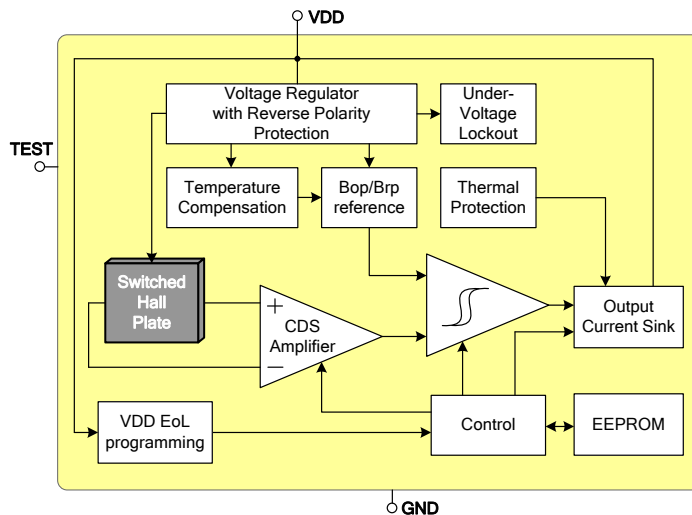


## 4. Functional Diagram



## 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. Lateral sensing option is available by using the Melexis IMC technology.

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.

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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
NC	Not Connected
POR	Power on Reset
IMC	integrated magnetic concentrator (lateral sensing)

## 7. Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Voltage <sup>(1, 2)</sup>	V <sub>DD</sub>	+28	V
Supply Voltage (Load Dump) <sup>(1, 4)</sup>	V <sub>DD</sub>	+32	V
Supply Current <sup>(1, 2, 3)</sup>	I <sub>DD</sub>	+20	mA
Supply Current <sup>(1, 3, 4)</sup>	I <sub>DD</sub>	+50	mA
Reverse Supply Voltage <sup>(1, 2)</sup>	V <sub>DDREV</sub>	-24	V
Reverse Supply Voltage <sup>(1, 4)</sup>	V <sub>DDREV</sub>	-30	V
Reverse Supply Current <sup>(1, 2, 5)</sup>	I <sub>DDREV</sub>	-20	mA
Reverse Supply Current <sup>(1, 4, 5)</sup>	I <sub>DDREV</sub>	-50	mA
Maximum Junction Temperature <sup>(6)</sup>	T <sub>J</sub>	+165	°C
ESD Sensitivity – HBM <sup>(7)</sup>	-	8	kV
ESD Sensitivity – System level <sup>(8)</sup>	-	15	kV
ESD Sensitivity – CDM <sup>(9)</sup>	-	1000	V
Magnetic Flux Density	B	Unlimited	mT

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

<sup>1</sup> The maximum junction temperature should not be exceeded

<sup>2</sup> For maximum 1 hour

<sup>3</sup> Including current through protection device

<sup>4</sup> For maximum 500ms

<sup>5</sup> Through protection device

<sup>6</sup> For 1000 hours

<sup>7</sup> Human Model according AEC-Q100-002 standard

<sup>8</sup> Indirect discharge according VW TL82466 standard, typical value, only for option MLX92242LUA-AAA-1xx and -3xx

<sup>9</sup> Charged Device Model according AEC-Q100-011 standard

## 8. General Electrical Specifications

DC Operating Parameters  $V_{DD} = 2.7V$  to  $24V$ ,  $T_J = -40^{\circ}C$  to  $165^{\circ}C$  (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ <sup>(1)</sup>	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 <sup>(2)</sup>	$t_R/t_F$	$V_{DD} = 12V$ , $C_{LOAD} = 50pF$ to GND	0.1	0.3	1	$\mu s$
Power-On Time <sup>(3, 4)</sup>	$t_{ON}$	$V_{DD} = 5V$ , $dV_{DD}/dt > 2V/\mu s$ , activated output with $>1mT$ overdrive	-	40	70	$\mu s$
Chopping Frequency	$f_{CHOP}$		-	350	-	kHz
Delay Time <sup>(2, 5)</sup>	$t_D$	Average over 1000 successive switching events @10kHz, Latch, $B_{OP}$ set to 5mT, triangle wave magnetic field with $B > \pm 20mT$	-	7.5	-	$\mu s$
		Over 1000 successive switching events @10kHz, Latch, $B_{OP}$ set to 5mT, triangle wave magnetic field with $B > \pm 20mT$	-	$\pm 3.5$	-	$\mu s$
Maximum Switching Frequency <sup>(2, 7)</sup>	$f_{SW}$	Latch, $B_{OP}$ set to 5mT, triangle wave magnetic field with $B > \pm 20mT$	-	50	-	kHz
Under-voltage Lockout Threshold	$V_{UVL}$		-	-	2.7	V
Under-voltage Lockout Reaction time <sup>(2)</sup>	$t_{UVL}$		-	1	-	$\mu s$
Max Programming Supply Voltage	$V_{DDprog}$		-	22	28	V
Integrated bypass capacitor	$C_{BP}$	Only for options MLX92242LUA-AAA-1xx and -3xx	-	68	-	nF
Thermal Protection Activation	$T_{PROT}$		-	190 <sup>(8)</sup>	-	$^{\circ}C$
Thermal Protection Release	$T_{REL}$		-	180 <sup>(8)</sup>	-	$^{\circ}C$
UA Package Thermal Resistance	$R_{THJA}$		-	200	-	$^{\circ}C/W$
SE Package Thermal Resistance	$R_{THJA}$		-	300	-	$^{\circ}C/W$

<sup>1</sup> Typical values are defined at  $T_A = +25^{\circ}C$  and  $V_{DD} = 12V$ .

