MLX90340

Datasheet

1. Features and Benefits

- Triaxis® Hall Technology
- On Chip Signal Processing for Robust Absolute Position Sensing
- Programmable Measurement Range
- Programmable Linear Transfer Characteristic (Multi-points 4 or Piece-Wise-Linear 17)
- Selectable Analog (Ratiometric) or PWM Output
- 12 bit Resolution - 10 bit Thermal Accuracy
- 48 bit ID Number option
- Single Die – SOIC-8 Package RoHS Compliant
- Dual Die (Full Redundant) – TSSOP-16 Package RoHS Compliant



SOIC-8



TSSOP-16

2. Application Examples

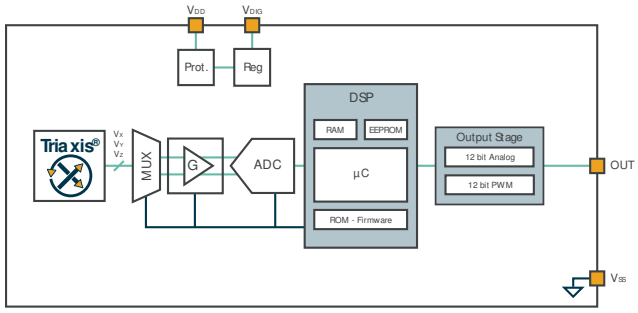
- Absolute Rotary Position Sensor
- Absolute Linear Position Sensor
- Non-Contacting Potentiometer

3. Description

The MLX90340 is a monolithic sensor IC sensitive to the flux density applied orthogonally and parallel to the IC surface.

The MLX90340 is sensitive to the three components of the flux density applied to the IC (i.e. Bx, By and Bz). This allows the MLX90340 with the correct magnetic circuit to decode the absolute position of any moving magnet (e.g. rotary position from 0 to 360 Degrees or linear displacement, stroke - Figure 2). It enables the design of novel generation of non-contacting position sensors that are frequently required for both heavy-duty and industrial applications.

The MLX90340 reports a programmable ratiometric analog output signal compatible with a programmable linear Hall sensor. Through programming, the MLX90340 provides also a digital PWM (Pulse Width Modulation) output characteristic.



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4. Ordering Information

Product	Temp. code	Package code	Option Code	Packing Form	Definition
MLX90340	L	GO	AAA-000	RE	Standard version – Heavy-duty
MLX90340	L	DC	AAA-000	RE	Standard version – Heavy-duty
MLX90340	E	GO	AAA-000	RE	Standard version – Industrial
MLX90340	E	DC	AAA-000	RE	Standard version - Industrial
MLX90340	E	DC	AAA-100	RE	90deg Pre-programmed analog - Industrial
MLX90340	E	DC	AAA-200	RE	360deg Pre-programmed analog - Industrial
MLX90340	E	DC	AAA-300	RE	180deg Pre-programmed analog - Industrial
MLX90340	E	DC	AAA-400	RE	270deg Pre-programmed analog - Industrial
MLX90340	S	DC	AAA-000	RE	Standard version - Consumer
MLX90340	S	DC	AAA-100	RE	90deg Pre-programmed analog - Consumer
MLX90340	S	DC	AAA-200	RE	360deg Pre-programmed analog - Consumer
MLX90340	S	DC	AAA-300	RE	180deg Pre-programmed analog - Consumer
MLX90340	S	DC	AAA-400	RE	270deg Pre-programmed analog - Consumer

Legend:

Temperature Code:	L: from -40°C to 150°C E: from -40°C to 85°C S: from -20°C to 85°C
Package Code:	"DC" for SOIC-8 package "GO" for TSSOP-16 package (dual die)
Option Code:	AAA-xxx: die Version xxx-**1**2**3** **1**: Application ▪ 0: Standard version ▪ 1: Pre-programmed version in Analog output mode – Transfer function of 80%Vdd /90deg ▪ 2: Pre-programmed version in Analog output mode – Transfer function of 80%Vdd /360deg ▪ 3: Pre-programmed version in Analog output mode – Transfer function of 80%Vdd /180deg ▪ 4: Pre-programmed version in Analog output mode – Transfer function of 80%Vdd /270deg **2**: N/A **3**: N/A
Packing Form:	RE "for Reel", TU "for Tube",
Ordering Example:	"MLX90340EDC-AAA-000-RE" For a Standard version from -40 to 85degC in SOIC-8 package, delivered in Reel.

Table 1: Ordering information Legend

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5. Functional Diagram

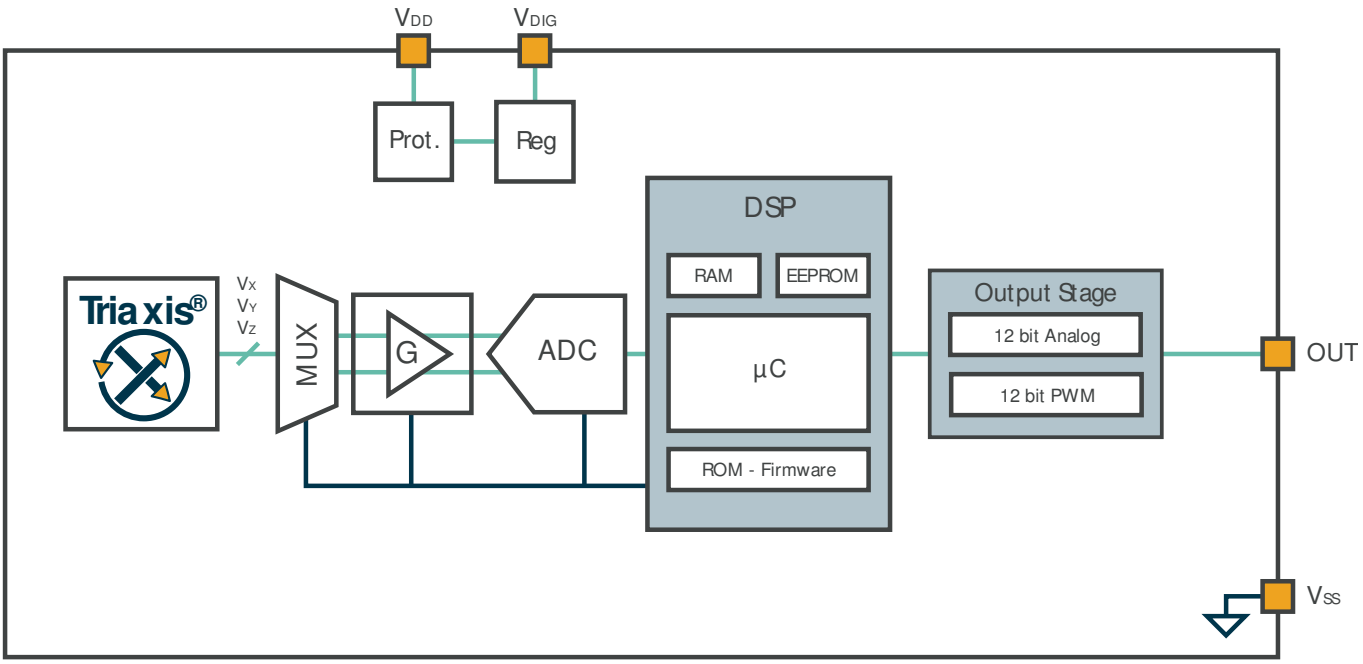
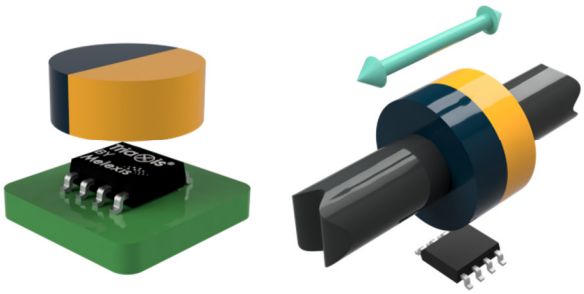


Figure 1: Block diagram

Angle XY, Angle XZ, Angle YZ



$$\theta = \arctan(\frac{Bi}{Bj})$$

Figure 2: Application examples

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6. Glossary of Terms

Gauss (G), Tesla (T)	**Units for the magnetic flux density – 1 mT = 10 G**
TC	Temperature Coefficient (in ppm/Deg.C.)
NC	Not Connected
PWM	Pulse Width Modulation
%DC	Duty Cycle of the output signal i.e. TON /(TON + TOFF)
ADC	Analog-to-Digital Converter
DAC	Digital-to-Analog Converter
LSB	Least Significant Bit
MSB	Most Significant Bit
DNL	Differential Non-Linearity
INL	Integral Non-Linearity
RISC	Reduced Instruction Set Computer
ASP	Analog Signal Processing
DSP	Digital Signal Processing
CoRDiC	Coordinate Rotation Digital Computer (i.e. iterative rectangular-to-polar transform)
EMC	Electro-Magnetic Compatibility
DLS	Digital Low Speed
DHS	Digital High Speed

Table 2: Glossary

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7. Pin Definitions and Descriptions

7.1. Pin Definition for SOIC-8

Pin #	Name	Description
1	VDD	Supply
2	Test Input	For test
3	Test	For test
4	Not Used	
5	OUT	Output
6	Test1	Test pin
7	VDIG	3.3V Regulator pin
8	Vss	Ground pin

Table 3: SOIC-8 Pinout

For optimal EMC behavior, it is recommended to connect the unused pins (Not Used and Test) to the Ground

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7.2. Pin Definition for TSSOP-16

Pin #	Name	Description
1	VDIG1	3.3V Regulator pin
2	VSS_1	Ground Die 1
3	VDD_1	Supply Die1
4	Test0_1	For test
5	Test2_2	For test
6	OUT2	Output Die 2
7	Not Used2	
8	Test1_2	For test
9	VDIG2	3.3V Regulator pin
10	VSS_2	Ground Die 2
11	VDD_2	Supply Die 2
12	Test0_2	For test
13	Test2_1	For test
14	Not Used1	
15	OUT1	Output
16	Test1_1	For test

Table 4: TSSOP-16 Pinout

For optimal EMC behavior, it is recommended to connect the unused pins (Not Used and Test) to the Ground

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8. Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage	V_{DD}			24	V	
Reverse Voltage Protection	V_{DD-REV}			-12	V	Independent of time, Breakdown at -14V
Positive Output Voltage	V_{OUT}			18	V	Independent of time, Breakdown at 24V
Reverse Output Voltage				-0.3	V	
Operating Temperature	T_{AMB}	-40		+150	°C	
Junction Temperature	T_{JUNC}			160	°C	
Storage Temperature	T_{ST}	-40		+150	°C	
Magnetic Flux Density		-1		1	T	

Table 5 – Maximum ratings

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

9. Detailed General Description

As described on the block diagram the three vector components of the magnetic flux density (BX, BY and BZ) applied to the IC are sensed through the sensor front-end. The respective Hall signals (VX, VY and VZ) are generated at the Hall plates and amplified.

