MLX90290

High Speed Programmed Linear Hall IC

1. Features and Benefits

- Linear Hall Sensor
- Small Size
- High Sensitivity
- High Accuracy
- High Speed
- Fast Start-Up for Micro-power applications
- Factory Programmability

2. Application Examples

- Linear Position Sensor
- Rotary Position Sensor
- Current Sensing
- Motor Commutation, compatible

3. Ordering Information

Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
MLX90290	L	UA	AAA-XYZ	BU
MLX90290	L	SE	AAA-XYZ	RE

Legend:

Temperature Code: L(-40°C to 150°C)

Package Code: UA=TO-92-3L/ SE=TSOT-3L

Option Code: AAA-XYZ:
AAA = die version
X = V_{DDNOM} and package options

	Package Options	
Supply Voltage	SE UA with straight leads	UA with 2.54mm pitch, see section “UA package, trim and form”
3.3 V ± 5 %	X=3	X=4
5.0 V ± 10 %	X=5	X=6

Y= S_{REL}

- 1: 5.1/T = 2.5 mV/G @ 5.0V
- 2: 6.25 1/T = 3.125 mV/G @ 5.0V
- 3: 10 1/T = 5.0 mV/G @ 5.0V
- 4: 20 1/T = 10 mV/G@ 5.0V

Z = TCS

- 0: 0 ppm/°C
- 1: 500 ppm/°C
- 2 2000 ppm/°C

Packing Form: RE = Reel for SE
CR = Radial Tape for UA (Carton Tape on Reel)
CA = Radial Tape for UA (Carton Tape in Ammopack)
BU = Bulk for SE or UA

Ordering example: MLX90290-LUA-AAA-612-CR. This order code will give you a 5V UA part with leads separated by 2.54mm pitch on Carton Tape. The other settings a sensitivity of 25mV/mT and a thermal drift of 2000 ppm/°C

