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
- Melexis pre-programmed versions

2 Application Examples

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

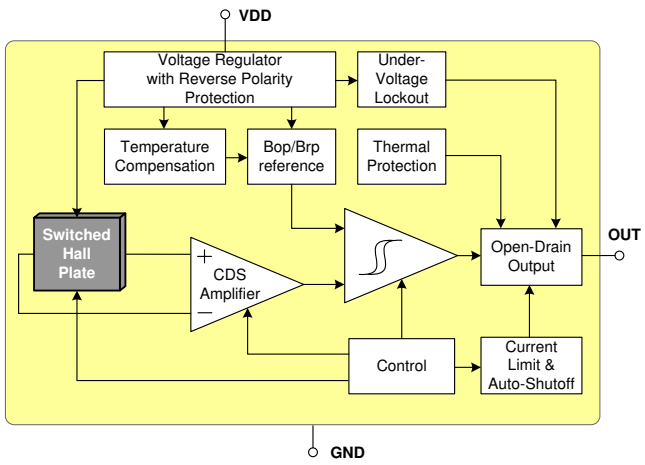
3 Ordering Information

Product Code	Temperature Code	Package Code	Option Code	Packing form Code
MLX92231	L	SE	AAA-0xx	RE
MLX92231	L	UA	AAA-0xx	BU
MLX92231	L	SE	AAA-2xx	RE
MLX92231	L	UA	AAA-2xx	BU

Legend:

Temperature Code: L (-40°C to 150°C)
Package Code: SE = TSOT-3L / UA = TO92-3L
Option Code: 0xx => Perpendicular sensitive
2xx => Lateral sensitive (IMC version)
Packing Form: RE = Reel | BU=Bulk
Ordering Example: MLX92231LSE-AAA-003-RE

4 Functional Diagram



5 General Description

The Melexis MLX92231 is a Hall-effect unipolar switch 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.

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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
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

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

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 MLX92231LSE-AAA-003

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	32.4	37.3	42.7	25.6	29.8	34.6	-2000[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	29.6	33.0	36.7	23.3	26.4	29.7			
T_A = 150°C	21.2	24.8	28.6	16.6	19.8	23.3			

9.2 MLX92231LSE-AAA-004

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	-7.7	-5.9	-4.3	-5.6	-4.0	-2.3	-1100[2]	Z-axis sensitive Direct Switch North Pole	SE (TSOT-3L)
T_A = 25°C	-6.8	-5.5	-4.2	-5.0	-3.7	-2.3			
T_A = 150°C	-6.8	-4.7	-3.1	-5.0	-3.2	-1.5			

9.3 MLX92231LSE-AAA-005

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	-33.0	-27.9	-23.4	-25.1	-20.9	-17.1	-1100[2]	Z-axis sensitive Direct Switch North Pole	SE (TSOT-3L)
T_A = 25°C	-29.0	-26.0	-23.2	-22.3	-19.5	-16.8			
T_A = 150°C	-26.7	-22.4	-18.6	-20.4	-16.8	-13.6			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.4 MLX92231LSE-AAA-007

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	20.0	26.0	33.0	14.0	20.0	25.0	0[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	20.0	26.0	33.0	14.0	20.0	25.0			
T_A = 150°C	20.0	26.0	33.0	14.0	20.0	25.0			

9.5 MLX92231LSE-AAA-009

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	2.0	3.5	5.0	1.4	2.5	3.3	0[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	2.5	3.5	4.5	1.8	2.5	3.1			
T_A = 150°C	2.0	3.5	5.0	1.4	2.5	3.3			

9.6 MLX92231LSE-AAA-010

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	8.7	10.7	13.4	6.8	9.0	11.5	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	8.3	10.0	11.8	6.8	8.5	10.1			
T_A = 150°C	6.1	8.6	11.4	4.9	7.3	9.8			

9.7 MLX92231LSE-AAA-012

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	13.5	16.1	18.8	10.4	12.9	15.5	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	13.0	15.0	17.1	10.0	12.0	14.1			
T_A = 150°C	10.7	12.9	15.4	8.1	10.4	12.7			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.8 MLX92231LSE-AAA-013