The analog signal processing is based on a fully differential analog chain featuring the classic offset cancellation technique (Hall plate 2-Phases spinning and chopper-stabilized amplifier).

The conditioned analog signals are converted through an ADC (15 bits) and provided to a DSP block for further processing. The DSP stage is based on a 16 bit RISC micro-controller whose primary function is the extraction of the position from two (out of three) raw signals (after so-called front-end compensation steps) through the following function:

$$\alpha = \angle\left(V_1, k \times V_2\right)$$

Figure 3: Angular calculation formula

where alpha is the magnetic angle <(B1, B2), V1 = Vx or Vy or Vz , V2 = Vx or Vy or Vz

The DSP functionality is governed by the micro-code (firmware – F/W) of the micro-controller which is stored into the ROM (mask programmable). In addition to the magnetic angle extraction, the F/W controls

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the whole analog chain, the output transfer characteristic, the output protocol, the programming/calibration and also the self-diagnostic modes.

The magnetic angular information is intrinsically self-compensated vs. flux density variations. This feature allows therefore an improved thermal accuracy vs position sensor based on conventional linear Hall sensors.

In addition to the improved thermal accuracy, the realized position sensor features excellent linearity performances taking into account typical manufacturing tolerances (e.g. relative placement between the Hall IC and the magnet).

Once the position (angular or linear stroke) information is computed, it is further conditioned (mapped) vs. the target transfer characteristic and it is provided at the output(s) as either a ratiometric analog output level through a 12 bit DAC followed by a buffer or a digital PWM output.

For instance, the analog output can be programmed for offset, gain and clamping to meet any rotary position sensor output transfer characteristic:

$$Vout(\alpha) = ClampLo \text{ for } \alpha \leq \alpha min$$
$$Vout(\alpha) = Voffset + Gain \times \alpha \quad \text{for } \alpha min \leq \alpha \leq \alpha max$$
$$Vout(\alpha) = ClampHi \text{ for } \alpha \geq \alpha max$$

where Voffset, Gain, ClampLo and ClampHi are the main adjustable parameters for the end-user. The linear part of the transfer curve can be adjusted through a multi-point calibration: This back-end step consists into either up to 4 arbitrary points (5 segments + clamping levels) calibration or a Piece-Wise-Linear (PWL) output transfer characteristics - 17 equidistant points w/ programmable origin over 16 different angle ranges from 65 to 360 degrees.

The calibration parameters are stored in NVRAM featuring a Hamming Error Correction Coding (ECC).

The programming steps do not require any dedicated pins. The operation is done using the supply and output nodes of the IC. The programming of the ML90340 is handled at both engineering lab and production line levels by the Melexis Programming Unit PTC-04 with the dedicated DB90316 and software tools (DLL – User Interface).

10. General Electrical Specifications

DC Operating Parameters at V_{DD} = 5V (unless otherwise specified) and for T_A as specified by the Temperature suffix (S or E or L).

Electrical Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage	V_{DD}	4.5	5	5.5	V	
Supply Current			13.5	15	mA	no resistive load at OUT PIN (OUT1 and OUT2 for TSSOP-16 package)

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Electrical Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Power-On reset (rising)	POR LH	2.4	2.7	3	V	Refer to internal voltage Vdig
Power-On reset Hysteresis			400		mV	
ASP Start Rising Level	LT4VLH	3.5		4.1	V	
ASP Start Hysteresis	LT4V Hyst	0.1		0.5	V	
PTC Entry Rising Level	MT7V LH	6.6		7.2	V	
PTC Entry Hysteresis	MT7V Hyst	0.1		0.4	V	
Switch Off Rising Level	LT11V LH	8.6		14	V	
Switch Off Hysteresis	LT11V Hyst	0.1		1	V	
Output Load	RL	1	10	∞	kΩ	See Analog saturation
Output short circuit current	Ishort			15	mA	Vout to GND
				15	mA	Vout to 5V
				18	mA	Vout to 14V (Ta=25degC)
Analog Saturation Output level / Active Diagnostic output level	Vsat_lo /		0.5	2	%Vdd	PU load RL ≥ 10 kΩ to 5 V
	Diag_lo		2	3	%Vdd	PU load RL ≥ 1 kΩ to 5V
	Vsat_hi /	94	96		%Vdd	PD load RL ≥ 5 kΩ
	Diag_hi	96	98		%Vdd	PD load RL ≥ 10 kΩ
		97	97.5		%Vdd	PD load RL = 5 kΩ
Passive Diagnostic Output Level (Broken VSS /VDD)	BVSSPD	0		4	%Vdd	Pull-down load $R_L \leq 10$ kΩ
		0		10	%Vdd	Pull-down load $R_L \leq 25$ kΩ
	BVSSPU	99		100	%Vdd	Pull-up load $R_L \geq 1$kΩ
	BVDDPD		0	1	%Vdd	Pull-down load $R_L \geq 1$kΩ
	BVDDPU	96		100	%Vdd	Pull-down load $R_L \leq 10$ kΩ
Rdson	Rdson_lo	15		30		Rdson Low side
	Rdson_hi	120		300		Rdson High side
Clamping Output Level	Clamp_lo	0		100	%Vdd	to be higher than Vsat_lo
	Clamp_hi	0		100	%Vdd	to be lower than Vsat_hi

Table 6: MLX90340 Electrical specifications

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As an illustration of the previous table, the MLX90340 fits the typical classification of the output span described on Figure 4.

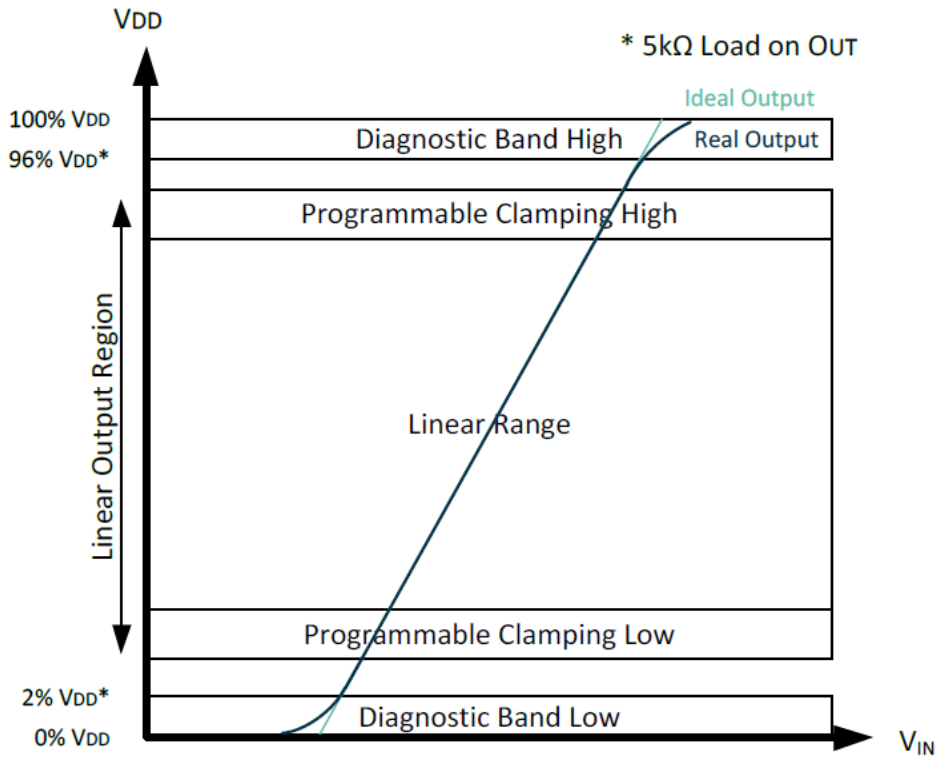


Figure 4: Example of Output Span Classification for typical application.

11. Isolation Specification

DC Operating Parameters at VDD = 5V (unless otherwise specified) and for T_A as specified by the Temperature suffix (S or E or L). Only valid for the package code GO, i.e. dual die version.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Isolation Resistance		4	-	-	MΩ	Between dice

Table 7: Isolation

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12. Timing Specification

DC Operating Parameters at VDD = 5V (unless otherwise specified) and for T_A as specified by the Temperature suffix (S or E or L).

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Main Clock Frequency	Ck	9.5	10	10.5	MHz	
Main Clock Frequency Thermal Drift		-10	-	10	%Ck	Lifetime included
Refresh Rate			400	440	µs	
Latency			400		µs	
Step Response Time			800	1320	µs	Filter=0 (FIR1)
			1200	1760	µs	Filter=1 (FIR11)
			1600	2200	µs	Filter=2 (FIR1111)
Watchdog			4.58		ms	See Section 18
Start-up Time			7.5	10	ms	excluding slew rate
Analog OUT Slew-rate			37		V/ms	Mode1
			320		V/ms	Mode2

Table 8: Timings specification

12.1. Latency time Definition

The latency time is a suitable metric for the "delay" of the sensor in case of a slow ramp of the magnetic change, for instance, when the magnet has an angular frequency of 10 radians per second, i.e., 360 Deg. rotation within 100ms. A graphic illustration can be seen in Figure 5.

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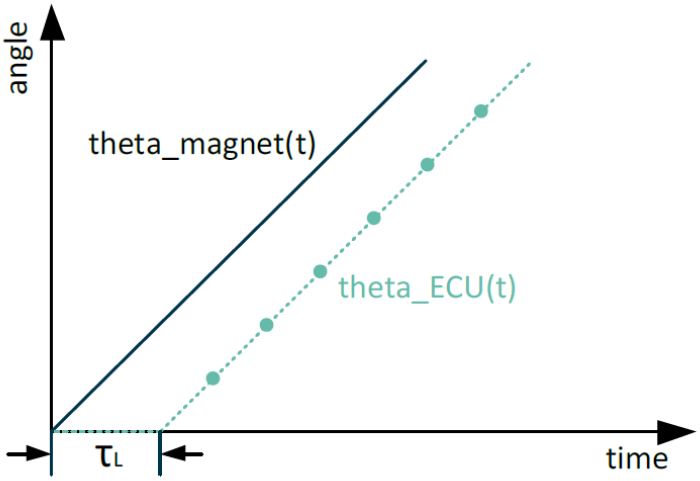


Figure 5: Latency time defintion

12.2. Step Response Definition

The step response is a suitable metric for the "delay" of the sensor in case of an abrupt step in the magnetic change, considering 100% settling time without any DSP filter. Full settling is typically achieved in just two steps. The sensor is asynchronous with the magnetic step change: the 100% settling time will fall in a time window; worst case is given in Table 8.