<sup>2</sup> Guaranteed by design and verified by characterization, not production tested.

<sup>3</sup> The Power-On Time represents the time from reaching  $V_{DD} = 2.7V$  to the first refresh of the supply current state.

<sup>4</sup> Power-On Slew Rate is not critical for the proper device start-up.

<sup>5</sup> The Delay Time is the time from magnetic threshold reached to the start of the output switching.

<sup>6</sup> Output jitter is the unpredictable deviation of the Delay time.

<sup>7</sup> Maximum switching frequency corresponds to the maximum frequency of the applied magnetic field which is detected without loss of pulses.

<sup>8</sup>  $T_{PROT}$  and  $T_{REL}$  are the corresponding junction temperature values.

## 9. Magnetic Specifications

### 9.1. MLX92242LUA-AAA-000, MLX92242LSE-AAA-000 and MLX92242LUA-AAA-100

DC Operating Parameters  $V_{DD} = 3.5V$  to  $24V$ ,  $T_J = -40^{\circ}C$  to  $150^{\circ}C$  (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ <sup>(1)</sup>	Max	Units
Operating Point Range <sup>(2)</sup>	B <sub>OP</sub>	$V_{DD} = 5V$ , $T_J = 25^{\circ}C$	-100	-	100	mT
Factory pre-programmed Operating Point, Switch	B <sub>OP</sub>	$V_{DD} = 5V$ , $T_J = 25^{\circ}C$ , programming target 28mT	26	28	30	mT
Factory pre-programmed Release Point, Switch	B <sub>RP</sub>	$V_{DD} = 5V$ , $T_J = 25^{\circ}C$ , programming target 28mT, HYS <sub>RATIO</sub> = 0.75	19	21	23	mT
B <sub>OP</sub> Magnitude Programming <sup>(3)</sup>			-	8	-	bit
B <sub>OP</sub> Polarity Selection			-	1	-	bit
B <sub>OP</sub> /B <sub>RP</sub> Temperature Coefficient Programming Range <sup>(4, 5)</sup>	TC <sup>(6)</sup>	$V_{DD} = 5V$ , Latch with B <sub>OP</sub> = 28mT, B <sub>RP</sub> = -28mT	-2000	-	0	ppm/°C
B <sub>OP</sub> /B <sub>RP</sub> Temperature Coefficient Programming			-	5	-	bit
Switch/Latch Function Selection			-	1	-	bit
Proportional/Absolute Hysteresis Selection			-	1	-	bit
Hysteresis Programming <sup>(7)</sup>			-	5	-	bit
Proportional Hysteresis Ratio Programming Range HYS <sub>RATIO</sub> = B <sub>HYS<sub>PR</sub></sub> / B <sub>OP</sub> <sup>(4)</sup>	HYS <sub>RATIO</sub>	Programming step 0.025	0.025	-	0.800	-
Absolute Hysteresis Range <sup>(4)</sup>	B <sub>HYSABS</sub>	Programming step 0.1mT	0	-	3.1	mT
Absolute Hysteresis tolerance <sup>(8)</sup>	B <sub>HYSTOL</sub>	B <sub>HYSABS</sub> = 0.8mT to 1.6mT, B <sub>OP</sub> = 3mT, $V_{DD} = 3.5$ to 14V	-0.6	0	0.6	mT
Absolute Hysteresis tolerance <sup>(8)</sup>	B <sub>HYSTOL</sub>	B <sub>HYSABS</sub> = 1.7mT to 3.1mT, B <sub>OP</sub> = 3mT, $V_{DD} = 3.5$ to 14V	-0.7	0	0.7	mT
B <sub>OP</sub> , B <sub>RP</sub> and B <sub>HYS<sub>PR</sub></sub> life time drift		HTOL 1000h at $T_J = 165^{\circ}C$	-(4%+0.2mT)		4%+0.2mT	
Output Polarity Selection			-	1	-	Bit
$V_{DD}$ Programming Lock			-	1	-	bit

<sup>1</sup> Typical values are defined at  $T_A = +25^{\circ}C$  and  $V_{DD} = 5V$

<sup>2</sup> Guaranteed by correlation with production test at  $B = 28mT$  and verified by characterization

<sup>3</sup> The programming step is typically from 0.4% to 0.8% of the programmed B<sub>OP</sub> value for  $|B_{OP}| \geq 2mT$  and 0.016mT for  $|B_{OP}| \leq 2mT$

<sup>4</sup> The minimum and maximum limits are typical values

<sup>5</sup> The factory pre-programmed TC value is -2000 ppm/°C

<sup>6</sup> The B<sub>OP</sub>/B<sub>RP</sub> Temperature Coefficient is calculated using the following formula:

$$TC = \frac{(B_{OPT2} - B_{RPT2}) - (B_{OPT1} - B_{RPT1})}{(B_{OPT1} - B_{RPT1}) * (T_2 - T_1)} * 10^6, \frac{ppm}{^{\circ}C}; T_1 = 25^{\circ}C; T_2 = 150^{\circ}C$$

<sup>7</sup> 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<sub>DD</sub> switching between I<sub>ON</sub> and I<sub>OFF</sub> in combination with the device TC could cause B<sub>OP</sub> or B<sub>RP</sub> shift. If the chosen magnetic hysteresis is close or below the above shift and inverted output polarity is selected, an output toggling could appear

<sup>8</sup> Including life time drift. Guaranteed by correlation with production test at  $B = 3mT$ ,  $T_J = +25^{\circ}C$  and verified by characterization