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	2.0	3.5	5.0	1.4	2.5	3.3	0[2]	Z-axis sensitive Inverted Switch South Pole	SE (TSOT-3L)
T_A = 25°C	2.5	3.5	4.5	1.8	2.5	3.1			
T_A = 150°C	2.0	3.5	5.0	1.4	2.5	3.3			

9.9 MLX92231LSE-AAA-014

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	4.3	5.9	7.7	2.1	3.8	5.4	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	3.8	5.5	7.2	2.0	3.5	5.0			
T_A = 150°C	3.2	4.8	6.8	1.7	3.0	5.2			

9.10 MLX92231LSE-AAA-016

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	7.7	9.7	11.9	6.2	8.3	10.6	0[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	8.2	9.7	11.3	6.7	8.3	10.0			
T_A = 150°C	7.7	9.7	11.9	6.2	8.3	10.6			

9.11 MLX92231LSE-AAA-017

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	9.5	11.7	14.2	8.0	10.3	12.9	0[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	10.0	11.7	13.4	8.5	10.3	12.1			
T_A = 150°C	9.5	11.7	14.2	8.0	10.3	12.9			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.12 MLX92231LSE-AAA-019

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	21.5	26.0	31.0	19.0	24.0	28.5	-2000[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	20.0	23.0	26.0	17.5	21.0	24.0			
T_A = 150°C	13.0	17.0	22.0	12.0	15.0	20.0			

9.13 MLX92231LUA-AAA-020

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	2.0	3.5	5.0	1.4	2.5	3.3	0[2]	Z-axis sensitive Direct Switch South Pole	UA (TO92-3)
T_A = 25°C	2.5	3.5	4.5	1.8	2.5	3.1			
T_A = 150°C	2.0	3.5	5.0	1.4	2.5	3.3			

9.14 MLX92231LSE-AAA-021

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	4.3	5.9	7.7	2.1	3.8	5.4	-1100[2]	Z-axis sensitive Inverted Switch South Pole	SE (TSOT-3L)
T_A = 25°C	3.8	5.5	7.2	2.0	3.5	5.0			
T_A = 150°C	3.2	4.8	6.8	1.7	3.0	5.2			

9.15 MLX92231LSE-AAA-022

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	8.8	11.3	14.0	7.2	9.8	12.6	-2000[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	8.1	10	11.9	6.5	8.5	10.5			
T_A = 150°C	5.5	7.5	9.7	3.9	6.0	8.3			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.16 MLX92231LSE-AAA-023

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	39.0	46.1	53.9	36.3	44.1	52.5	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	38.5	43.0	47.5	35.9	41.0	46.0			
T_A = 150°C	28.8	37.1	46.5	25.6	35.0	45.1			

9.17 MLX92231LSE-AAA-025

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	45.2	53.6	63.2	43.1	51.6	61.3	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	44.9	50.0	55.4	48.2	48.0	53.5			
T_A = 150°C	36.2	43.1	51.1	34.1	41.1	49.2			

9.18 MLX92231LSE-AAA-026

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	21.5	26.0	31.0	19.0	24.0	28.5	-2000[2]	Z-axis sensitive Inverted Switch South Pole	SE (TSOT-3L)
T_A = 25°C	20.0	23.0	26.0	17.5	21.0	24.0			
T_A = 150°C	13.0	17.0	22.0	12.0	15.0	20.0			

9.19 MLX92231LSE-AAA-029

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	13.5	16.0	18.8	12.5	15.0	17.9	-1100[2]	Z-axis sensitive Inverted Switch South Pole	SE (TSOT-3L)
T_A = 25°C	13.3	15.0	16.7	12.3	14.0	15.7			
T_A = 150°C	10.2	13.0	16.0	9.1	12.0	15.0			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.20 MLX92231LSE-AAA-030

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	23.3	27.9	33.0	17.2	21.0	25.4	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	23.1	26.0	29.1	16.9	19.6	22.5			
T_A = 150°C	18.6	22.4	26.7	13.6	16.9	20.6			

