

1. Features and Benefits

- Current interface for 2-wire applications
- Pre-programmed magnetic Unipolar or Omnipolar Switch
- End-of-Line (Customer programmable)
- Temperature compensation coefficient in the range -2000 to 0 ppm/°C
- Wide magnetic range from 0.5mT to 200mT (40mT for IMC variant)
- Optional IMC integration for lateral magnetic sensing (X or Y)
- Integrated self-diagnostic functions activating a dedicated Safe State
- Parallel or Sequential diagnostic modes
- Safe State Duration from 0.5ms to 800ms
- Wide operating voltage range 2.7V to 28V
- Developed according ISO26262 ASIL-B SEooC
- AEC-Q100 qualified device
- Packages, RoHS compliant
 - UA (Through hole)
 - UA with integrated capacitor (PCB-less)
 - TSOT23 (Surface mount)
- Integrated protections
 - Reverse supply voltage protection
 - Thermal protection
 - Under-voltage reset

2. Application Examples

- Seat position
- Seatbelt buckle
- Steering column motor
- Active air skirt, flaps & e-vents
- Expansion valves & pumps
- Brake fluid level sensor
- Wheel speed sensor
- Transmission applications

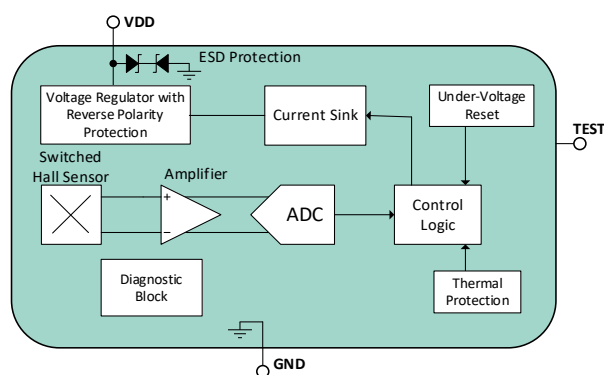
3. Description

The MLX92342/1 is a monolithic sensor IC sensitive to perpendicular or lateral magnetic field (version dependent). The output state of the device is changing the supply current. The two-wire interface not only saves one wire, but also allows implementation of diagnostic functions as reverse polarity connection and malfunction detection.

The MLX92342 can be programmed to act as magnetic unipolar switch, omnipolar switch or latch. The device has two magnetic thresholds (B_{OP} and B_{RP}), each of them can be programmed independently.

The MLX92342/1 has comprehensive on-chip diagnostic mechanisms, compliant with ASIL-B level. All diagnostic functions are leading to one and the same Safe state, reported with a dedicated Safe current. The user can select between Parallel or Sequential diagnostic modes, respectively selecting between fast magnetic update or fast diagnostic response.

Customers can benefit from the end-of-line (EoL) programming capability of the MLX92342 to trim mechanical tolerances away or alternatively choose a pre-programmed MLX92341 switch device. Programming is available with the PTC04 or EVB2 through the VDD pin.



MLX92342/1 functional diagram

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4. Ordering Information

Product	Temperature	Package	Option Code	Packing Form	Definition
MLX92342	L	SE	AAA-000	RE	Customer EoL programmable
MLX92342	L	UA	AAA-000	BU	Customer EoL programmable
MLX92342	L	UA	AAA-100	BU	Customer EoL programmable
MLX92342	L	UA	AAA-300	BU	Customer EoL programmable
MLX92341	L	UA	AAA-101	BU	Pre-programmed Unipolar Switch
MLX92341	L	UA	AAA-102	BU	Pre-programmed Unipolar Switch

Legend:

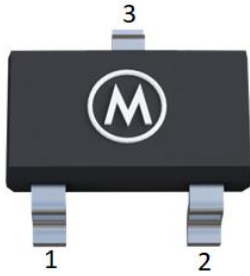
Product	MLX92341 – Factory Pre-Programmed Switch sensor MLX92342 – Customer EoL Programmable sensor
Temperature Code:	L: T _A from -40°C to 150°C
Package Code:	“UA” for TO92-3L package “SE” for TSOT23-3L package
Option Code:	0xx => Perpendicular sensitive 1xx => Integrated capacitor (UA package only, perpendicular sensitive) 3xx => Integrated capacitor and IMC (UA package only, lateral sensitive)
Packing Form:	BU: Bulk RE: Reel
Ordering Example:	MLX92342LUA-AAA-000-BU

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5. Pin Definitions and Descriptions

5.1. Pin Definition for SE package



Pin #	Name	Description
1	VDD	Power Supply
2	TEST	For Melexis use only
3	GND	Ground

5.2. Pin Definition for UA package



Pin #	Name	Description
1	VDD	Power Supply
2	GND	Ground
3	TEST	For Melexis use only

5.3. Pin Definition for UA package with integrated capacitor



Pin #	Name	Description
1	VDD	Power Supply
2	TEST	For Melexis use only
3	GND	Ground pin

6. Glossary of Terms

Term	Definition
Gauss (G), Tesla (T)	Units for the magnetic flux density – 1 mT = 10 G
TC	Temperature Coefficient of the magnetic threshold (in ppm/°C)
ADC	Analog-to-Digital Converter
B _{OP}	Operating magnetic threshold
B _{RP}	Release magnetic threshold

7. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply voltage	V _{DD}	32	V
Reverse supply voltage	V _{DDREV}	-32	V
Maximum junction temperature ⁽¹⁾	T _{J_MAX}	+175	°C
ESD – HBM ⁽²⁾	-	8	kV
System ESD ⁽³⁾ - contact discharge	-	15	kV
System ESD ⁽³⁾ - indirect discharge	-	25	kV
ESD – CDM ⁽⁴⁾	-	1	kV

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

¹ Guaranteed by 1000 hours HTOL

² Human Body Model according AEC-Q100-002 standard

³ According to ISO10605, only for option codes in UA with Capacitor

⁴ Charged Device Model according AEC-Q100-011 standard

8. General Electrical and Timing Specifications

Operating conditions $V_{DD} = 2.7V$ to $28V$, $T_J = -40^{\circ}C$ to $175^{\circ}C$ (unless otherwise specified)

Electrical Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
OFF Supply current	I_{OFF}		2	–	5	mA
			5	–	6.9	
ON Supply current	I_{ON}		12	–	17	mA
Reverse supply current	I_{DDREV}	$V_{DD} = -28V$	-0.1	–	–	mA
Safe State supply current	I_{SAFE}		0.2	0.5	0.8	mA
Under Voltage Reset threshold	V_{UVR}		–	–	2.5	V
Under Voltage Reset reaction time ⁽²⁾	t_{UVR}	V_{DD} drop to 1.5V	–	0.5	–	μs
Power-On time ^(3, 5)	t_{ON_MAG}	$V_{DD} = 5V$, $\Delta V_{DD}/\Delta t \geq 2V/\mu s$	–	60	75	μs
Power-On time ^(4, 5, 6) (including the first diagnostics update)	$t_{ON_DIAG_SEQ}$	$V_{DD} = 5V$, $\Delta V_{DD}/\Delta t \geq 2V/\mu s$ Sequential Diagnostic Mode	–	85	100	μs
	$t_{ON_DIAG_PAR}$	$V_{DD} = 5V$, $\Delta V_{DD}/\Delta t \geq 2V/\mu s$ Parallel Diagnostic Mode	–	6.2	6.8	ms
Output update period ⁽⁶⁾	T_{UPD_SEQ}	Sequential Diagnostic Mode	43	48	53	μs
	T_{UPD_PAR}	Parallel Diagnostic Mode	7	8	9	μs
Fault handling time ⁽⁶⁾	T_{DIAG_SEQ}	Sequential Diagnostic Mode	58	64	70	μs
	T_{DIAG_PAR}	Parallel Diagnostic Mode	7.4	8.2	9	ms
Safe State Duration tolerance ⁽⁶⁾	ΔT_{SAFE_STATE}		-10	–	10	%
Supply current rise/fall time ⁽²⁾	t_R/t_F	$V_{DD} = 12V$, $C_{LOAD}=50pF$ to GND	–	0.3	1	μs

¹ Unless otherwise specified the typical values are defined at $T_A = +25^{\circ}C$ and $V_{DD} = 12V$

² Guaranteed by design and verified by characterization, not production tested

³ The Power-On Time represents the time from reaching $V_{DD} = 2.7V$ to the first refresh of the output state according to applied magnetic field

⁴ The Diagnostic Power-On Time represents the time from reaching $V_{DD} = 2.7V$ to the first refresh of the output state according to applied magnetic field and the complete diagnostic checks