## 9.2. MLX92242LSE-AAA-200 and MLX92242LUA-AAA-300

DC Operating Parameters  $V_{DD} = 3.5V$  to  $24V$ ,  $T_J = -40^{\circ}C$  to  $150^{\circ}C$  (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ <sup>(1)</sup>	Max	Units
Operating Point Programming Range <sup>(2)</sup>	B <sub>OP</sub>	$V_{DD} = 5V$ , $T_J = 25^{\circ}C$	-40	-	40	mT
Factory pre-programmed Operating Point, Latch	B <sub>OP</sub>	$V_{DD} = 5V$ , $T_J = 25^{\circ}C$ , programming target 12mT	9	12	15	mT
Factory pre-programmed Release Point, Latch	B <sub>RP</sub>	$V_{DD} = 5V$ , $T_J = 25^{\circ}C$ , programming target 12mT	-15	-12	-9	mT
B <sub>OP</sub> Magnitude Programming <sup>(3)</sup>			-	8	-	bit
B <sub>OP</sub> Polarity Selection			-	1	-	bit
B <sub>OP</sub> /B <sub>RP</sub> Temperature Coefficient Programming Range <sup>(4, 5)</sup>	TC <sup>(6)</sup>	$V_{DD} = 5V$ , Latch with B <sub>OP</sub> = 12mT, B <sub>RP</sub> = -12mT	-2000	-	0	ppm/ $^{\circ}C$
B <sub>OP</sub> /B <sub>RP</sub> Temperature Coefficient Programming			-	5	-	bit
Switch/Latch Function Selection			-	1	-	bit
Proportional/Absolute Hysteresis Selection			-	1	-	bit
Hysteresis Magnitude Programming <sup>(7)</sup>			-	5	-	bit
Proportional Hysteresis Ratio Programming Range HYS <sub>RATIO</sub> = B <sub>HYS<sub>PR</sub></sub> / B <sub>OP</sub> <sup>(4)</sup>	HYS <sub>RATIO</sub>	Programming step 0.025	0.025	-	0.800	-
Absolute Hysteresis Programming Range <sup>(4)</sup>	B <sub>HYSABS</sub>	Programming step 0.1mT	0	-	3.1	mT
Absolute Hysteresis tolerance <sup>(8)</sup>	B <sub>HYSTOL</sub>	B <sub>HYSABS</sub> = 1.5mT to 3.1mT, B <sub>OP</sub> = 3mT, $V_{DD} = 3.5$ to $14V$	-1.2	-	1.2	mT
B <sub>OP</sub> , B <sub>RP</sub> and B <sub>HYS</sub> life time drift		HTOL 1000h at $T_J = 165^{\circ}C$	-(4%+0.2mT)		4%+0.2mT	
Output Polarity Selection			-	1	-	bit
V <sub>DD</sub> Programming Lock			-	1	-	bit

<sup>1</sup> Typical values are defined at  $T_A = +25^{\circ}C$  and  $V_{DD} = 5V$

<sup>2</sup> Guaranteed by correlation with production test at B = 12mT and verified by characterization

<sup>3</sup> The programming step is typically from 0.4% to 0.8% of the programmed B<sub>OP</sub> value for  $|B_{OP}| \geq 2mT$  and 0.016mT for  $|B_{OP}| \leq 2mT$

<sup>4</sup> The minimum and maximum limits are typical values

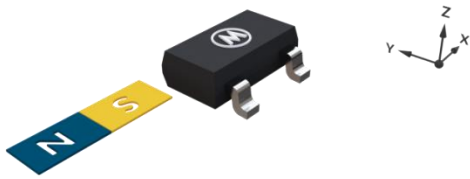
<sup>5</sup> The factory pre-programmed TC value is 0 ppm/ $^{\circ}C$

<sup>6</sup> The B<sub>OP</sub>/B<sub>RP</sub> Temperature Coefficient is calculated using the following formula:

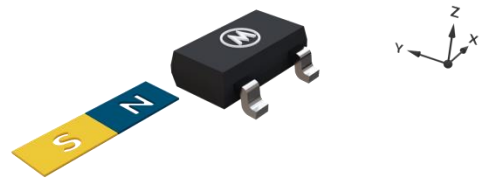
$$TC = \frac{(B_{OPT2} - B_{RPT2}) - (B_{OPT1} - B_{RPT1})}{(B_{OPT1} - B_{RPT1}) * (T_2 - T_1)} * 10^6, \frac{ppm}{^{\circ}C}; T_1 = 25^{\circ}C; T_2 = 150^{\circ}C$$

<sup>7</sup> Programming of very low hysteresis magnitude (<1.5mT) 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<sub>DD</sub> switching between I<sub>ON</sub> and I<sub>OFF</sub> in combination with the device TC could cause B<sub>OP</sub> or B<sub>RP</sub> shift. If the chosen magnetic hysteresis is close or below the above shift and inverted output polarity is selected, an output toggling could appear

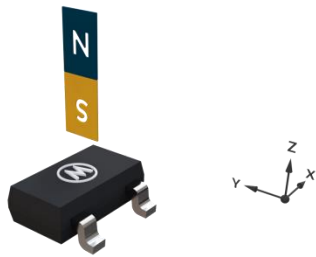
<sup>8</sup> Including life time drift. Guaranteed by correlation with production test at B = 3mT,  $T_J = +25^{\circ}C$  and verified by characterization



