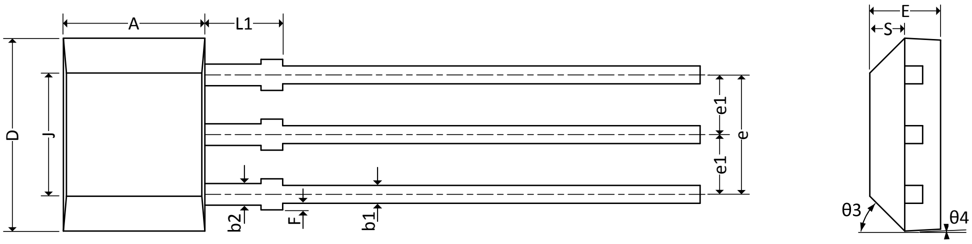


SE Package pinout

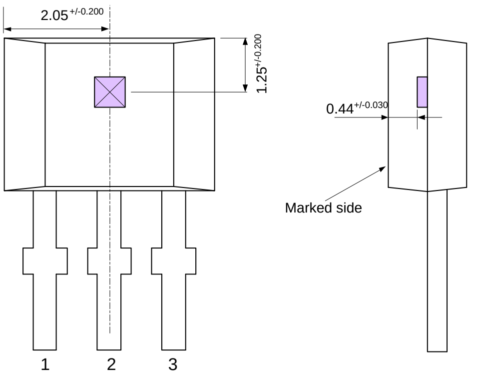
14.2 UA (TO92-3L) Package Information



Marking:
1st Line : 31WW → WW - calendar week
2nd Line : YLLL: → Y - last digit of year
LLL- Lot number (3 digits)



Hall plate location



Notes:
1. All dimensions are in millimeters

All dimensions are in mm:

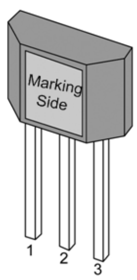
	A	D	E	F	J	L	L1	S	b1	b2	c	e	e1
min	2.80	3.90	1.40	0.00	2.51	14.0	0.90	0.63	0.35	0.43	0.35	2.51	1.24
max	3.20	4.30	1.60	0.20	2.72	15.0	1.10	0.84	0.44	0.52	0.44	2.57	1.30

	θ1	θ2	θ3	θ4
min max	7° REF	7° REF	45° REF	7° REF

Notes:
1. Mold flashes and protrusion are not included.
2. Gate burrs shall not exceed 0.127mm on the top side.

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

UA Package pinout



15 Contact

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