⁵ Power-On Slew Rate is not critical for proper device start-up

⁶ Verified by characterization. In correlation with a production test

Electrical Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
Output Jitter (p-p) ⁽²⁾	$t_{\text{JITTER_SEQ}}$	Triangular magnetic field with $B_{\text{PEAK}} \geq 10 \times B_{\text{OP}}$, $F_B = 10\text{kHz}$; Magnetic Latch, Sequential Diagnostic Mode	—	55	—	μs
	$t_{\text{JITTER_PAR}}$	Triangular magnetic field with $B_{\text{PEAK}} \geq 10 \times B_{\text{OP}}$, $F_B = 10\text{kHz}$; Magnetic Latch, Parallel Diagnostic Mode	—	10	—	μs
Maximum switching frequency ⁽²⁾	$F_{\text{SW_MAX_SEQ}}$	Triangular magnetic field with $B_{\text{PEAK}} \geq 10 \times B_{\text{OP}}$; Magnetic Latch, Sequential Diagnostic Mode	6	7	—	kHz
	$F_{\text{SW_MAX_PAR}}$	Triangular magnetic field with $B_{\text{PEAK}} \geq 10 \times B_{\text{OP}}$; Magnetic Latch, Parallel Diagnostic Mode	30	40	—	kHz
Thermal Protection threshold	T_{PROT}		—	190	—	$^{\circ}\text{C}$
Integrated bypass capacitor	C_{BP}	Only for option -1xx / -3xx	—	100	—	nF
UA package thermal resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards, still air (LFPM=0)	—	200	—	$^{\circ}\text{C/W}$
SE package thermal resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards, still air (LFPM=0)	—	300	—	$^{\circ}\text{C/W}$

9. Version Specific Parameters

MLX92342 devices are unlocked and can be tuned with the Melexis PTC04 programmer, the MLX92342 comes with a default setting which is described in this section. MLX92341 switch devices are pre-programmed and locked by Melexis, these variants cannot be changed at customer side.

¹ Unless otherwise specified the typical values are defined at $T_A = +25^{\circ}\text{C}$ and $V_{\text{DD}} = 12\text{V}$

² Guaranteed by design and verified by characterization, not production tested

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9.1. MLX92342LUA-AAA-000, MLX92342LUA-AAA-100 and MLX92342LSE-AAA-000

Operating conditions $V_{DD} = 2.7V$ to $28V$, $T_J = -40^{\circ}C$ to $175^{\circ}C$ (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ ⁽¹⁾	Max	Units
Operating point programming range	Bop	$V_{DD} = 12V$, $T_J = 25^{\circ}C$	-200	-	200	mT
Release point programming range	Brp		-200	-	200	mT
B _{OP} /B _{RP} programming resolution	N _{BOP} /N _{BRP}		-	16	-	bit
B _{OP} /B _{RP} tolerance after programming, absolute error ⁽²⁾	$\Delta B_{XP(abs)}$	$V_{DD} = 12V$, $T_J = 25^{\circ}C$	-0.7	-	0.7	mT
B _{OP} /B _{RP} tolerance after programming, relative error ⁽²⁾	$\Delta B_{XP(rel)}$	$V_{DD} = 12V$, $T_J = 25^{\circ}C$	-4	-	4	%
B _{OP} /B _{RP} tolerance over temperature after programming, absolute error ⁽²⁾	$\Delta B_{XP_TC(abs)}$		-0.002	-	0.002	mT/ $^{\circ}C$
B _{OP} /B _{RP} tolerance over temperature after programming, relative error ⁽²⁾	$\Delta B_{XP_TC(rel)}$		-0.06	-	0.06	%/ $^{\circ}C$
B _{OP} /B _{RP} Temperature Coefficient Programming Range ⁽³⁾	TC		-2000	-	0	ppm/ $^{\circ}C$
TC programming resolution	N _{TC}		-	8	-	bit
Diagnostic Enable			-	1	-	bit
Diagnostic Mode (Parallel/Sequential)			-	1	-	bit
Safe State Duration programming range	T _{SAFE_STATE}		0.5	—	800	ms
T _{SAFE_STATE} programming resolution	N _{TSAFE_STATE}		-	8	-	bit
Omnipolar mode selection			-	1	-	bit
Output Polarity Selection			-	1	-	bit
Programming Lock			-	1	-	bit
Customer programmable ID			-	8	-	bit

Factory pre-programmed settings

Magnetic Parameter	Symbol	Condition	Min	Typ ⁽²⁾	Max	Unit
Operating point	B _{OP}	$T_J = -40^{\circ}C$	14.8	16.1	17.7	mT
		$T_J = 25^{\circ}C$	13.9	15.0	16.3	
		$T_J = 150^{\circ}C$	11.3	12.9	14.9	

¹ Unless otherwise specified the typical values are defined at $T_A = +25^{\circ}C$ and $V_{DD} = 12V$

² The magnetic tolerance coefficients can be used for approximate magnetic specification over the lifetime of the IC. Contact Melexis application engineering for a more precise magnetic specification. The usage of the coefficients is described in chapter 10.7.

³ The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XT2} - B_{XT1}}{B_{XT1} \times (T_2 - T_1)} \times 10^6, ppm/^{\circ}C \quad \text{where: } T_1 = 25^{\circ}C, T_2 = 150^{\circ}C$$

In case of magnetic Latch application: B_{XT1} (B_{XT2}) = B_{HYS} at T_1 (T_2)

In case of magnetic Switch application: B_{XT1} (B_{XT2}) = B_{OP} or B_{RP} at T_1 (T_2)

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Magnetic Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
Release point	B _{RP}	T _J = -40°C	11.8	12.9	14.3	mT
		T _J = 25°C	11.0	12.0	13.2	
		T _J = 150°C	8.9	10.4	12.1	
Hysteresis ⁽²⁾	B _{HYS}	T _J = -40°C	2.6	3.2	3.8	mT
		T _J = 25°C	2.4	3.0	3.5	
		T _J = 150°C	1.9	2.6	3.3	

Sensitive Axis	Magnetic Function	Active Pole	TC ⁽³⁾ (ppm/°C)	I _{OFF} (mA)	Output Polarity	Diagnostic Mode	Diagnostic Functions	Safe State Duration (ms)
Z	Unipolar Switch	South	-1100	6	Direct	Parallel	Enabled	10

¹ Unless otherwise specified the typical values are defined at T_A = +25°C and V_{DD} = 12V

² B_{HYS} = B_{OP} - B_{RP}

³ The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XT2} - B_{XT1}}{B_{XT1} \times (T_2 - T_1)} \times 10^6, ppm/°C \quad \text{where: } T_1 = 25°C, T_2 = 150°C$$

In case of magnetic Latch application: B_{XT1} (B_{XT2}) = B_{HYS} at T₁ (T₂)

In case of magnetic Switch application: B_{XT1} (B_{XT2}) = B_{OP} or B_{RP} at T₁ (T₂)

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9.2. MLX92342LUA-AAA-300

Operating conditions $V_{DD} = 2.7V$ to $28V$, $T_J = -40^{\circ}C$ to $175^{\circ}C$ (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ ⁽¹⁾	Max	Units
Operating point programming range	Bop	$V_{DD} = 12V$, $T_J = 25^{\circ}C$	-40	-	40	mT
Release point programming range	Brp		-40	-	40	mT
B _{OP} /B _{RP} programming resolution	N _{BOP} /N _{BRP}		-	16	-	bit
B _{OP} /B _{RP} tolerance after programming, absolute error ⁽²⁾	$\Delta B_{XP(abs)}$	$V_{DD} = 12V$, $T_J = 25^{\circ}C$	-0.8	-	0.8	mT
B _{OP} /B _{RP} tolerance after programming, relative error ⁽²⁾	$\Delta B_{XP(rel)}$	$V_{DD} = 12V$, $T_J = 25^{\circ}C$	-4	-	4	%
B _{OP} /B _{RP} tolerance over temperature after programming, absolute error ⁽²⁾	$\Delta B_{XP_TC(abs)}$		-0.002	-	0.002	mT/ $^{\circ}C$
B _{OP} /B _{RP} tolerance over temperature after programming, relative error ⁽²⁾	$\Delta B_{XP_TC(rel)}$		-0.06	-	0.06	%/ $^{\circ}C$
B _{OP} /B _{RP} Temperature Coefficient Programming Range	TC ⁽³⁾		-2000	-	0	ppm/ $^{\circ}C$
TC programming resolution	N _{TC}		-	8	-	bit
Diagnostic Enable			-	1	-	bit
Diagnostic Mode (Parallel/Sequential)			-	1	-	bit
Safe State Duration programming range	T _{SAFE_STATE}		0.5	—	800	ms
T _{SAFE_STATE} programming resolution	N _{TSAFE_STATE}		-	8	-	bit
Omnipolar mode selection			-	1	-	bit
Output Polarity Selection			-	1	-	bit
Programming Lock			-	1	-	bit
Customer programmable ID			-	8	-	bit

Factory pre-programmed settings

Magnetic Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
Operating point	B _{OP}	$T_J = -40^{\circ}C$	11.1	12.9	14.3	mT
		$T_J = 25^{\circ}C$	11.0	12.0	13.2	
		$T_J = 150^{\circ}C$	8.9	10.4	12.1	

¹ Unless otherwise specified the typical values are defined at $T_A = +25^{\circ}C$ and $V_{DD} = 12V$

² The magnetic tolerance coefficients can be used for approximate magnetic specification over the lifetime of the IC. Contact Melexis application engineering for a more precise magnetic specification. The usage of the coefficients is described in chapter 10.7.

