MLX90316

Rotary Position Sensor IC

Features and Benefits

Absolute Rotary Position Sensor IC
Simple & Robust Magnetic Design
Tria⊗is™ Hall Technology
Programmable Angular Range up to 360 Degrees
Programmable Linear Transfer Characteristic
Selectable Analog (Ratiometric), PWM, Serial Protocol
12 bit Angular Resolution - 10 bit Angular Thermal Accuracy
40 bit ID Number
Single Die – SO8 Package RoHS Compliant
Dual Die (Full Redundant) – TSSOP16 Package RoHS Compliant



Applications

Absolute Rotary Position Sensor
Pedal Position Sensor
Throttle Position Sensor
Ride Height Position Sensor
Steering Wheel Position Sensor
Motor-shaft Position Sensor
Float-Level Sensor
Non-Contacting Potentiometer

Ordering Information[1]

Part No.	Temperature Suffix	Package Code	Option code
MLX90316	S (– 20°C to + 85°C)	DC [SOIC-8]	-[2]
MLX90316	E (– 40°C to + 85°C)	DC [SOIC-8]	-[2]
MLX90316	K (– 40°C to + 125°C)	DC [SOIC-8]	-[2]
MLX90316	L (– 40°C to + 150°C)	DC [SOIC-8]	-[2]
MLX90316	S (– 20°C to + 85°C)	GO [TSSOP-16]	-[2]
MLX90316	E (– 40°C to + 85°C)	GO [TSSOP-16]	-[2]
MLX90316	K (– 40°C to + 125°C)	GO [TSSOP-16]	-[2]
MLX90316	L (– 40°C to + 150°C)	GO [TSSOP-16]	-[2]
MLX90316	E (– 40°C to + 85°C)	DC [SOIC-8]	SPI[3]
MLX90316	K (– 40°C to + 125°C)	DC [SOIC-8]	SPI[3]
MLX90316	L (– 40°C to + 150°C)	DC [SOIC-8]	SPI[3]
MLX90316	E (– 40°C to + 85°C)	GO [TSSOP-16]	SPI[3]
MLX90316	K (– 40°C to + 125°C)	GO [TSSOP-16]	SPI[3]
MLX90316	L (– 40°C to + 150°C)	GO [TSSOP-16]	SPI[3]
MLX90316	K (– 40°C to + 125°C)	DC [SOIC-8]	PPA[4]
MLX90316	K (– 40°C to + 125°C)	GO [TSSOP-16]	PPA[4]
MLX90316	K (– 40°C to + 125°C)	DC [SOIC-8]	PPD[5]
MLX90316	K (– 40°C to + 125°C)	GO [TSSOP-16]	PPD[5]

[1] Example: MLX90316KDC-PPA
[2] Fully end-user programmable version through the Melexis Programming Unit PTC-04
[3] SPI Version pre-programmed and locked for 360deg rotary position application in SPI mode (High Speed). The standard version can also be programmed in SPI but the application diagram described in section 17.4.3 is recommended.
[4] Pre-Programmed Analog – 360deg angular span for an analog output between 0.5V and 4.5V, Low Speed Mode (Locked)
[5] Pre-Programmed PWM – 360deg angular span, 10-90% at 1 kHz, High Speed Mode (Locked)

1. Functional Diagram

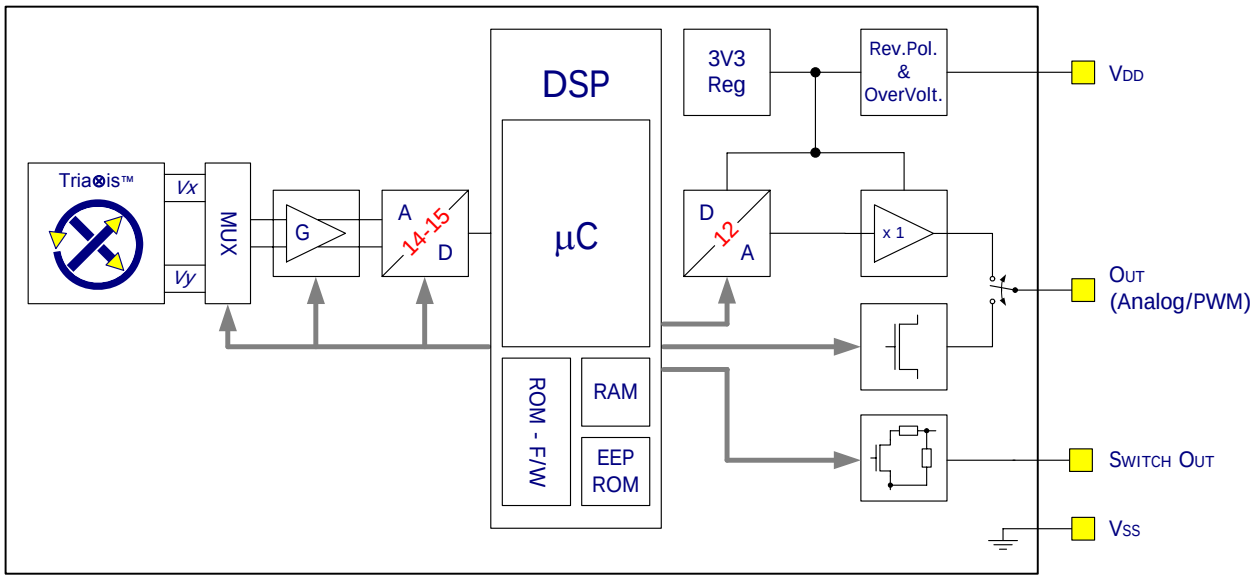


Figure 1 - Block Diagram (Analog & PWM)

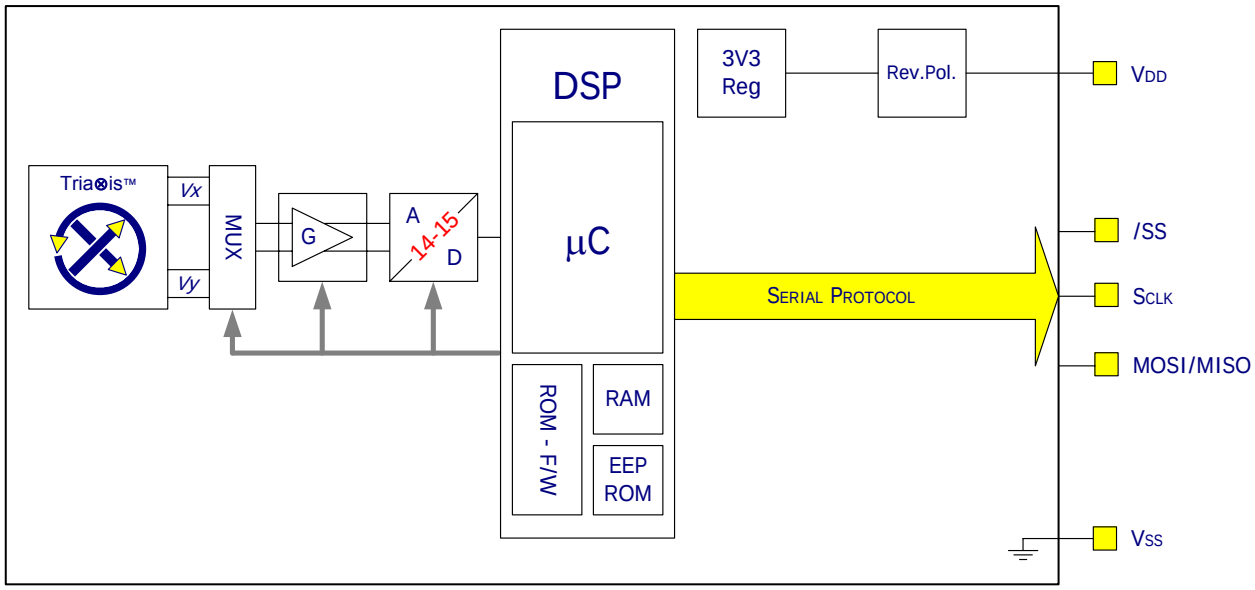


Figure 2 - Block Diagram (Serial Protocol)

2. Description

The MLX90316 is a monolithic sensor IC featuring the Tria⊗is™ Hall technology. Conventional planar Hall technology is only sensitive to the flux density applied orthogonally to the IC surface. The Tria⊗is™ Hall sensor is also sensitive to the flux density applied parallel to the IC surface. This is obtained through an Integrated Magneto-Concentrator (IMC®) which is deposited on the CMOS die (as an additional back-end step).

The MLX90316 is only sensitive to the flux density coplanar with the IC surface. This allows the MLX90316 with the correct magnetic circuit to decode the absolute rotary (angular) position from 0 to 360 Degrees. It enables the design of novel generation of non-contacting rotary position sensors that are frequently required for both automotive and industrial applications.

In combination with the appropriate signal processing, the magnetic flux density of a small magnet (diametral magnetization) rotating above the IC can be measured in a non-contacting way (Figure 3). The angular information is computed from both vectorial components of the flux density (i.e. B_X and B_Y). MLX90316 produces an output signal proportional to the decoded angle. The output is selectable between Analog, PWM and Serial Protocol.

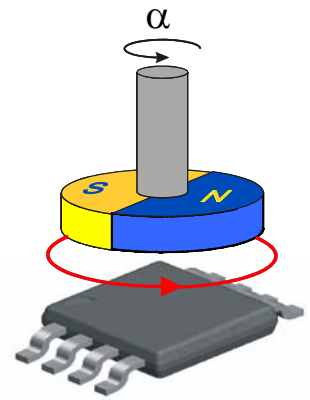


Figure 3 - Typical application of MLX90316

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3. Glossary of Terms – Abbreviations – Acronyms

- Gauss (G), Tesla (T): Units for the magnetic flux density – 1 mT = 10 G
- TC: **T**emperature **C**oefficient (in ppm/Deg.C.)
- NC: **N**ot **C**onnected
- PWM: **P**ulse **W**idth **M**odulation
- %DC: **D**uty **C**ycle of the output signal i.e. T_{ON} /(T_{ON} + T_{OFF})
- ADC: **A**nalog-to-**D**igital **C**onverter
- DAC: **D**igital-to-**A**nalog **C**onverter
- LSB: **L**east **S**ignificant **B**it
- MSB: **M**ost **S**ignificant **B**it
- DNL: **D**ifferential **N**on-**L**inearity
- INL: **I**ntegral **N**on-**L**inearity
- RISC: **R**educed **I**nstruction **S**et **C**omputer
- ASP: **A**nalog **S**ignal **P**rocessing
- DSP: **D**igital **S**ignal **P**rocessing
- ATAN: trigonometric function: arctangent (or inverse tangent)
- IMC: **I**ntegrated **M**agneto-**C**oncentrator (IMC®)
- CoRDiC: **Co**ordinate **R**otation **Di**gital **C**omputer (i.e. iterative rectangular-to-polar transform)
- EMC: **E**lectro-**M**agnetic **C**ompatibility

4. Pinout

Pin #	SOIC-8		TSSOP-16	
	Analog / PWM	Serial Protocol	Analog / PWM	Serial Protocol
1	V_{DD}	V_{DD}	V_{DIG1}	V_{DIG1}
2	Test 0	Test 0	V_{SS1} (Ground$_1$)	V_{SS1} (Ground$_1$)
3	Switch Out	/SS	V_{DD1}	V_{DD1}
4	Not Used	SCLK	Test 0$_1$	Test 0$_1$
5	Out	MOSI / MISO	Switch Out$_2$	/SS$_2$
6	Test 1	Test 1	Not Used$_2$	SCLK$_2$
7	V_{DIG}	V_{DIG}	Out$_2$	MOSI$_2$ / MISO$_2$
8	V_{SS} (Ground)	V_{SS} (Ground)	Test 1$_2$	Test 1$_2$
9			V_{DIG2}	V_{DIG2}
10			V_{SS2} (Ground$_2$)	V_{SS2} (Ground$_2$)
11			V_{DD2}	V_{DD2}
12			Test 0$_2$	Test 0$_2$
13			Switch Out$_1$	/SS$_1$
14			Not Used$_1$	SCLK$_1$
15			Out$_1$	MOSI$_1$ / MISO$_1$
16			Test 1$_1$	Test 1$_1$

For optimal EMC behavior, it is recommended to connect the unused pins (Not Used and Test) to the Ground (see section 17).

5. Absolute Maximum Ratings

Parameter	Value
Supply Voltage, V_{DD} (overvoltage)	+ 20 V
Reverse Voltage Protection	– 10 V
Positive Output Voltage – Standard Version (Analog or PWM)	+ 10 V + 14 V (200 s max – T_A = + 25°C)
Positive Output Voltage – SPI Version	V_{DD} + 0.3V
Positive Output Voltage (Switch Out)	+ 10 V + 14 V (200 s max – T_A = + 25°C)
Output Current (I_{OUT})	± 30 mA
Reverse Output Voltage	– 0.3 V
Reverse Output Current	– 50 mA
Operating Ambient Temperature Range, T_A	– 40°C … + 150°C
Storage Temperature Range, T_S	– 40°C … + 150°C
Magnetic Flux Density	± 700 mT

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

6. Detailed Description

As described on the block diagram (Figure 1 and Figure 2), the magnetic flux density parallel to the IC surface (i.e. $B_{//}$) is sensed through the Tria⊗is™ sensor front-end. This front-end consists into two orthogonal pairs (for each of the two directions parallel with the IC surface i.e. X and Y) of conventional planar Hall plates (blue area on Figure 4) and an Integrated Magneto-Concentrator (IMC® yellow disk on Figure 4).