9.21 MLX92231LSE-AAA-031

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	-17.5	-13.5	-10.0	-12.0	-8.5	-5.7	0[2]	Z-axis sensitive Direct Switch North Pole	SE (TSOT-3L)
T_A = 25°C	-17.5	-13.5	-10.0	-12.0	-8.5	-5.7			
T_A = 150°C	-17.5	-13.5	-10.0	-12.0	-8.5	-5.7			

9.22 MLX92231LSE-AAA-032

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	20.4	24.6	29.4	17.7	22.6	27.9	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	20.2	23.0	25.9	17.6	21.0	24.4			
T_A = 150°C	15.4	19.8	25	12.6	17.7	23.5			

9.23 MLX92231LSE-AAA-033

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	15.7	19.3	23.3	10.5	13.5	16.9	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	15.6	18.0	20.6	10.2	12.5	15.1			
T_A = 150°C	12.5	15.5	18.9	8.2	10.9	13.8			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.24 MLX92231LUA-AAA-034

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	4.3	5.9	7.7	2.1	3.8	5.4	-1100[2]	Z-axis sensitive Direct Switch South Pole	UA (TO92-3)
T_A = 25°C	3.8	5.5	7.2	2.0	3.5	5.0			
T_A = 150°C	3.2	4.8	6.8	1.7	3.0	5.2			

9.25 MLX92231LUA-AAA-035

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	23.5	28.2	33.6	21.2	26.0	31.5	0[2]	Z-axis sensitive Inverted Switch South Pole	UA (TO92-3)
T_A = 25°C	25.0	28.2	31.6	22.7	26.0	29.5			
T_A = 150°C	23.4	28.2	33.6	21.1	26.0	31.5			

9.26 MLX92231LSE-AAA-038

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	25.0	28.9	33.3	23.8	27.9	32.3	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	24.1	27.0	30.1	23.2	26.0	29.0			
T_A = 150°C	20.0	23.3	26.9	19.0	22.3	26.2			

9.27 MLX92231LUA-AAA-039

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	10.0	13.5	17.4	5.7	8.5	12.0	0[2]	Z-axis sensitive Direct Switch South Pole	UA (TO92-3)
T_A = 25°C	10.0	13.5	17.4	5.7	8.5	12.0			
T_A = 150°C	10.0	13.5	17.4	5.7	8.5	12.0			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.28 MLX92231LSE-AAA-040

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	60.0	70.7	83.1	44.5	53.0	62.8	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	59.6	66.0	72.9	44.1	49.5	55.3			
T_A = 150°C	48.0	56.9	67.1	35.6	42.7	50.8			

9.29 MLX92231LSE-AAA-041

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	8.6	10.9	13.5	6.9	9.3	12.0	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	8.4	10.2	12.1	6.7	8.6	10.6			
T_A = 150°C	6.7	8.8	11.1	5.0	7.2	9.6			

9.30 MLX92231LSE-AAA-042

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	46.5	54.9	64.5	36.8	43.9	52.0	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	46.2	51.2	56.6	36.4	41.0	45.8			
T_A = 150°C	37.2	44.2	52.1	29.4	35.3	42.1			

9.31 MLX92231LSE-AAA-045

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	16.7	20.0	23.7	12.2	15.0	18.2	0[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	17.8	20.0	22.4	12.8	15.0	17.3			
T_A = 150°C	16.7	20.0	23.7	12.2	15.0	18.2			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.32 MLX92231LSE-AAA-046

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	11.8	14.7	17.9	10.7	13.7	17.0	-2000[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	11.0	13.0	15.1	9.9	12.0	14.2			
T_A = 150°C	7.5	9.8	12.2	6.4	8.8	11.3			

9.33 MLX92231LSE-AAA-048

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	15.1	18.5	22.3	13.0	16.5	20.4	-400[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	15.6	18.0	20.5	13.5	16.0	18.6			
T_A = 150°C	13.9	17.1	20.7	11.8	15.1	18.8			

9.34 MLX92231LSE-AAA-049

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	13.5	16.0	18.8	12.5	15.0	17.9	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	13.3	15.0	16.7	12.3	14.0	15.7			
T_A = 150°C	10.2	13.0	16.0	9.1	12.0	15.0			

