MLX92253 Datasheet

Dual Hall-Effect Latch with two Speed Outputs
Datasheet

1. Features and Benefits

- Triaxis® Hall Technology
- Magnetic dual latch functionality
- Two independent signal tracks for reliable Speed-Speed sensing
- Vertical (Z) & Lateral (X) magnetic fields
- In quadrature outputs (90° phase shift) for pitch independent designs
- Output state feedback during start-up
- For microcontroller embedded designs
- Chopping frequency of 500 kHz
- Operating voltage range from 2.7V to 5.5V
- Operating temperature from -40°C to 150°C
- High ESD rating: 8kV (HBM)
- Under-Voltage Reset
- Industry standard TSOT23-5L & VA package
- AEC-Q100 automotive qualified

2. Application Examples

- Linear speed & direction detection: window lifters and closures with anti-pinch features, power lift gates
- Rotation speed & direction detection: cadence sensor for e-bikes, fans, valves
- Angular position detection: knobs, jog wheels, DC motor indexing

3. Description

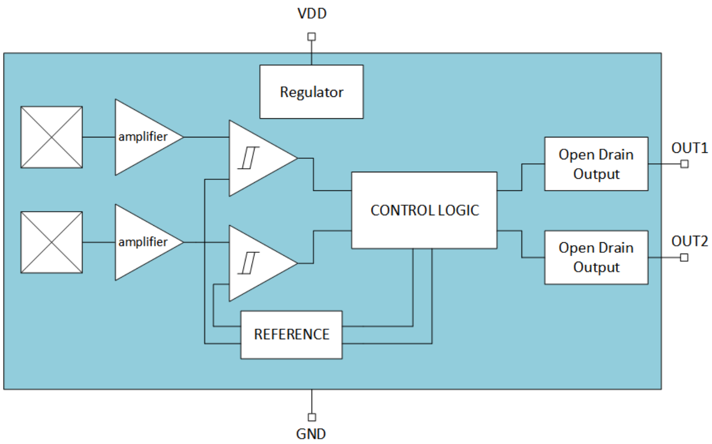
The MLX92253 is a Hall-effect dual latch designed in CMOS technology. The device integrates a voltage regulator, two Hall sensors with offset cancellation and two open-drain outputs in a single package.

The two Hall sensors, one sensing the Z axis and one sensing the X axis, are integrated on the same piece of silicon with two independent signal tracks and a common magnetic center. This ensures that the two speed outputs have a 90° phase shift regardless of magnet pole pitch, giving the customer more freedom in their magnetic design and faster reuse across multiple platforms.

Each speed output can be switched ON (LOW state) or OFF (HIGH state) by applying a sufficiently strong positive (South) or negative (North) magnetic field on one of the axes. OUT1 is sensitive to magnetic field on the Z axis, while OUT2 is sensitive to magnetic field on the X axis. Without magnetic field, the device will keep its last state.

The start-up feedback function can be used to turn the two outputs into inputs during Power-On. This function enables the customer to recover the last known state of the IC prior power-down in order to never miss a turn. The microcontroller should provide the necessary inputs at the starting point. This function is described in detail in chapter 9.2.

The MLX92253 is delivered in a green compliant 5-pin Thin Small Outline Transistor (TSOT) package for surface-mount applications. Engineering samples are available in a leaded 4-pin (VA) package.



Contents

4. Ordering Information

Product	Temperature	Package	Option Code	Packing Form	Definition
MLX92253	L	SE	AAA-000	-RE	Dual latch with two speed outputs in TSOT-5L package.
MLX92253	L	VA(1)	AAA-000	-BU	Dual latch with two speed outputs in VA package.

Engineering samples available for the VA package variant.

Legend:

Temperature Code:	L: T_a from -40°C to 150°C
Package Code:	SE: TSOT-5L package VA: VA package
Option Code:	MLX92253Lxx-AAA-000-xx = Dual latch (ZX) with two speed outputs where OUT1 is corresponding to the B_Z magnetic field and OUT2 corresponding to the B_X magnetic field.
Packing Form:	RE: REEL BU: BULK
Ordering Example:	MLX92253LSE-AAA-000-RE

Contact your sales representative for different product variants such as Pulse & Direction output types.