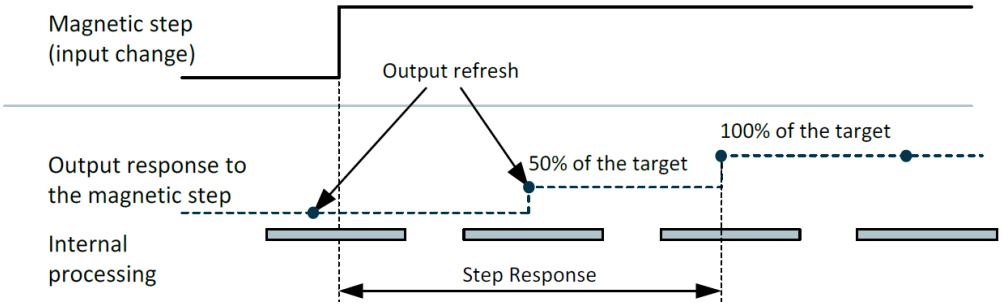


Figure 6: Step Response time definition

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13. Accuracy

DC Operating Parameters at VDD = 5V (unless otherwise specified) and for TA as specified by the Temperature suffix (S or E or L).

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
XY – Intrinsic Linearity Error[1]	Le	-1		1	Deg.	TA=25degC
XZ (YZ) - Intrinsic Lin. Error[1]	Le	-20	+/-2.5	20	Deg.	TA=25degC
Analog Output Resolution	Rdac		0.025		%Vdd/Lsb12	
		-4		4	LSB12	
		0.05	1	3	LSB12	
Output stage Noise			0.05	0.075	%Vdd	Output in clamping
ADC Resolution on the raw signals sine and cosine[2]	Radc		15		Bits	
Thermal Offset Drift #1 at the DSP input (excl. DAC and output stage)	Tofs1	-0.35	-	0.35	Deg.	Temperature Suffix S
		-0.4	-	0.4	Deg.	Temperature Suffix E
		-0.55	-	0.55	Deg.	Temperature Suffix L
Thermal Offset Drift #2 (Output Stage Drift)	Tofs2	-0.25		0.25	%Vdd	
Thermal Sensitivity Mismatch Drift	Tsmm	-0.1		0.1	Deg.	XY axis, Temp Suffix S
		-0.15		0.15	Deg.	XY axis, Temp Suffix E
		-0.2		0.2	Deg.	XY axis, Temp Suffix L
		-0.3		0.3	Deg.	XZ axis, Temp Suffix S, E
		-0.4		0.4	Deg.	XZ Axis, Temp Suffix L
Magnetic Angle phase error		-0.3		0.3	Deg.	T_A = 25°C – XY axis
		-10		10	Deg.	T_A = 25°C – XZ (YZ) axis

[1] *The Intrinsic Linearity Error refers to the IC itself (offset, sensitivity mismatch, orthogonality) taking into account an ideal rotating field for Bx and By. Once associated to a practical magnetic construction and the associated mechanical and magnetic tolerances, the output linearity error increases. However, it can be improved with the multi-point end-user calibration. The intrinsic Linearity Error for Magnetic angle XZ and YZ can be reduced through the programming of the k factor.*

[2] *16 bits corresponds to 15 bits + sign. Internal computation is performed using 16 bits.*

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Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Ratiometry Error (Analog output only)		-0.1 -1		0.1 1	%Vdd %Vdd	4.5V ≤ V_{DD} ≤ 5.5V LT4V ≤ V_{DD} ≤ MT7V
Noise		-0.125	+/- 0.075	0.125	Deg.	+/-3σ, No Filtering

Table 9: Accuracy specifications

14. Magnetic Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Magnetic Flux Density	Bx, By Bz			70[3] 130	mT mT	√[$B_X^2 + B_Y^2$]
Magnetic Field Norm	Norm	20[4]	40		mT	√[$B_X^2 + B_Y^2 + (Bz/1.2)^2$]
IMC Gain in X and Y[5]	GainIMCxy	1.2	1.4	1.8	mT	
IMC Gain in Z	GainIMCz	1.1		1.3	mT	
K factor	k	1	1.2	1.5		GainIMCxy / GainIMCz

Table 10: Magnetic specifications

[3] *Above 70 mT, the IMC starts saturating yielding to an increase of the linearity error.*
[4] *Below 20 mT, the performances slightly degrade due to a reduction of the signal-to-noise ratio, signal-to-offset ratio…*
[5] *This is the magnetic gain linked to the Integrated Magneto Concentrator structure. It applies to Bx and By and not to z. This is the overall variation. Within one lot, the part to part variation is typically ± 10% versus the average value of the IMC gain of that lot.*

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15. CPU & Memory Specification

The DSP is based on a 16 bit RISC µController. This CPU provides 2.5 Mips while running at 10 MHz.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
ROM			7		kB	
RAM			256		B	
EEPROM			128		B	

Table 11: Memory specifications

16. End-User Programmable Items

Parameter	000	200	100	300	400	coding	Unit	Description
Output mode	1	1	1	1	1	3	bits	Define the output stage mode
DIAG	0	0	0	0	0	1	bits	Diagnostic mode (Low/Hi)
ADIAG	0	0	0	0	0	1	bits	Analog diagnostic option (Low/Hiz or HiZ/Hi)
MAPXYZ	MLX	MLX	MLX	MLX	MLX	3	bits	Mapping fields for output angle
CLAMP_HIGH	50%	10%	10%	10%	10%	16	bits	Clamping High (50%)
CLAMP_LOW	50%	90%	90%	90%	90%	16	bits	Clamping Low (50%)
FILTER	0h	1h	1h	1h	1h	2	bits	Filter mode selection
k (SMISM)	MLX	MLX	MLX	MLX	MLX	16	bits	Sensitivity mismatch factor
GAINMIN	00h	00h	00h	00h	00h	8	bits	Low threshold for virtual gain
GAINMAX	29h	29h	29h	29h	29h	8	bits	High threshold for virtual gain
PWMPOL	0	N/A	N/A	N/A	N/A	1	bits	PWM polarity
PWMT	1B58h	N/A	N/A	N/A	N/A	16	bits	PWM Frequency
DP	0000h	0000h	0000h	0000h	0000h	15	bits	Discontinuity point
CW	0h	0h	0h	0h	0h	1	bits	Enable Clock Wise direction
CUSTOMERID4	4	5	6	7	8	16	bits	Customer identification reference
4POINTS	1h	1h	1h	1h	1h	1	bits	Selection of correction method 4pts or 16 segments
LNR_S0	0h	0h	0h	0h	0h	16	bits	4pts – Initial Slope
LNR_A_X	7FFFh	0	0	0	0	16	bits	4pts – AX Coordinate
LNR_A_Y	0	10%	10%	10%	10%	16	bits	4pts – AY Coordinate
LNR_A_S	0	80%/360d	80%/90d	80%/180d	80%/270d	16	bits	4pts – AS Coordinate
LNR_B_X	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	16	bits	4pts – BX Coordinate
LNR_B_Y	0	0	0	0	0	16	bits	4pts – BY Coordinate
LNR_B_S	0	0	0	0	0	16	bits	4pts – BS Coordinate

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Parameter	000	200	100	300	400	coding	Unit	Description
LNR_C_X	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	16	bits	4pts – CX Coordinate
LNR_C_Y	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	16	bits	4pts – CY Coordinate
LNR_C_S	0	0	0	0	0	16	bits	4pts – CS Coordinate
LNR_D_X	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	16	bits	4pts – DX Coordinate
LNR_D_Y	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	16	bits	4pts – DY Coordinate
LNR_D_S	0	0	0	0	0	16	bits	4pts – DS Coordinate
WorkingRange	0h	0h	0h	0h	0h	4	bits	16pts – Output angle range
LNR_Y0/ CUSTOMERID1	N/A	N/A	N/A	N/A	N/A	16	bits	16pts – Y-coordinate point 0 / Cust. id reference
LNR_Y1/ CUSTOMERID2	N/A	N/A	N/A	N/A	N/A	16	bits	16pts – Y-coordinate point 1 / Cust. id reference
LNR_Y2/ CUSTOMERID3	N/A	N/A	N/A	N/A	N/A	16	bits	16pts – Y-coordinate point 2/ Cust. id reference
LNR_Yn	N/A	N/A	N/A	N/A	N/A	16	bits	16pts – Y-coordinate point n
LNR_Y16	N/A	N/A	N/A	N/A	N/A	16	bits	16pts – Y-coordinate point 16
HAMHOLE	3131h	0	0	0	0	16	bits	Hamming code recovery
LOCK	00h	4Ch	4Ch	4Ch	4Ch	8	bits	Lock byte

Table 12: End user NVRAM Parameters

The values given in table 12 are the default EEPROM content for each of the MLX90340 versions.

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17. Description of End-User Programmable Items

17.1. Output mode

Parameter	Value	Description
Analog Output Mode	1	Analog Rail to Rail – Coutmin= 47nF
	2	Analog Rail to Rail – Coutmin= 10nF
PWM Output Mode	5	Low Side (Open Drain NMOS)
	7	Push-Pull

Table 13: Output mode parameters

17.1.1. Analog Output mode

The Analog Output Mode is a rail-to-rail and ratiometric output with a push-pull output stage configuration allows the use of a pull-up or pull-down resistor.
With respect to the application diagram described in section 19.1, Melexis recommendation is Analog Output Mode 1.

17.1.2. PWM Output mode

If PWM output mode is selected, the output signal is a digital signal with Pulse Width Modulation (PWM).

The PWM polarity is selected by the PWMPOL1 parameter:

- PWMPOL = 0 for a low level at 100%
- PWMPOL = 1 for a high level at 100%

The PWM frequency is selected by the PWMT parameter. The following table provides typical code for different target PWM frequency and for both low and high speed modes.

PWM Frequency (Hz)	100	200	500	1000
PWM Frequency code (PWMT)	50000	25000	10000	5000

Table 14: PWMT to PWM Frequency Correspondance

Notes:

A more accurate trimming can be performed to take into account initial tolerance of the main clock.

The PWM frequency is subjected to the same tolerances as the main clock (see $\Delta^{T}Ck$).

17.2. Output Transfer Characteristic

There are 2 different possibilities to define the transfer function (LNR):

- With 4 arbitrary points (defined on X and Y coordinates) and 5 slopes
- With 17 equidistant points for which only the Y coordinates are defined.