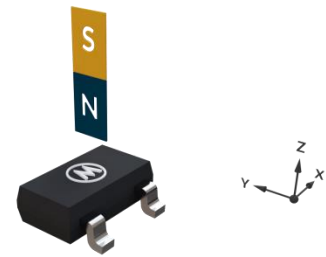
*South active pole (IMC version)*



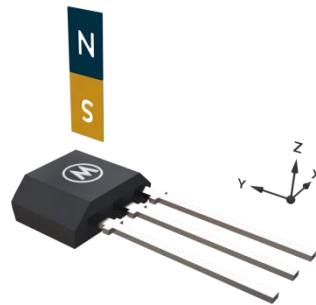
*North active pole (IMC version)*



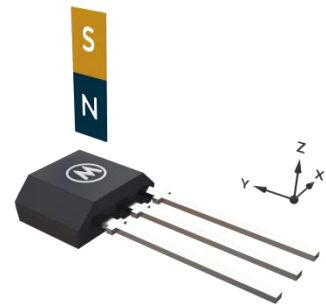
*South active pole*



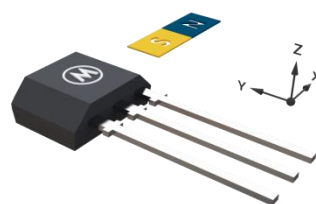
*North active pole*



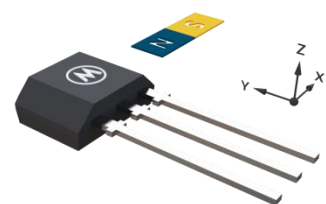
*South active pole*



*North active pole*



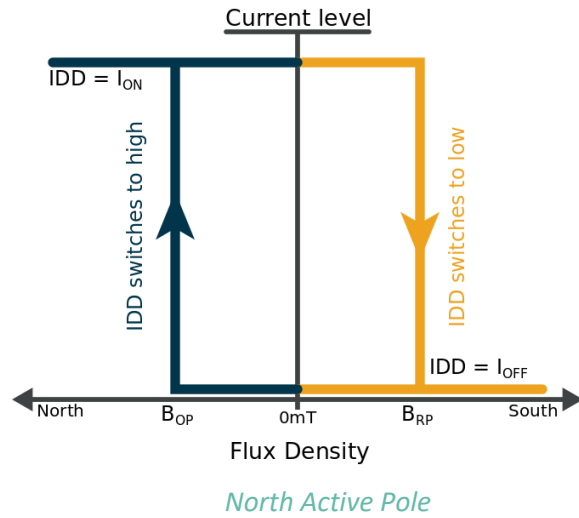
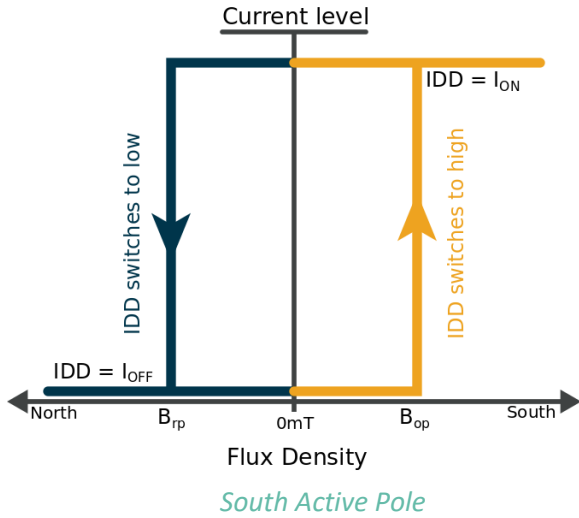
*South active pole (IMC version)*



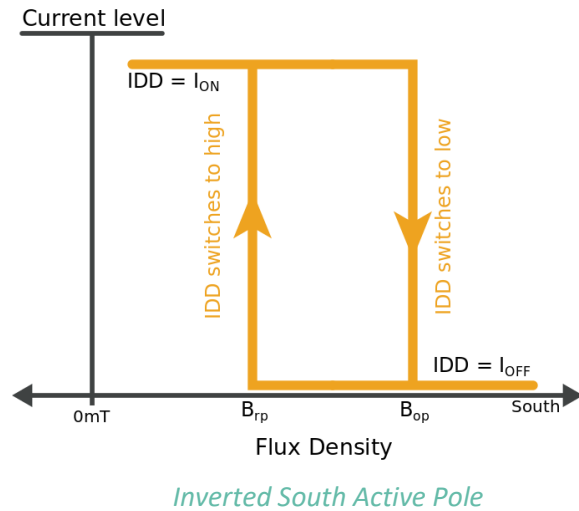
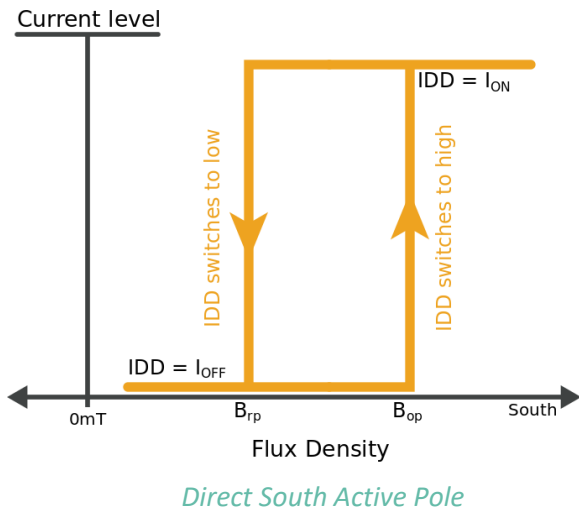
*North active pole (IMC version)*