9.35 MLX92231LSE-AAA-051

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	28.1	32.1	36.7	12.1	14.5	17.1	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	27.0	30.0	33.2	11.6	13.5	15.5			
T_A = 150°C	22.5	25.9	29.6	9.5	11.6	14.0			

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

[2] Temperature coefficient is calculated using the following formula:

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

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

9.37 MLX92231LSE-AAA-052

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	29.0	34.3	40.3	19.9	24.0	28.7	-1100[2]	Z-axis sensitive Direct Switch South Pole	SE (TSOT-3L)
T_A = 25°C	28.8	32.0	35.4	19.6	22.4	25.4			
T_A = 150°C	23.2	27.6	32.6	15.8	19.3	23.3			

9.38 MLX92231LSE-AAA-204

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	4.7	7.0	9.4	3.5	6.2	9.0	-1100[2]	X-axis sensitive Inverted Switch South Pole	SE (TSOT-3L)
T_A = 25°C	4.4	6.5	8.7	3.2	5.6	8.1			
T_A = 150°C	3.4	5.5	7.8	2.2	4.6	7.3			

9.39 MLX92231LSE-AAA-207

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	-13.1	-10.5	-8.1	-12.2	-9.5	-7.2	-1300[2]	X-axis sensitive Inverted Switch North Pole	SE (TSOT-3L)
T_A = 25°C	-11.6	-9.7	-7.9	-10.7	-8.7	-7.0			
T_A = 150°C	-10.4	-8.1	-6.0	-9.5	-7.1	-5.1			

9.40 MLX92231LSE-AAA-208

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)	Output Polarity Active Pole	Package Information
	Min	Typ[1]	Max	Min	Typ[1]	Max	Typ[1]		
T_A = -40°C	-12.2	-9.7	-7.2	-11.3	-8.7	-6.1	-1300[2]	X-axis sensitive Inverted Switch North Pole	SE (TSOT-3L)
T_A = 25°C	-10.8	-8.9	-7.0	-9.9	-7.9	-5.9			
T_A = 150°C	-9.7	-7.4	-5.2	-8.8	-6.4	-4.1			

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

[2] Temperature coefficient is calculated using the following formula:

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

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



SE - South active pole



SE - North active pole



SE - South active pole (IMC version)



SE - North active pole (IMC version)



UA - South active pole



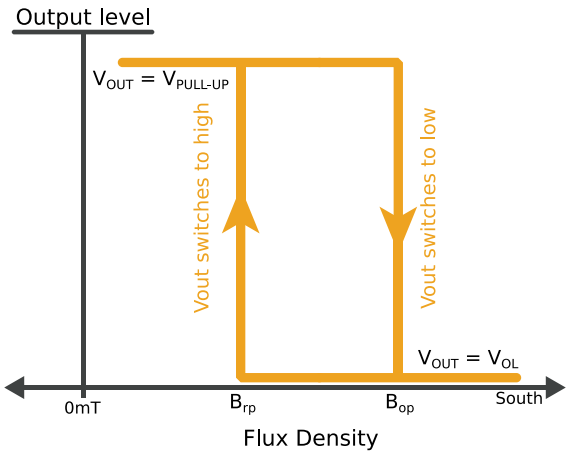
UA - North active pole



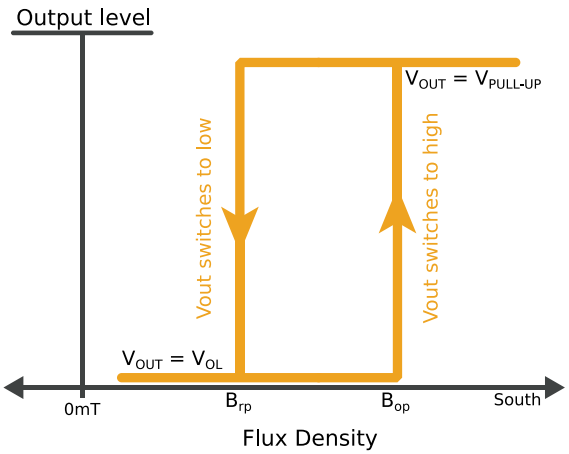
UA - South active pole (IMC version)