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Parameter	LNR type	Value	Unit
CLOCKWISE	Both	0 → CounterClockWise 1 → ClockWise	LSB
DP	Both	0 … 359.9999	deg
LNR_A_X LNR_B_X LNR_C_X LNR_D_X	Only 4 pts	0 … 359.9999	deg
LNR_A_Y LNR_B_Y LNR_C_Y LNR_D_Y	Only 4 pts	0 … 100	%
LNR_S0 LNR_A_S LNR_B_S	Only 4 pts	0 … 17	%/deg
LNR_C_S LNR_D_S	Only 4 pts	-17 … 0 … 17	%/deg
LNR_Y0 LNR_Y1 … LNR_Y16	Only 17 pts	-50 … + 150	%
WorkingRange	Only 17 pts	65.5 … 360	Deg
CLAMP_LOW	Both	0 … 100	%
CLAMP_HIGH	Both	0 … 100	%

Table 15: Output transfer methods

17.2.1. Enable Scaling Parameter

This parameter enables to scale LNR_x_Y from -50% - 150% according to the following formula

(Scaled Out)%V_{DD} = 2 x Out%V_{DD} – 50%

17.2.2. Clockwise parameter

The CLOCKWISE parameter defines the magnet rotation direction.

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- CCW is the defined by the 1-4-5-8 pin order direction for the SOIC-8 package and 1-8-9-16 pin order direction for the TSSOP-16 package.
- CW is defined by the reverse direction: 8-5-4-1 pin order direction for the SOIC-8 and 16-9-8-1 pin order direction for the TSSOP-16 package.

Refer to the drawing in the sensitive spot positioning sections (Section 22.3)

17.2.3. Discontinuity point (or Zero degree point)

The Discontinuity Point defines the 0° point on the circle. The discontinuity point places the origin at any location of the trigonometric circle. The DP is used as reference for all the angular measurements.

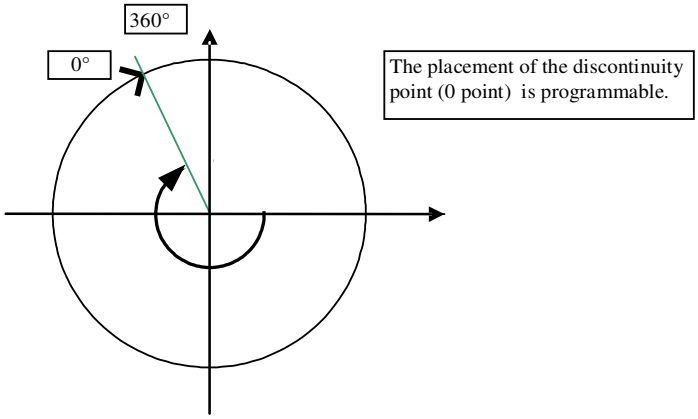


Figure 7: Discontinuity Point Positioning

17.2.4. 4-Pts LNR Parameters

The LNR parameters, together with the clamping values, fully define the relation (the transfer function) between the digital angle and the output signal.

The shape of the MLX90340 transfer function from the digital angle value to the output voltage is described by the drawing below. Six segments can be programmed but the clamping levels are necessarily flat.

Two, three, or even six calibration points are then available, reducing the overall non-linearity of the IC by almost an order of magnitude each time. Three or six calibration point will be preferred by customers looking for excellent non-linearity figures. Two-point calibrations will be preferred by customers looking for a cheaper calibration set-up and shorter calibration time.

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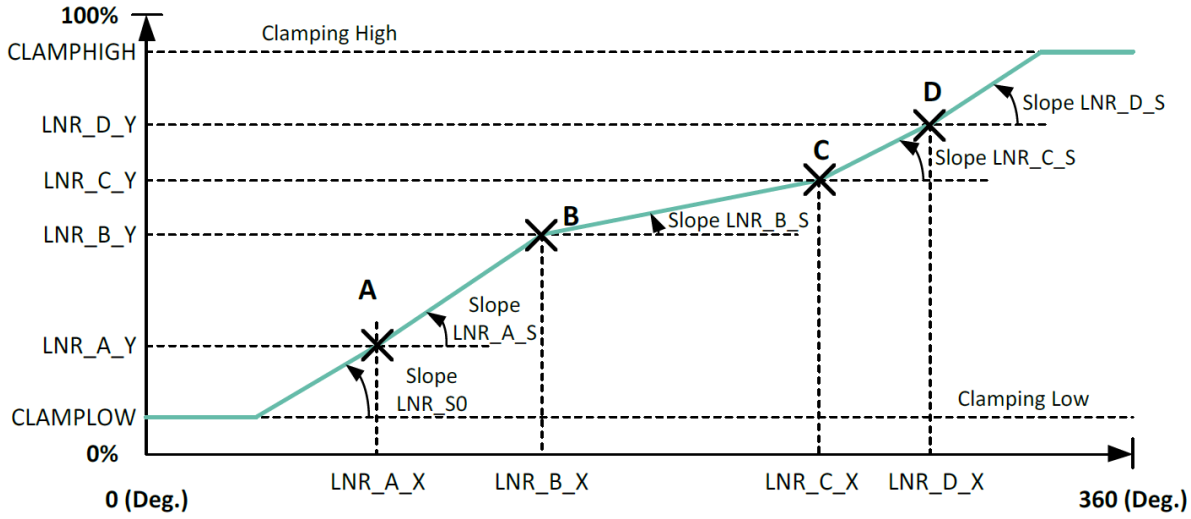


Figure 8: 4 arbitratry points calibration method

17.2.5. 17-Pts LNR Parameters

The LNR parameters, together with the clamping values, fully define the relation (the transfer function) between the digital angle and the output signal.

The shape of the MLX90340 transfer function from the digital angle value to the output voltage is described by the drawing below. In the 16-segments mode (or 17 pts), the output transfer characteristic is Piece-Wise-Linear (PWL).

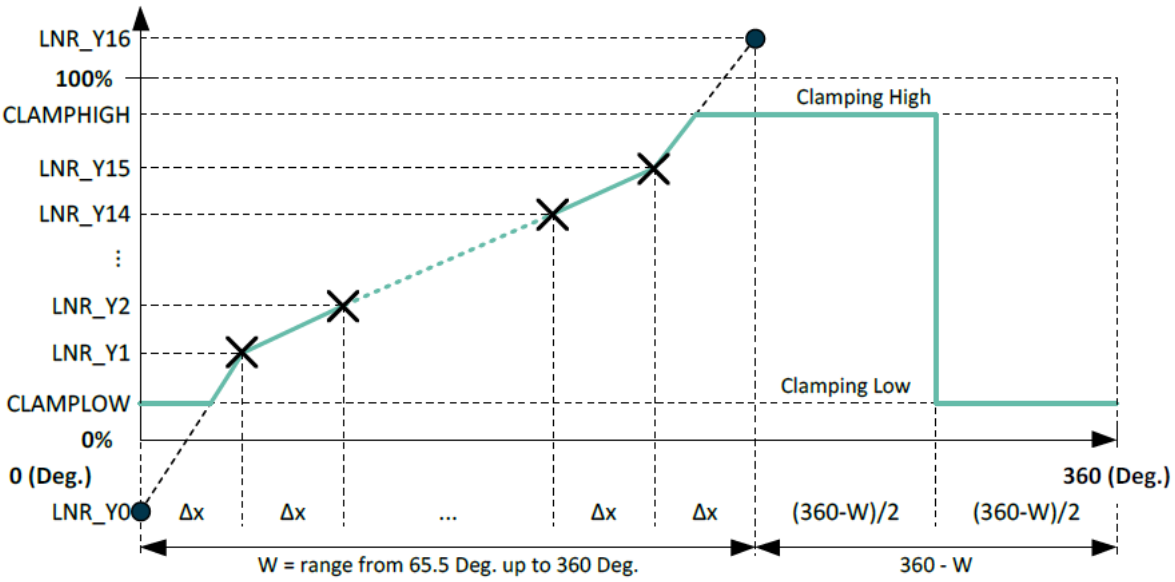


Figure 9 – 16 segments calibration method

All the Y-coordinates can be programmed from -50% up to +150% to allow clamping in the middle of one segment (like on the figure), but the output value is limited to CLAMPLOW and CLAMPHIGH values.

Between two consecutive points, the output characteristic is interpolated.

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The parameter W determines the input range on which the 17 points (16 segments) are uniformly spread:

W	Range	Δx	W	Range	Δx
0	360.0deg	22.5deg	8	180.0deg	11.3deg
1	320.0deg	20.0deg	9	144.0deg	9.0deg
2	288.0deg	18.0deg	10	120.0deg	7.5deg
3	261.8deg	16.4deg	11	102.9deg	6.4deg
4	240.0deg	15.0deg	12	90.0deg	5.6deg
5	221.5deg	13.8deg	13	80.0deg	5.0deg
6	205.7deg	12.9deg	14	72.0deg	4.5deg
7	192.0deg	12.0deg	15	65.5deg	4.1deg

Table 16: Working range

Outside of the selected range, the output will remain in clamping levels.

17.2.6. CLAMPING Parameters

The clamping levels are two independent values to limit the output voltage range. The CLAMPLOW parameter adjusts the minimum output voltage level. The CLAMPHIGH parameter sets the maximum output voltage level. Both parameters have 16 bits of adjustment and are available for both LNR modes. In analog mode, the resolution will be limited by the D/A converter (12 bits) to 0.024%V_{DD}. In PWM mode, the resolution will be 0.024%$_{DC}$.

17.3. Identification

Parameter	Value
MELEXISID1	0 … 65535
MELEXISID2	0 … 65535
MELEXISID3	0 … 65535
CUSTOMERID1	0 … 65535
CUSTOMERID2	0 … 65535
CUSTOMERID3	0 … 65535
CUSTOMERID4	0 … 65535

Table 17: Identifications Parameters

Identification number: 64 bits (4 words) freely useable by Customer for traceability purpose.

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Those 64 bits are only available if the 4pts-LNR. For the 17-Pts LNR, the corresponding EEPROM area of CUSTOMERID1,2,3 are used by the LNR function.

17.4. Sensor Front-End

Parameter	Value
MAPXYZ	0 .. 5
k (or SMISM)	0 .. 65535
GAINMIN GAINMAX	0 … 41

Table 18: Front-end parameters

17.4.1. MAPXYZ

The MAPXYZ parameter defines which fields are used to calculate the angle. The different possibilities are described in the tables below.

MAPXYZ	Angle Definition
0	$\angle XY = \angle(k \cdot B_X, B_Y)$
1	$\angle YX = \angle(B_X, k \cdot B_Y)$
2	$\angle XZ = \angle(k \cdot B_X, B_Z)$
3	$\angle ZX = \angle(B_X, k \cdot B_Z)$
4	$\angle YZ = \angle(k \cdot B_Y, B_Z)$
5	$\angle ZY = \angle(B_Y, k \cdot B_Z)$

Table 19: Magnetic Mapping Parameters

17.4.2. K parameter

The k parameter defines the sensitivity mismatch between the 2 selected axis used for the angular calculation. Its value is defined through an unsigned 16 bits value from 0.0 to 1.0. Typical values are between 0.5 and 1.

The MAPXYZ is defined in factory to be 0 or 1. For an end-user XY-application, don't overwrite this parameter.

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17.4.3. GAINMIN and GAINMAX Parameters

GAINMIN and GAINMAX define the boundaries within the virtual gain setting is allowed to vary. Outside this range, the output is set in diagnostic mode.