## 10. Magnetic Behavior

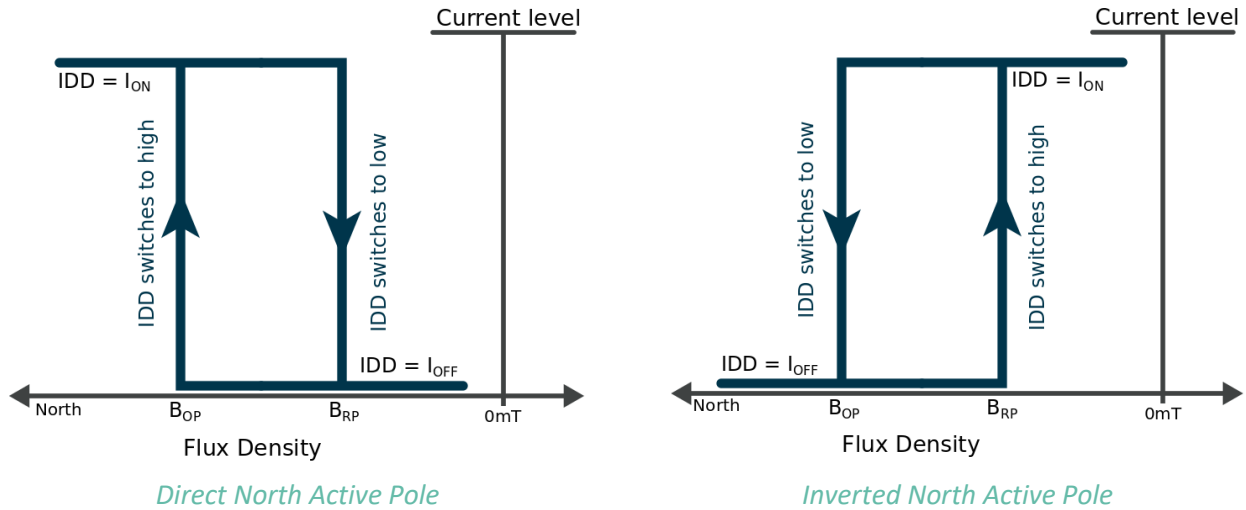
### 10.1. Latch sensor



### 10.2. Unipolar Switch sensor

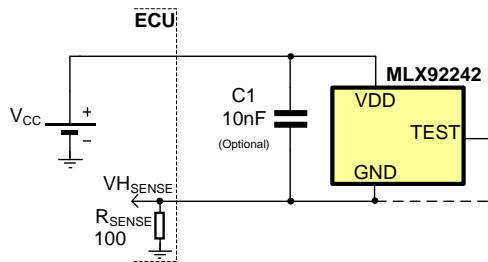






## 11. Application Information

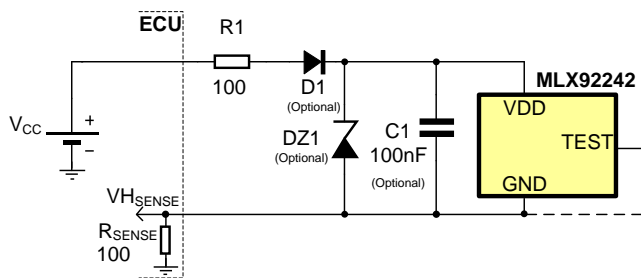
### 11.1. Typical Automotive Application Circuit



**Notes:**

1. For proper operation, a 10 to 100nF bypass capacitor should be placed as close as possible to the V<sub>DD</sub> 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.

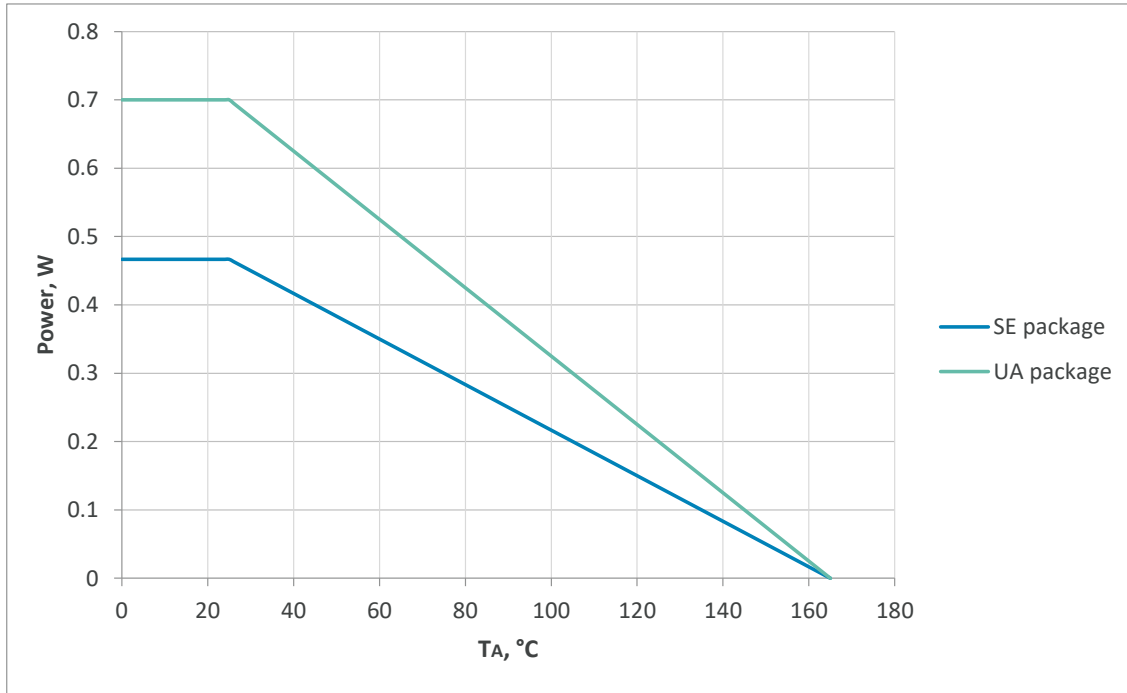
### 11.2. Automotive and Harsh, Noisy Environments Application Circuit