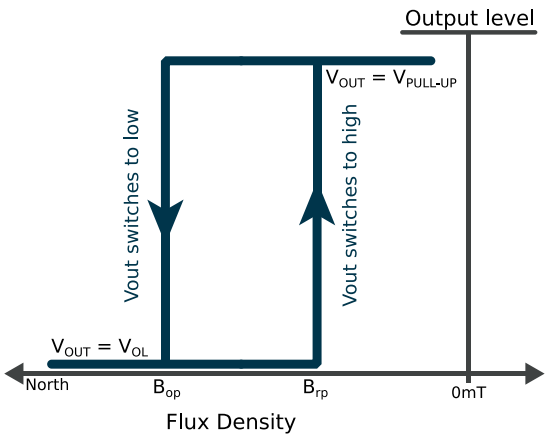
UA - North active pole (IMC version)



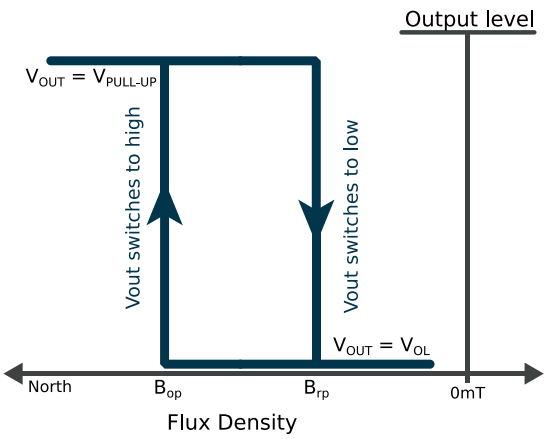
Direct South Active Pole



Inverted South Active Pole



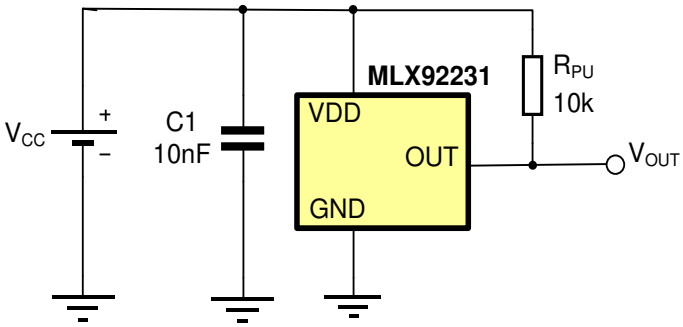
Direct North Active Pole



Inverted North Active Pole

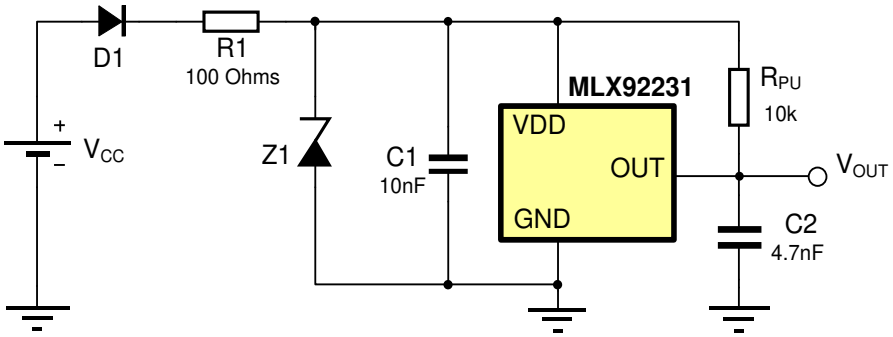
10 Application Information

10.1 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.

10.2 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.