³ The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XT2} - B_{XT1}}{B_{XT1} \times (T_2 - T_1)} \times 10^6, ppm/^{\circ}C \quad \text{where: } T_1 = 25^{\circ}C, T_2 = 150^{\circ}C$$

In case of magnetic Latch application: B_{XT1} (B_{XT2}) = B_{HYS} at T_1 (T_2)

In case of magnetic Switch application: B_{XT1} (B_{XT2}) = B_{OP} or B_{RP} at T_1 (T_2)

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Magnetic Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
Release point	B _{RP}	T _J = -40°C	-14.3	-12.9	-11.8	mT
		T _J = 25°C	-13.2	-12.0	-11.0	
		T _J = 150°C	-12.1	-10.4	-8.9	
Hysteresis ⁽²⁾	B _{HYS}	T _J = -40°C	23.9	25.8	27.5	mT
		T _J = 25°C	22.7	24.0	25.4	
		T _J = 150°C	18.6	20.7	23.3	

Sensitive Axis	Magnetic Function	Active Pole	TC ⁽³⁾ (ppm/°C)	I _{OFF} (mA)	Output Polarity	Diagnostic Mode	Diagnostic Functions	Safe State Duration (ms)
X	Latch	South	-1100	6	Direct	Parallel	Enabled	10

9.3. MLX92341LUA-AAA-101

Operating conditions V_{DD} = 2.7V to 28V, T_J = -40°C to 175°C (unless otherwise specified)

Magnetic Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
Operating point	B _{OP}	T _J = -40°C	7.5	8.5	9.7	mT
		T _J = 25°C	7	7.9	9	
		T _J = 150°C	5.7	6.8	8.2	
Release point	B _{RP}	T _J = -40°C	4.9	5.7	6.8	mT
		T _J = 25°C	4.5	5.3	6.3	
		T _J = 150°C	3.5	4.6	5.8	
Hysteresis ⁽²⁾	B _{HYS}	T _J = -40°C	2.2	2.8	3.3	mT
		T _J = 25°C	2	2.6	3.1	
		T _J = 150°C	1.6	2.2	2.9	

Sensitive Axis	Magnetic Function	Active Pole	TC ⁽³⁾ (ppm/°C)	I _{OFF} (mA)	Output Polarity	Diagnostic Mode	Diagnostic Functions	Safe State Duration (ms)
Z	Unipolar Switch	South	-1100	3.5	Inverted	Sequential	Disabled	10

¹ Unless otherwise specified the typical values are defined at T_A = +25°C and V_{DD} = 12V

² B_{HYS} = B_{OP} - B_{RP}

³ The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XT2} - B_{XT1}}{B_{XT1} \times (T_2 - T_1)} \times 10^6, ppm/°C \quad \text{where: } T_1 = 25°C, T_2 = 150°C$$

In case of magnetic Latch application: B_{XT1} (B_{XT2}) = B_{HYS} at T₁ (T₂)

In case of magnetic Switch application: B_{XT1} (B_{XT2}) = B_{OP} or B_{RP} at T₁ (T₂)

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9.4. MLX92341LUA-AAA-102

Operating conditions $V_{DD} = 2.7V$ to $28V$, $T_J = -40^{\circ}C$ to $175^{\circ}C$ (unless otherwise specified)

Magnetic Parameter	Symbol	Condition	Min	Typ ⁽¹⁾	Max	Unit
Operating point	B_{OP}	$T_J = -40^{\circ}C$	7.5	8.5	9.7	mT
		$T_J = 25^{\circ}C$	7	7.9	9	
		$T_J = 150^{\circ}C$	5.7	6.8	8.2	
Release point	B_{RP}	$T_J = -40^{\circ}C$	4.9	5.7	6.8	mT
		$T_J = 25^{\circ}C$	4.5	5.3	6.3	
		$T_J = 150^{\circ}C$	3.5	4.6	5.8	
Hysteresis ⁽²⁾	B_{HYS}	$T_J = -40^{\circ}C$	2.2	2.8	3.3	mT
		$T_J = 25^{\circ}C$	2	2.6	3.1	
		$T_J = 150^{\circ}C$	1.6	2.2	2.9	

Sensitive Axis	Magnetic Function	Active Pole	TC ⁽³⁾ (ppm/ $^{\circ}C$)	I_{OFF} (mA)	Output Polarity	Diagnostic Mode	Diagnostic Functions	Safe State Duration (ms)
Z	Unipolar Switch	South	-1100	6	Inverted	Sequential	Disabled	10

¹ Unless otherwise specified the typical values are defined at $T_A = +25^{\circ}C$ and $V_{DD} = 12V$

² $B_{HYS} = B_{OP} - B_{RP}$

³ The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XT2} - B_{XT1}}{B_{XT1} \times (T_2 - T_1)} \times 10^6, ppm/^{\circ}C \quad \text{where: } T_1 = 25^{\circ}C, T_2 = 150^{\circ}C$$

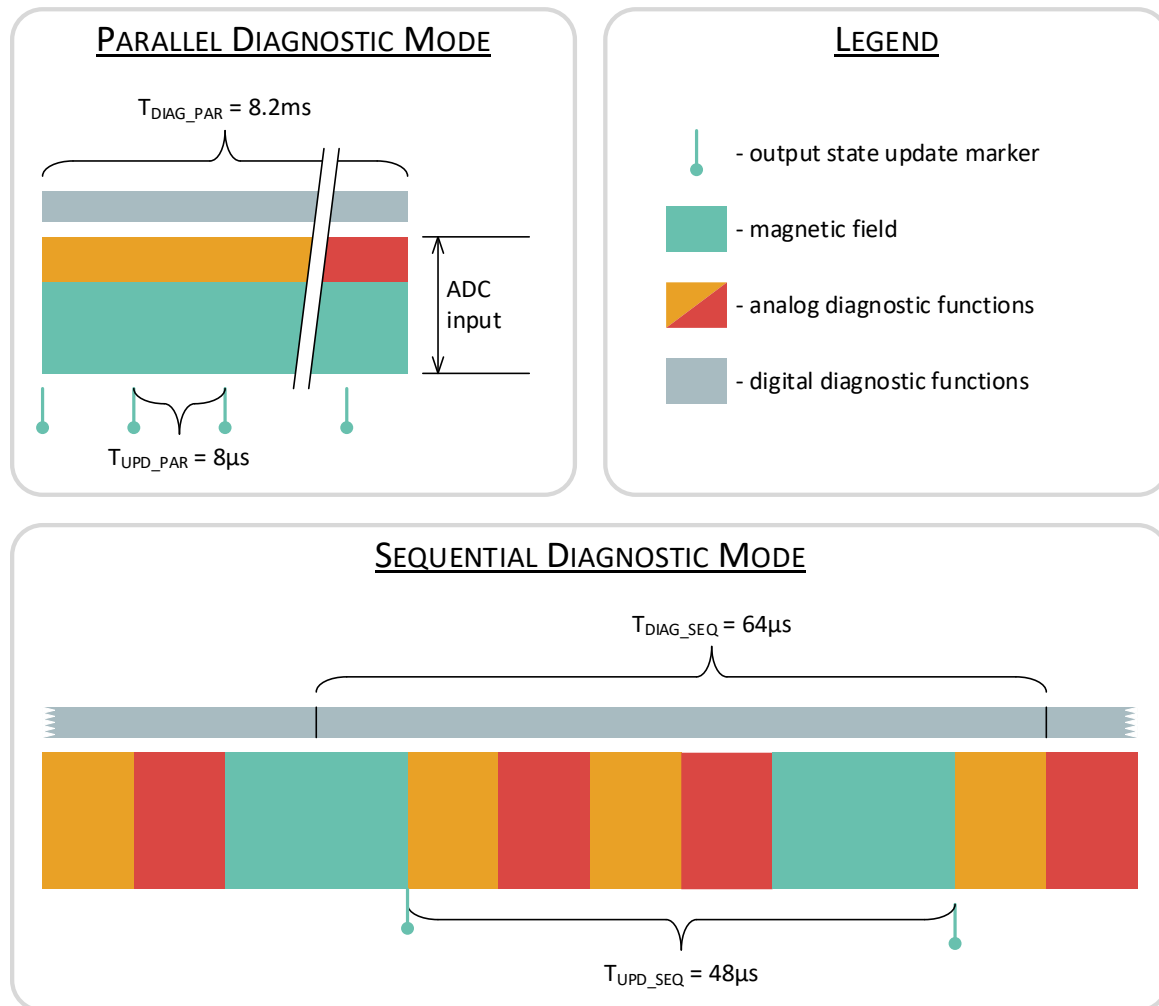
In case of magnetic Latch application: B_{XT1} (B_{XT2}) = B_{HYS} at T_1 (T_2)

In case of magnetic Switch application: B_{XT1} (B_{XT2}) = B_{OP} or B_{RP} at T_1 (T_2)

10. Detailed Description

10.1. Diagnostic modes

The MLX92342/1 can operate in two Diagnostic modes – Parallel Diagnostic Mode and Sequential Diagnostic Mode. The diagnostic modes are acquisition modes, they change how the chip acquires the magnetic and diagnostic signal, even if all diagnostic functions are disabled. The diagnostic modes don't change the diagnostic coverage. The diagrams below illustrate how the two modes are different.