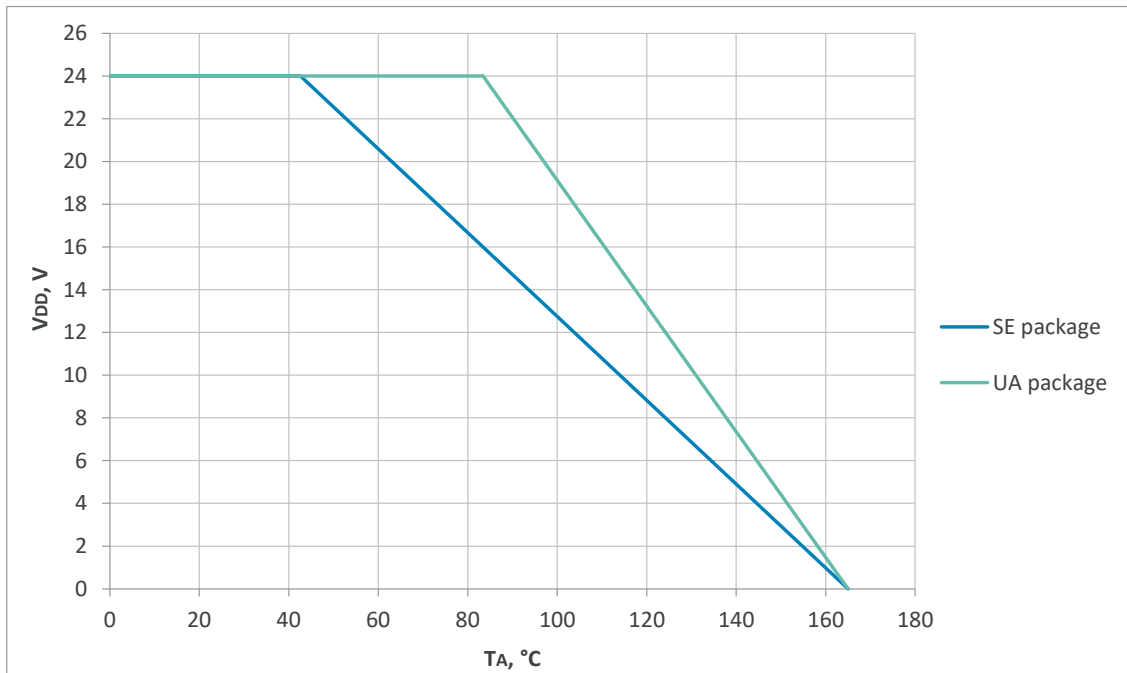
**Notes:**

1. For proper operation, a 10 to 100nF bypass capacitor should be placed as close as possible to the V<sub>DD</sub> and ground (GND) pin. For MLX92242LUA-AAA-1xx and -3xx 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.

### 11.3. Power Dissipation Derating Curve



### 11.4. Voltage Derating Curve



## 12. Standard information regarding manufacturability of Melexis products

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

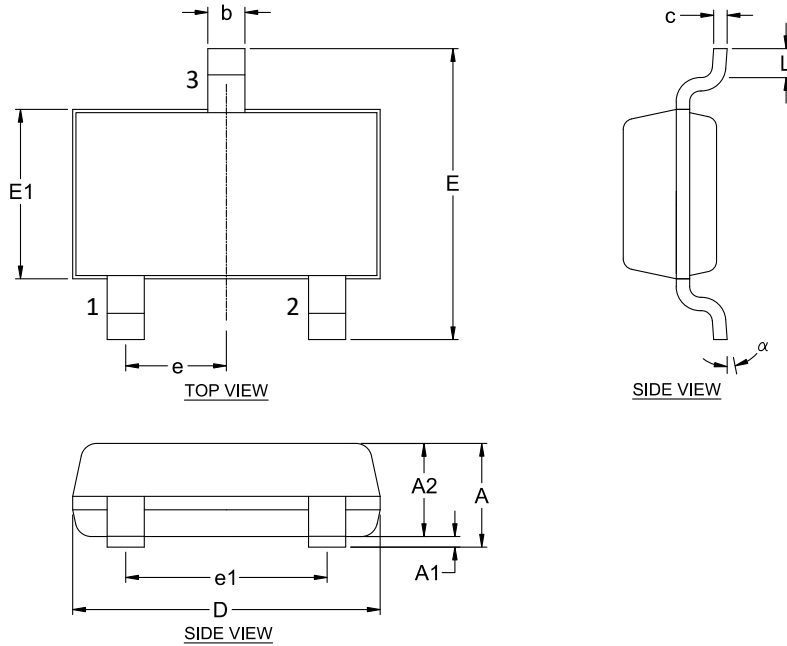
Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).

Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

## 14. Package Information

### 14.1. TSOT-3L (SE Package)

#### 14.1.1. TSOT-3L – Package dimensions

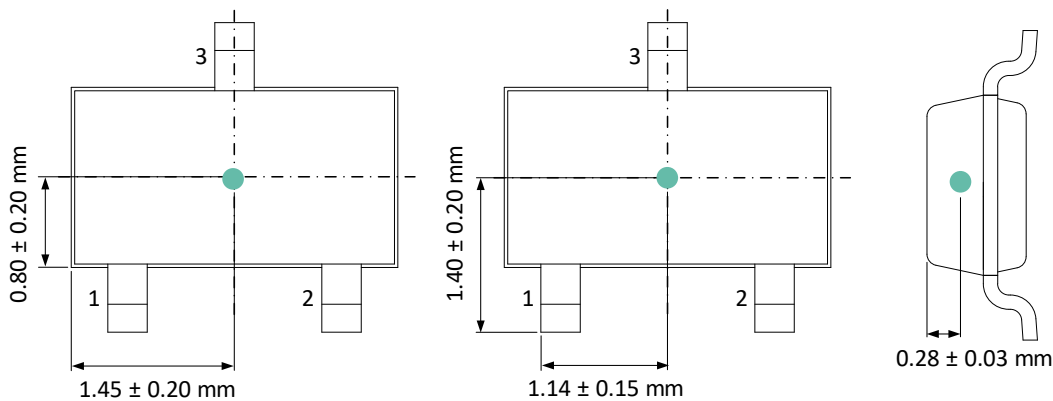


SYMBOL	MINIMUM	MAXIMUM
A	---	1.00
A1	0.025	0.10
A2	0.85	0.90
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
L	0.30	0.50
b	0.30	0.45
c	0.10	0.20
e	0.95 BSC	
e1	1.90 BSC	
$\alpha$	0°	8°

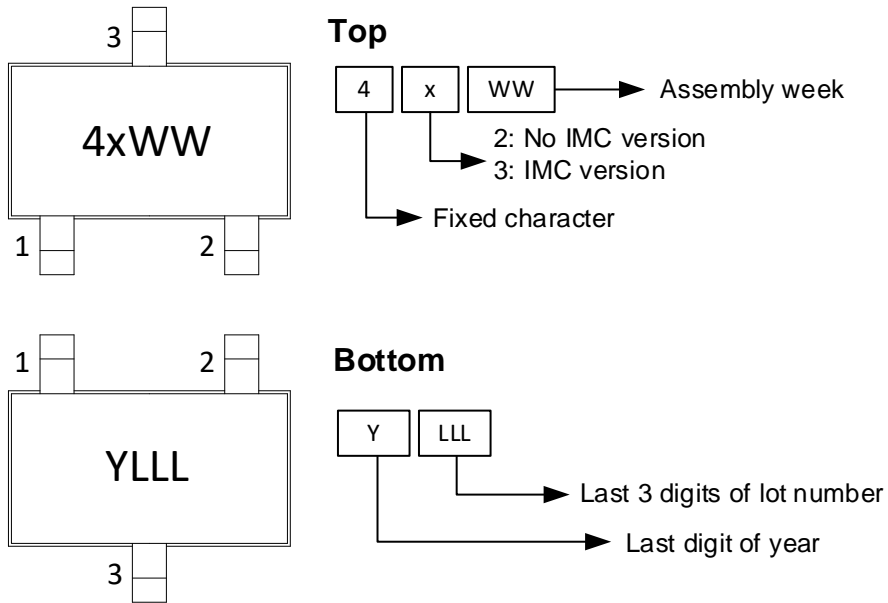
NOTE :

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 E 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 SUBSTRATE.
6. FORMED LEAD SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITH 0.076 mm SEATING PLANE.

#### 14.1.2. TSOT-3L – Sensitive spot



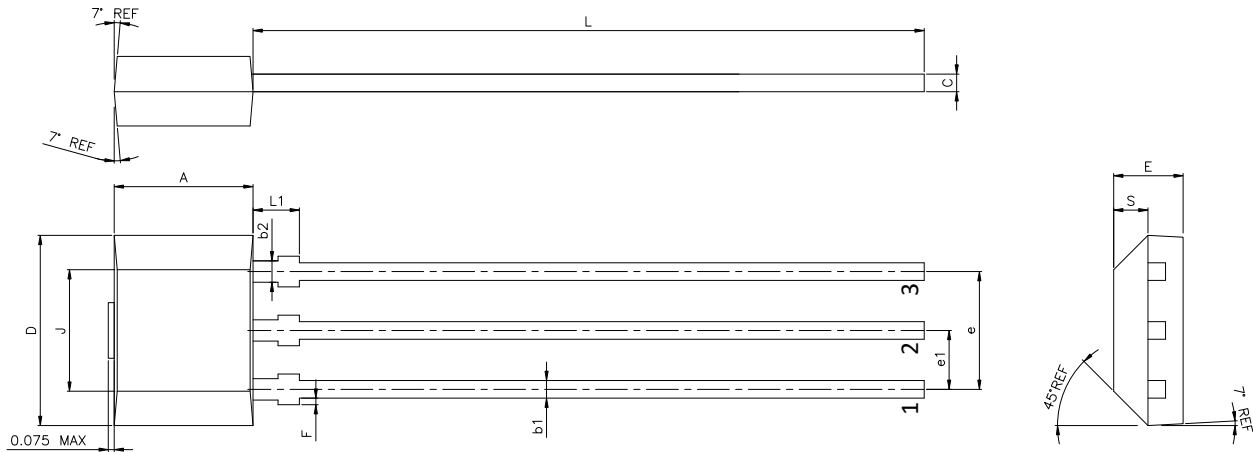
### 14.1.3. TSOT-3L – Package marking / Pin definition



Pin #	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	TEST	I/O	For Melexis use only
3	GND	Ground	Ground pin