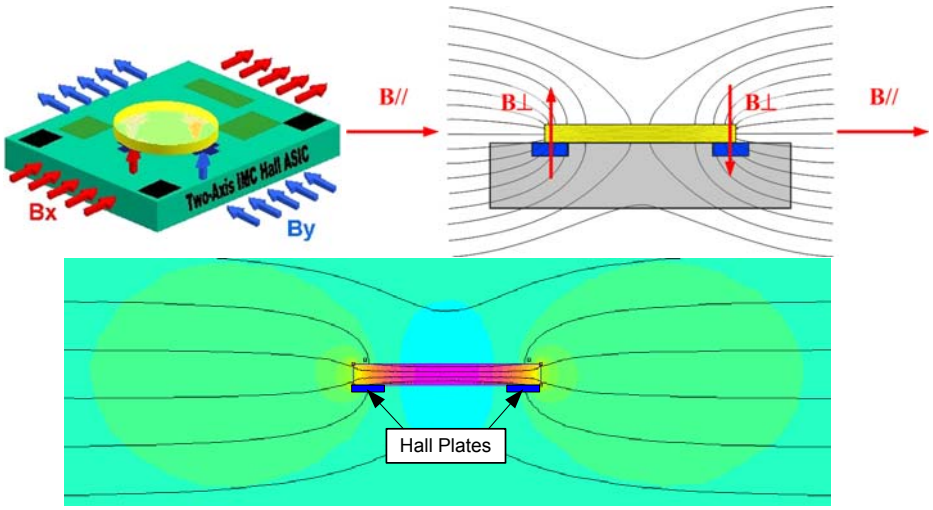


Figure 4 - Tria⊗is™ sensor front-end (4 Hall plates + IMC® disk)

Both components of the applied flux density $B_{//}$ are measured individually i.e. $B_{X//}$ and $B_{Y//}$. Two orthogonal components (respectively $B_{X\perp}$ and $B_{Y\perp}$) proportional to the parallel components (respectively $B_{X//}$ and $B_{Y//}$) are induced through the IMC and can be measured by both respective pairs of conventional planar Hall plates as those are sensitive to the flux density applied orthogonally to them and the IC surface.

While a magnet (diametrically magnetized) rotates above the IC as described on Figure 3, the sensing stage provides two differential signals in quadrature (sine and cosine – Figure 5 and Figure 6)

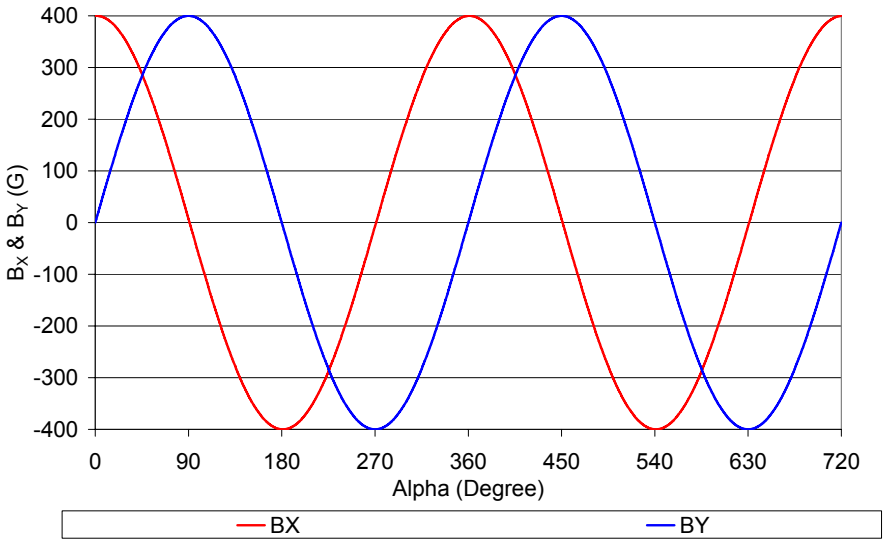


Figure 5 – Magnetic Flux Density – $B_X \propto \cos(\alpha)$ & $B_Y \propto \sin(\alpha)$

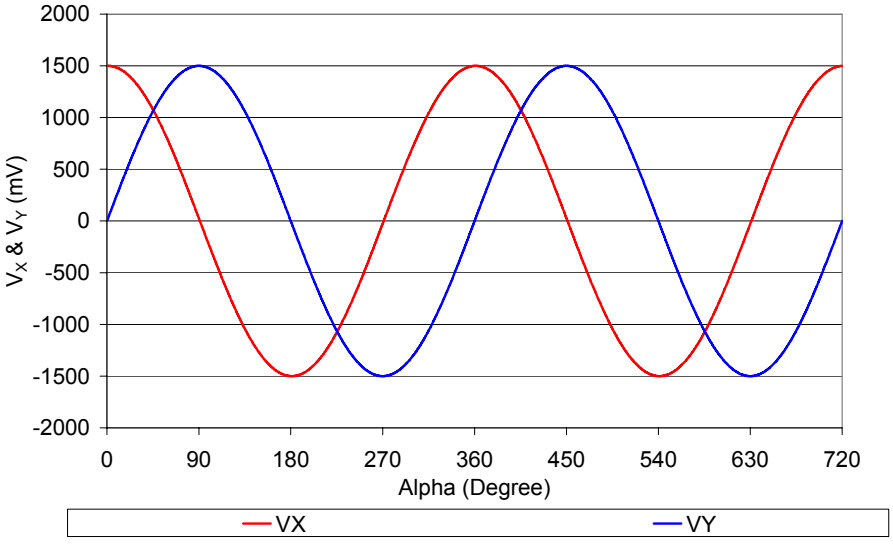


Figure 6 – Tria⊗is™ sensor front-end – Output signals – $V_X \propto B_X \propto \cos(\alpha)$ & $V_Y \propto B_Y \propto \sin(\alpha)$

Those Hall signals are processed through a fully differential analog chain featuring the classic offset cancellation technique (Hall plate quadrature spinning and chopper-stabilized amplifier).

The conditioned analog signals are converted through an ADC (configurable – 14 or 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 angular position from the two raw signals (after so-called front-end compensation steps) through the following operation:

$$\alpha = ATAN\left(\frac{V_Y}{V_X}\right)$$

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 ″ATAN″ function, the F/W controls the whole analog chain, the output transfer characteristic, the output protocol, the programming/calibration and also the self-diagnostic modes.

In the MLX90316, the ″ATAN″ function is computed via a look-up table (i.e. it is not obtained through a CoRDiC algorithm).

Due to the fact that the ″ATAN″ operation is performed on the ratio ″V_Y/V_X″, the angular information is intrinsically self-compensated vs. flux density variations (due to airgap change, thermal or ageing effects) affecting both signals. This feature allows therefore an improved thermal accuracy vs. rotary position sensor based on conventional linear Hall sensors.

In addition to the improved thermal accuracy, the realized rotary position sensor is capable of measuring a complete revolution (360 Degrees) and the linearity performances are excellent taking into account typical manufacturing tolerances (e.g. relative placement between the Hall IC and the magnet).

Once the angular information is computed (over 360 degrees), it is further conditioned (mapped) vs. the target transfer characteristic and it is provided at the output(s) as:

- an analog output level through a 12 bit DAC followed by a buffer
- a digital PWM signal with 12 bit depth (programmable frequency 100 Hz … 1 kHz)
- a digital Serial Protocol (SP – 14 bits computed angular information available)

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

$$\begin{aligned} &Vout(\alpha) = ClampLo && \text{for } \alpha \le \alpha min \\ &Vout(\alpha) = Voffset + Gain \times \alpha && \text{for } \alpha min \le \alpha \le \alpha max \\ &Vout(\alpha) = ClampHi && \text{for } \alpha \ge \alpha max \end{aligned}$$

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 either a 2 point or a 3 point calibration depending on the linearity requirement.

A digital output is also available and used as a programmable angular switch.

The calibration parameters are stored in EEPROM 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 MLX90316 is handled at both engineering lab and production line levels by the Melexis Programming Unit PTC-04 with the dedicated MLX90316 daughterboard and software tools (DLL – User Interface).

7. MLX90316 Electrical Specification

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Nominal Supply Voltage	V_{DD}		4.5	5	5.5	V
Supply Current[6]	Idd	Slow mode[7] Fast mode[7]		8.5 13.5	11 16	mA mA
POR Level	V_{DD} POR	Supply Under Voltage	2	2.7	3	V
Output Current	Iout	Analog Output mode PWM Output mode	-8 -20		8 20	mA mA
Output Short Circuit Current	I_{short}	Vout = 0 V Vout = 5 V Vout = 14 V (T_A = 25°C)		12 12 24	15 15 45	mA mA mA
Output Load	R_L	Pull-down to Ground Pull-up to 5V[8]	1 1	10 10	∞[9] ∞[9]	kΩ kΩ
Analog Saturation Output Level	Vsat_lo	Pull-up load $R_L \geq 10$ kΩ			3	%V_{DD}
	Vsat_hi	Pull-down load $R_L \geq 10$ kΩ	96			%V_{DD}
Digital Saturation Output Level	VsatD_lo	Pull-up Low Side $R_L \geq 10$ kΩ Push-Pull (I_{OUT} = -20mV)			1.5	%V_{DD}
	VsatD_hi	Push-Pull (I_{OUT} = 20mV)	97			%V_{DD}
Active Diagnostic Output Level	Diag_lo	Pull-down load $R_L \geq 10$ kΩ Pull-up load $R_L \geq 10$ kΩ			1 1.5	%V_{DD}
	Diag_hi	Pull-down load $R_L \geq 10$ kΩ Pull-up load $R_L \geq 10$ kΩ	97 98			%V_{DD}
Passive Diagnostic Output Level (Broken Track Diagnostic) [10]	BV$_{SS}$PD	Broken V_{SS}[11] & Pull-down load $R_L \leq 10$ kΩ			4[10]	%V_{DD}
	BV$_{SS}$PU	Broken V_{SS}[11] & Pull-up load $R_L \geq 1$kΩ	99	100		%V_{DD}
	BV$_{DD}$PD	Broken V_{DD}[11] & Pull-down load $R_L \geq 1$kΩ		0	1	%V_{DD}
	BV$_{DD}$PU	Broken V_{DD} & Pull-up load to 5V	No Broken Track diagnostic			%V_{DD}

MLX 90316 Electrical Specification continues...

[6] For the dual version, the supply current is multiplied by 2
[7] See section 14.4.1 for details concerning Slow and Fast mode
[8] Applicable for output in Analog and PWM (Open-Drain) modes
[9] RL < ∞ for output in PWM mode
[10] For detailed information, see also section 15
[11] Not Valid for the SPI Version

...MLX 90316 Electrical Specification						
Clamped Output Level	Clamp_lo	Programmable	0		100	%V_{DD}[12]
	Clamp_hi	Programmable	0		100	%V_{DD}[12]
Switch Out[13]	Sw_lo	Pull-up Load 1.5k to 5V	0.55		1.1	V
	Sw_hi	Pull-up Load 1.5k to 5V	3.65		4.35	V

As an illustration of the previous table, the MLX90316 fits the typical classification of the output span described on the Figure 7.

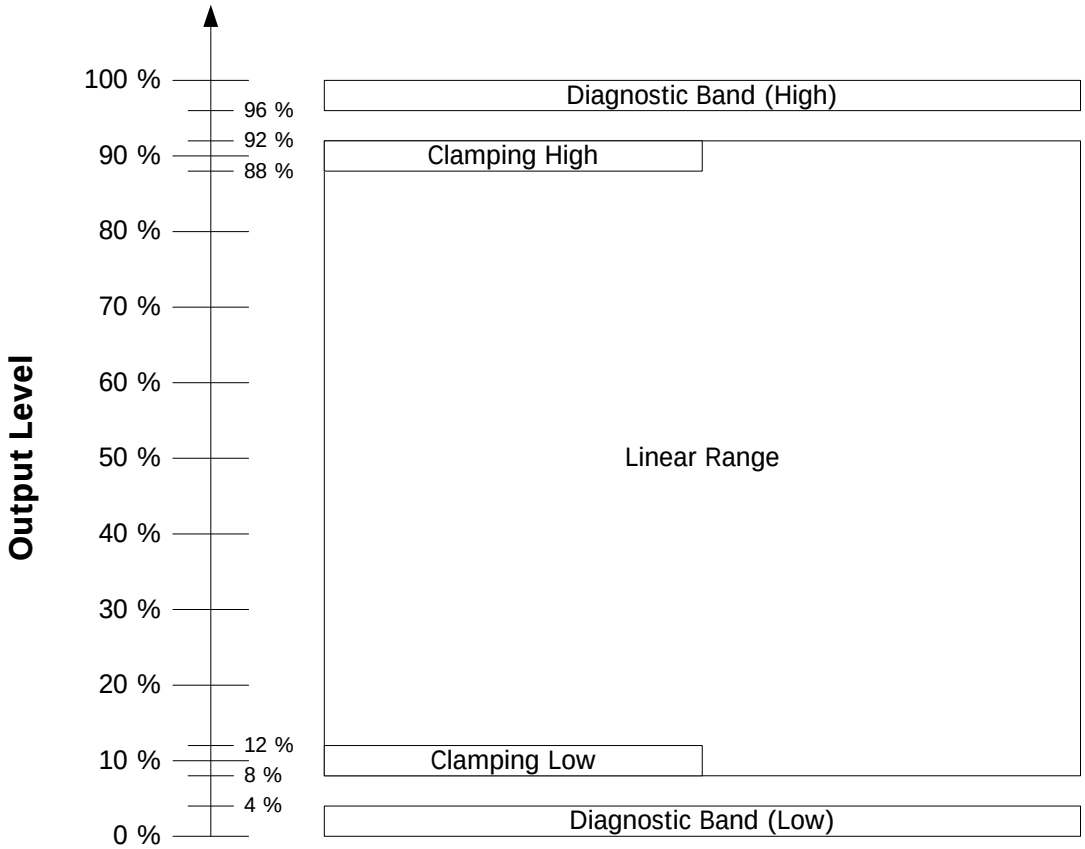


Figure 7 - Output Span Classification

[12] Clamping levels need to be considered vs the saturation of the output stage (see Vsat_lo and Vsat_hi)
[13] See section 14.1.4 for the application diagram