10.1.1. Parallel Diagnostic Mode

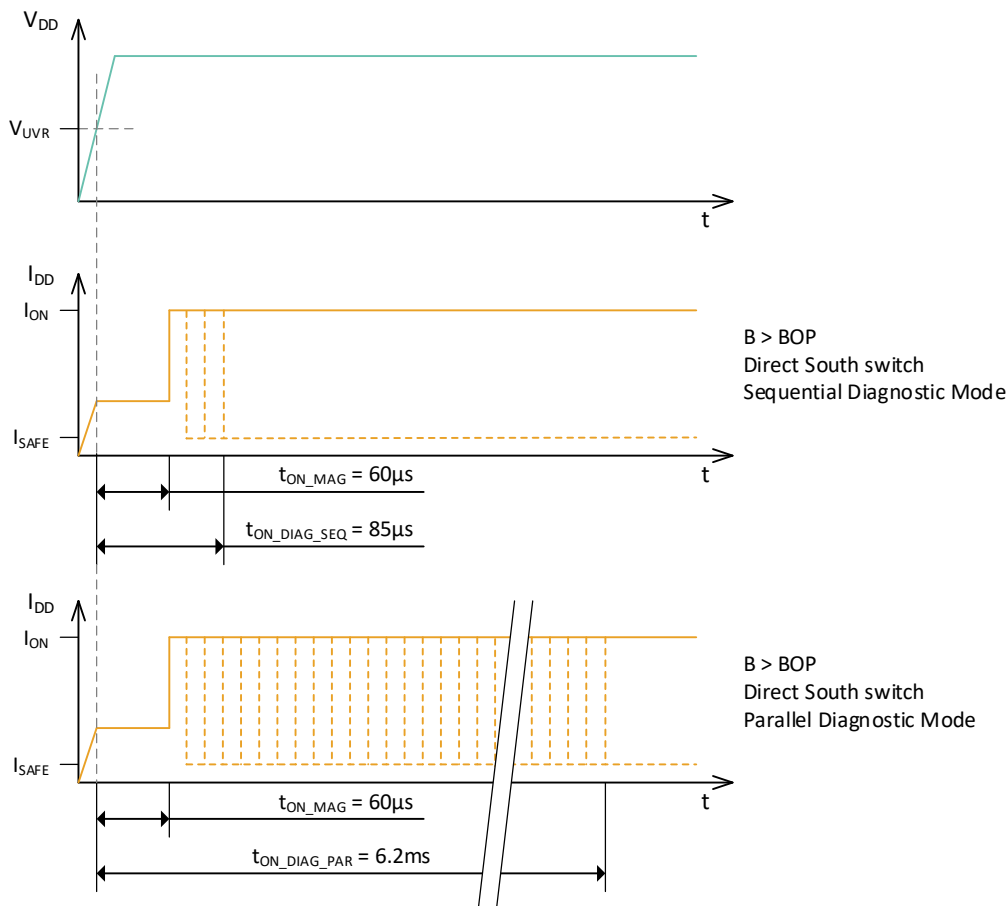
In Parallel Diagnostic Mode the analog diagnostic signals are summed with the magnetic signal in the analog domain, allowing both signals to be converted simultaneously. In the digital domain the diagnostic signals and the magnetic signal are again separated and used for diagnostic functions and magnetic comparison. Applying a magnetic field higher than the magnetic range can lead to distortion of the diagnostic signals and ultimately to a diagnostic failure. In Parallel Diagnostic Mode, the magnetic output state update (T_{UPD_PAR}) occurs every $8\mu s$, while the complete diagnostic cycle (T_{DIAG_PAR}) takes $8.2ms$. The analog diagnostic functions are slower than the digital diagnostic function and therefore define the overall diagnostic period. This mode prioritizes the processing of the magnetic signal, making it better suited for applications where the magnetic field is quickly changing or where output jitter is important (e.g. Latch in motor commutation applications).

10.1.2. Sequential Diagnostic Mode

In Sequential Diagnostic Mode, the analog diagnostic signals and the magnetic signal are converted by the ADC in sequence, hence the name – Sequential Diagnostic Mode. This mode allows for direct use of the diagnostic signals and the magnetic signal without needing separation. In this mode, magnetic fields beyond the magnetic range won't distort the diagnostic signals and won't lead to false diagnostic failures. The output state update (T_{UPD_SEQ}) occurs every $48\mu s$, while the complete diagnostic cycle (T_{DIAG_SEQ}) takes $64\mu s$. In Sequential Diagnostic Mode, digital diagnostic functions are slower than analog diagnostic functions and therefore define the overall diagnostic period. This mode prioritizes processing of the diagnostic signals, making it better suited for applications where the magnetic field does not change often or where the chip is supplied for short durations and a fast output state update reflecting the result from the diagnostic functions directly leads to power savings (e.g. Switch in end position applications).

10.2. Start-up procedure

The Start-up procedure begins when the undervoltage reset is reached during supply voltage ramp-up and ends at the first magnetic output state update. The Start-up procedure is illustrated below. During this procedure, the chip always operates in Sequential Diagnostic Mode, regardless of its programming. First, the junction temperature is acquired, then the magnetic field, followed by an output state update based on the applied magnetic field and programmed settings. This concludes the Start-up procedure with a typical duration of t_{ON_MAG} ($60\mu s$). The chip then continues in Parallel Diagnostic Mode or Sequential Diagnostic Mode, depending on its programming.



If Sequential Diagnostic Mode is selected, the chip continues with the conversion of analog diagnostic signals. Meanwhile, if a diagnostic fault occurs, the chip will transition to a safe output state (I_{SAFE} current). All diagnostic functions are completed at $t_{ON_DIAG_SEQ}$ (85 μ s). If all diagnostic checks have passed successfully, the output state will be equal to I_{ON} or I_{OFF} after $t_{ON_DIAG_SEQ}$. The output state between t_{ON_MAG} and $t_{ON_DIAG_SEQ}$ may not be valid (not corresponding to the magnetic field). In applications with Functional Safety requirements, it is recommended to sample the output state after $t_{ON_DIAG_SEQ}$, with Sequential Diagnostic Mode selected. After $t_{ON_DIAG_SEQ}$ the chip continues to do magnetic output state updates with a period of T_{UPD_SEQ} and diagnostic checks with a period of T_{DIAG_SEQ} .

If Parallel Diagnostic Mode is selected, the chip continues acquiring the rest of the diagnostic signals and the magnetic field simultaneously. Since the junction temperature was acquired in Sequential Diagnostic Mode during the Start-up procedure, the duration to complete acquisition of the rest of the diagnostic signals $t_{ON_DIAG_PAR}$ (6.2ms) takes less time than the normal diagnostic period T_{DIAG_PAR} (8.2ms). Between t_{ON_MAG} and $t_{ON_DIAG_PAR}$, the output is continuously updated based on the magnetic field (with an update period of T_{UPD_PAR}). Meanwhile, if a diagnostic fault occurs, the chip will transition to a safe output state (I_{SAFE} current). All diagnostic functions are completed at $t_{ON_DIAG_PAR}$. All diagnostic checks have passed successfully if the output state is equal to I_{ON} or I_{OFF} after $t_{ON_DIAG_PAR}$. The output state between t_{ON_MAG} and $t_{ON_DIAG_PAR}$ may not be valid (not corresponding to the magnetic field). In applications with Functional Safety requirements, it is recommended to sample the output state after $t_{ON_DIAG_PAR}$, with Parallel Diagnostic Mode selected. After $t_{ON_DIAG_PAR}$ the chip continues to do magnetic output state updates with a period of T_{UPD_PAR} and diagnostic checks with a period of T_{DIAG_PAR} .