17.5. Filter

Parameter	Value
Filter	0 … 2

Table 20: Filtering value

The MLX90340 includes the possibility to filter the angular value:

Low Pass FIR Filters controlled with the FILTER parameter

The MLX90340 features 2 FIR filter modes controlled with Filter = 1…2. Filter = 0 corresponds to no filtering. The transfer function is described below:

$$y_n = \frac{1}{\sum_{i=0}^{j} a_i} \sum_{i=0}^{j} a_i x_{n-i}$$

The filters characteristics are given in the following table:

Filter No	0	1	2
j	0	1	3
Type	Disable	Finite Impulse Response	
Coefficients a_i	1	11	1111
Title	No filter	ExtraLight	Light
99% Response Time	1	2	4
Efficiency RMS (dB)	0	3.0	6.0

Table 21: Filtering characteristic

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17.6. Programmable Diagnostic Settings

Parameter	Value
DIAG	0 or 1
ADIAG	0 or 1
HAMHOLE	0 or 3131h

Table 22: Diagnostics control parameters

17.6.1. Fixed-level diagnostic reporting

In analog output mode

DIAG and ADIAG parameters allow selecting all diagnostic modes:

Mode	Type	Description
With pull-up ADIAG = 0	DIAG = 0 DIAG = 1	Diagnostic Low Diagnostic Hi (HiZ + pull-up)
With pull-down ADIAG = 1	DIAG = 0 DIAG = 1	Diagnostic Low (HiZ + pull-down) Diagnostic Hi

Table 23: Diagnostics control details in Analog modes

Mode	Type	Description
Open drain NMOS	DIAG = 0 DIAG = 1	Diagnostic Low Diagnostic Hi (HiZ + pull-up)
Push-pull output	DIAG = 0 DIAG = 1	Diagnostic Low Diagnostic Hi

Table 24: Diagnostics control details in PWM modes

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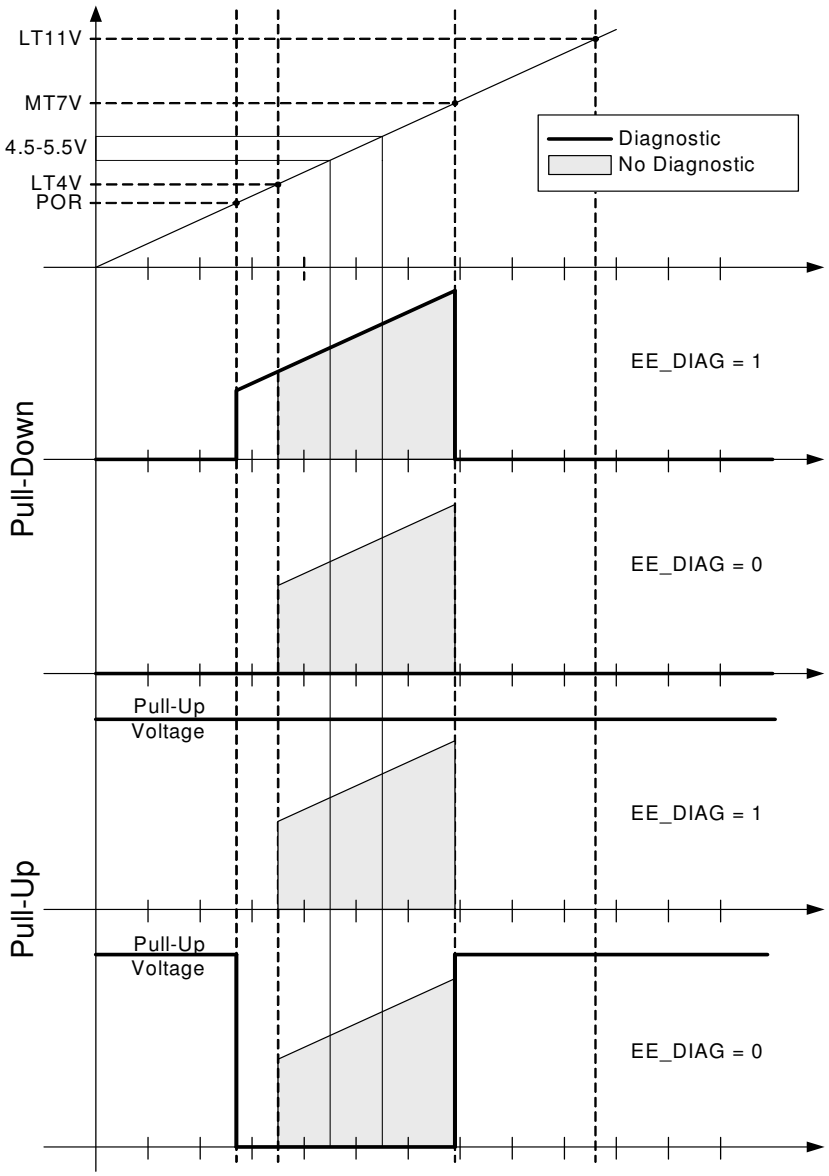


Figure 10 - Output voltage in diagnostic modes over supply voltage

17.6.2. HAMHOLE Parameter

The HAMHOLE parameter enables or disables the memory recovery based on Hamming codes in case of EEPROM CRC error. By default, the memory recovery and EEPROM CRC check are disabled (Hamhole=3131h). These two features are enabled automatically when locking the part (see paragraph 17.7).

17.7. Lock

The LOCK parameter locks all the parameters set by the user. Once the lock is enabled, it is not possible to change the EEPROM values anymore as PTC communication in writing mode is not available anymore.

Note that the lock bit should be set by the solver function “MemLock”.

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17.8. EEPROM endurance

Although the EEPROM is used for Calibration Data Storage (similarly to an OTPROM), the MLX90340 embedded EEPROM is qualified to guarantee an endurance of minimum 1000 write cycles at 125˚C for (engineering/calibration purpose).

18. Self Diagnostic

The MLX90340 provides numerous self-diagnostic features. Those features increase the robustness of the IC functionality as it will prevent the IC to provide erroneous output signal in case of internal or external failure modes ("fail-safe").

	Action	Effects on OUT	Comments
ROM CRC Error at start up (64 words including Intelligent Watch Dog - IWD)	CPU Reset [6]	Diagnostic low/high[19]	All the outputs are already in Diagnostic low/high - (start-up)
ROM CRC Error (Operation - Background task)	Enter Endless Loop: - Progress (watchdog Acknowledge) - Set Outputs in Diagnostic low/high	Immediate Diagnostic low//high[19]	
RAM Test Fail (Start up)	CPU Reset	Diagnostic low/ high [19]	All the outputs are already in Diagnostic low/high (start-up)
Calibration Data CRC Error (Start-Up)	Hamming Code Recovery		Start-Up Time is increased by 3 ms if successful recovery
Hamming Code Recovery Error (Start-Up)	CPU Reset	Diagnostic low/high[19]	See section HAMHOLE

[6] *CPU reset means*

1. Core Reset (same as Power-On-Reset). It induces a typical start up time.
2. Periphery Reset (same as Power-On-Reset)
3. Fault Flag/Status Lost

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	Action	Effects on OUT	Comments
Calibration Data CRC Error (Operation - Background)	CPU Reset	Diagnostic low/high[19]	
ADC Clipping (ADC Output is 0000h or 7FFFh)	Set Outputs in Diagnostic low/high Normal mode and CPU Reset If recovery	Immediate Diagnostic low/high[19]	
Norm Too Low (< 25 %)	Set Outputs in Diagnostic low/high Normal mode and CPU Reset If recovery	Immediate Diagnostic low/high[19]	If no magnet IC in Diag. mode.
Rough Offset Clipping (RO is = 0d or = 127d)	Set Outputs in Diagnostic low/high Normal mode, with immediate recovery without CPU reset	Immediate Diagnostic low/high[19]	
Gain Clipping (Gain < GAINMIN or Gain > GAINMAX)	Set Outputs in Diagnostic low/high Normal mode, and CPU Reset If recovery	Immediate Diagnostic low/high[19]	See also Section GAINMIN and GAINMAX.
ADC Monitor (Analog to Digital Converter)	Set Outputs in Diagnostic low/high. Normal Mode with immediate recovery without CPU Reset	Immediate Diagnostic low/high[19]	ADC Inputs are Shorted and connected to Vref. ADC output is compared to a fixed value.

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	Action	Effects on OUT	Comments
Undervoltage Mode	At Start-Up, wait Until VDD > LT4V. During operation, CPU Reset after 3 ms debouncing.	- VDD < POR level => Output high impedance - POR level < VDD < ~LT4V => Output in Diagnostic low/high[7].	
Firmware Flow Error	CPU Reset	Immediate Diagnostic low/high[19]	Intelligent Watchdog (Observer)
Read/Write Access out of physical memory	CPU Reset	Immediate Diagnostic low/high[19]	100% Hardware detection
Write Access to protected area (IO and RAM Words)	CPU Reset	Immediate Diagnostic low/high[19]	100% Hardware detection
Unauthorized entry in “SYSTEM” Mode	CPU Reset	Immediate Diagnostic low/high[19]	100% Hardware detection
VDD > MT7V	Set Output High Impedance (Analog)	Pull down resistive load => Diag. Low Pull up resistive load => Diag. High	100% Hardware detection
VDD > LT11V	IC is switched off (internal supply) CPU Reset on recovery	Pull down resistive load => Diag. Low Pull up resistive load => Diag. High	100% Hardware detection
Broken VSS	CPU Reset on recovery	Pull down resistive load < 10kΩ => Diag. Low Pull up resistive load (any value) => Diag. High	100% Hardware detection
Broken VDD	CPU Reset on recovery	Pull down resistive load (any value) => Diag. Low Pull up resistive load < 10kΩ => Diag. High	100% Hardware detection

[7] The diagnostics can be selectable between Diagnostic Low/Diagnostic High by setting the bits EE_DIAG and EE_ADIAG (for analog modes only). See section Programmable Diagnostic Settings for the Diagnostic Output Level specifications.