8. MLX90316 Isolation Specification

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Isolation Resistance		Between 2 dies	4			MΩ

9. MLX90316 Timing Specification

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Main Clock Frequency	Ck	Slow mode(14) Fast mode(14)		7 20		MHz MHz
Sampling Rate		Slow mode(15) Fast mode(15)		600 200		µs µs
Step Response Time	Ts	Slow mode(14), Filter=5(15) Fast mode(14), Filter=0(15)		 400	4 600	ms µs
Watchdog	Wd	See Section 15			5	ms
Start-up Cycle	Tsu	Slow and Fast mode(14)			15	ms
Analog Output Slew Rate		C_{OUT} = 42 nF C_{OUT} = 100 nF		200 100		V/ms
PWM Frequency	F_{PWM}	PWM Output Enabled	100		1000	Hz
Digital Output Rise Time		Mode 5 – 10nF, R_L = 10 kΩ Mode 7 – 10nF, R_L = 10 kΩ		120 2.2		µs µs
Digital Output Fall Time		Mode 5 – 10nF, R_L = 10 kΩ Mode 7 – 10nF, R_L = 10 kΩ		1.8 1.9		µs µs

[14] See section 14.4.1 for details concerning Slow and Fast mode
[15] See section 14.5 for details concerning Filter parameter

10. MLX90316 Accuracy Specification

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
ADC Resolution on the raw signals sine and cosine	R_{ADC}	Slow Mode[16] Fast Mode[16]		15 14		bits bits
Thermal Offset Drift #1[17]		Thermal Offset Drift at the DSP input (excl. DAC and output stage) Temperature suffix S, E and K Temperature suffix L	 -60 -90		 +60 +90	 LSB_{15} LSB_{15}
Thermal Offset Drift #2 (to be considered only for the analog output mode)		Thermal Offset Drift of the DAC and Output Stage Temperature suffix S, E and K Temperature suffix L	 - 0.3 - 0.4		 + 0.3 + 0.4	 $\%V_{DD}$ $\%V_{DD}$
Thermal Drift of Sensitivity Mismatch[18]		Temperature suffix S, E and K Temperature suffix L	- 0.3 - 0.5		+ 0.3 + 0.5	% %
Intrinsic Linearity Error[19]	Le	T_A = 25°C	-1		1	Deg
Analog Output Resolution	R_{DAC}	12 bits DAC (Theoretical – Noise free) INL DNL	 -4 0.05	0.025 1	 +4 2	$\%V_{DD}$/LSB LSB LSB
Output stage Noise		Clamped Output		0.05		$\%V_{DD}$
Noise pk-pk[20]		RG = 9, Slow mode, Filter=5 RG = 9, Fast mode, Filter=0		0.03 0.1	0.06 0.2	Deg Deg
Ratiometry Error			-0.1	0	0.1	$\%V_{DD}$
PWM Output Resolution	R_{PWM}	12 bits (Theoretical – Jitter free)		0.025		$\%_{DC}$/LSB
PWM Jitter[21]	J_{PWM}	RG = 6, F_{PWM} = 250 Hz – 800Hz			0.2	$\%_{DC}$
Serial Protocol Output Resolution	R_{SP}	14 bits – 360 Deg. mapping (Theoretical – Jitter free)		0.022		Deg/LSB

[16] 15 bits corresponds to 14 bits + sign and 14 bits corresponds to 13 bits + sign. After angular calculation, this corresponds to 0.005Deg/LSB_{15} in Low Speed Mode and 0.01Deg/LSB_{14} in High Speed.

[17] For instance, Thermal Offset Drift #1 equal ± 60LSB_{15} yields to max. ± 0.3 Deg. angular error for the computed angular information (output of the DSP). See Front End Application Note for more details. This is only valid if automatic gain is set (See Section 14.4.2)

[18] For instance, Thermal Drift of Sensitivity Mismatch equal ± 0.4% yields to max. ± 0.1 Deg. angular error for the computed angular information (output of the DSP). See Front End Application Note for more details.

[19] The Intrinsic Linearity Error refers to the IC itself (offset, sensitivity mismatch, orthogonality) taking into account an ideal rotating field. 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 that is available on the MLX90316.

[20] The application diagram used is described in the recommended wiring. For detailed information, refer to section Filter in application mode (Section 14.5).

[21] Jitter is defined by ± 3 σ for 1000 successive acquisitions and the slope of the transfer curve is 100%DC/360 Deg.

11. MLX90316 Magnetic Specification

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Magnetic Flux Density	B		20	50	70[23]	mT
Magnet Temperature Coefficient	TCm		-2400		0	ppm/°C

12. MLX90316 CPU & Memory Specification

The DSP is based on a 16 bit RISC µController. This CPU provides 5 Mips while running at 20 MHz.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
ROM				10		kB
RAM				256		B
EEPROM				128		B

[23] Above 70 mT, the IMC starts saturating yielding to an increase of the linearity error.

13. MLX90316 End-User Programmable Items

Parameter	Comments	Default Values				
		-	SPI	PPA	PPD	# bit
Output Mode	Define the output stage mode	4	N/A	4	7	3
PWMPOL1	PWM Polarity	0	N/A	N/A	1	1
PWM_Freq	PWM Frequency	1000h	N/A	N/A	1kHz	16
CLOCKWISE		0	0	0	1	1
DP	Discontinuity Point	0h	0h	0h	0h	15
LNR_S0	Initial Slope	0h	N/A	N/A	N/A	16
LNR_A_X	AX Coordinate	8000h	0	0	0	16
LNR_A_Y	AY Coordinate	0h	0%	10%	10%	16
LNR_A_S	AS Coordinate	0h	100%/360d	80%/360d	80%/360d	16
LNR_B_X	BX Coordinate	FFFFh	FFFFh	FFFFh	FFFFh	16
LNR_B_Y	BY Coordinate	FFFFh	FFFFh	FFFFh	FFFFh	16
LNR_B_S	BS Coordinate	0h	N/A	N/A	N/A	16
LNR_C_X	CX Coordinate	FFFFh	FFFFh	FFFFh	FFFFh	16
LNR_C_Y	CY Coordinate	FFFFh	FFFFh	FFFFh	FFFFh	16
LNR_C_S	CS Coordinate	0h	N/A	N/A	N/A	16
CLAMP_HIGH	Clamping High	8%	0%	10%	10%	16
CLAMP_LOW	Clamping Low	8%	100%	90%	90%	16
KD	Switch Out	FFFFh	FFFFh	FFFFh	FFFFh	16
KDHYST	Hysteresis on the Switch Out	0	N/A	N/A	N/A	8
DEADZONE		0	0	0	0	8
FHYST		4	0	0	0	8
MELEXISID1		MLX	MLX	MLX	MLX	16
MELEXISID2		MLX	MLX	MLX	MLX	16
MELEXISID3		MLX	MLX	MLX	MLX	16
CUSTUMERID1		1	1	1	1	8
CUSTUMERID2		6	19	16	20	16
CUSTUMERID3		MLX	MLX	MLX	MLX	16
HIGHSPEED		0	1	0	1	1
FSWAP		1	1	0	1	1
FILTER		5	0	2	5	8
FILTER A1	Filter coefficient A1 for FILTER=6	6600h	N/A	N/A	N/A	16
FILTER A2	Filter coefficient A2 for FILTER=6	2A00h	N/A	N/A	N/A	16
ARGC	Auto Gain at Start Up	0	1	1	1	1
AUTO_RG	Automatic Rough Gain Selection	0	1	1	1	1
RoughGain		9	0	3	0	8
RGThresL		0	0	0	0	4
RGThresH		15	15	15	15	4
EEHAMHOLE		3131h	0	0	0	16
RESONFAULT		0	1	1	1	2
MLXLOCK		0	1	1	1	1
LOCK		0	1	1	1	1

14. Description of End-User Programmable Items

14.1. Output Mode

The MLX90316 output type is defined by the Output Mode parameter.

Parameter	Value	Description
Analog Output Mode	2, 4	Analog Rail-to-Rail
PWM Output Mode	5 7	Low Side (NMOS) Push-Pull
Serial	N/A	Low Side (NMOS)

14.1.1. 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.

14.1.2. PWM Output Mode

If one of the PWM Output modes is selected, the output signal is a digital signal with Pulse Width Modulation (PWM).
In mode 5, the output stage is an open drain NMOS transistor (low side), to be used with a pull-up resistor to V_{DD}.
In mode 7, the output stage is a push-pull stage for which Melexis recommends the use of a pull-up resistor to V_{DD}.

The PWM polarity is selected by the PWMPOL1 parameter:

- PWMPOL1 = 0 for a low level at 100%
- PWMPOL1 = 1 for a high level at 100%

The PWM frequency is selected by the PWM_Freq parameter.

PWM Frequency Code				
Oscillator Mode	Pulse-Width Modulation Frequency (Hz)			
	100	200	500	1000
Low Speed	35000	17500	7000	3500
High Speed	-	50000	20000	10000

For instance, in Low Speed Mode, set PWM_Freq = 7000 (decimal) to set the PWM frequency at 500Hz.

14.1.3. Serial Protocol Output Mode

The MLX90316 features a digital Serial Protocol mode. The MLX90316 is considered as a Slave node. See the dedicated Serial Protocol section for a full description (Section 16).

14.1.4. Switch Out

Parameter	Value	Unit
KD	0…359.9999	deg
KDHYST	0 … 1.4	deg

The switch is activated (Sw_lo) when the digital angle is greater than the value stored in the KD parameter. This angle refers to the internal angular reference linked to the parameter DP and not to the absolute physical 0° angle.

The KDHYST defines the hysteresis amplitude around the Switch point. The switch is actually activated if the digital angle is greater than KD+KDHYST. It is deactivated if the digital angle is less than KD-KDHYST.

The mandatory application diagram to use this feature is depicted in the Figure 8. See section 7 for the electrical characteristic.

If the Switch feature is not used in the application, the output pin needs to be connected to the ground.

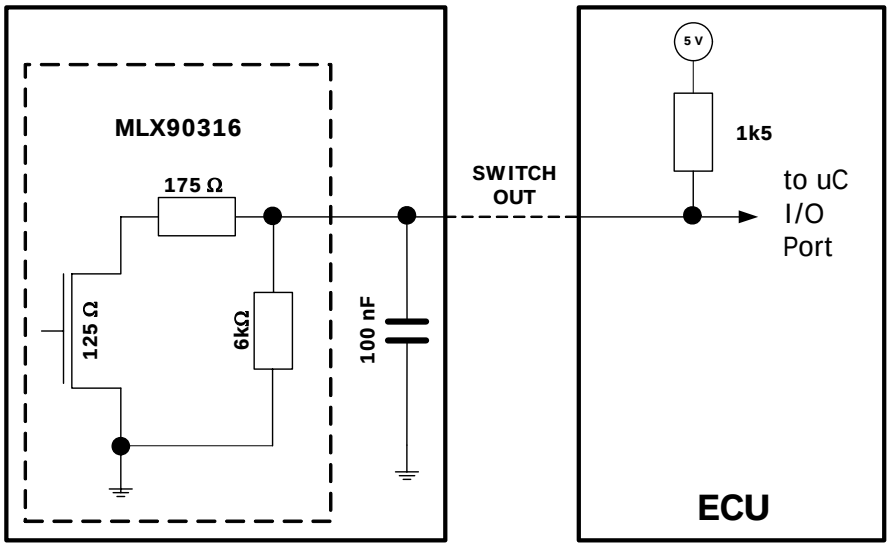


Figure 8 – Application Diagram for the Switch Out

14.2. Output Transfer Characteristic

Parameter	Value	Unit
CLOCKWISE	0 → CCW 1 → CW	
DP	0 … 359.9999	deg
LNR_A_X LNR_B_X LNR_C_X	0 … 359.9999	deg
LNR_A_Y LNR_B_Y LNR_C_Y	0 … 100	%
LNR_S0 LNR_A_S LNR_B_S	0 … 17	%/deg
LNR_C_S	-17 … 0 … 17	%/deg
CLAMP_LOW	0 … 100	%
CLAMP_HIGH	0 … 100	%
DEADZONE	0 … 359.9999	deg

14.2.1. CLOCKWISE Parameter

The CLOCKWISE parameter defines the magnet rotation direction.

- CCW is the defined by the 1-4-5-8 pin order direction for the SOIC8 package and 1-8-9-16 pin order direction for the TSSOP16 package.
- CW is defined by the reverse direction: 8-5-4-1 pin order direction for the SOIC8 and 16-9-8-1 pin order direction for the TSSOP16 package.

Refer to the drawing in the IMC positioning sections (Section 20.3 and 20.6).

14.2.2. 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.