4. Functional Diagram

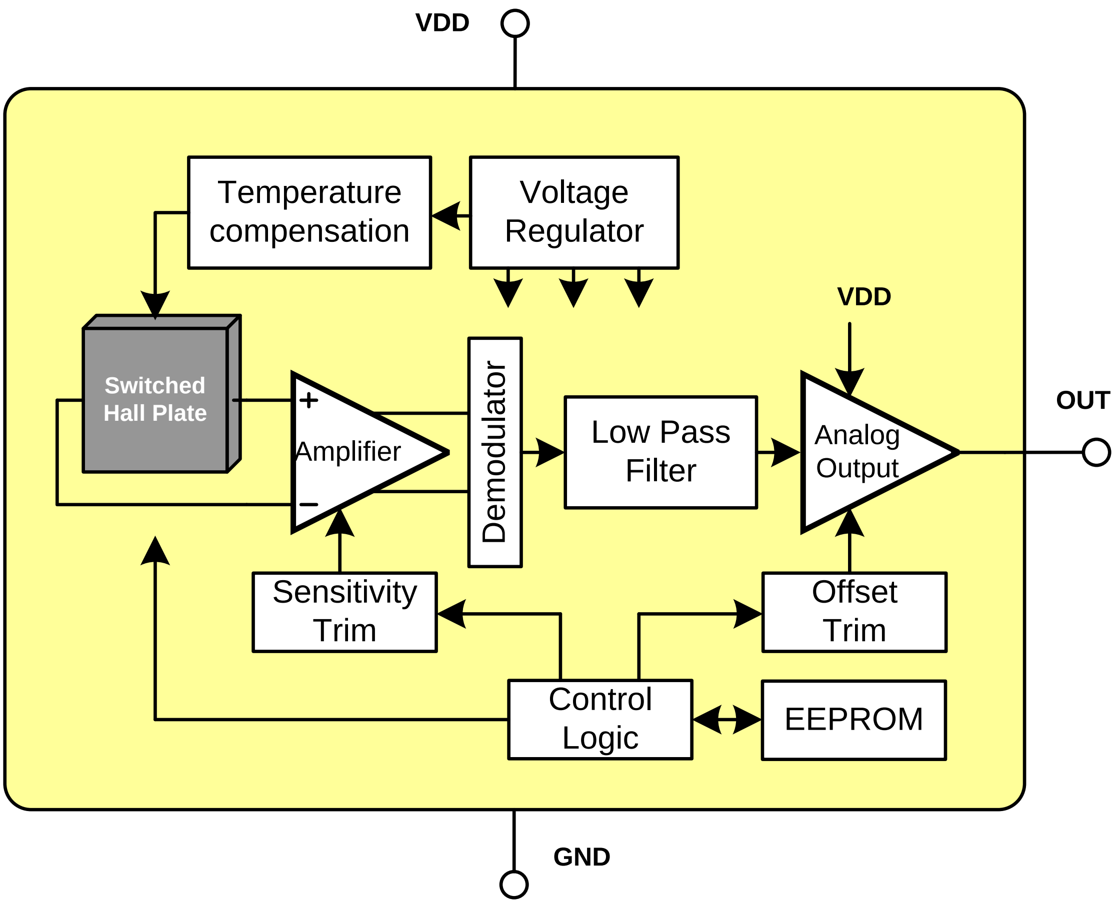


Figure 1 Functional Block Diagram MLX90290

5. General Description

The Melexis MLX90290 is a Second Generation linear Hall-effect sensor designed in mixed signal CMOS technology.

The device integrates a voltage regulator, Hall sensor with advanced offset cancellation system and an analog output driver, all in a single package.

The Output voltage is proportional to the applied magnetic field and to the chip supply voltage (ratiometric).

The Output Offset Level (Quiescent Level) at zero magnetic field equals to 50% of the chip supply voltage.

The device is offered in a RoHS compliant Thin Small Outline Transistor (TSOT) for surface mount and UA (TO-92) for Pin Through Hole mount.

6. Table of Contents

7. Glossary of Terms

Tesla [T]	Units of magnetic flux density: 1mT = 10 Gauss
ESD	Electro-Static Discharge
TSOT	Thin Small Outline Transistor package
PSRR	Power Supply Rejection Ratio
ECU	Electronic Control Unit
SMD	Surface Mount Devices
THD	Through Hole Device
RoHS	Restriction of Hazardous Substances

8. Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Voltage	V_{DD}	-0.3 to 7	V
Supply Current(1)	I_{DD}	±20	mA
Output Voltage	V_{OUT}	-0.3 to V_{DD}+0.3	V
Output Current(1)	I_{OUT}	±20	mA
Operating Temperature Range	T_A	-40 to 150	°C
Maximum Junction Temperature	T_J	165	°C
Storage Temperature Range	T_S	-55 to 165	°C
ESD Sensitivity (Human Body Model)(2)	ESD_{HBM}	4000	V
ESD Sensitivity (Charged Device Model)(3) (AEC Q100 002)	ESD_{CDM}	500	V
Maximum Flux Density	B	> 1000	mT

Table 1 Absolute Maximum Ratings

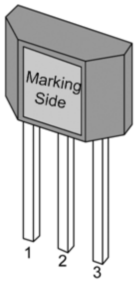
- ***Note 1:*** *Including the current flowing through the protection structure. Maximum power dissipation should be also considered*
- ***Note 2:*** *Human Body Model according AEC-Q100-002 standard*
- ***Note 3:*** *Charged Device Model according AEC-Q100-011 standard*

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

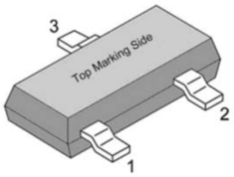
9. Pin Definitions and Descriptions

SE Pin №	UA Pin №	Name	Type	Function
1	1	VDD	Supply	Supply Voltage
2	3	OUT	I/O	Analog Output
3	2	GND	Ground	Ground

Table 2 Pin Definitions and Descriptions



UA package



SE package

10. General Electrical Specifications

Operating Characteristics, V_{DD} = 3.15V to 5.5V, T_A = -40°C to 150°C, C1 ≥ 0.1µF (unless otherwise specified)