10.3. Fault Handling Time

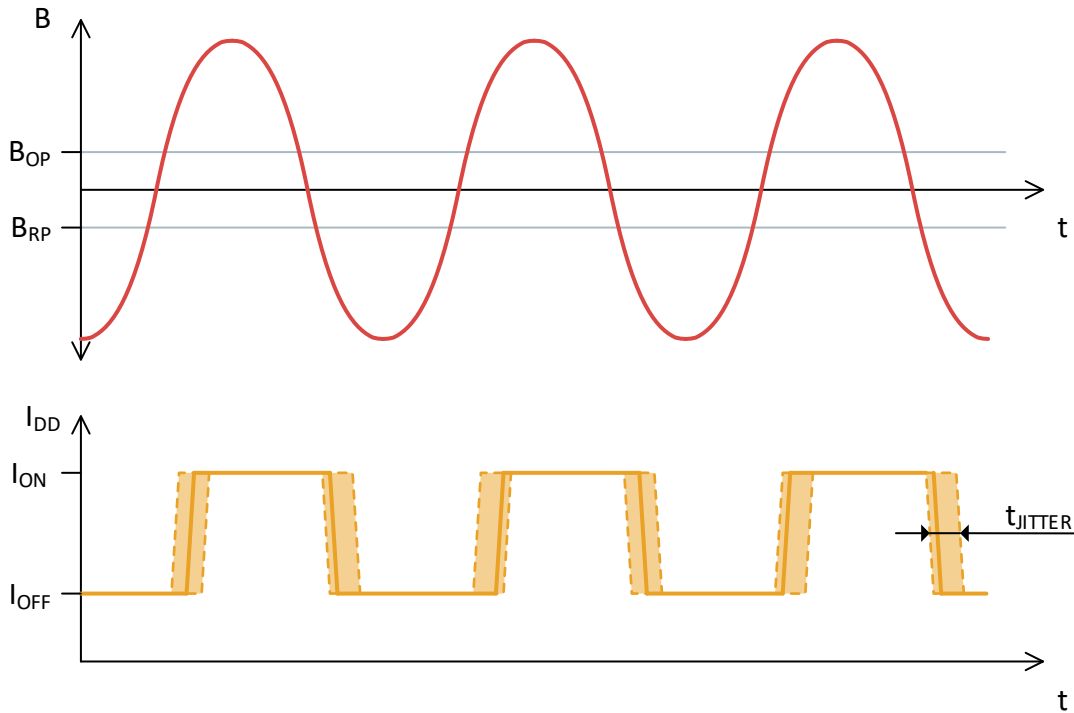
Fault Handling Time refers to the maximum amount of time that elapses between a fault occurring and the output state transitioning to I_{SAFE} . The Fault Handling Time is equal to T_{DIAG_SEQ} or T_{DIAG_PAR} in Sequential Diagnostic Mode or Parallel diagnostic mode respectively.

10.4. Safe state duration (Retry period)

The Safe state is the state MLX92341/2 enters when a diagnostic failure occurs. It is characterized by reduced supply current, equal to I_{SAFE} . The amount of time the chip spends in this state is programmable and is called Safe state duration (T_{SAFE_STATE}). After T_{SAFE_STATE} has elapsed, the chip will perform a diagnostic retry. Therefore, the diagnostic retry period is roughly equal to the Safe state duration. During the diagnostic retry, the supply current will rise above the maximum of I_{SAFE} . T_{SAFE_STATE} must be selected long enough so that the detection of the safe state is guaranteed, otherwise it may not be properly detected because of the diagnostic retry.

10.5. Jitter

The jitter is the variation of the delay between the magnetic field crossing the threshold and the change of the output state. The jitter is primarily caused by the asynchronous sampling of the magnetic field. A secondary source of jitter is the thermal noise of the analog signal processing chain. The jitter has a different value for Parallel Diagnostic Mode and Sequential Diagnostic Mode. The diagram below illustrates the jitter.



10.6. Self-heating

The self-heating of the chip is an effect caused by the power dissipated in the chip and the junction-to-air thermal resistance of the package. The self-heating should be taken into account for two reasons. First, it may limit significantly the maximum ambient temperature the chip operates. Second, it may lead to a shift of the magnetic thresholds.

The maximum ambient temperature can be calculated using the following formula:

$$T_{A_{MAX}} = T_{J_{MAX}} - V_{DD_{MAX}} \times I_{ON} \times R_{THJA}$$

For UA package and maximum supply voltage, the formula yields the following maximum ambient temperature:

$$T_{A_{MAX}} = 175^{\circ}\text{C} - 28\text{V} \times 14.5\text{mA} \times 200^{\circ}\text{C}/\text{W} = 93.8^{\circ}\text{C}$$

The maximum supply voltage can be calculated based on the desired ambient temperature:

$$V_{DD_{MAX}} = \frac{T_{J_{MAX}} - T_{A_{MAX}}}{I_{ON} \times R_{THJA}}$$

For UA package and a maximum desired T_A of 125°C, the formula yields the following maximum supply voltage:

$$V_{DD_{MAX}} = \frac{175^{\circ}\text{C} - 125^{\circ}\text{C}}{14.5\text{mA} \times 200^{\circ}\text{C}/\text{W}} = 17.2\text{V}$$

The maximum supply voltage of the chip should not exceed 28V. The maximum limit of I_{ON} can be used in the calculations instead of the typical value for a worst-case calculation. Based in the above formulas, a graph can be found in chapter 12.2 Voltage Derating Curve for a quick reference.

The self-heating is also affecting the magnetic thresholds, through the TC of the magnetic thresholds. The TC is intended to compensate the temperature coefficient of the magnet. Since the temperature sensor is on the die it is affected by the power dissipation of the chip. The formula below shows the additional error caused by the self-heating.

$$\Delta B_{XP_SH} = \frac{TC \times V_{DDMAX} \times I_{ON} \times R_{THJA}}{10000}, \%$$

For UA package, 28V maximum supply voltage and TC of -2000ppm/°C the additional error due to self-heating is:

$$\Delta B_{XP_SH} = \frac{-2000 \times 28V \times 14.5mA \times 200^{\circ}C/W}{10000} = -16.24\%$$

This additional error should be applied on top of the normal magnetic tolerances. All magnetic specifications (for B_{OP} and B_{RP}) provided by Melexis are for T_J . The self-heating error must be added to convert the magnetic specification to T_A . The self-heating error is only influencing the minimum limits for positive magnetic thresholds and only the maximum limits for negative magnetic thresholds. The self-heating error should be calculated using and typical value of the magnetic threshold for the respected temperature. For example, the provided specification is the following:

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)
	Min	Typ	Max	Min	Typ	Max	
$T_J = -40^{\circ}C$	9.3	11.3	13.3	-13.3	-11.3	-9.3	-2000
$T_J = 25^{\circ}C$	8	10	12	-12	-10	-8	
$T_J = 150^{\circ}C$	5.5	7.5	9.5	-9.5	-7.5	-5.5	

Using the calculated ΔB_{XP_SH} from above, the limits with self-heating taken into account are calculated in the following way:

$$B_{XP} = B_{XP_MIN} + B_{XP_TYP} \times \Delta B_{XP_SH}$$

For B_{OP} at $T_J = -40^{\circ}C$:

$$B_{OP_MIN-40} = 9.3mT + 11.3mT \times -16.24\% = 7.46mT$$

Repeating the calculation for all temperature condition and for each threshold yields the following table:

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)
	Min	Typ	Max	Min	Typ	Max	
$T_A = -40^{\circ}C$	7.5	11.3	13.3	-13.3	-11.3	-7.5	-2000
$T_A = 25^{\circ}C$	6.4	10	12	-12	-10	-6.4	
$T_A = 150^{\circ}C$	4.3	7.5	9.5	-9.5	-7.5	-4.3	

All changes are bolded. It should be noted that the combination of 28V, UA package (used for the ΔB_{XP_SH} calculation) and $T_A = 150^\circ\text{C}$ will lead to overheating and activation of the thermal protection. Therefore, $T_A = 150^\circ\text{C}$ in the table above just demonstrates the methodology without practical application.

The error can be reduced by using a magnet with lower TC coefficient, by lowering the supply voltage or by using a package with lower thermal resistance (UA instead of SE).

10.7. B_{OP}/B_{RP} tolerances after programming

This chapter is valid only for MLX92342. The tolerance of the magnetic thresholds after programming with applied magnetic field at 25°C are calculated using the following formula:

$$B_{XP} = B_{XP_UI} \times \frac{\Delta B_{XP(rel)}}{100} + \Delta B_{XP(abs)}$$

B_{XP} is either B_{OP} or B_{RP} , B_{XP_UI} is the trimmed magnetic threshold displayed in the programming user interface and $\Delta B_{XP(rel)}$ and $\Delta B_{XP(abs)}$ are the tolerance coefficients for the respected version (can be found in the version specification). The tolerance of the magnetic thresholds over temperature are calculated using the following formula:

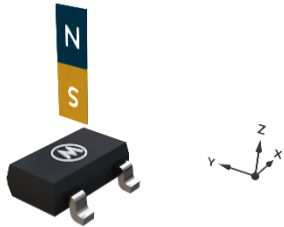
$$B_{XP_T} = B_{XP_UI} \times \left(1 + \frac{TC \times (T_J - 25^\circ\text{C})}{10^6} \right) \times \left(1 + \frac{\Delta B_{XP(rel)}}{100} + \frac{\Delta B_{XP_TC(rel)} \times |T_J - 25^\circ\text{C}|}{100} \right) + \Delta B_{XP(abs)} + \Delta B_{XP_TC(abs)} \times |T_J - 25^\circ\text{C}|$$

TC is the programmed temperature coefficient in ppm/ $^\circ\text{C}$, T_J is desired temperature for the calculation (e.g., -40°C or 125°C), $\Delta B_{XP_TC(rel)}$ and $\Delta B_{XP_TC(abs)}$ are the tolerance coefficients over temperature for the respected version (can be found in the version specification). Self-heating is not taken into account in the above formula.