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	Action	Effects on OUT	Comments
Temperature Monitor	Set Outputs in Diagnostic low/high. Normal Mode with immediate recovery without CPU Reset	Immediate Diagnostic low/high(19)	Temperature Sensor 1 is compared to temperature sensor 2

Table 25: Diagnostics details

19. Recommended Application Diagrams

19.1. MLX90340 in SOIC-8 Package

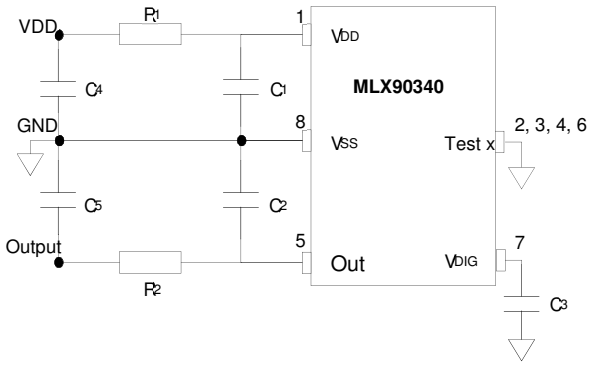


Figure 11 –Recommended wiring for the MLX90340 in SOIC-8 package

Output	Compact PCB routing			EMC robust PCB routing			
Analog Output	Min	Typ.	Max	Min	Typ.	Max	Remarks
C1	100 nF	100 nF	1 uF	47 nF	100 nF	1 uF	Close to the pin
C2 (20)	47 nF	100 nF	330 nF	47 nF	100 nF	330 nF	Close to the pin
C3	47 nF	100 nF	220 nF	47 nF	100 nF	220 nF	Close to the pin
C4	-	-	-	500 pF	1 nF	10 nF	Connector Side
C5	-	-	-	500 pF	1 nF	10 nF	Connector Side
R1	-	-	-	0 Ω	10 Ω	33 Ω	Increased ratiometry error
R2	-	-	-	10 Ω	50 Ω	100 Ω	

Figure 12 – Analog Ouptut mode - Recommended capacitor/resistor values for the MLX90340 in SOIC-8 package

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Output	Compact PCB routing			EMC robust PCB routing			
PWM Output	Min	Typ.	Max	Min	Typ.	Max	Remarks
C1	100 nF	100 nF	1 uF	47 nF	100 nF	1 uF	Close to the pin
C2	2.2 nF	4.7 nF	22 nF	2.2 nF	4.7 nF	22 nF	Close to the pin
C3	47 nF	100 nF	220 nF	47 nF	100 nF	220 nF	Close to the pin
C4	-	-	-	500 pF	1 nF	10 nF	Connector Side
C5	-	-	-	500 pF	1 nF	2.2 nF	Connector Side
R1	-	-	-	0 Ω	10 Ω	33 Ω	Impacts the Voltage on VDD pin
R2	-	-	-	10 Ω	50 Ω	100 Ω	

Figure 13 – Analog Ouptut mode - Recommended capacitor/resistor values for the MLX90340 in SOIC-8 package

19.2. MLX90340 in TSSOP-16 Package

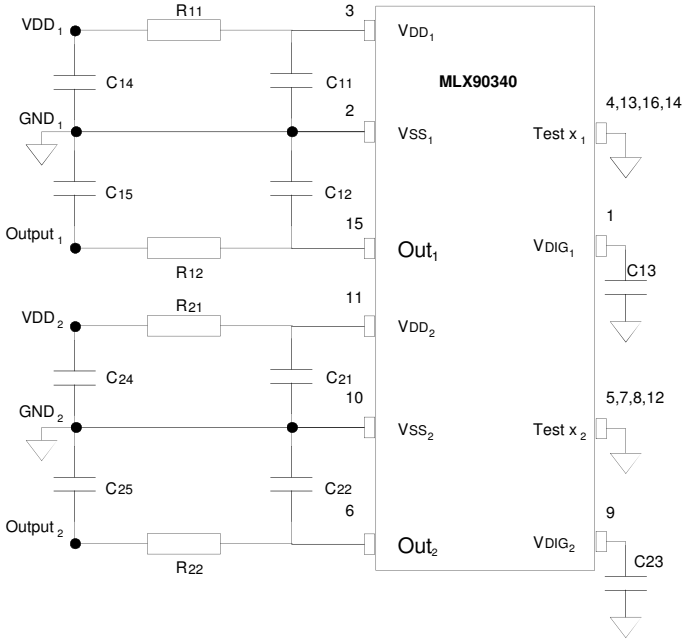


Figure 14 –Recommended wiring for the MLX90340 in TSSOP16 package (dual die)

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Output	Compact PCB routing			EMC robust PCB routing			
Analog Output	Min	Typ.	Max	Min	Typ.	Max	Remarks
C11, C21	100 nF	100 nF	1 uF	47 nF	100 nF	1 uF	Close to the pin
C12, C22	47 nF	100 nF	330 nF	47 nF	100 nF	330 nF	Close to the pin
C13, C23	47 nF	100 nF	220 nF	47 nF	100 nF	220 nF	Close to the pin
C14, C24	-	-	-	500 pF	1 nF	10 nF	Connector Side
C15, C25	-	-	-	500 pF	1 nF	10 nF	Connector Side
R11, R21	-	-	-	0 Ω	10 Ω	33 Ω	Increased ratiometry error
R12, R22	-	-	-	10 Ω	50 Ω	100 Ω	

Output	Compact PCB routing			EMC robust PCB routing			
PWM Output	Min	Typ.	Max	Min	Typ.	Max	Remarks
C11, C21	100 nF	100 nF	1 uF	47 nF	100 nF	1 uF	Close to the pin
C12, C22	22 nF	4.7 nF	22 nF	2.2 nF	4.7 nF	22 nF	Close to the pin
C13, C23	47 nF	100 nF	220 nF	47 nF	100 nF	220 nF	Close to the pin
C14, C24	-	-	-	500 pF	1 nF	10 nF	Connector Side
C15, C25	-	-	-	500 pF	1 nF	2.2 nF	Connector Side
R11, R21	-	-	-	0 Ω	10 Ω	33 Ω	Impacts the Voltage on VDD pin
R12, R22	-	-	-	10 Ω	50 Ω	100 Ω	

20. 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 standards in place in Semiconductor industry.

For further details about test method references and for compliance verification of selected soldering method for product integration, Melexis recommends reviewing on our web site the General Guidelines soldering recommendation (http://www.melexis.com/en/quality-environment/soldering).

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

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For package technology embedding trim and form post-delivery capability, Melexis recommends consulting the dedicated trim&forming recommendation application note: lead trimming and forming recommendations (http://www.melexis.com/en/documents/documentation/application-notes/lead-trimming-and-forming-recommendations).

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/en/quality-environment

21. ESD Precautions

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

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

22. Package Information

22.1. SOIC-8 - Package Dimensions

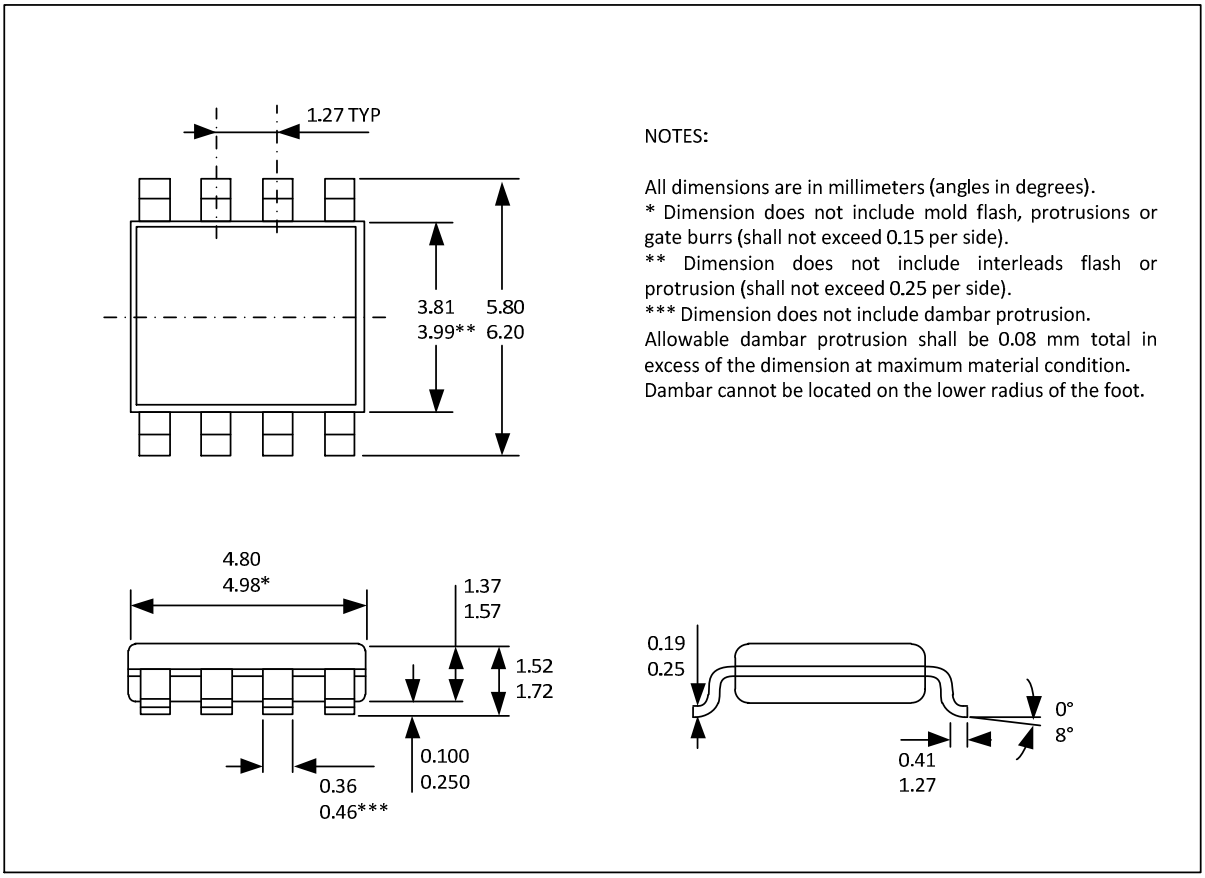


Figure 15

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22.2. SOIC-8 - Pinout and Marking