Characteristics	Symbol	Test Conditions	Min	Typ[1]	Max	Units
Supply Voltage	V_{DD}	Operating	3.15	-	5.5	V
Supply Current	I_{DD}		3	5	8	mA
Reset Voltage	V_{POR}	OUT → High Impedance	-	2.7	2.95	V
Load Current Range	I_{OUT}		-1	-	1	mA
Load Resistance Range	R_L	Connected between OUT and GND	5	-	Infinite	kΩ
Load Capacitor Range [2]	C_L	Connected between OUT and GND	0	10	100 with R_S=50Ω	nF
Output Saturation Voltage	V_{OSHI}	I_{OUT}= -1mA, B=1.1*(V_{DD} - V_{OQ})/S	V_{DD} - 0.25	-	V_{DD}	V
	V_{OSHI} [2]	I_{OUT}= -0.1mA, B=1.1*(V_{DD} - V_{OQ})/S	V_{DD} - 0.1	-	V_{DD}	V
	V_{OSLO}	I_{OUT}=1mA, B=1.1*(-V_{OQ})/S	0	-	0.25	V
	V_{OSLO} [2]	I_{OUT}=0.1mA, B=1.1*(-V_{OQ})/S	0	-	0.1	V
Output Resistance	R_{OUT}	I_{OUT}= ±1mA	-	1.5	5	Ω
Power-On Time [3,4]	t_{ON}	V_{DD}=V_{DDNOM} [5], B=0.4/S_{REL}, dV_{DD}/dt>2V/us	-	40	70	µs
Chopping Frequency	F_{CHOP}		-	900	-	kHz
Sample / Update Period	T_{SAMPLE}	T_{SAMPLE}=1/F_{CHOP}	-	1.1	-	us
Power Supply Rejection Ratio [2]	PSRR	From 80kHz to 200kHz	20	-	-	dB
Package Thermal Resistance Junction to Ambient	R_{THJA}	TSOT-3L	-	230	-	°C/W
		3-SIP-UA / TO92-UA	-	180	-	°C/W

Table 3: General Electrical Specifications

Note 1: *Typical values are defined at T_A = 25ºC and V_{DD} = V_{DDNOM}*

Note 2: *Guaranteed by design and characterization*

Note 3: *The Power-On Time represents the time from reaching V_{DD} = 3.15V to VOUT settled within ±5% from its final value*

Note 4: *Power-On Slew Rate is not critical for the proper device start-up*

Note 5: *V_{DDNOM} = 5V or 3.3V - the value used at trimming*

11. Sensor Specific Specifications

Operating Characteristics, V_{DD} = 3.15V to 5.5V, T_A = -40°C to 150°C, C1 ≥ 0.1µF (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Relative Sensitivity Accuracy	εS	T_A=25°C, V_{DD}=V_{DDNOM} (2)	-5	-	5	%
Sensitivity Ratiometry	$ε^R$ S		-2.5	-	2.5	% / V
Linearity	Lin	V_{DD}=V_{DDNOM} (2)	-1.5	-	1.5	%
Symmetry	Sym	V_{DD}=V_{DDNOM} (2)	-1.5	-	1.5	%
Relative Output Offset Level	V_{OQREL}	B=0mT, T_A=25°C, V_{DD}=V_{DDNOM} (2)	0.49	0.5	0.51	-
Thermal Offset Drift	$ε^T$ V_{OQ} (3)	B=0mT, V_{DD}=V_{DDNOM} (2)	-(25mV+0.9mT*S)	0	+(25mV+0.9mT*S)	-
Output Offset Ratiometry	$ε^R$ V_{OQREL}	B=0mT	-2.5	-	2.5	% / V
Signal Bandwidth	BW	At -3dB, B<0.4/S_{REL}, UA package SOT package	15 (4) 25 (4)	30 (4) 50 (4)	-	kHz
Signal Phase Shift	PHI	Sine wave magnetic field at F = 1 kHz UA package SOT package	-	3.6 (4) 2.4 (4)	5 (4) 3.2 (4)	Degree

Table 4: Magnetic specification

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Relative Sensitivity Range	S_{REL}	V_{DD}=V_{DDNOM} (2)	5	-	10	1 / T
Sensitivity Temperature Coefficient	TCS	V_{DD}=V_{DDNOM} (2)	0		2000	ppm/°C