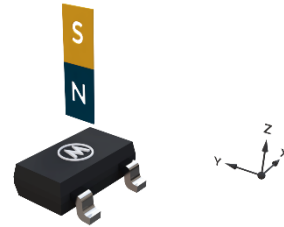
11. Magnetic Behavior

The MLX92342 can be programmed to act as magnetic Latch, Unipolar Switch or Omnipolar Switch. The magnetic function, thresholds and active magnetic axis can be programmed. Any magnetic behavior can be configured by the user for MLX92342 or it can be pre-defined as a Switch by Melexis for MLX92341.

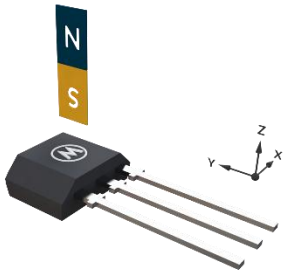
11.1. Active magnetic pole definition



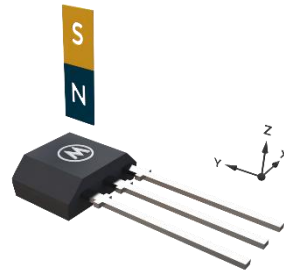
SE package – South Active pole



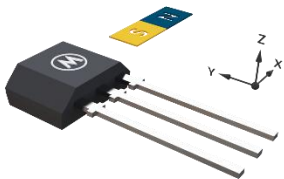
SE package – North Active pole



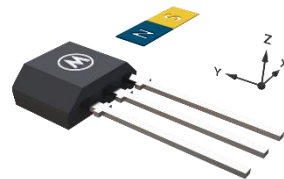
UA package – South Active pole



UA package – North Active pole



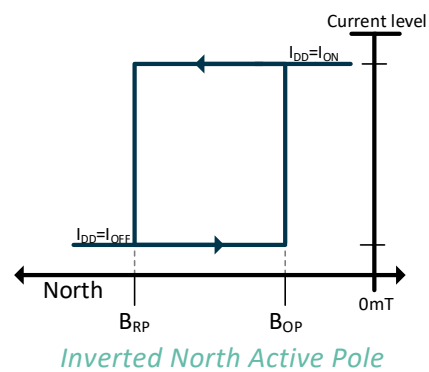
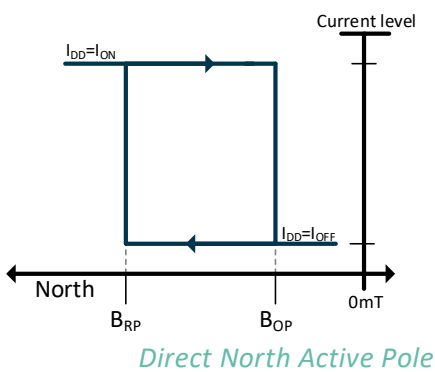
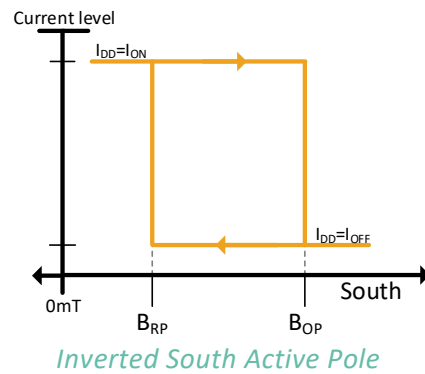
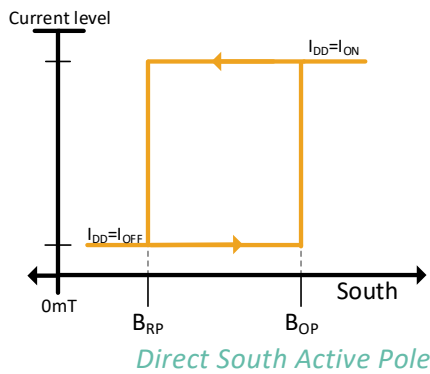
UA package – South Active pole (IMC version)



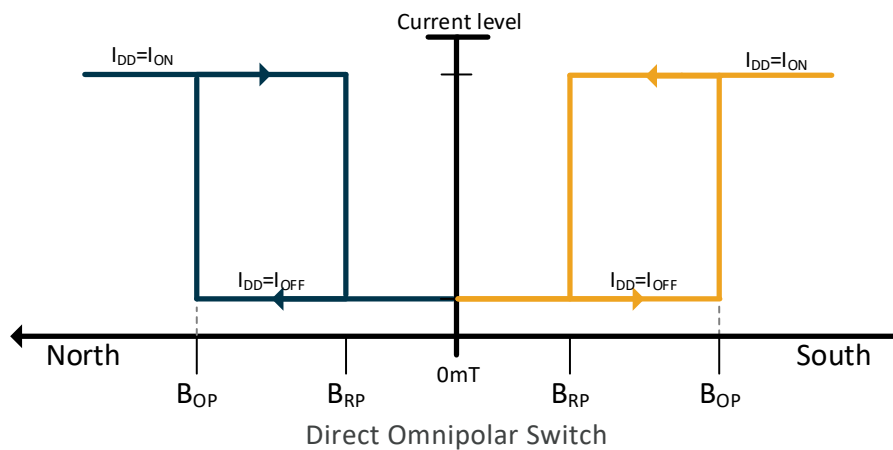
UA package – North Active pole (IMC version)

11.2. Output behavior

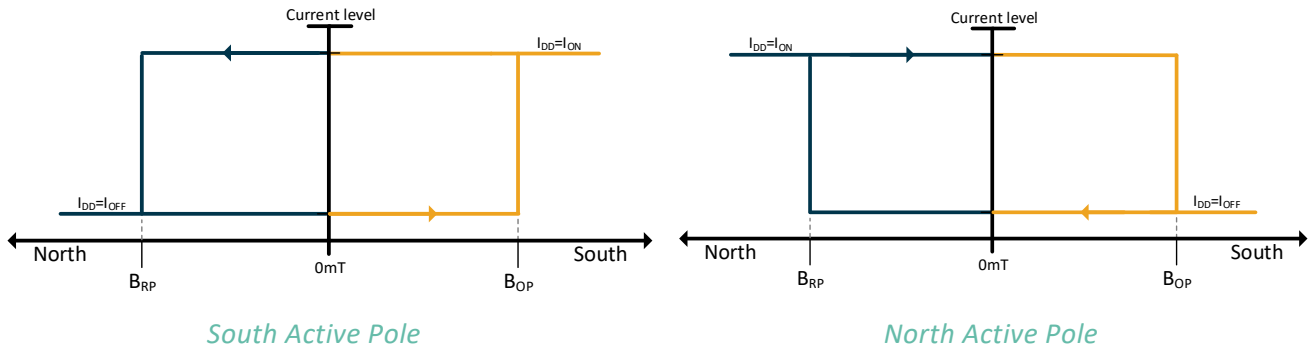
11.2.1. Unipolar switch sensor



11.2.2. Omnipolar switch sensor

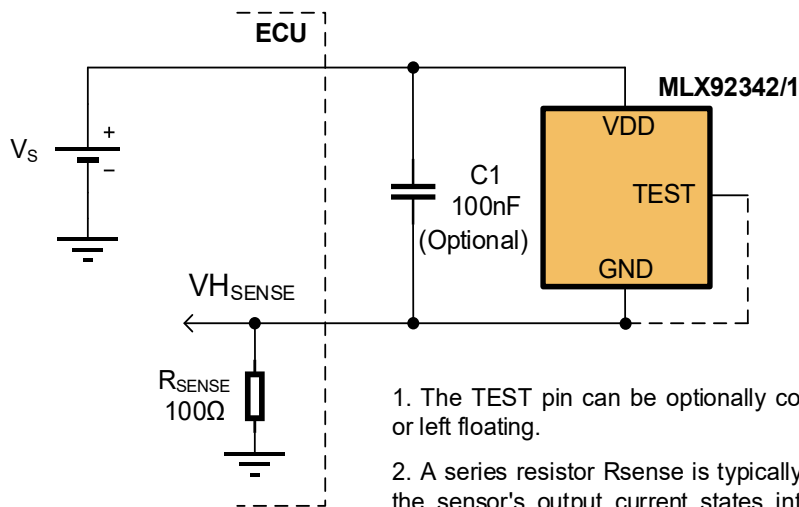


11.2.3. Latch Sensor ¹



12. Application Information

12.1. Typical application Schematic



1. The TEST pin can be optionally connected to GND or left floating.

2. A series resistor R_{sense} is typically used to convert the sensor's output current states into corresponding measurable voltage levels. This resistor is placed on the GND path as a low-side shunt and is usually integrated within the ECU module (A high-side placement on the V_S line is also possible).