## 14.2. TO92-3L (UA Package)

### 14.2.1. TO92-3L – Package dimensions



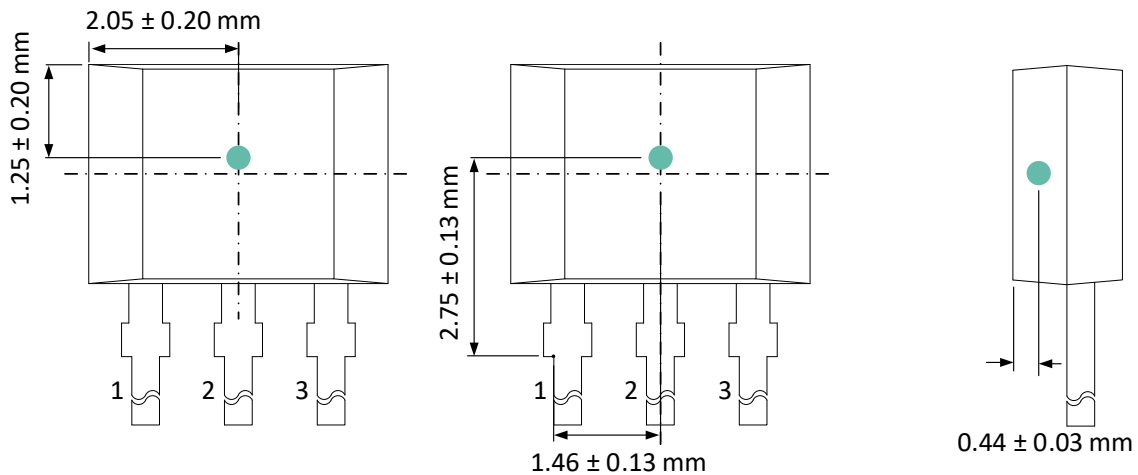
SYMBOL	MINIMUM	MAXIMUM
A	2.90	3.10
D	4.00	4.20
E	1.40	1.60
F	0.00	0.15
J	2.51	2.72
L	14.00	15.00
L1	0.90	1.10
S	0.63	0.84
b1	0.35	0.44
b2	0.43	0.52
c	0.35	0.44
e	2.51	2.57
e1	1.24	1.30

**NOTES :**

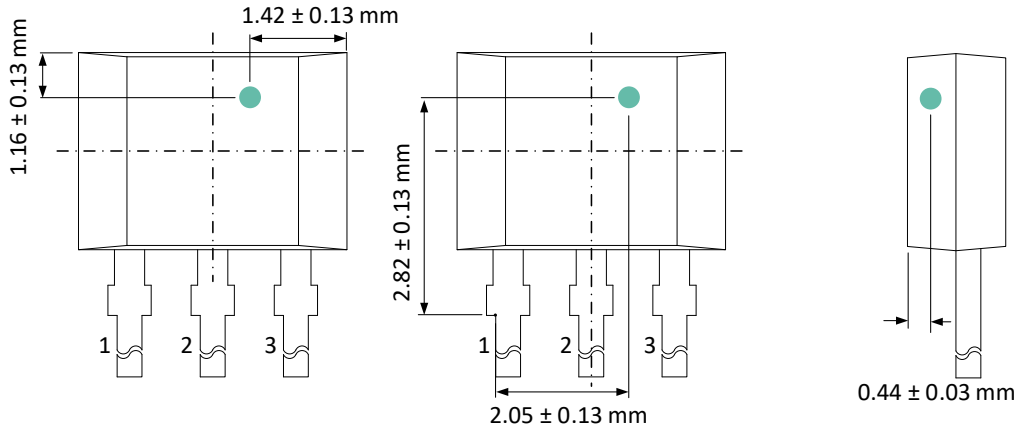
1. DIMENSIONS IN MILLIMETERS (mm) UNLESS NOTED OTHERWISE.
2. PACKAGE DIMENSIONS DO NOT INCLUDE MOLD FLASHES AND PROTRUSIONS.
3. DIMENSION A AND D DO NOT INCLUDE MOLD GATE AND SIDE FLASH (PROTRUSION) of MAXIMUM 0.127 mm PER SIDE.
4. THE LEADS MAY BE SLIGHTLY DEFORMED DURING TRANSPORTATION IF PACKED IN 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.

### 14.2.2. TO92-3L – Sensitive spot

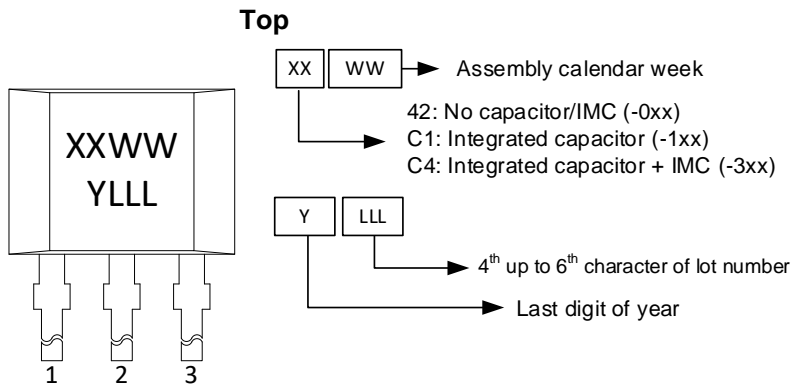
**Without integrated capacitor (-0xx)**



**With integrated capacitor (-1xx, -3xx)**



**14.2.3. TO92-3L – Package marking / Pin definition**



**Without integrated capacitor (-0xx)**

Pin #	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	GND	Ground	Ground pin
3	TEST	I/O	For Melexis use only

**With integrated capacitor (-1xx, -3xx)**

Pin #	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	TEST	I/O	For Melexis use only
3	GND	Ground	Ground pin

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