Table 5: Factory programmable parameters

Parameter	Code	Symbol	Test Conditions	Min	Typ	Max	Units
Sensitivity Temperature Coefficient	Z =0	TCS_{-40} (3)	T_A= -40°C, V_{DD}=V_{DDNOM} (2)		0		ppm/°C
		TCS_{150} (5)	T_A=150°C, V_{DD}=V_{DDNOM} (2)		0		ppm/°C
Sensitivity Temperature Coefficient	Z = 1	TCS_{-40} (3)	T_A= -40°C, V_{DD}=V_{DDNOM} (2)	0	650	1300	ppm/°C
		TCS_{150} (5)	T_A=150°C, V_{DD}=V_{DDNOM} (2)	0	500	1000	ppm/°C
Sensitivity Temperature Coefficient	Z = 2	TCS_{-40} (3)	T_A= -40°C, V_{DD}=V_{DDNOM} (2)	1100	2000	2900	ppm/°C
		TCS_{150} (5)	T_A=150°C, V_{DD}=V_{DDNOM} (2)	1100	2000	2900	ppm/°C
Relative Sensitivity Range(programmable)	Y = 1	S_{REL}	V_{DD}=V_{DDNOM} (2)		5		1/T
Relative Sensitivity Range(programmable)	Y = 2	S_{REL}	V_{DD}=V_{DDNOM} (2)		6.25		1/T
Relative Sensitivity Range(programmable)	Y = 3	S_{REL}	V_{DD}=V_{DDNOM} (2)		10		1/T

Table 6: Available Settings

Note 1: *Typical values are defined at TA = 25ºC and VDD = VDDNOM*

Note 2: *VDDNOM = 5V or 3.3V - the value used at trimming*

Note 3: *Guaranteed by design and characterization*

Note 4 *Signal Bandwidth & Signal Phase Shift mentioned here are defined for Z=1 & 2, resp. 500ppm/ºC & 2000ppm/ºC. The option code Z=0has internal filtering disabled. Products for 0ppm/ºC are targeted for current measurement applications. Therefore, Bandwidth & Phase Shift are not specified. No internal filter enables a step response time in the order of us. To get an idea of the phase & amplitude behavior over frequency, use a bode diagram for a 1st order RC filter with the Frequencies specified under "Band width . Also note that Melexis can support you to get an application specific filter setting. Contact your sales contact in such case.*

Note 5: *Guaranteed by correlation with wafer test and characterization*

12. Detailed General Description

12.1 Characteristic Definitions:

The Sensor DC Output Voltage is defined by:

$V_{OUT} = V_{DD} \cdot (V_{OQREL} + S_{REL} \cdot B),\ [V]$, where:

$V_{OQREL} = \frac{V_{OQ}}{V_{DD}},\ \left[\frac{V}{V}\right]$ is the measured relative quiescent output voltage, its nominal value is 0.5;

$V_{OQ} = V_{OUT},\ [V]$ is the measured quiescent output voltage at $B = 0$;

$S_{REL} = \frac{S}{V_{DD}} = \frac{\Delta V_{OUT}}{\Delta B} \cdot \frac{1}{V_{DD}},\ \left[\frac{1}{T}\right]$ is the relative magnetic sensitivity;

$S = \frac{\Delta V_{OUT}}{\Delta B} = S_{REL} \cdot V_{DD},\ \left[\frac{V}{T}\right]$ is the magnetic sensitivity at given supply voltage V_{DD}.

Magnetic Sensitivity Temperature Coefficient TCS is defined by:

$$TCS = \frac{S_{REL}(T_A) - S_{REL}(25°C)}{S_{REL}(25°C) \cdot (T_A - 25°C)} \cdot 10^6,\ \left[\frac{ppm}{°C}\right].$$

Magnetic Sensitivity Ratiometry is defined by:

$$\varepsilon^R S = \frac{S_{REL}(V_{DD}) - S_{REL}(V_{DDNOM})}{S_{REL}(V_{DDNOM}) \cdot (V_{DD} - V_{DDNOM})} \cdot 100\%,\ \left[\frac{\%}{V}\right].$$

Linearity for both positive and negative magnetic fields is defined by:

$Lin = \frac{S_{REL}(B_2) - S_{REL}(B_1)}{S_{REL}(B_1)} \cdot 100\%,\ [\%]$, where $B_1 = \pm\frac{0.2}{S_{REL}},\ B_2 = \pm\frac{0.4}{S_{REL}}$ and

$$S_{REL}(B_X) = \frac{V_{OUT}(B_X) - V_{OQ}}{B_X \cdot V_{DD}}.$$

Symmetry for positive and negative magnetic fields is defined by:

$Sym = \frac{S_{REL}(B_2) - S_{REL}(B_1)}{\frac{1}{2}(S_{REL}(B_1) + S_{REL}(B_2))} \cdot 100\%,\ [\%]$, where $B_1 = \frac{0.4}{S_{REL}},\ B_2 = -\frac{0.4}{S_{REL}}$ and

$$S_{REL}(B_X) = \frac{V_{OUT}(B_X) - V_{OQ}}{B_X \, . \, V_{DD}} \, .$$

Output Offset Temperature Drift is defined by:

$$\varepsilon^{T} V_{OQ} = V_{OQ}(T_A) - V_{OQ}(25°C) \, , \, [mV] .$$

Output Offset Ratiometry is calculated by:

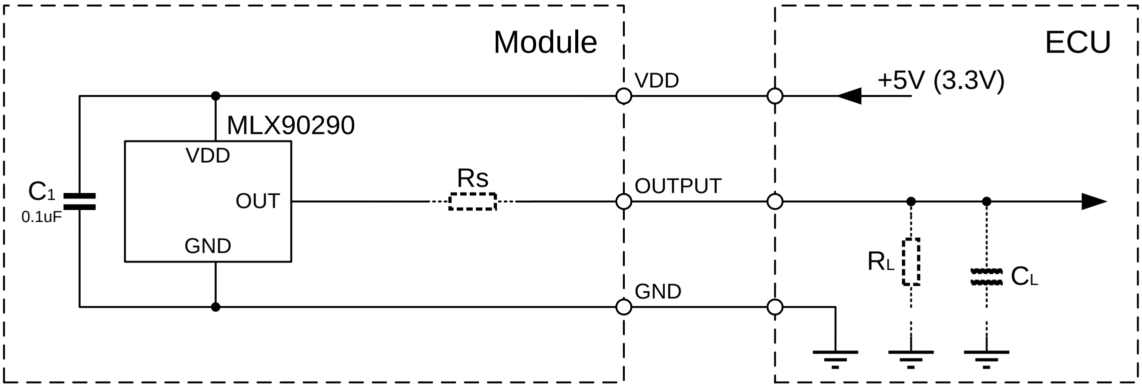
$$\varepsilon^{R} V_{OQREL} = \frac{V_{OQREL}(V_{DD}) - V_{OQREL}(V_{DDNOM})}{V_{OQREL}(V_{DDNOM}) \, . \, (V_{DD} - V_{DDNOM})} \, . \, 100\% \, , \, \left[\frac{\%}{V}\right] .$$

13. Unique Features

The MLX90290 offers a wide factory programmable temperature coefficient range to be able to operate with almost all available magnet grades or with TC = 0 ppm/DegC.

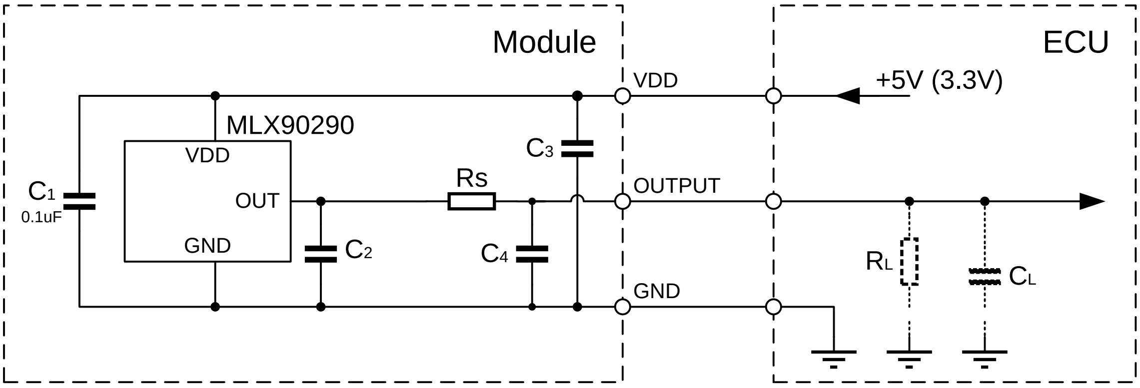
14. Application Information

14.1 Typical Application Circuit



Notes:
For proper operation a 100nF or bigger bypass capacitor C1 should be placed as close as possible to the VDD and GND pins of MLX90290.
For embedded applications the components R_S, R_L and C_L are not required.