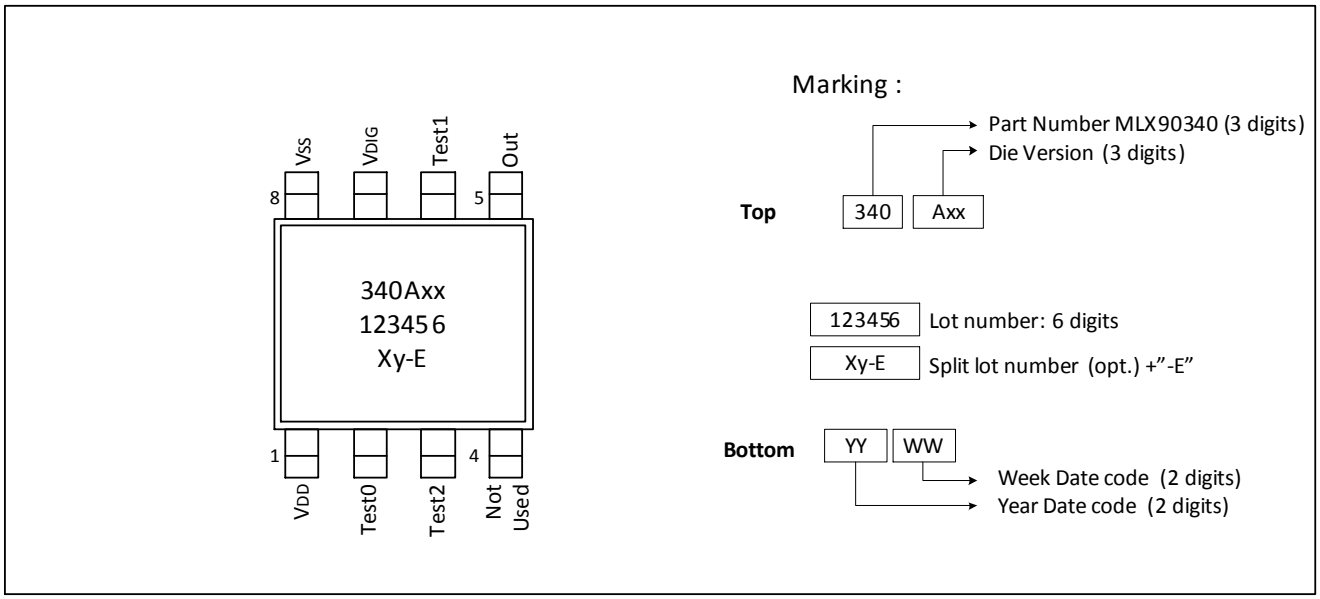


Figure 16

22.3. SOIC-8 - Sensitive spot Positioning

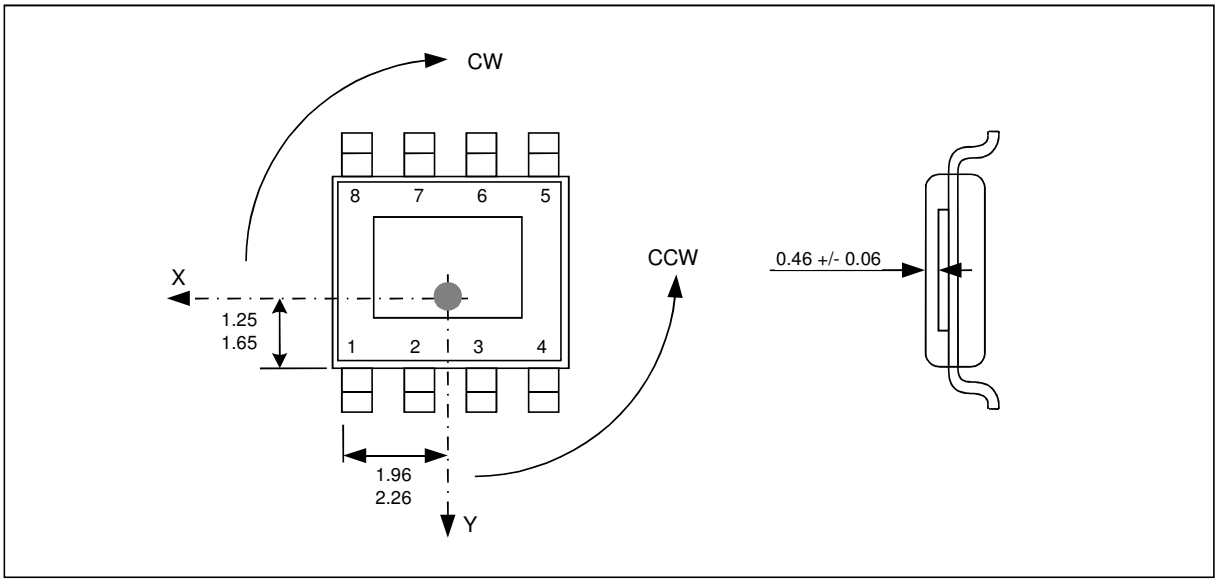


Figure 17

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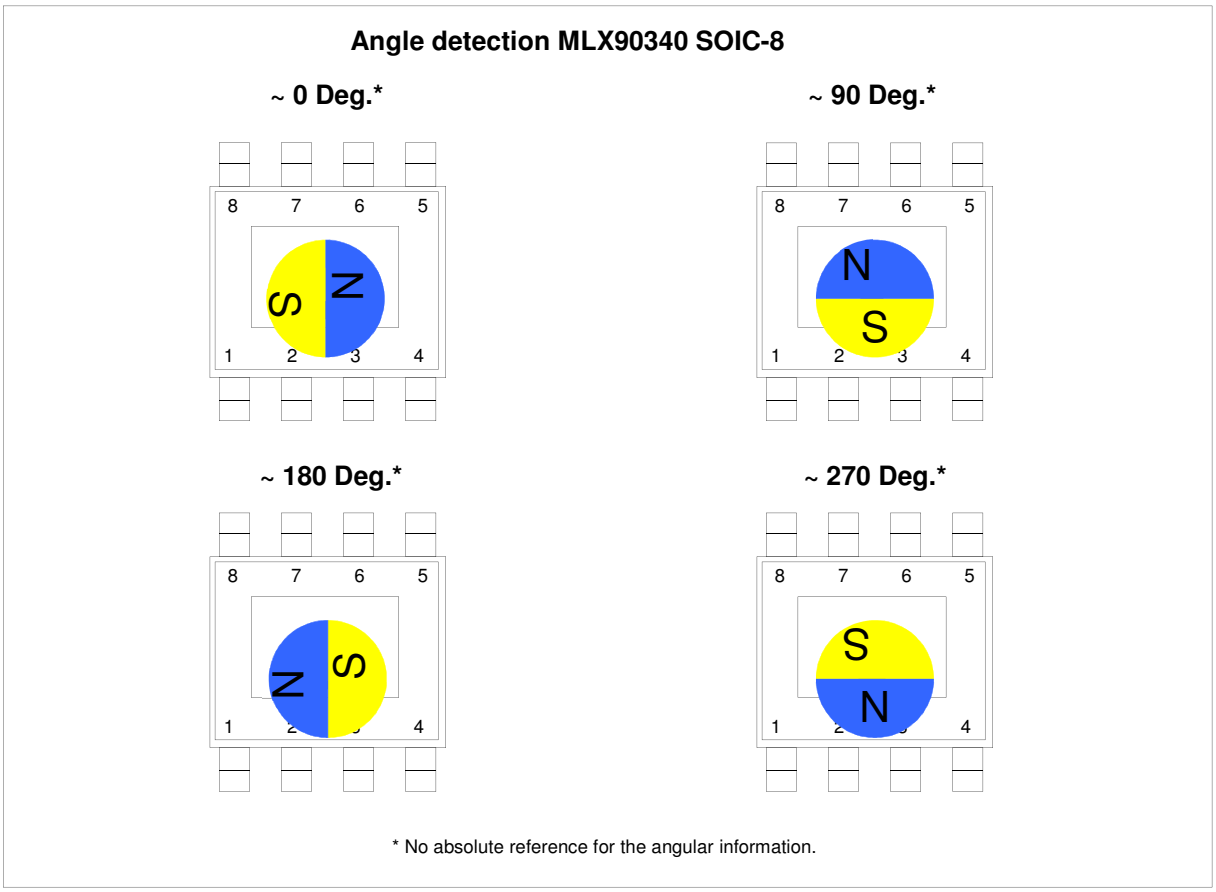
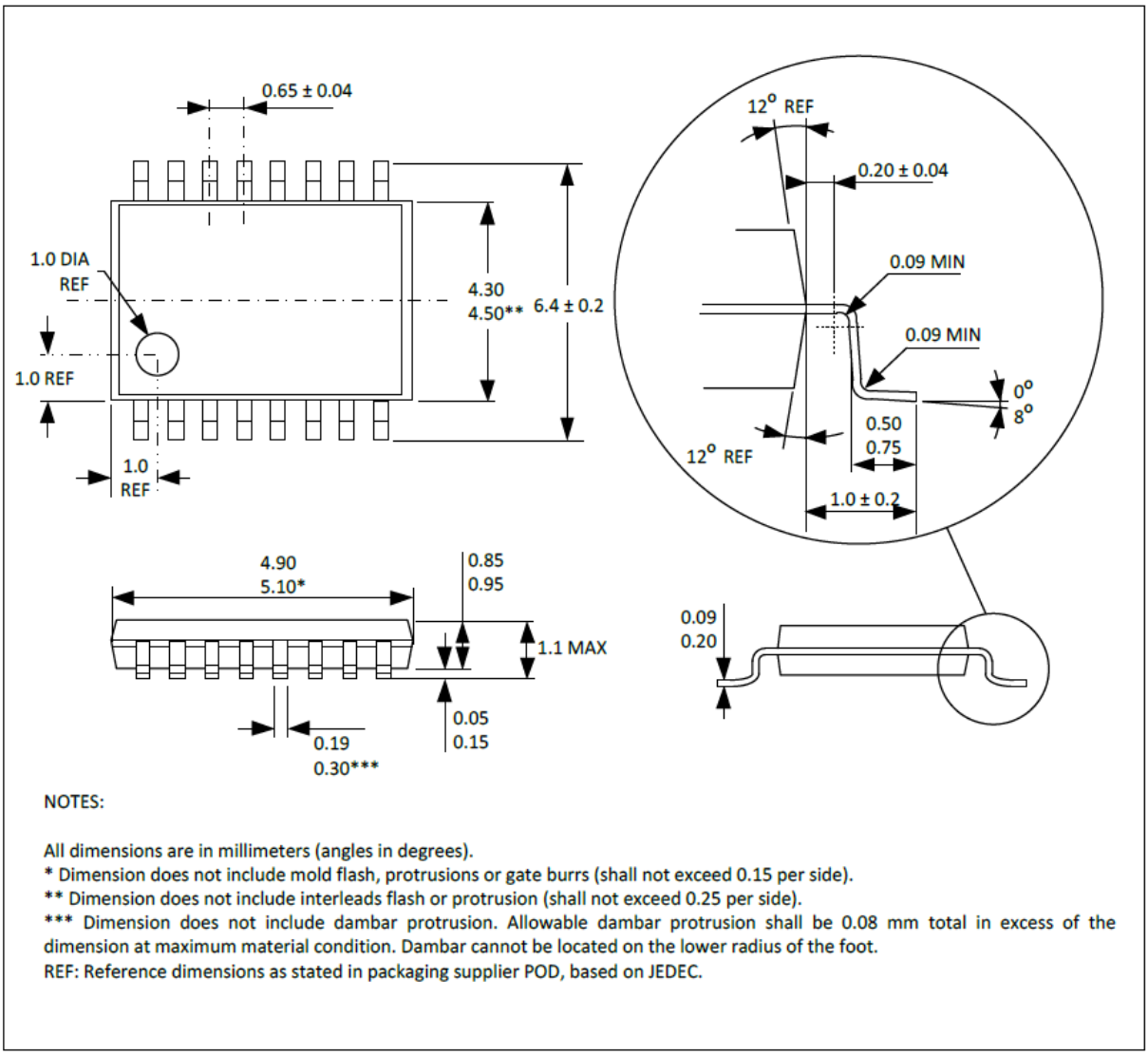


Figure 18

The MLX90340 is an absolute angular position sensor but the linearity error (See section 13) does not include the error linked to the absolute reference 0 Deg (which can be fixed in the application through the discontinuity point).