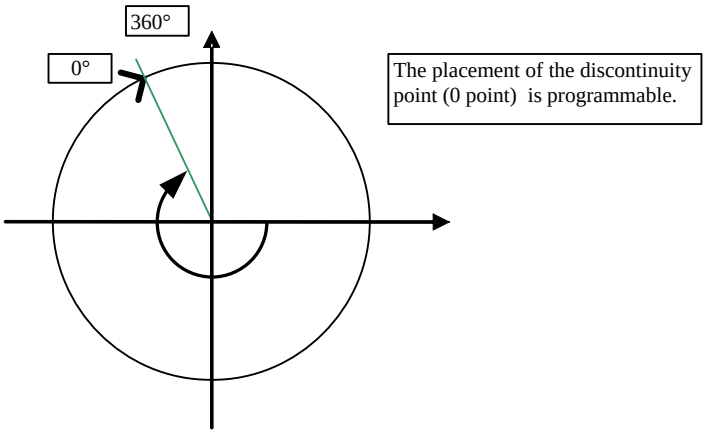
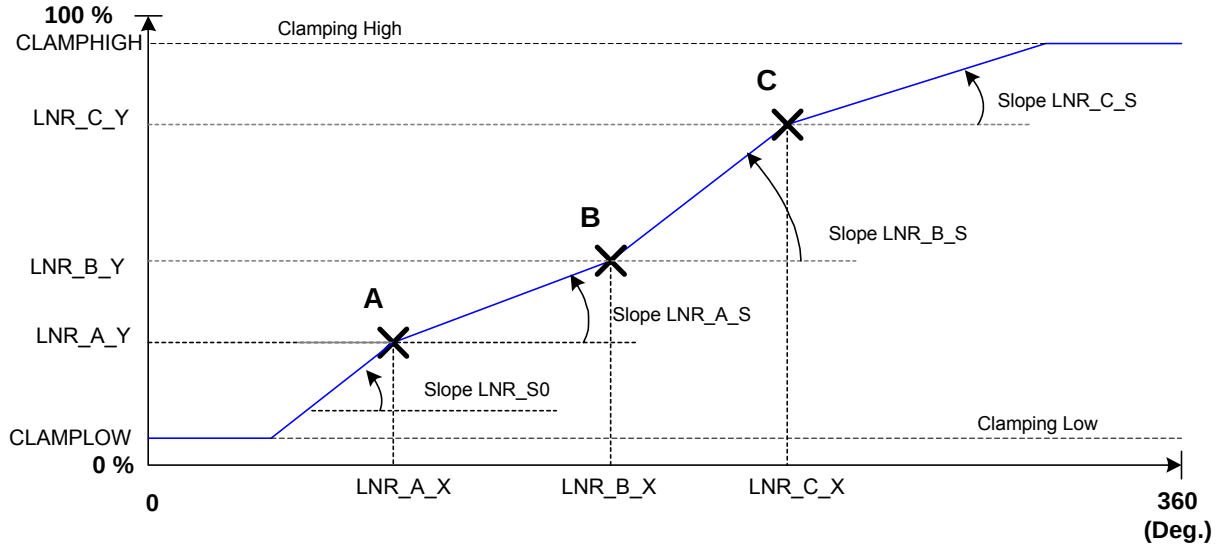


Figure 9 - Discontinuity Point Positioning

14.2.3. 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 MLX90316 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 five calibration points are then available, reducing the overall non-linearity of the IC by almost an order of magnitude each time. Three or five point calibration 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.



14.2.4. CLAMPING Parameters

The clamping levels are two independent values to limit the output voltage range. The CLAMP_LOW parameter adjusts the minimum output voltage level. The CLAMP_HIGH parameter sets the maximum output voltage level. Both parameters have 16 bits of adjustment. 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. In SPI mode, the resolution is 14bits or 0.022deg over 360deg.

14.2.5. DEADZONE Parameter

The dead zone is defined as the angle window between 0 and 359.9999.
When the digital angle lies in this zone, the IC is in fault mode (RESONFAULT must be set to “1” – See 14.6.1).

14.3. Identification

Parameter	Value	Unit
MELEXSID1 MELEXSID2 MELEXSID3	0 … 65535 0 … 65535 0 … 65535	
CUSTUMERID1 CUSTUMERID2 CUSTUMERID3	0 … 255 0 … 65535 0 … 65535	

Identification number: 40 bits freely useable by Customer for traceability purpose.

14.4. Sensor Front-End

Parameter	Value	Unit
HIGHSPEED	0 = Slow mode 1 = Fast mode	
ARGC	0 = disable 1 = enable	
AUTO_RG	0 = disable 1 = enable	
RoughGain	0 … 15	
RGThresL	0 … 15	
RGThresH	0 … 15	

14.4.1. HIGHSPEED Parameter

The HIGHSPEED parameter defines the main frequency for the DSP.

- HIGHSPEED = 0 selects the Slow mode with a 7 MHz master clock.
- HIGHSPEED = 1 selects the Fast mode with a 20 MHz master clock.

For better noise performance, the Slow Mode must be enabled.

14.4.2. ARGC, AUTO_RG, RoughGain Parameters

AUTO_RG and ARGC parameters enable the automatic gain control (AGC) of the analog chain. The AGC loop is based on

$$(V_X)^2 + (V_Y)^2 = (\text{Amplitude})^2 = (\text{Radius})^2$$

and it targets an amplitude of 90% of the ADC input span.

At Start-Up phase, the gain stored in the parameter RoughGain is always used. Depending of the AUTO_RG and ARGC settings, the AGC regulation acts as follow:

- If ARGC is set, the regulation proceeds by jump to reach the target gain. Note that this regulation is only valid if the starting gain does not saturate the ADC. Melexis recommendation is to use RoughGain ≤ 3 if ARGC=1.
- If ARGC is “0” and AUTO_RG is set to “1”, the regulation adapts every cycle by one gain code the current gain to reach the 90% ADC span target. Note that if the value of RoughGain is too far from the actual gain, the chip will enter the normal operating mode (after the Start-Up phase) with an incorrect gain which will cause the device to go in diagnostic low (field too low/field too high – See section 15).
- If ARGC and AUTO_RG are “0”, the AGC regulation is off and the gain used is the value stored in the parameter RoughGain. Melexis does not advise the use of this mode.

The parameter AUTO_RG activates the automatic regulation during normal operation of the device as background task.

Melexis strongly recommend to set ARGC = “1”, AUTO_RG = “1” and RoughGain ≤ 3 for all types of application. If the magnetic specifications of the application are well known and under control, the appropriate RoughGain can also be programmed with ARGC set to “0” and AUTO_RG to “1”.

Please note that the angular errors listed in the section 10 are only valid if the AUTO_RG is activated. AUTO_RG avoids also the saturation of the analog chain and the associated linearity error.

The current gain (RG) can be read out with the PTC-04 and gives a rough indication of the applied magnetic flux density (Amplitude).

14.4.3. RGThresL, RGThresH Parameters

RGThresL & RGThresH define the boundaries within the gain setting (Rough Gain) is allowed to vary. Outside this range, the output is set in diagnostic low.

14.5. FILTER

Parameter	Value	Unit
FHYST	0 … 11 ; step 0.04	deg
FILTER	0… 6	
FSWAP	0 1	

The MLX90316 includes 3 types of filters:

- Hysteresis Filter: programmable by the FHYST parameter
- Low Pass FIR Filters controlled with the Filter parameter
- Low Pass IIR Filter controlled with the Filter parameter and the coefficients FILTER A1 and FILTER A2

Note: if the parameter FSWAP is set to “1”, the filtering is active on the digital angle. If set to “0”, the filtering is active on the output transfer function.

14.5.1. Hysteresis Filter

The FHYST parameter is a hysteresis filter. The output value of the IC is not updated when the digital step is smaller than the programmed FHYST parameter value. The output value is modified when the increment is bigger than the hysteresis. The hysteresis filter reduces therefore the resolution to a level compatible with the internal noise of the IC. The hysteresis must be programmed to a value close to the noise level.

Please note that for the programmable version, the FHYST parameter is set to 4 by default. If you do not wish this feature, please set it to “0”.

14.5.2. FIR Filters

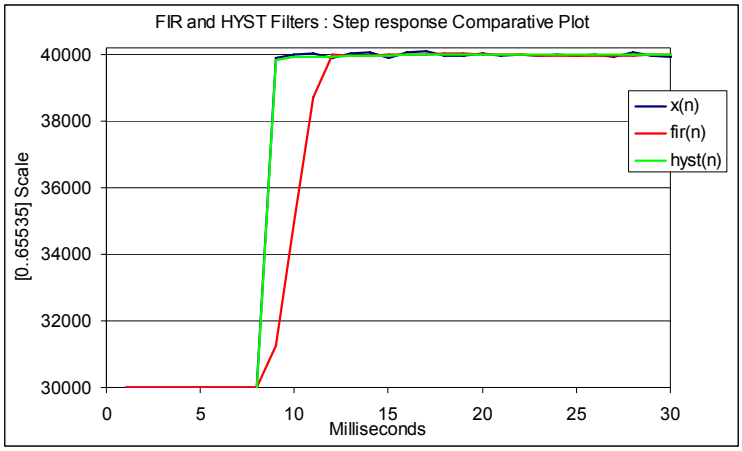
The MLX90316 features 6 FIR filter modes controlled with Filter = 0…5. The transfer function is described below:

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

The characteristics of the filters no 0 to 5 is given in the Table 1.

Filter No (j)	0	1	2	3	4	5
Type	Disable	Finite Impulse Response				
Coefficients a_0... a_5	N/A	110000	121000	133100	111100	122210
Title	No Filter	Extra Light		Light		
90% Response Time	1	2	3	4	4	5
99% Response Time	1	2	3	4	4	5
Efficiency RMS (dB)	0	2.9	4.0	4.7	5.6	6.2
Efficiency P2P (dB)	0	2.9	3.6	5.0	6.1	7.0

Table 1 - FIR Filters Selection Table



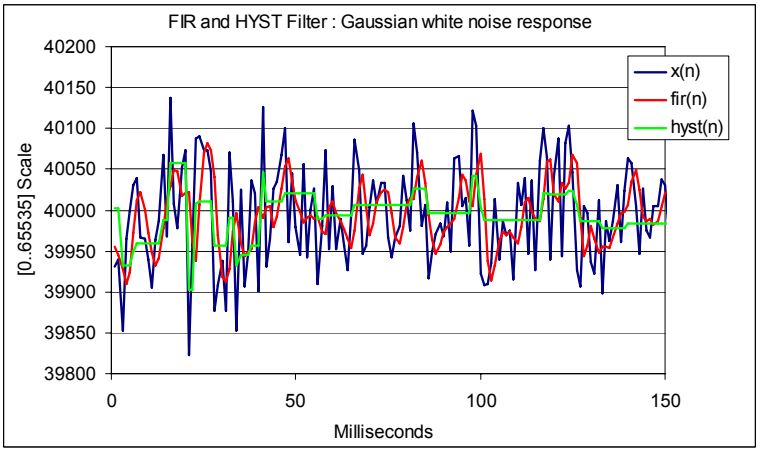


Figure 10 - Step Response and Noise Response for FIR (No 3) and FHYST=10

14.5.3. IIR Filters

The IIR Filter is enabled with Filter = 6. The diagram of the IIR Filter implemented in the MLX90316 is given in Figure 11. Only the parameter A1 and A2 are configurable (See Table 2).

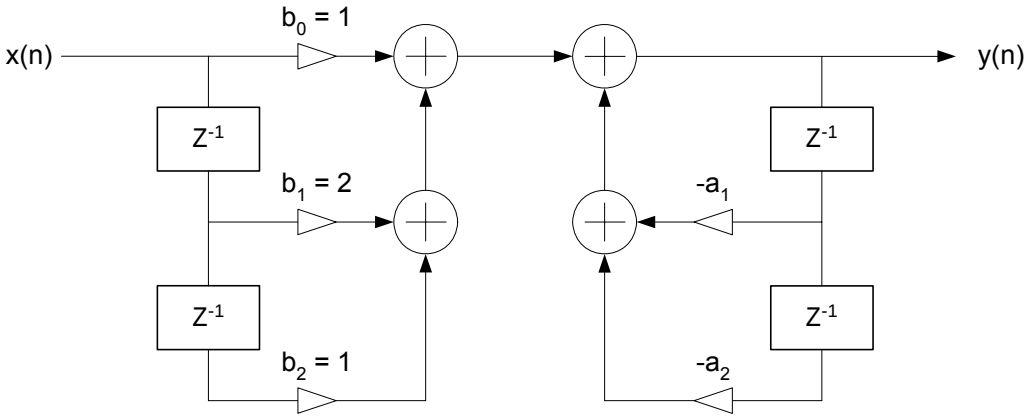


Figure 11 - IIR Diagram

Filter No	6					
Type	2nd Order Infinite Impulse Response (IIR)					
Title	Medium & Strong					
90% Response Time	11	16	26	40	52	100
Efficiency RMS (dB)	9.9	11.4	13.6	15.3	16.2	>20
Efficiency P2P (dB)	12.9	14.6	17.1	18.8	20	>20
Coefficient A1	26112	28160	29120	30208	31296	31784
Coefficient A2	10752	12288	12992	13952	14976	15412

Table 2 - IIR Filter Selection Table

The Figure 12 shows the response of the filter to a Gaussian noise with default coefficient A1 and A2.