14.2 Application Circuit for Harsh and Noisy Environment



Notes:
For proper operation a 100nF or bigger bypass capacitor C1 should be placed as close as possible to the VDD and GND pins of MLX90290. For harsh and noisy environment, a bypass capacitor C2 of 1nF to 10nF can be placed on the output. For improved EMC performance an additional resistance, Rs and capacitors, C3 and C4 placed close to the connector of the module are recommended. Recommended values for: Rs ≥ 50E, 1nF ≥ C3 ≤ 4.7nF, 1nF ≥ C4 ≤ 10nF.
For embedded applications the components R_L and C_L are not required.

15. Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

Reflow Soldering SMD's (Surface Mount Devices)

- IPC/JEDEC J-STD-020
  Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113
  Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing (reflow profiles according to table 2)

Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EN60749-20
  Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

Iron Soldering THD's (Through Hole Devices)

- EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EIA/JEDEC JESD22-B102 and EN60749-21
  Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

Melexis recommends reviewing on our web site the General Guidelines soldering recommendation (http://www.melexis.com/Quality_soldering.aspx) as well as trim&form recommendations (http://www.melexis.com/Assets/Trim-and-form-recommendations-5565.aspx).

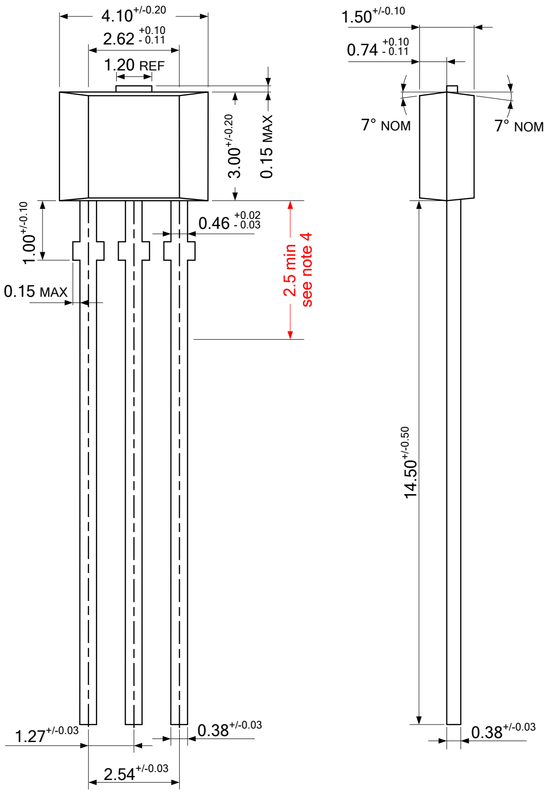
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: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

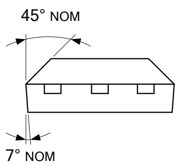
16. ESD Precautions

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

17. Package Information –Example from MLX90290

17.1 UA (TO92-3L) Package Information

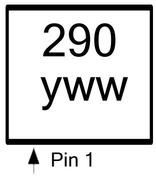




Notes:

1. All dimensions are in millimeters
2. Package dimension do not include mold protrusion.
3. The end flash shall not exceed 0.127 mm on each side.
4. To preserve reliability, it is recommended to have total lead length equal to 2.5mm minimum, measured from the package line.