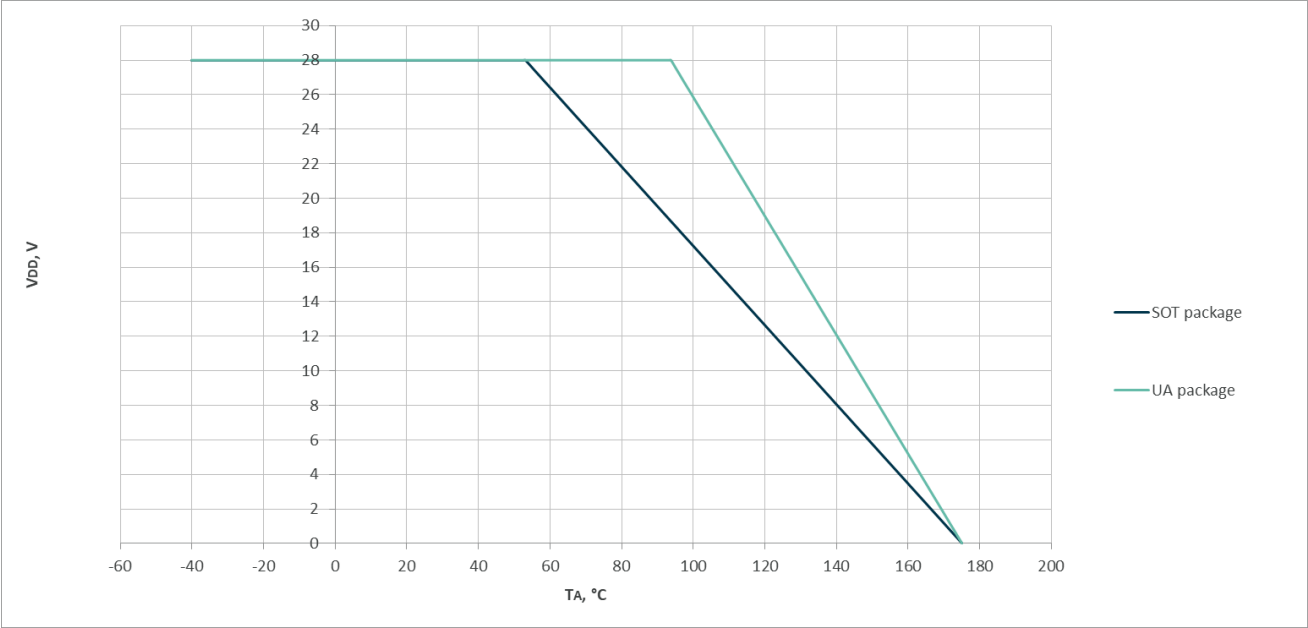
¹ Latch configuration can be achieved only with the programmable variant: MLX92342.

MLX92342/MLX92341

2-Wire Programmable ASIL-B Hall Effect Switch
Datasheet

12.2. Voltage Derating Curve

Specified for the typical I_{ON} value



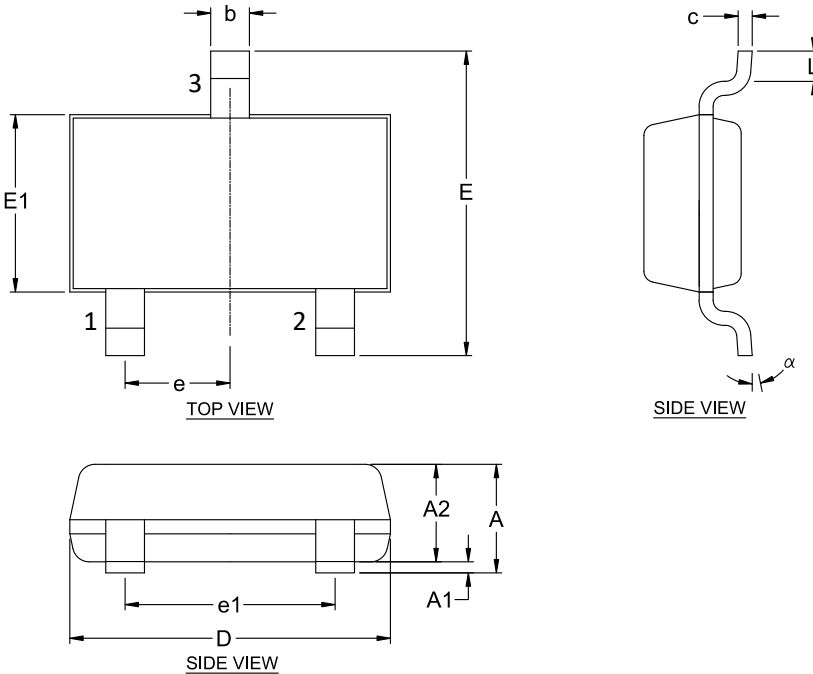
MLX92342/MLX92341

2-Wire Programmable ASIL-B Hall Effect Switch
Datasheet

13. Package Information

13.1. TSOT-3L (SE package)

13.1.1. TSOT-3L – Package dimensions

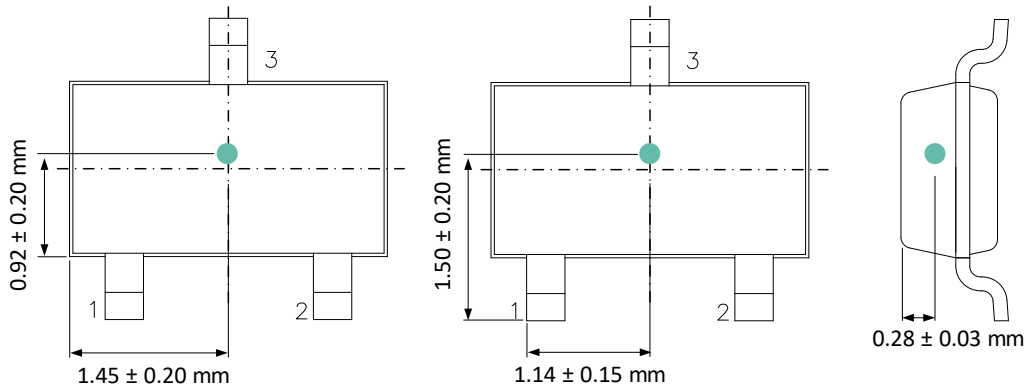


SYMBOL	MINIMUM	MAXIMUM
A	---	1.00
A1	0.025	0.10
A2	0.85	0.90
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
L	0.30	0.50
b	0.30	0.45
c	0.10	0.20
e	0.95 BSC	
e1	1.90 BSC	
α	0°	8°

NOTE :