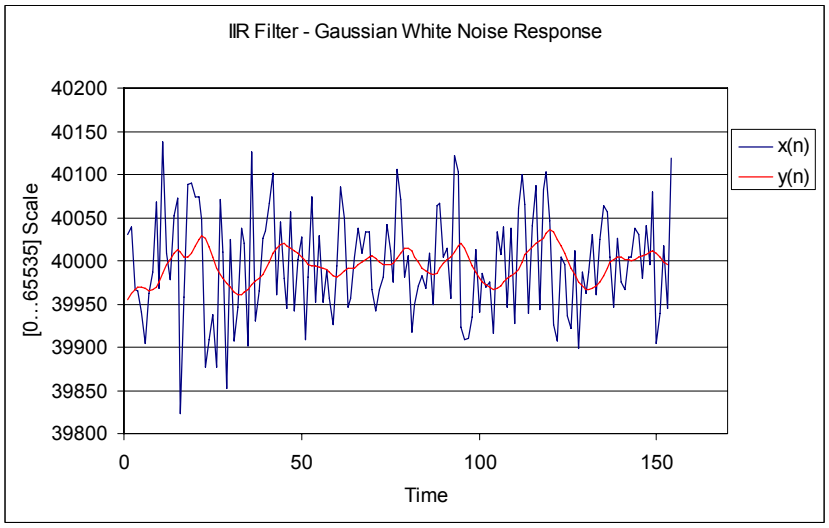


Figure 12 - Noise Response for the IIR Filter

14.6. Programmable Diagnostic Settings

Parameter	Value	Unit
RESONFAULT	0 1	
EEHAMHOLE	0 3131h	

14.6.1. RESONFAULT Parameter

This RESONFAULT parameter disables the soft reset when a fault is detected by the CPU when the parameter is set to 1. By default, the parameter is set to “0” but it is recommended to set it to “1” to activate the self diagnostic modes (See section 15).

Note that in the User Interface (MLX90316UI), the RESONFAULT is split in two bits:

- DRESONFAULT: disable the reset in case of a fault.
- DOUTINFAULT: disable output in diagnostic low in case of fault.

14.6.2. EEHAMHOLE Parameter

The EEHAMHOLE parameter disables the memory recovery (Hamming code) check when a fault is detected by the CRC when it is equal to 3131h. By default the parameter is set to 0 (enable memory recovery).

14.7. Lock

Parameter	Value	Unit
MLXLOCK	0 1	
LOCK	0 1	

14.7.1. MLXLOCK Parameter

MLXLOCK locks all the parameters set by Melexis.

14.7.2. LOCK Parameter

LOCK locks all the parameters set by the user. Once the lock is enabled, it is not possible to change the EEPROM values anymore.
Note that the lock bit should be set by the solver function “MemLock”.

15. MLX90316 Self Diagnostic

The MLX90316 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	Effect on Outputs	Remark
ROM CRC Error at start up (64 words including Intelligent Watch Dog - IWD)	CPU Reset [24]	Diagnostic low[25]	All the outputs are already in Diagnostic low - (start-up)
ROM CRC Error (Operation - Background task)	Enter Endless Loop: - Progress (watchdog Acknowledge) - Set Outputs in Diagnostic low	Immediate Diagnostic low	
RAM Test Fail (Start up)	CPU Reset	Diagnostic low	All the outputs are already in Diagnostic low (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	Immediate Diagnostic low	See 14.6.2
Calibration Data CRC Error (Operation - Background)	CPU Reset	Immediate Diagnostic low	
Dead Zone	Set Outputs in Diagnostic low. Normal Operation until the "dead zone" is left.	Immediate Diagnostic low	Immediate recovery if the "dead zone" is left
ADC Clipping (ADC Output is 0000h or 7FFFh)	Set Outputs in Diagnostic low Normal mode and CPU Reset If recovery	Immediate Diagnostic low	
Radius Overflow (> 100%) or Radius Underflow (< 50 %)	Set Outputs in Diagnostic low Normal mode and CPU Reset If recovery	Immediate Diagnostic low	(50 % - 100 %) No magnet / field too high See also 14.4.2
Fine Gain Clipping (FG < 0d or > 63d)	Set Outputs in Diagnostic low Normal mode, and CPU Reset If recovery	Immediate Diagnostic low	
Rough Offset Clipping (RO is < 0d or > 127d)	Set Outputs in Diagnostic low Normal mode, and CPU Reset If recovery	Immediate Diagnostic low	
Rough Gain Clipping (RG < RGTHRESLOW or RG > RGTHRESHIGH)	Set Outputs in Diagnostic low Normal mode, and CPU Reset If recovery	Immediate Diagnostic low	See also 14.4.2
DAC Monitor (Digital to Analog converter)	Set Outputs in Diagnostic low. Normal Mode with immediate recovery without CPU Reset	Immediate Diagnostic low	
MLX90316 Fault Mode continues...			

[24] 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
4. The reset can be disabled by clearing the RESONFAULT bit (See 14.6.1)

[25] Refer to section 7 for the Diagnostic Output Level specifications

...MLX90316 Fault Mode

Fault Mode	Action	Effect on Outputs	Remark
ADC Monitor (Analog to Digital Converter)	Set Outputs in Diagnostic low. Normal Mode with immediate recovery without CPU Reset	Immediate Diagnostic low	ADC Inputs are Shorted
Undervoltage Mode	At Start-Up, wait Until V_{DD} > 3V. During operation, CPU Reset after 3 ms debouncing	- V_{DD} < POR level => Outputs high impedance - POR level < V_{DD} < 3 V => Outputs in Diagnostic low.	
Firmware Flow Error	CPU Reset	Immediate Diagnostic low	Intelligent Watchdog (Observer)
Read/Write Access out of physical memory	CPU Reset	Immediate Diagnostic low	100% Hardware detection
Write Access to protected area (IO and RAM Words)	CPU Reset	Immediate Diagnostic low	100% Hardware detection
Unauthorized entry in “SYSTEM” Mode	CPU Reset	Immediate Diagnostic low	100% Hardware detection
V_{DD} > 7 V	Set Output High Impedance (Analog)	Pull down resistive load => Diag. Low Pull up resistive load => Diag. High[25]	100% Hardware detection
V_{DD} > 9.4 V	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 V_{SS}[26]	CPU Reset on recovery	Pull down resistive load => Diag. Low Pull up resistive load => Diag. High	100% Hardware detection. Pull down load ≤ 10 kΩ to meet Diag Low spec: - < 2% V_{DD} (temperature suffix S and E) - < 4% V_{DD} (temperature suffix K) - contact Melexis for temperature suffix L
Broken V_{DD}[26]	CPU Reset on recovery	Pull down resistive load => Diag. Low Pull up resistive load => Diag. High	No valid diagnostic for V_{PULLUP} = V_{DD}. Pull up load (≤ 10kΩ) to V_{PULLUP} > 8 V to meet Diag Hi spec > 96% Vdd.

[26] Not Valid for SPI Version

16. Serial Protocol

16.1. Introduction

The MLX90316 features a digital Serial Protocol mode. The MLX90316 is considered as a Slave node. The serial protocol of the MLX90316 is a three wires protocol (/SS, SCLK, MOSI-MISO):

- /SS pin is a 5 V tolerant digital input
- SCLK pin is a 5 V tolerant digital input
- MOSI-MISO pin is a 5 V tolerant open drain digital input/output

The basic knowledge of the standard SPI specification is required for the good understanding of the present section.

16.2. SERIAL PROTOCOL Mode

- CPHA = 1 → even clock changes are used to sample the data
- CPOL = 0 → active-Hi clock

The positive going edge shifts a bit to the Slave's output stage and the negative going edge samples the bit at the Master's input stage.

16.3. MOSI (Master Out Slave In)

The Master sends a command to the Slave to get the angle information.

16.4. MISO (Master In Slave Out)

The MISO of the slave is an open-collector stage. Due to the capacitive load (TBD) a >1 kΩ pull-up is used for the recessive high level (in fast mode). Note that MOSI and MISO use the same physical pin of the MLX90316.

16.5. /SS (Slave Select)

The /SS pin enables a frame transfer (if CPHA = 1). It allows a re-synchronization between Slave and Master in case of communication error.

16.6. Master Start-Up

/SS, SCLK, MISO can be undefined during the Master start-up as long as the Slave is re-synchronized before the first frame transfer.

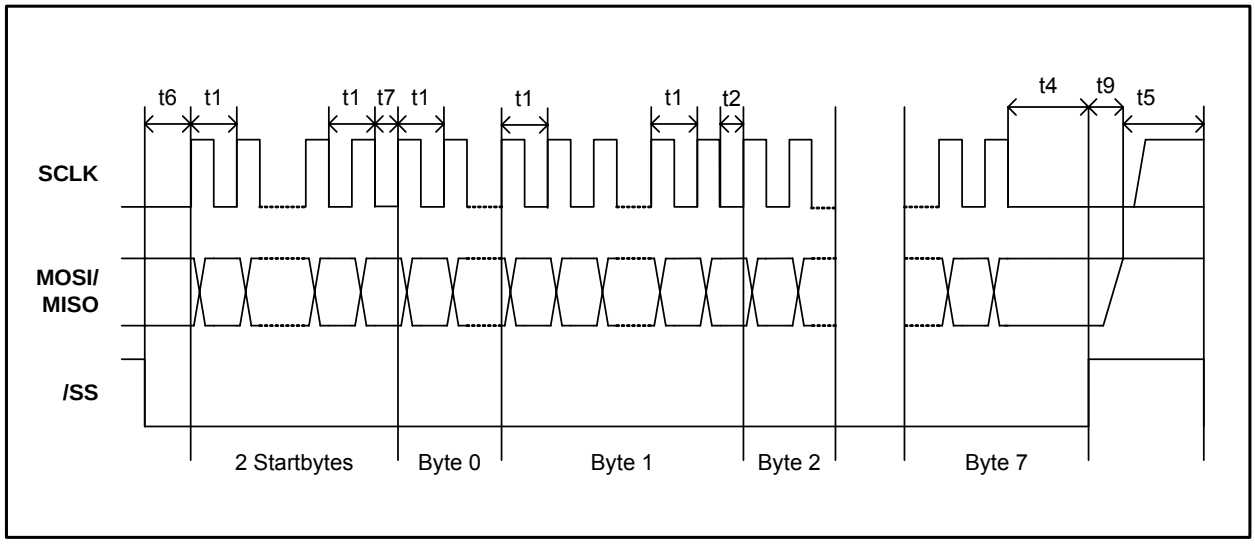
16.7. Slave Start-Up

The slave start-up (after power-up or an internal failure) takes 16 ms. Within this time /SS and SCLK is ignored by the Slave. The first frame can therefore be sent after 16 ms. MISO is Hi-Z (i.e. Hi-Impedance) until the Slave is selected by its /SS input. MLX90316 will cope with any signal from the Master while starting up.

16.8. Timing

To synchronize communication, the Master deactivates /SS high for at least t5 (1.5 ms). In this case, the Slave will be ready to receive a new frame. The Master can re-synchronize at any time, even in the middle of a byte transfer.

Note: Any time shorter than t5 leads to an undefined frame state, because the Slave may or may not have seen /SS inactive.



Timings	Min[27]	Max	Remarks
t1	2.3 µs / 6.9 µs	-	No capacitive load on MISO. t1 is the minimum clock period for any bits within a byte.
t2	12.5 µs / 37.5 µs	-	t2 the minimum time between any other byte
t4	2.3 µs / 6.9 µs	-	Time between last clock and /SS=high=chip de-selection
t5	300 µs / 1500 µs	-	Minimum /SS = Hi time where it's guaranteed that a frame re-synchronizations will be started.
t5	0µs	-	Maximum /SS = Hi time where it's guaranteed that NO frame re-synchronizations will be started.
t6	2.3 µs / 6.9 µs	-	The time t6 defines the minimum time between /SS = Lo and the first clock edge
t7	15 µs / 45 µs	-	t7 is the minimum time between the StartByte and the Byte0
t9	-	<1 µs	Maximum time between /SS = Hi and MISO Bus High-Impedance
$T_{StartUp}$	-	< 10 ms / 16 ms	Minimum time between reset-inactive and any master signal change

[27] Timings shown for oscillator base frequency of 20MHz (Fast Mode) / 7 MHz (Slow Mode)

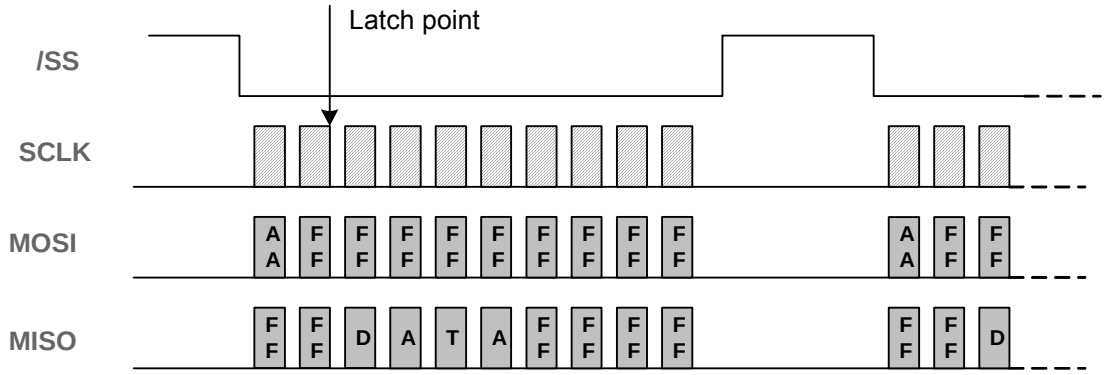
16.9. Slave Reset

On internal soft failures the Slave resets after 1 second or after an (error) frame is sent. On internal hard failures the Slave resets itself. In that case, the Serial Protocol will not come up. The serial protocol link is enabled only after the completion of the first synchronization (the Master deactivates /SS for at least t5).

16.10. Frame Layer

16.10.1. Command Device Mechanism

Before each transmission of a data frame, the Master should send a byte AAh to enable a frame transfer. The latch point for the angle measurement is at the last clock before the first data frame byte.