11 Standard information

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

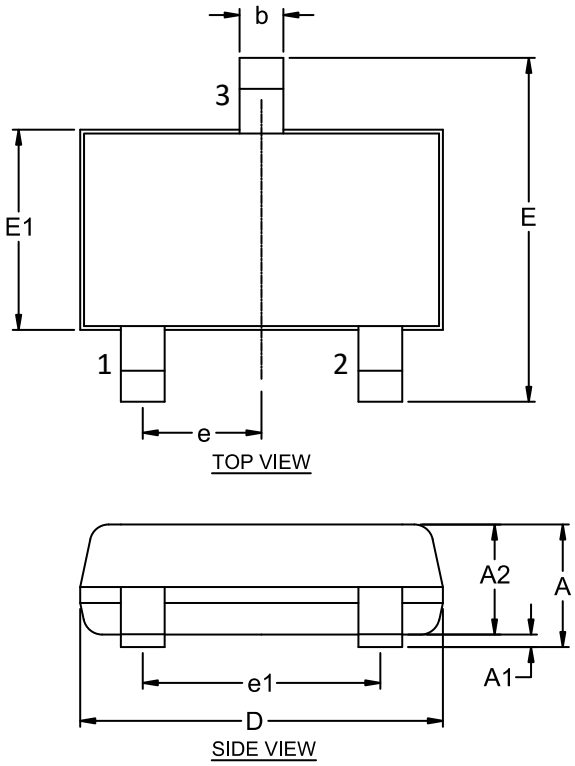
12 ESD Precautions

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

13 Package Information

13.1 TSOT-3L (SE Package)

13.1.1 TSOT-3L – Package dimensions

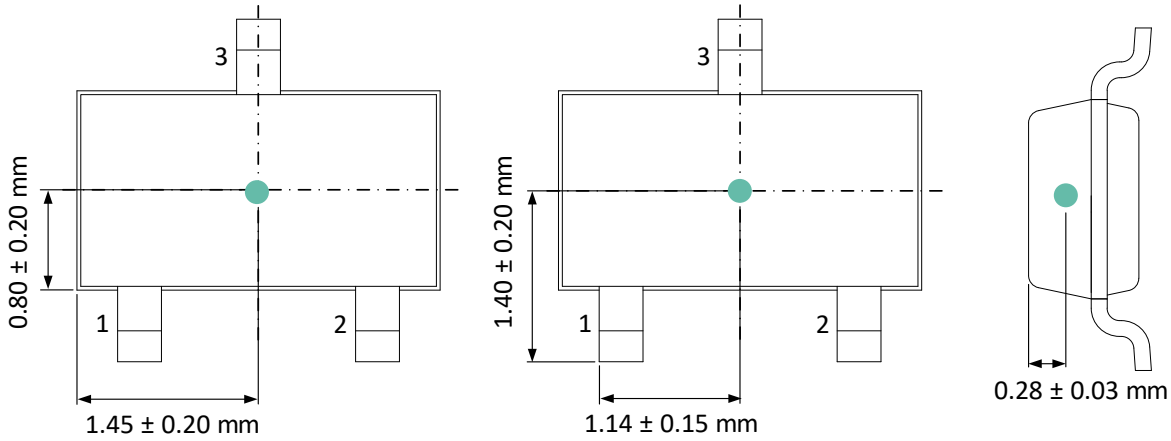


SYMBOL	MINIMUM	MAXIMUM
A	---	1.00
A1	0.025	0.10
A2	0.85	0.90
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
L	0.30	0.50
b	0.30	0.45
c	0.10	0.20
e	0.95 BSC	
e1	1.90 BSC	
α	0°	8°

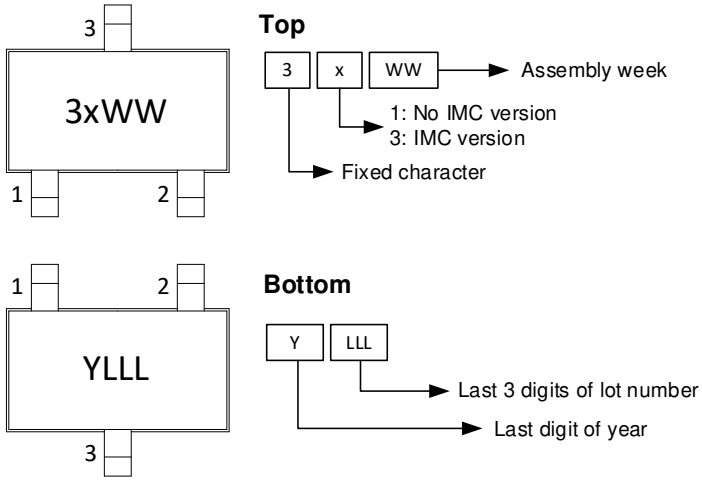
NOTE :

1. ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS OTHERWISE STATED.
2. DIMENSION D DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS OF MAX 0.15 mm PER SIDE.
3. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS OF MAX 0.25 mm PER SIDE.
4. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION OF MAX 0.07 mm.
5. DIMENSION L IS THE LENGTH OF THE TERMINAL FOR SOLDERING TO A SUBTRATE.
6. FORMED LEAD SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITH 0.076 mm SEATING PLANE.