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22.4. TSSOP16 - Package Dimensions



NOTES:

All dimensions are in millimeters (angles in degrees).
* Dimension does not include mold flash, protrusions or gate burrs (shall not exceed 0.15 per side).
** Dimension does not include interleads flash or protrusion (shall not exceed 0.25 per side).
*** Dimension does not include dambar protrusion. Allowable dambar protrusion shall be 0.08 mm total in excess of the dimension at maximum material condition. Dambar cannot be located on the lower radius of the foot.
REF: Reference dimensions as stated in packaging supplier POD, based on JEDEC.

Figure 19

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22.5. TSSOP16 - Pinout and Marking

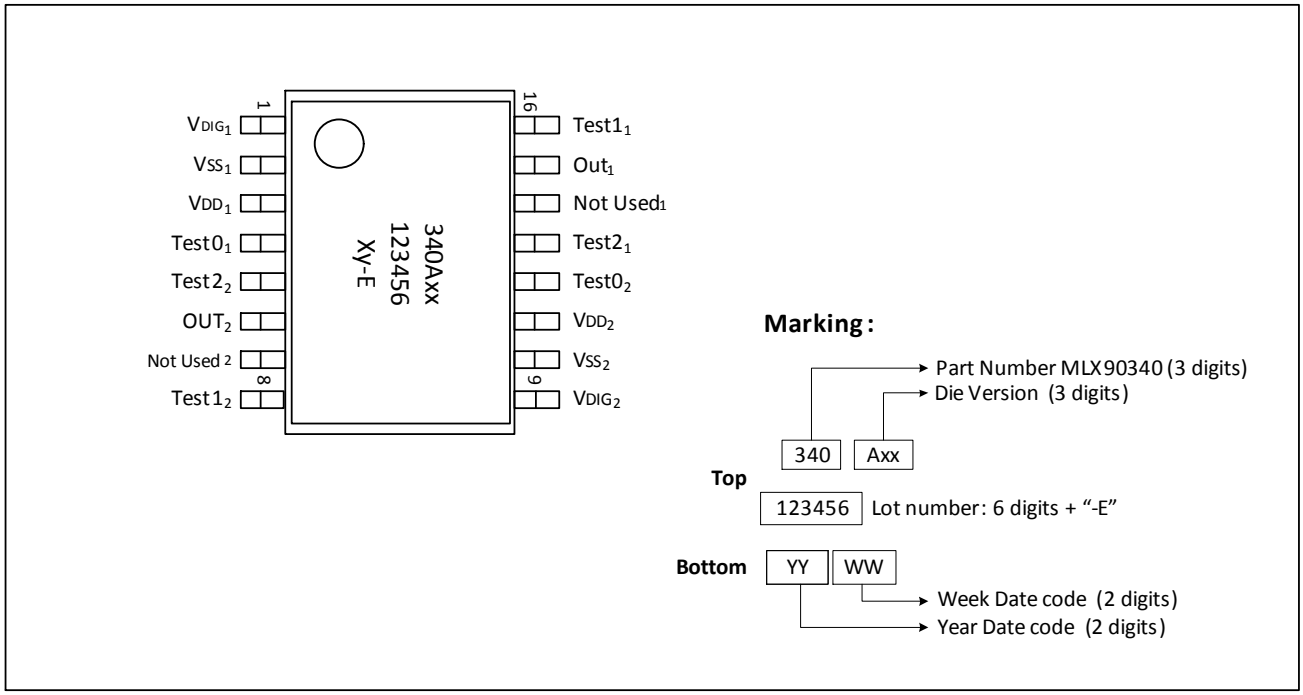


Figure 20

22.6. TSSOP16 - Sensitive spot Positioning

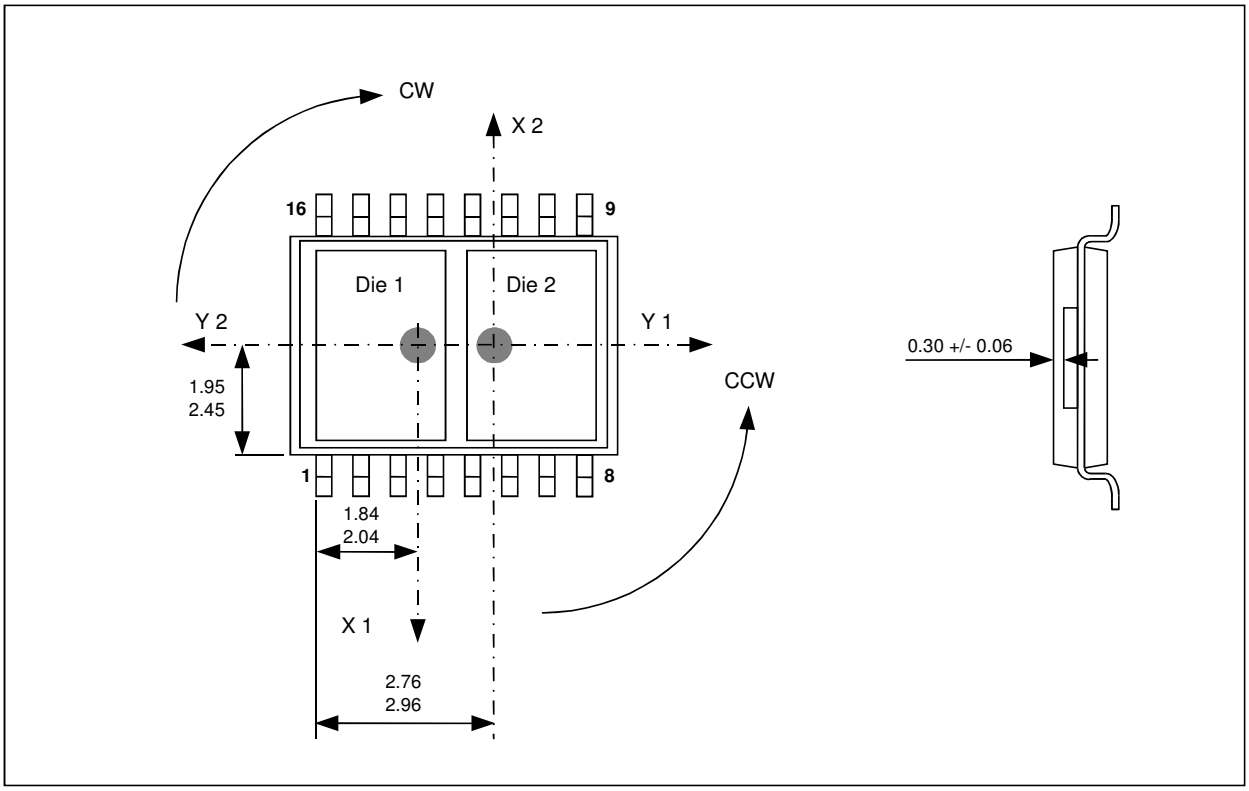


Figure 21

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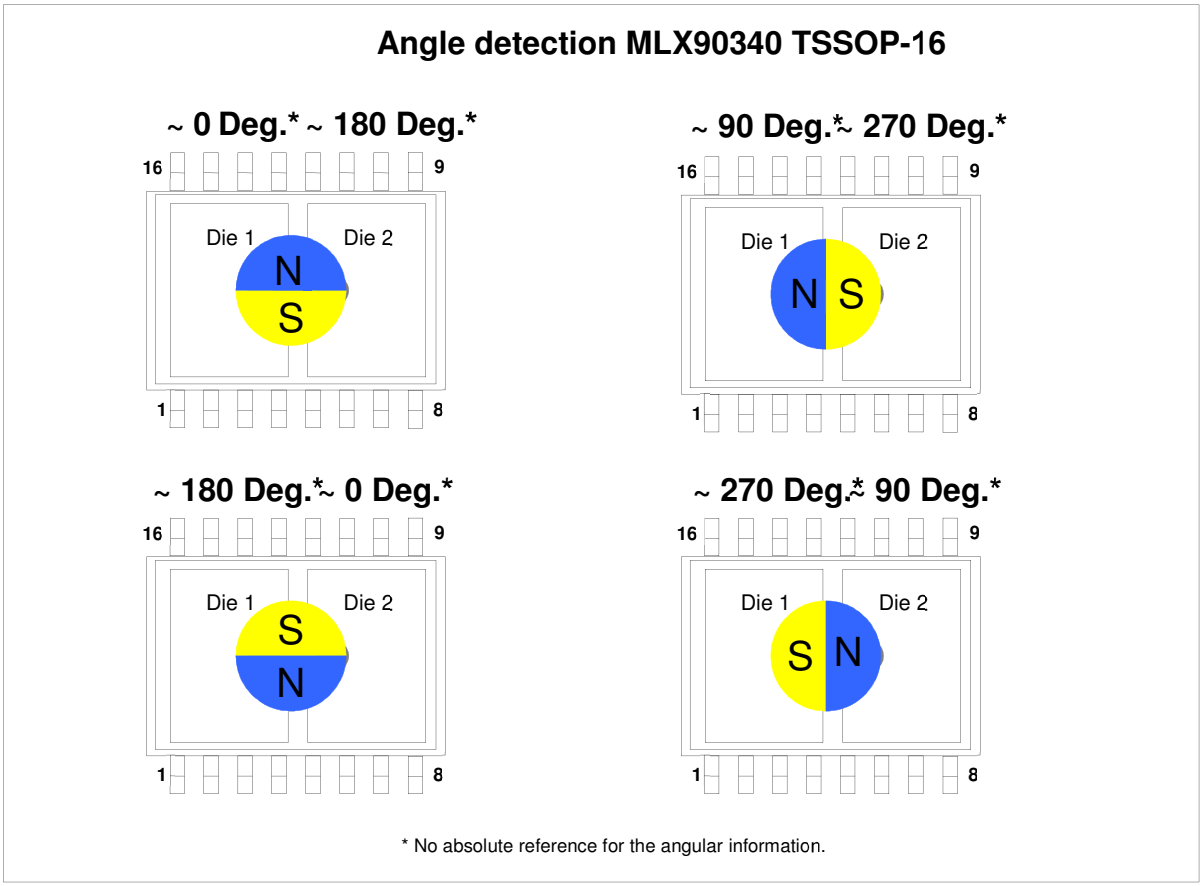


Figure 22

The MLX90340 is an absolute angular position sensor but the linearity error (See section 13) does not include the error linked to the absolute reference 0Deg (which can be fixed in the application through the discontinuity point).

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24. Contacts

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