Timing diagram

16.10.2. Data Frame Structure

A data frame consists of 10 bytes:

- 2 start bytes (AAh followed by FFh)
- 2 data bytes (DATA16 – most significant byte first)
- 2 inverted data bytes (/DATA16 - most significant byte first)
- 4 all-Hi bytes

The Master should send AAh (55h in case of inverting transistor) followed by 9 bytes FFh. The Slave will answer with two bytes FFh followed by 4 data bytes and 4 bytes FFh.

16.10.3. Timing

There are no timing limits for frames: a frame transmission could be initiated at any time. There is no inter-frame time defined.

16.10.4. Data Structure

The DATA16 could be a valid angle, or an error condition. The two meanings are distinguished by the LSB.

DATA16: Angle A[13:0] with (Angle Span)/2^{14}

Most Significant Byte								Less Significant Byte							
MSB							LSB	MSB							LSB
A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	0	1

DATA16: Error

Most Significant Byte								Less Significant Byte							
MSB							LSB	MSB							LSB
E15	E14	E13	E12	E11	E10	E9	E8	E7	E6	E5	E4	E3	E2	E1	E0

BIT	NAME	
E0	0	
E1	1	
E2	F_ADCMONITOR	ADC Failure
E3	F_ADCSATURA	ADC Saturation (Electrical failure or field too strong)
E4	F_RGTOOLOW	Analog Gain Below Trimmed Threshold (Likely reason : field too weak)
E5	F_MAGTOOLOW	Magnetic Field Too Weak
E6	F_MAGTOOHIGH	Magnetic Field Too Strong
E7	F_RGTOOHIGH	Analog Gain Above Trimmed Threshold (Likely reason : field too strong)
E8	F_FGCLAMP	Never occurring in serial protocol
E9	F_ROCLAMP	Analog Chain Rough Offset Compensation : Clipping
E10	F_MT7V	Device Supply V_{DD} Greater than 7V
E11	-	
E12	-	
E13	-	
E14	F_DACMONITOR	Never occurring in serial protocol
E15	-	

16.10.5. Angle Calculation

All communication timing is independent (asynchronous) of the angle data processing. The angle is calculated continuously by the Slave:

- Slow Mode: every 1.5 ms at most.
- Fast Mode: every 350 µs at most.

The last angle calculated is hold to be read by the Master at any time. Only valid angles are transferred by the Slave, because any internal failure of the Slave will lead to a soft reset.

16.10.6. Error Handling

In case of any errors listed in section 16.10.4, the Serial protocol will be initialized and the error condition can be read by the master. The slave will perform a soft reset once the error frame is sent.

In case of any other errors (ROM CRC error, EEPROM CRC error, RAM check error, intelligent watchdog error…) the Slave's serial protocol is not initialized. The MOSI/MISO pin will stay Hi-impedant (no error frames are sent).

17. Recommended Application Diagrams

17.1. Analog Output Wiring with the MLX90316 in SOIC Package

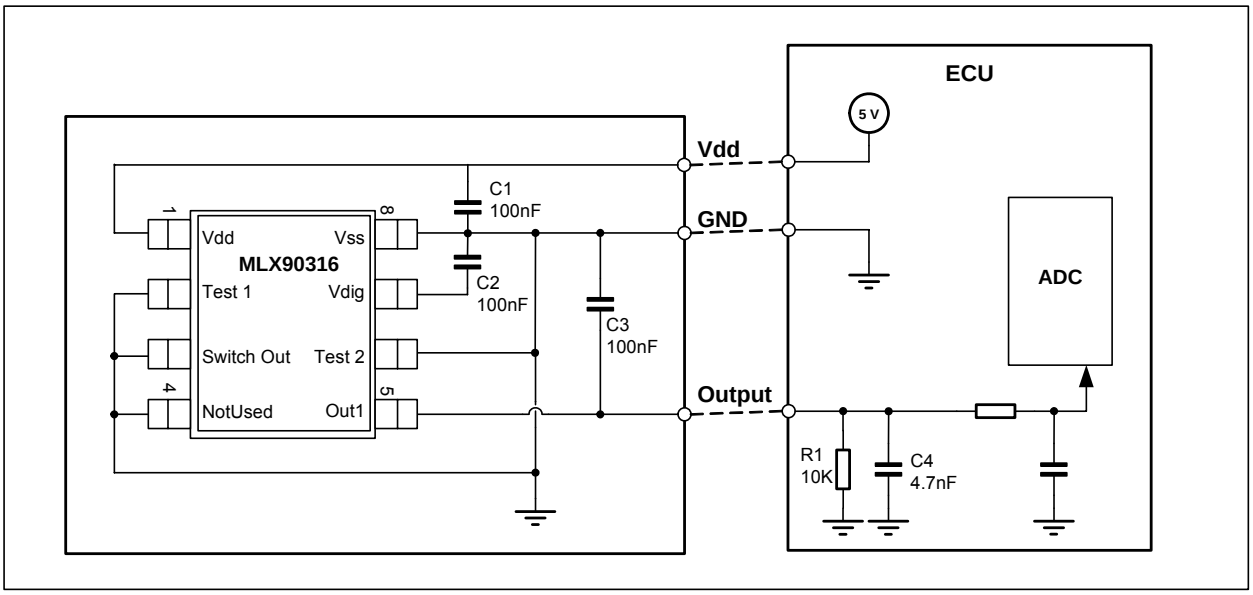


Figure 13 – Recommended wiring for the MLX90316 in SOIC8 package[28].

17.2. Analog Output Wiring with the MLX90316 in TSSOP Package

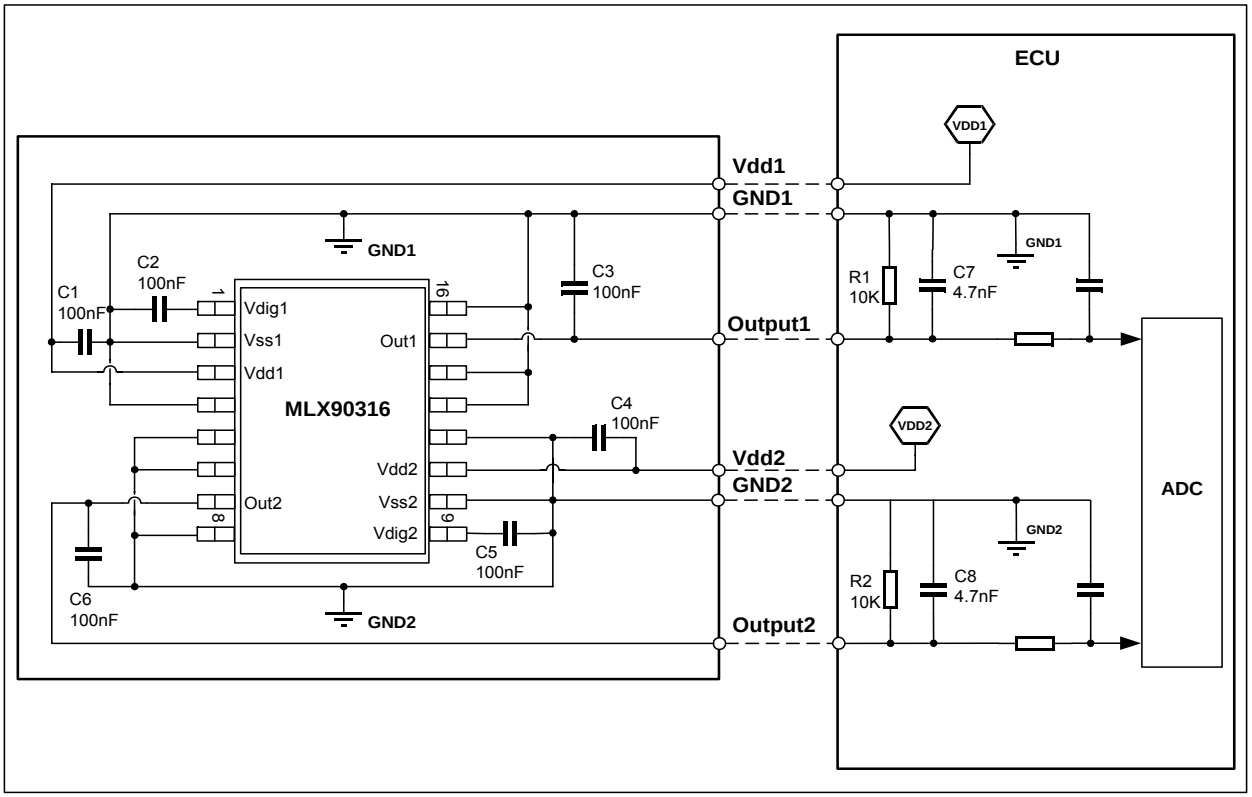


Figure 14 – Recommended wiring for the MLX90316 in TSSOP16 package (dual die).

[28] See section 14.1.4 if the Switch Output feature is used.

17.3. PWM Low Side Output Wiring

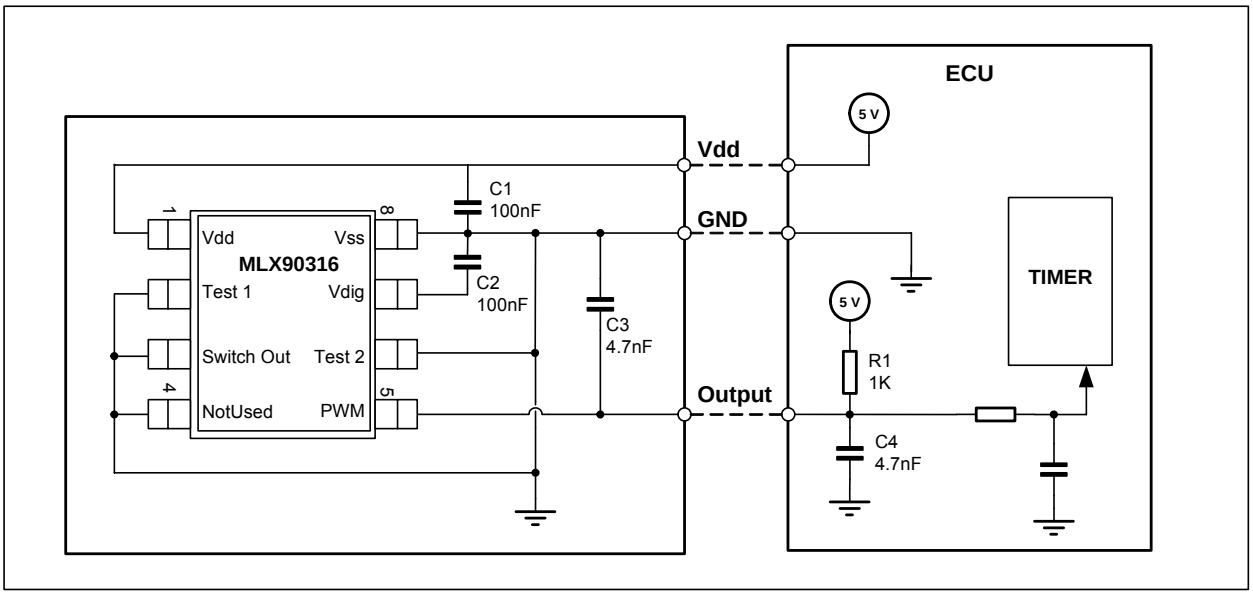


Figure 15 – Recommended wiring for a PWM Low Side Output configuration[29].

17.4. Serial Protocol

Generic schematics for single slave and dual slave applications are described.

17.4.1. SPI Version – Single Die

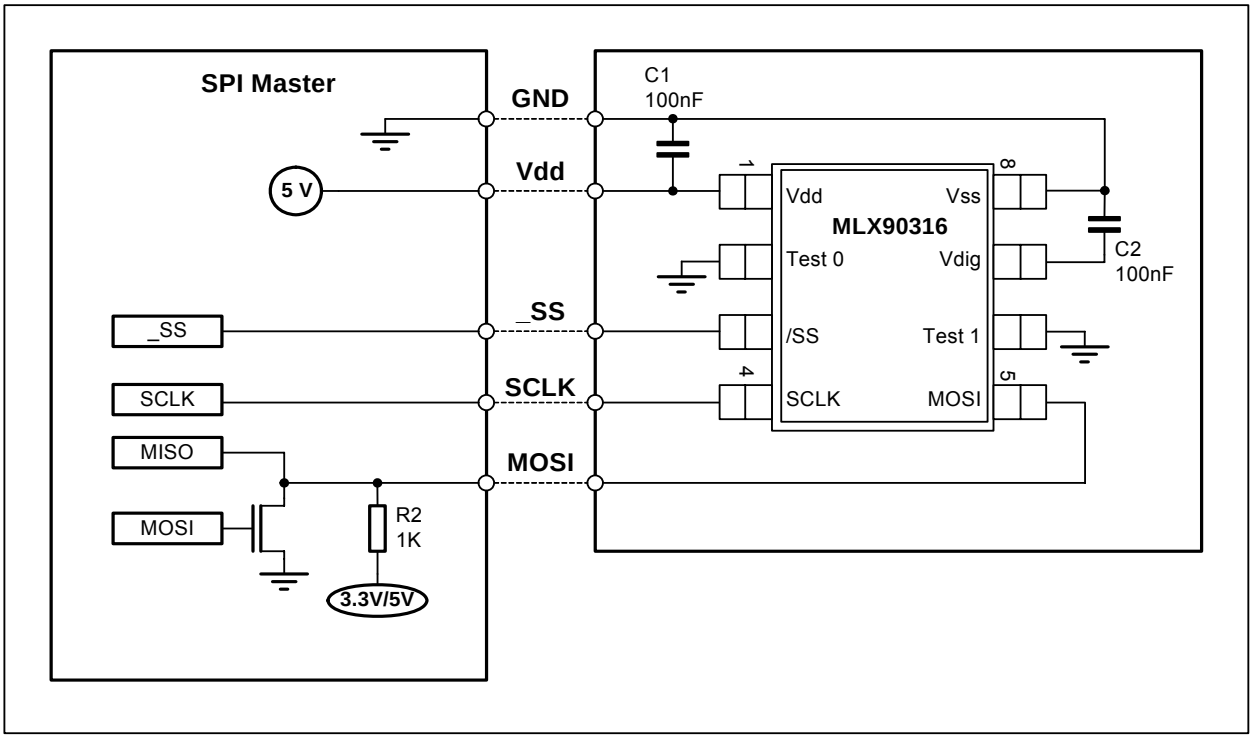


Figure 16 – MLX90316 SPI Version – Single Die – Application Diagram

[29] See section 14.1.4 if the Switch Output feature is used.