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

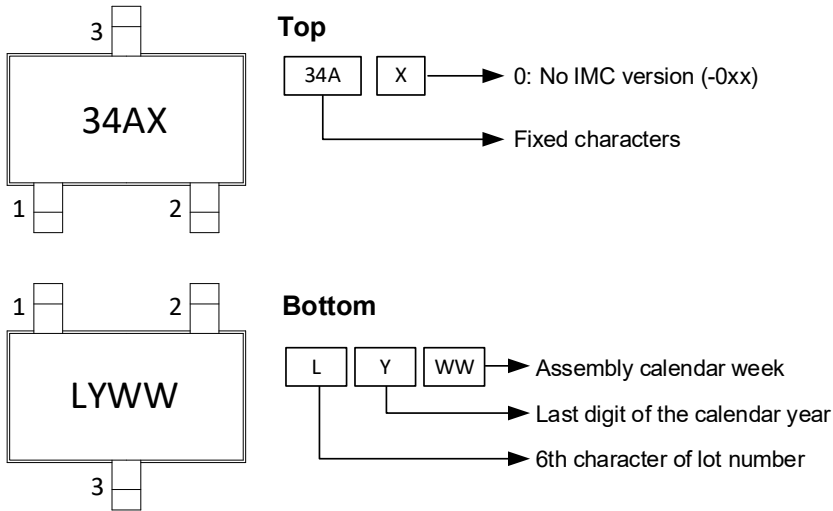
13.1.2. TSOT-3L – Sensitive spot



MLX92342/MLX92341

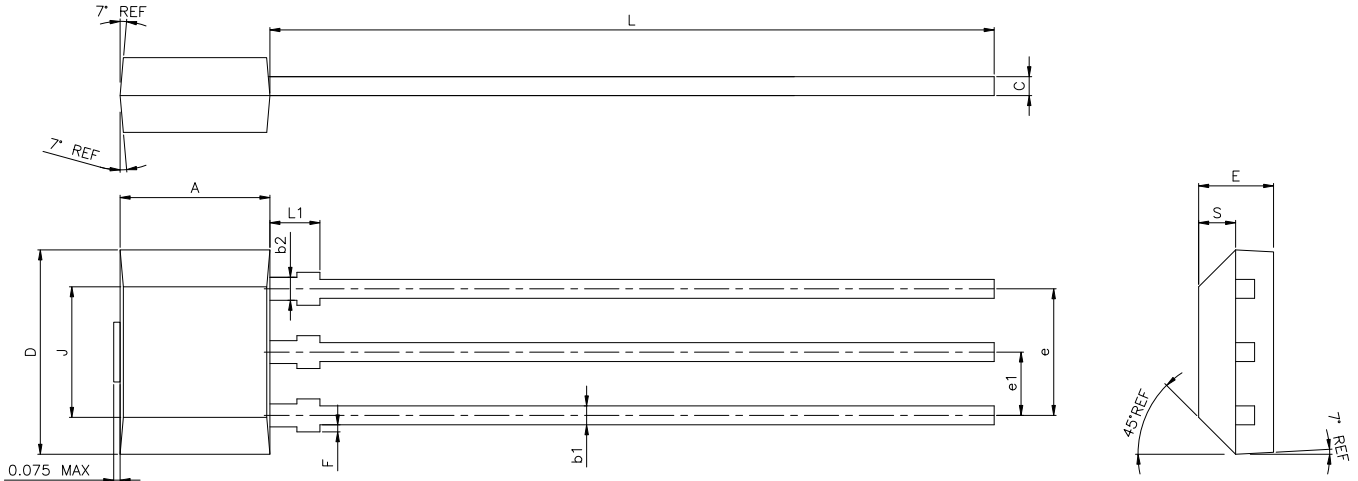
2-Wire Programmable ASIL-B Hall Effect Switch
Datasheet

13.1.3. TSOT-3L – Package marking



13.2. TO92(UA package)

13.2.1. TO92-3L – Package dimensions



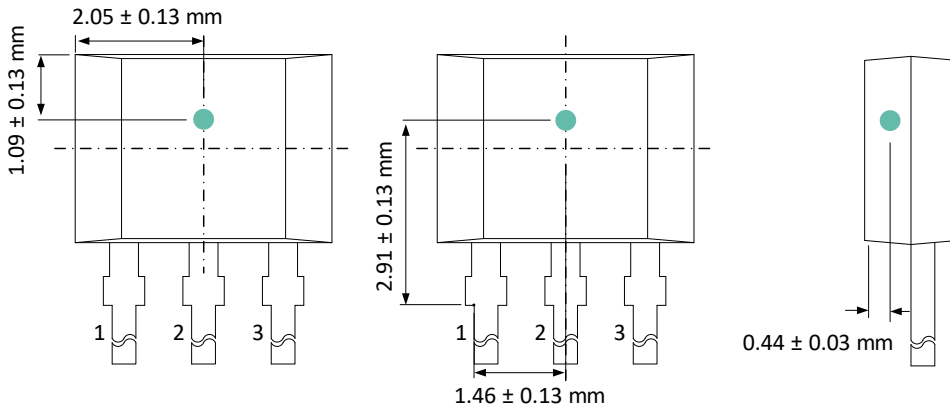
NOTES :

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

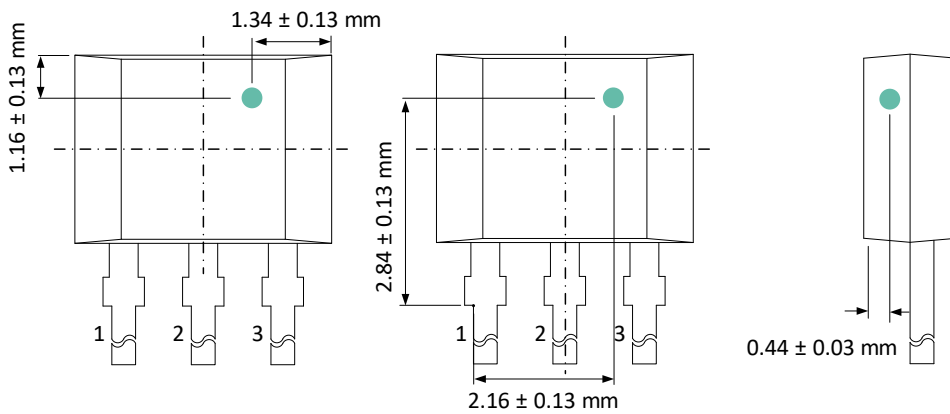
SYMBOL	MINIMUM	MAXIMUM
A	2.90	3.10
D	4.00	4.20
E	1.40	1.60
F	0.00	0.15
J	2.51	2.72
L	14.00	15.00
L1	0.90	1.10
S	0.63	0.84
b1	0.35	0.44
b2	0.43	0.52
c	0.35	0.44
e	2.51	2.57
e1	1.24	1.30

13.2.2. TO92-3L – Sensitive spot

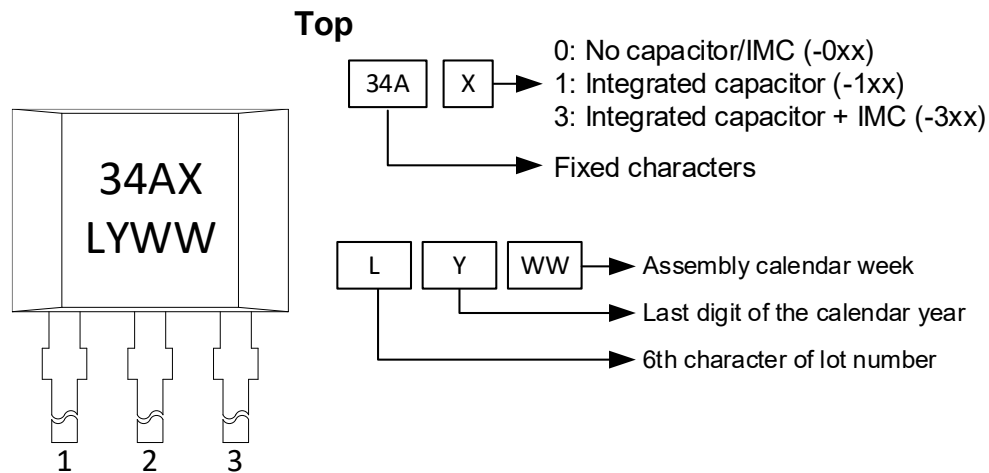
Without integrated capacitor (-0xx)



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



13.2.3. TO92-3L – Package marking



14. IC handling and assembly

14.1. Storage and handling of plastic encapsulated ICs

Plastic encapsulated ICs shall be stored and handled according to their MSL categorization level (specified in the packing label) as per J-STD-033.

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). The component assembly shall be handled in EPA (Electrostatic Protected Area) as per ANSI S20.20

For more information refer to Melexis [Guidelines for storage and handling of plastic encapsulated ICs](#)⁽¹⁾

14.2. Assembly of encapsulated ICs

For Surface Mounted Devices (SMD, as defined according to JEDEC norms), the only applicable soldering method is reflow.

For Through Hole Devices (THD), the applicable soldering methods are reflow, wave, selective wave and robot point-to-point. THD lead pre-forming (cutting and/or bending) is applicable under strict compliance with Melexis [Guidelines for lead forming of SIP Hall Sensors](#)⁽¹⁾.

Melexis products soldering on PCB should be conducted according to the requirements of IPC/JEDEC and J-STD-001. Solder quality acceptance should follow the requirements of IPC-A-610.

For PCB-less assembly refer to the relevant application notes ⁽¹⁾ or contact Melexis.

Electrical resistance welding or laser welding can be applied to Melexis products in THD and specific PCB-less packages following the [Guidelines for welding of PCB-less devices](#)⁽¹⁾.

Environmental protection of customer assembly with Melexis products for harsh media application, is applicable by means of coating, potting or overmolding considering restrictions listed in the relevant application notes ⁽¹⁾

For other specific process, contact Melexis via www.melexis.com/technical-inquiry

14.3. Environment and sustainability

Melexis is contributing to global environmental conservation by promoting non-hazardous solutions. For more information on our environmental policy and declarations (RoHS, REACH...) visit www.melexis.com/environmental-forms-and-declarations

¹ www.melexis.com/ic-handling-and-assembly

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- 3. defense related products, or other material for military use or for law enforcement;*
- 4. any applications that, alone or in combination with other goods, substances or organisms could cause serious harm to persons or goods and that can be used as a means of violence in an armed conflict or any similar violent situation.*

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