Top Marking:



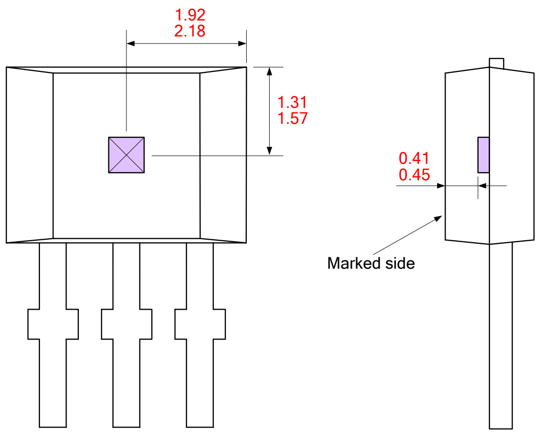
1st Line : 290

2nd Line : Date code

y = last digit of calendar year

ww = calender week #

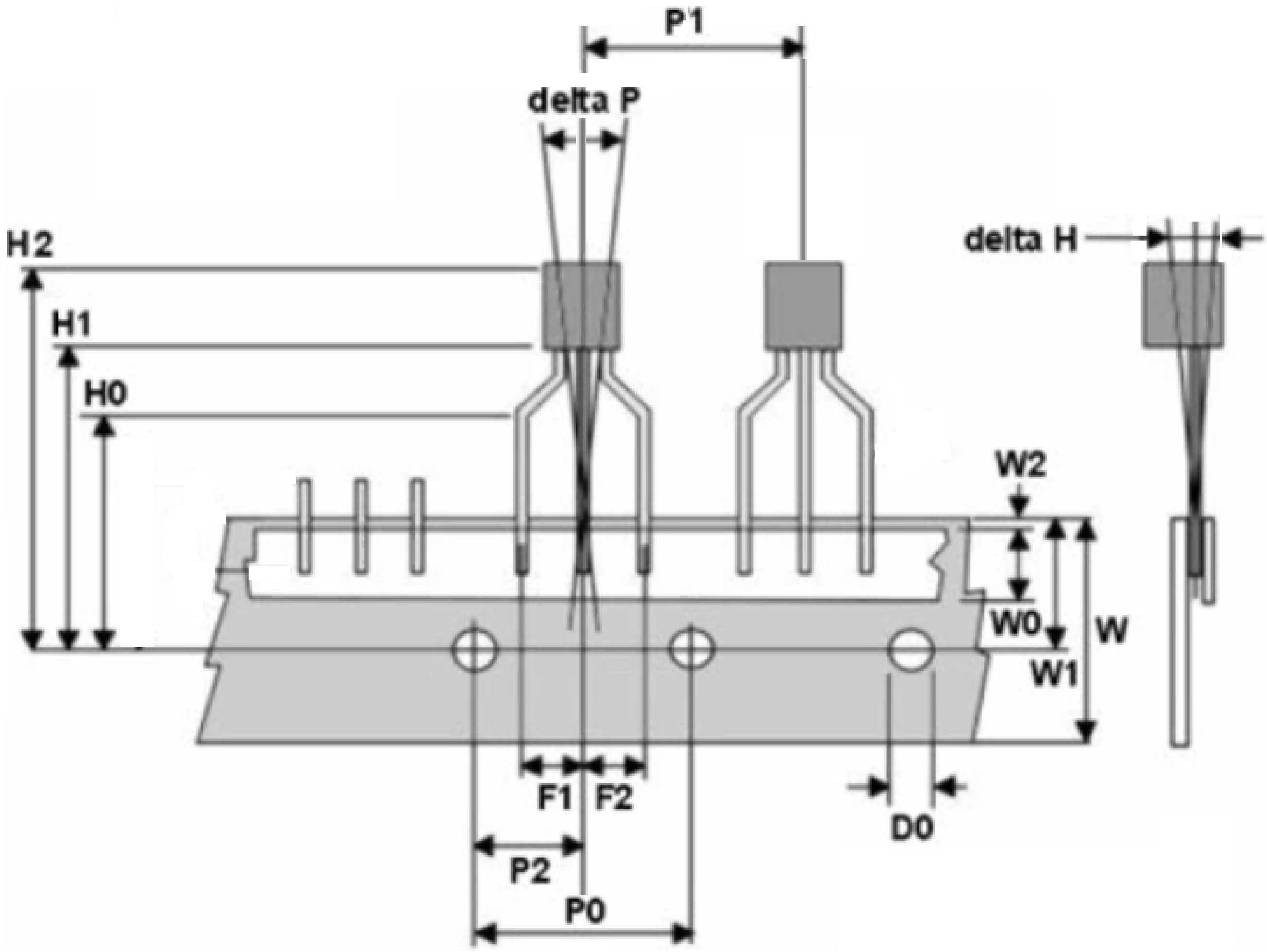
Hall plate location



Remarks:

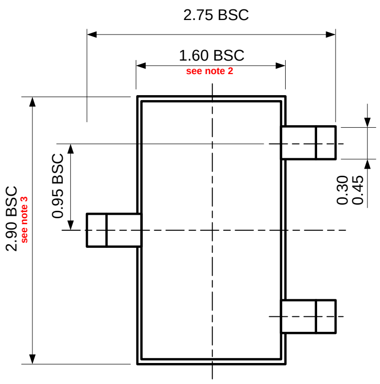
1. All dimensions are in millimeters

17.1.1 Trim and form with 2.54mm distance between leads; only available on tape

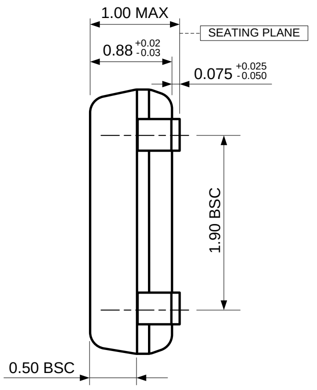


Parameter	Component Height	Component Position	Hole Diameter	Hole Position	Hole Pitch	Component Pitch	Right-Left Bending
	H1	P2	Do	W1	Po	P1	ΔP
Nominal (& Tolerance)	19mm (±0.5)	6.35mm (±0.4)	4mm (±0.2)	9mm (-0.5;+0.75)	12.7mm (±0.3)	12.7mm (±0.3)	±0.4mm

Parameter	Lead Spacing	Front-Rear Bending	Tape Width	Adhesive Tape Width	Adhesive to Carrier Tape Gap	Vertical Lead Length	Component Height Top
	F1 & F2	ΔH	W	Wo	W2	Ho	H2
Nominal (& Tolerance)	2.54mm (±0.25mm)	±.0.3deg	18mm (±0.5)	6mm (±0.2)	0.5mm (-0.5; +0.3)	15.5mm (±0.5)	22.0mm (±0.8mm)



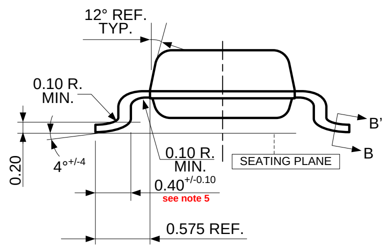
TOP VIEW



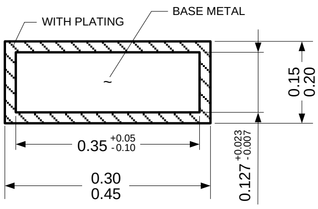
SIDE VIEW

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.



END VIEW



SECTION B-B'

see note 6

Marking:

Top marking : Pin 1

90XXX

XXX - last three digits of the lot

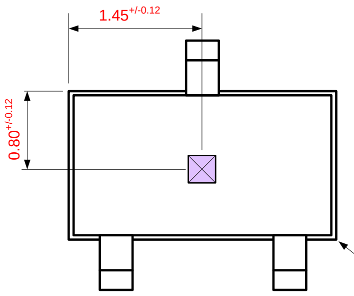
Bottom marking:

WWYY

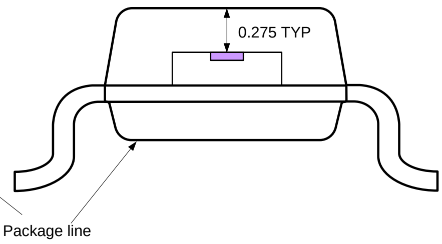
Pin 1

Date code - WW - calender week
Date code - YY - calender year

Hall plate location



TOP VIEW



END VIEW

Remarks:

1. All dimensions are in millimeters

18. Disclaimer

19. Contact Information

For the latest version of this document, go to our website at
www.melexis.com

Or for additional information contact Melexis Direct:

Europe, Africa, Asia:	America:
Phone: +32 1367 0495	Phone: +1 248 306 5400
E-mail:	E-mail:
sales_europe@melexis.com	sales_usa@melexis.com

ISO/TS 16949 and ISO14001 Certified