17.4.2. SPI Version – Dual Die

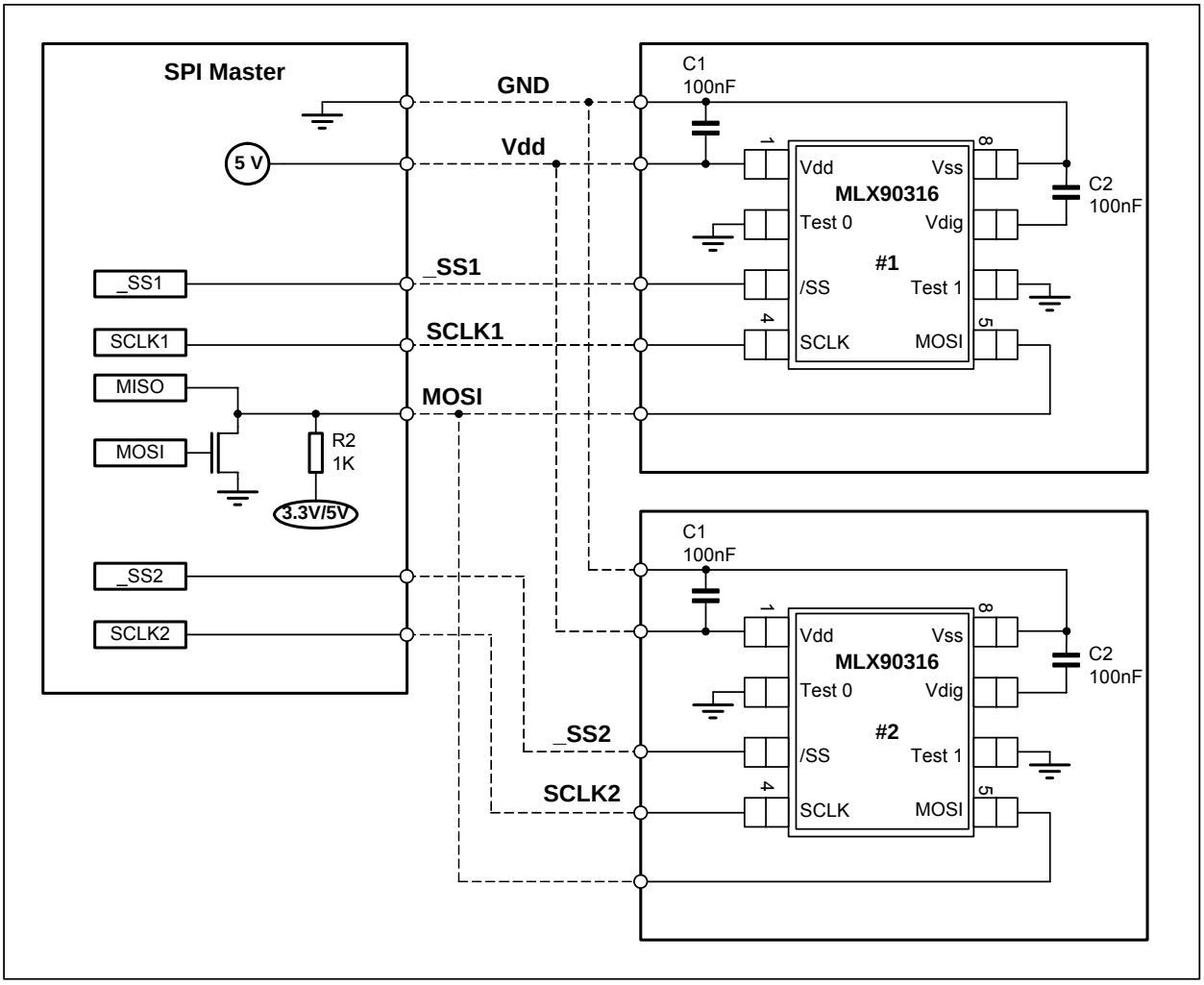


Figure 17 – MLX90316 SPI Version – Dual Die – Application Diagram

17.4.3. Non SPI Version (Standard Version)

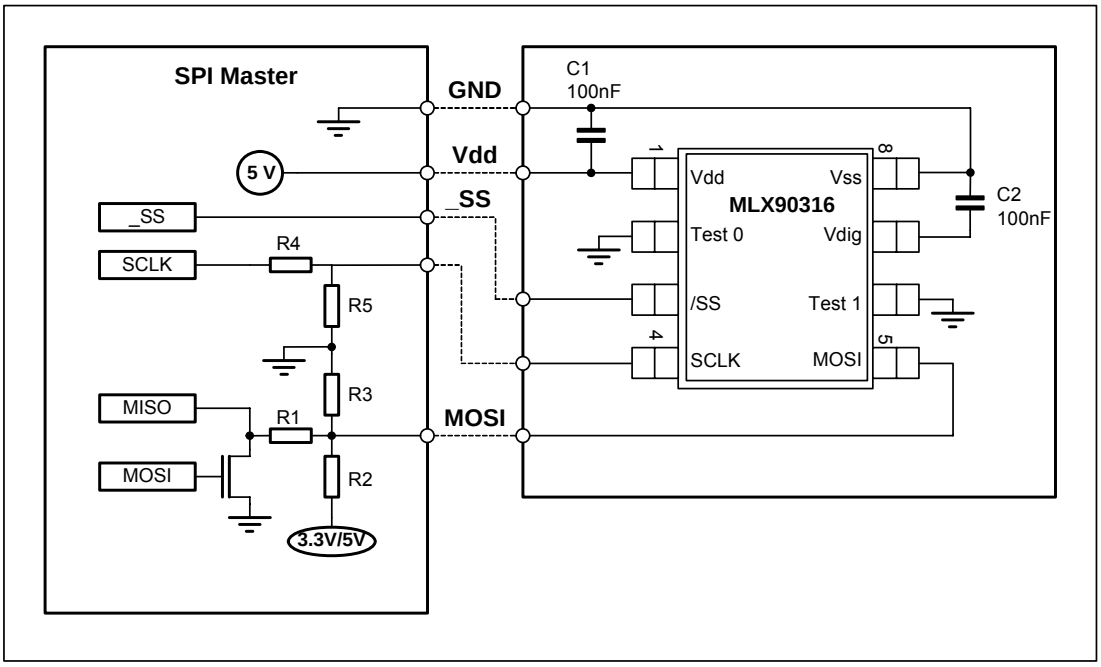


Figure 18 – MLX90316 – Single Die – Serial Protocol Mode

Application Type	µCtrl Supply (V)	Pull-up Supply (V)	90316 Supply (V)	R1 (Ω)	R2 (Ω)	R3 (Ω)	R4 (Ω)	R5 (Ω)	MOS Type
5V µCtrl w/o O.D. w/o 3.3V	5V	5V	5V	100	1000	20,000	1000	20,000	BS170
5V µCtrl w/o O.D. w/ 3.3V	5V	3.3V	5V	150	1000	N/A	1000	20,000	BS170
3.3V µCtrl w/o O.D. [30]	3.3V	3.3V	5V	150	1000	N/A	N/A	N/A	BS170
5V µCtrl w/ O.D. w/o 3.3V [31]	5V	5V	5V	100	1000	20,000	1000	20,000	N/A
3.3V µCtrl w/ O.D.	3.3V	3.3V	5V	150	1000	N/A	N/A	N/A	N/A

Table 3 - Resistor Values for Common Specific Applications

[30] µCtrl w/ O.D. : Micro-controller with open-drain capability (for instance NEC V850ES series)
[31] µCtrl w/o O.D. : Micro-controller without open-drain capability (like TI TMS320 series or ATMEL AVR)

18. 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)
- Melexis Working Instruction 341901308

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
- Melexis Working Instruction 341901309

Iron Soldering THD's (Through Hole Devices)

- EN60749-15
  Resistance to soldering temperature for through-hole mounted devices
- Melexis Working Instruction 341901309

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

- EIA/JEDEC JESD22-B102 and EN60749-21
  Solderability
- Melexis Working Instruction 3304312

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.

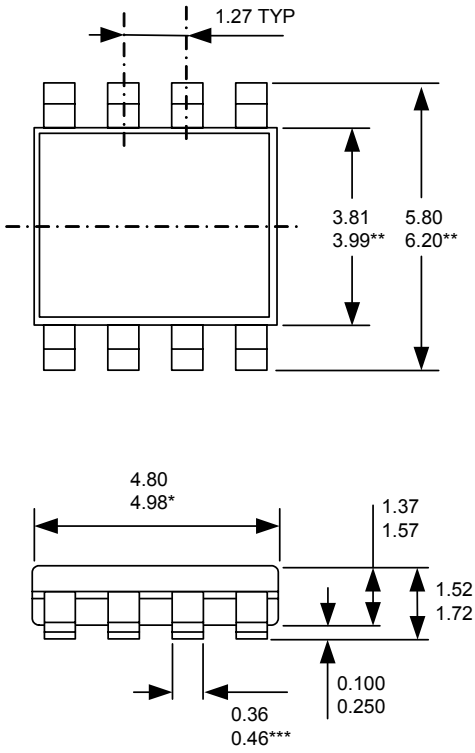
For more information on the lead free topic please see quality page at our website:
http://www.melexis.com/quality.aspx

19. ESD Precautions

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

20. Package Information

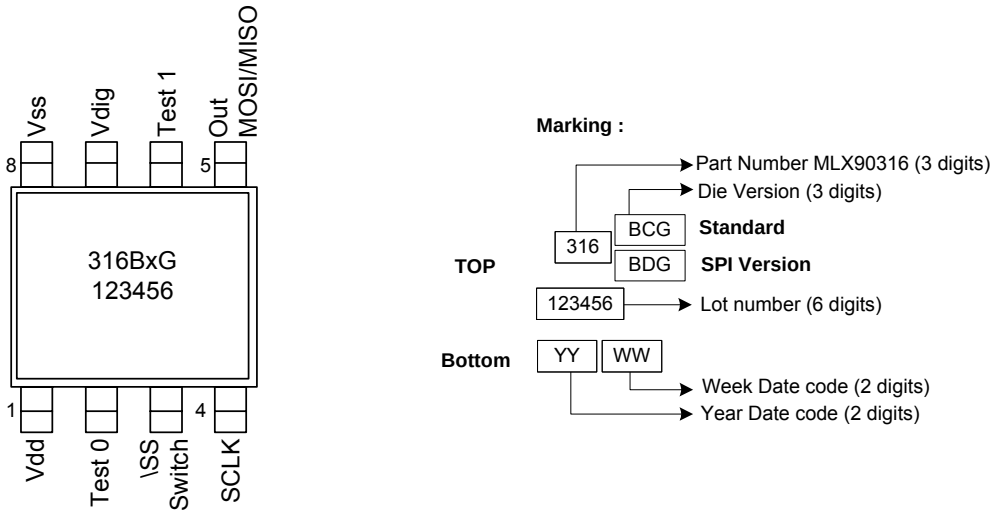
20.1. SOIC8 - Package Dimensions



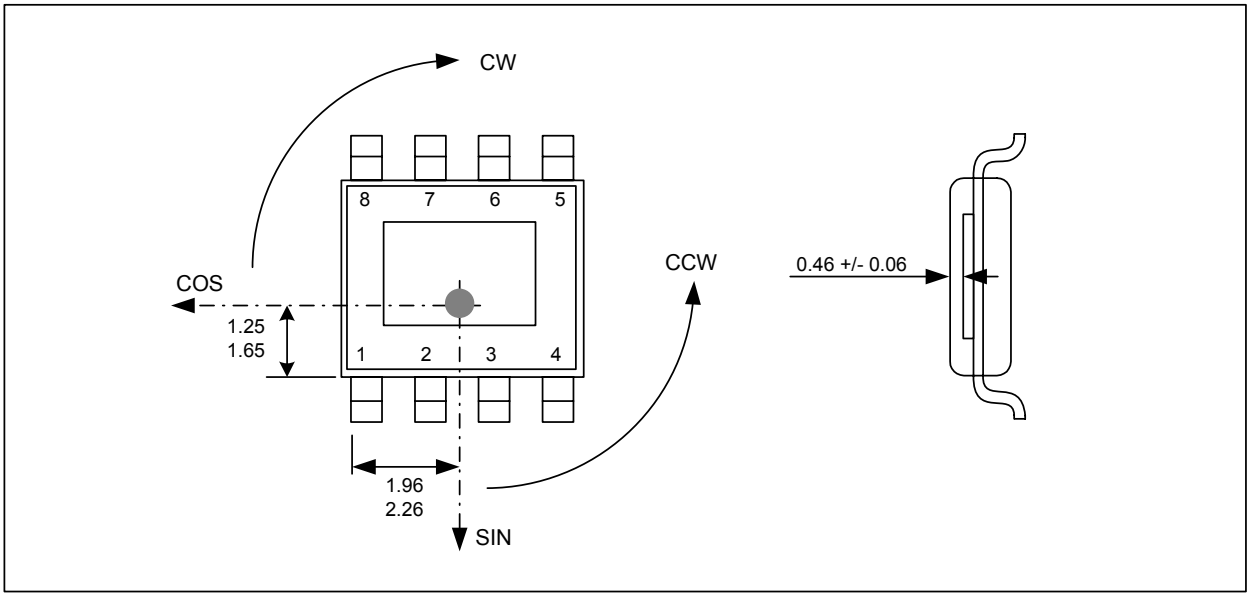
NOTES:

All dimensions are in millimeters (anlges 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.