13.1.3 TSOT-3L – Sensitive spot



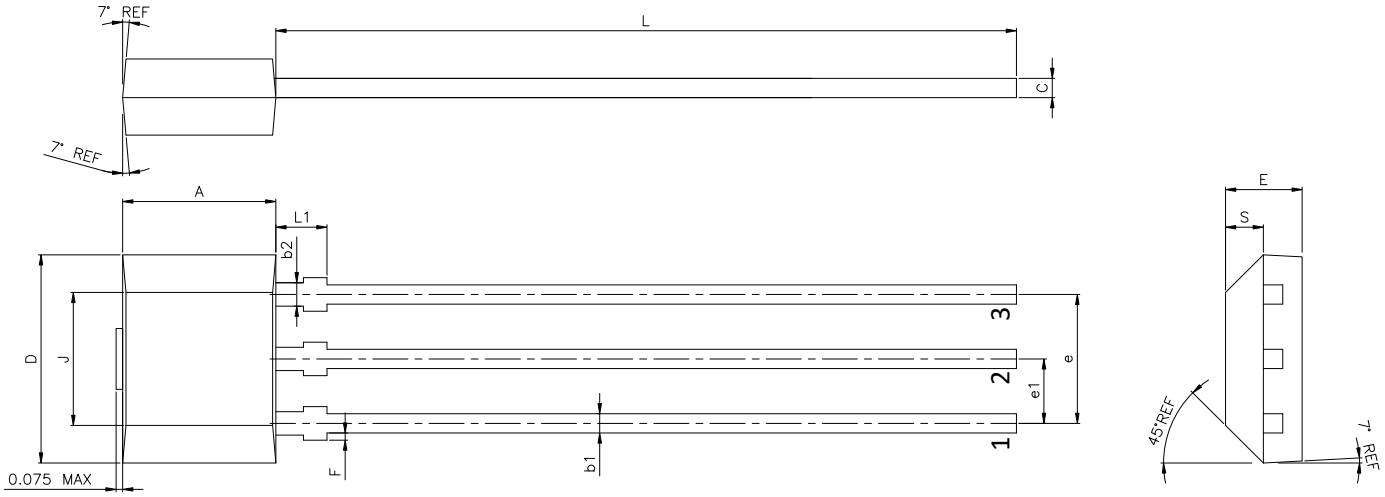
13.1.4 TSOT-3L – Package marking / Pin definition



Pin #	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	OUT	Out	Open drain output pin
3	GND	Ground	Ground pin