20.2. SOIC8 - Pinout and Marking

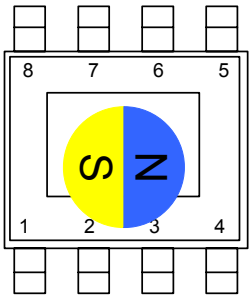


20.3. SOIC8 - IMC Positionning

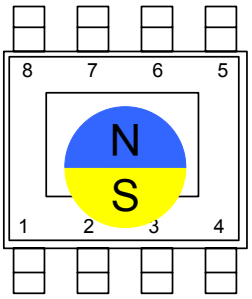


Angle detection MLX90316 SOIC8

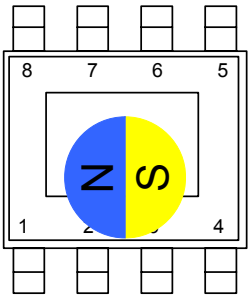
~ 0 Deg.*



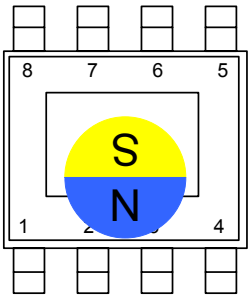
~ 90 Deg.*



~ 180 Deg.*



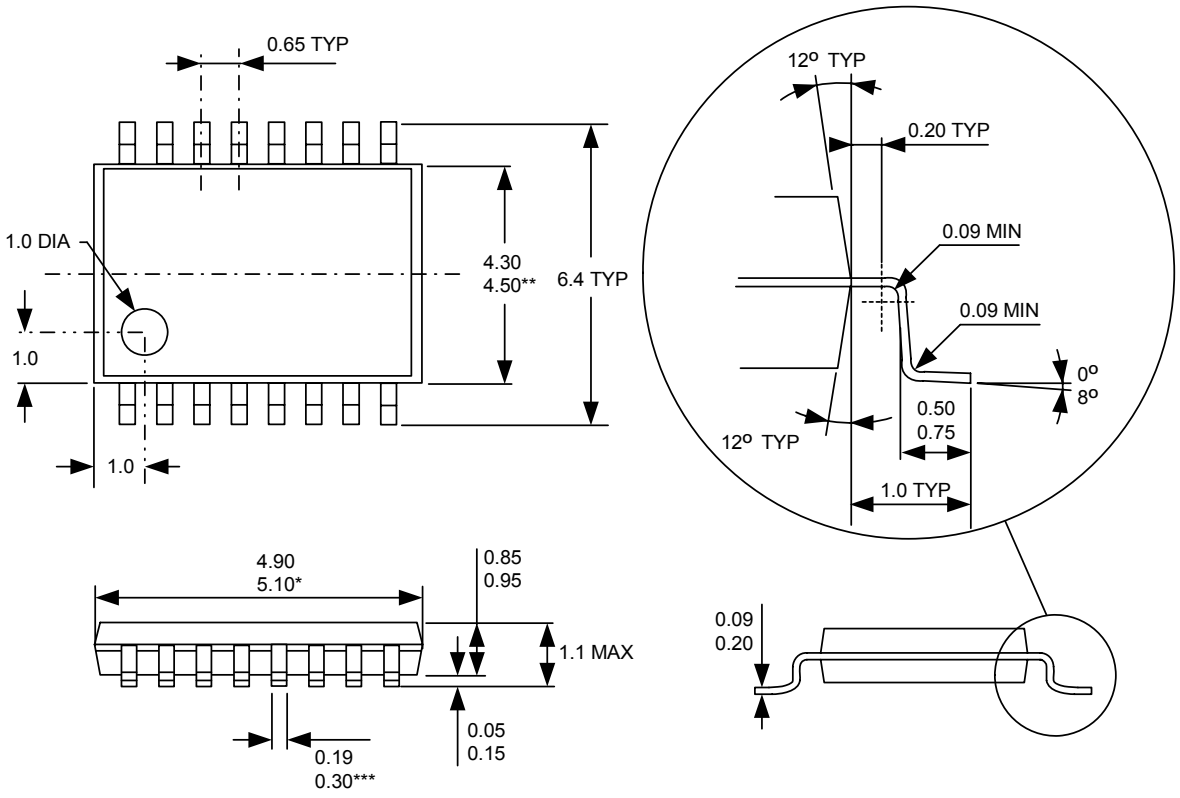
~ 270 Deg.*



* No absolute reference for the angular information.

The MLX90316 is an absolute angular position sensor but the linearity error (Le – See Section 10) does not include the error linked to the absolute reference 0 Deg (which can be fixed in the application through the discontinuity point – See 14.2.2).

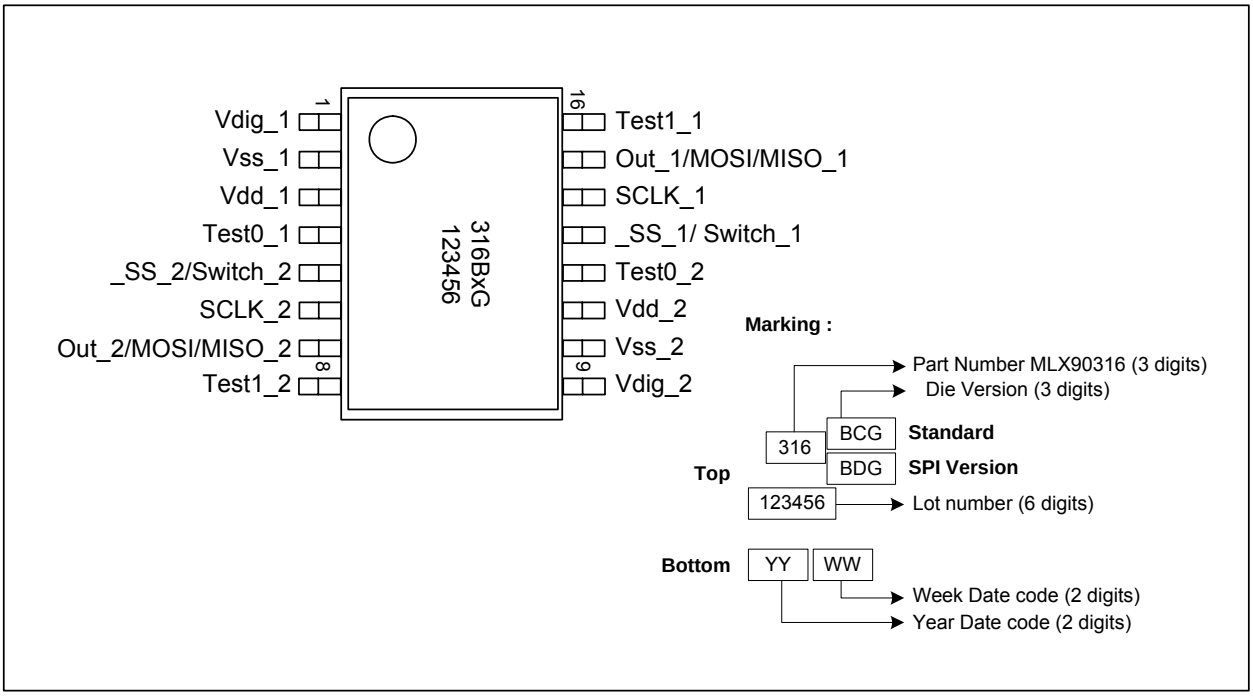
20.4. TSSOP16 - Package Dimensions



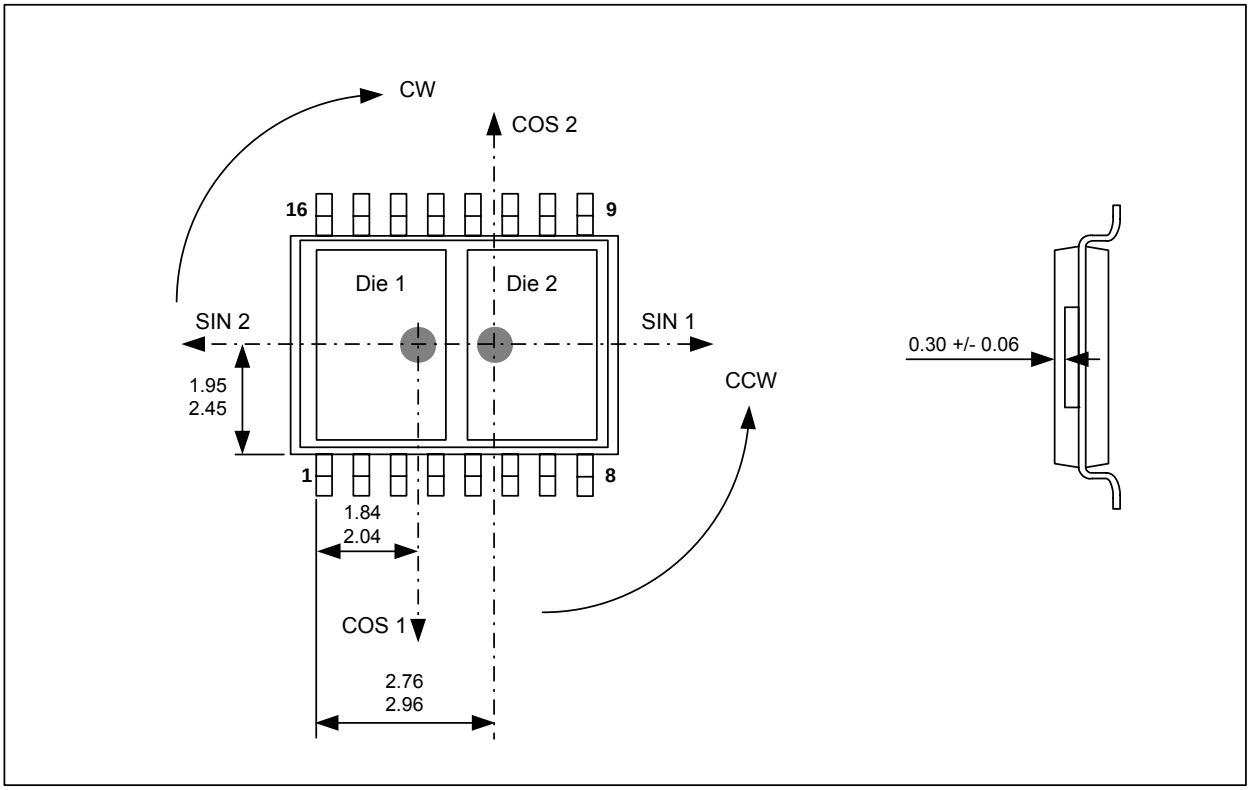
NOTES:

All dimensions are in millimeters (anlges 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.

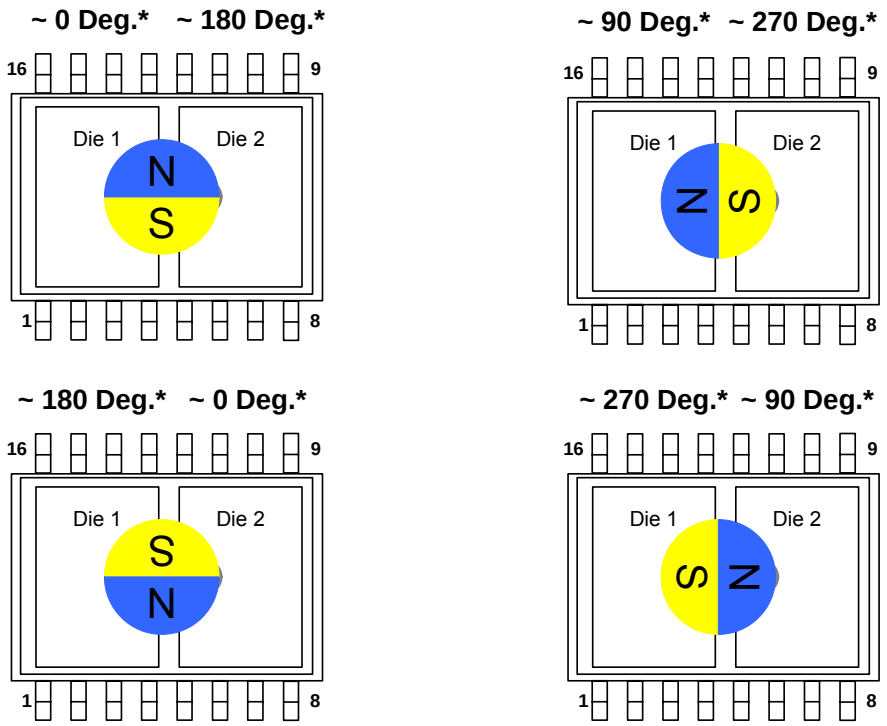
20.5. TSSOP16 - Pinout and Marking



20.6. TSSOP16 - IMC Positionning



Angle detection MLX90316 TSSOP16



* No absolute reference for the angular information.

The MLX90316 is an absolute angular position sensor but the linearity error (Le – See Section 10) does not include the error linked to the absolute reference 0 Deg (which can be fixed in the application through the discontinuity point – See 14.2.2).

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