13.2 TO92-3L (UA Package)

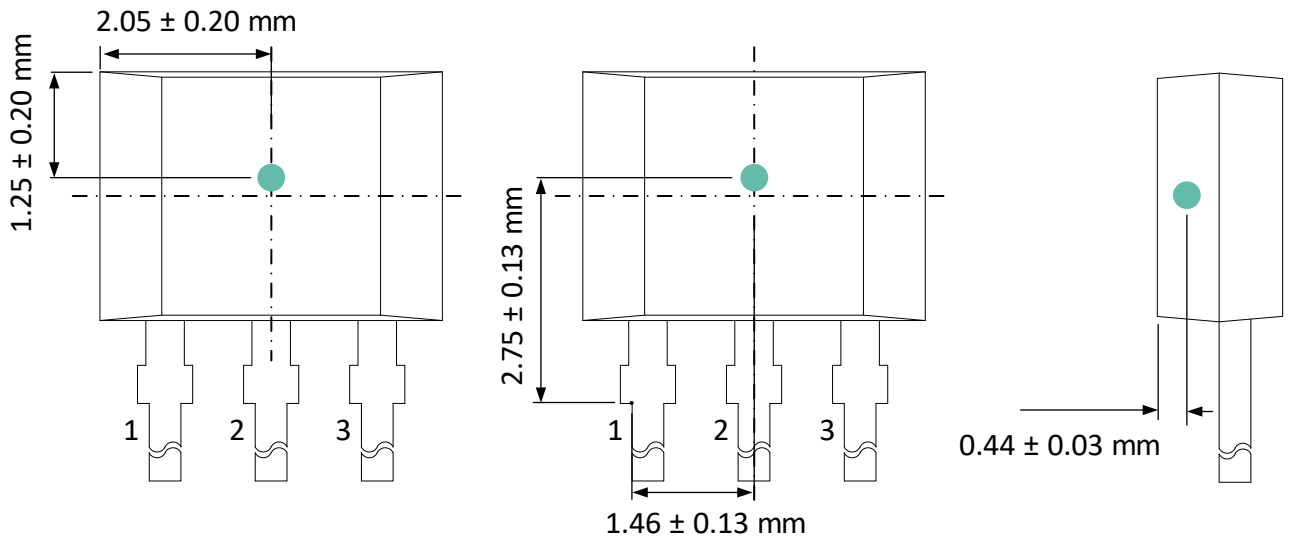
13.2.1 TO92-3L – Package dimensions



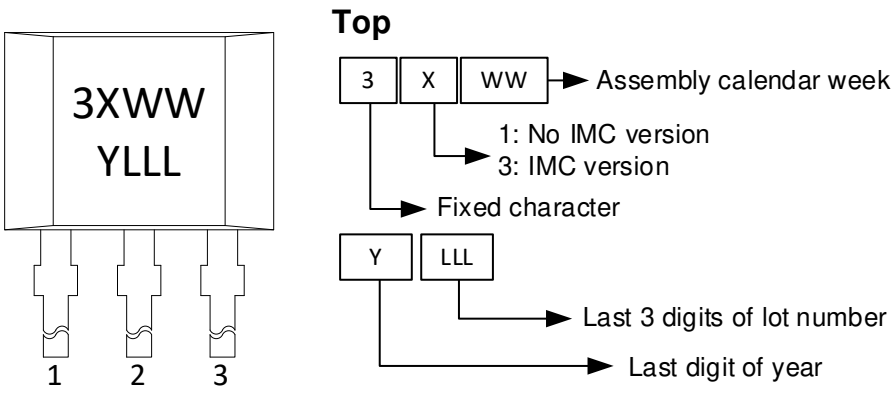
SYMBOL	MINIMUM	MAXIMUM
A	2.90	3.10
D	4.00	4.20
E	1.40	1.60
F	0.00	0.15
J	2.51	2.72
L	14.00	15.00
L1	0.90	1.10
S	0.63	0.84
b1	0.35	0.44
b2	0.43	0.52
c	0.35	0.44
e	2.51	2.57
e1	1.24	1.30

NOTES :
1. DIMENSIONS IN MILLIMETERS (mm) UNLESS NOTED OTHERWISE.
2. PACKAGE DIMENSIONS DO NOT INCLUDE MOLD FLASHES AND PROTRUSIONS.
3. DIMENSION A AND D DO NOT INCLUDE MOLD GATE AND SIDE FLASH (PROTRUSION) of MAXIMUM 0.127 mm PER SIDE.
4. THE LEADS MAY BE SLIGHTLY DEFORMED DURING TRANSPORTATION IF PACKED IN BULK (BAG), AFFECTING e1 DIMENSION. IT IS RECOMMENDED TO ORDER RADIAL TAPE (REEL OR AMMOPACK) IF SUCH DEFORMATION IS CRITICAL FOR THE LEAD FORMING PROCESS, EVEN IF MANUAL LOADING INTO THE TOOL IS FORESEEN.

13.2.2 TO92-3L – Sensitive spot



13.2.3 TO92-3L – Package marking / Pin definition



Pin #	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	GND	Ground	Ground pin
3	OUT	Out	Open drain output pin

14 Contact

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