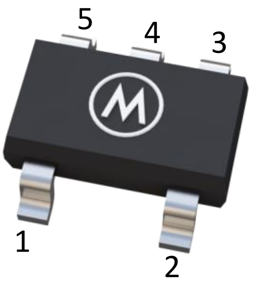
[1] *Samples delivered in VA package are engineering samples for prototyping.*

Glossary of Terms

Term	Definition
Gauss (G), Tesla (T)	Units for the magnetic flux density – 1 mT = 10 G
TC	Temperature Coefficient (in ppm/°C)
B_{OP}	Operating magnetic threshold
B_{RP}	Release magnetic threshold
HBM	Human Body Model

5. Pin Definitions and Descriptions

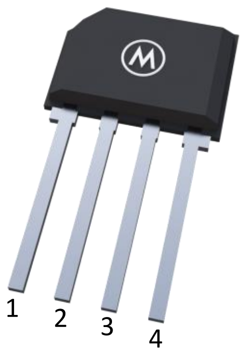
5.1. Pin definition for TSOT-5L (SE) package



Pin №	Name	Description
1	OUT1	Open-drain output 1/Feedback input (Z)
2	OUT2	Open-drain output 2/Feedback input (X)
3	VDD	Supply pin
4	GND	Ground pin
5	GND	Ground pin

Both GND pins (4 and 5) should be connected to ground

5.2. Pin definition for VA package (engineering samples available)



Pin №	Name	Description
1	OUT2	Open-drain output 2/Feedback input (X)
2	VDD	Power Supply
3	GND	Ground pin
4	OUT1	Open-drain output 1/Feedback input (Z)

6. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply voltage	V_{DD}	7	V
Supply current[1,2,3]	I_{DD}	20	mA
Reverse supply voltage	V_{DDREV}	-0.5	V
Reverse supply current[1,2,3]	I_{DDREV}	-20	mA
Output voltage	V_{OUT}	7	V
Reverse output voltage	V_{OUTREV}	-0.5	V
Reverse output current[1,2,3]	I_{OUTREV}	-20	mA
Maximum junction temperature	T_J	165	°C
ESD HBM[4]	-	8	kV

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

[1] *For a maximum of 500ms*
[2] *Including current through the protection device*
[3] *Maximum junction temperature should not be exceeded*
[4] *Human Body Model according AEC-Q100-002 standard*

7. General Electrical Specifications

Operating conditions T_A -40°C to 150°C (unless otherwise specified)

Electrical Parameter	Symbol	Min	Typ[1]	Max	Unit	Condition
Supply voltage	V_{DD}	2.7	-	5.5	V	
Supply current	I_{DD}	-	5	6.5	mA	
Power-on Reset voltage	V_{POR}	-	2.5	2.6	V	
Power-on Time[2]	t_{PON}	-	20	40	µs	V_{DD} = 5V, dV_{DD}/dt > 2V/µs
Power-on state	-	High			-	Output state during T_{PON}
Output leakage current	I_{OFF}	-	0.01	5	µA	B < B_{RP}, V_{OUT} = 5.5V
Output saturation voltage	V_{OUTS}	-	0.3	0.6	V	I_{OUT} = 10mA
Output short-circuit current	I_{SC}	15	-	40	mA	
Output rise/fall time[3,4]	T_R/T_F	0.15	0.3	0.5	µs	V_{DD} = 5V, V_{PU} = 5V, R_{PU} = 1kΩ, C_L = 50pF
Chopping frequency	F_{CHOP}	-	500	-	kHz	
Output refresh period	T_{PER}	-	4	6	µs	
Output jitter (p-p value)[3]	T_{jitter}	-	5	-	µs	Over 1000 successive switching events @10kHz triangle wave, B_{PEAK} ≥ 30mT
Maximum switching frequency[5]	F_{SW}	40	66	-	kHz	B ≥ 10mT triangle wave magnetic field
Feedback input HIGH voltage[6]	V_{IH}	1.8	-	-	V	
Feedback input LOW voltage[6]	V_{IL}	-	-	0.8	V	
SE package thermal resistance	R_{THJA}	-	300	-	°C/W	

[1] Typical values are given for T_A = 25°C and V_{DD} = 5V
[2] Measured from the moment V_{DD} = 2.7V until the first update of the outputs
[3] Guaranteed by design and verified during characterization, not production tested
*[4] Measured between 0.1*V_{PU} and 0.9*V_{PU} where V_{PU} is the pull-up voltage and R_{PU} is the pull-up resistance*
[5] The maximum frequency of the applied magnetic field which is detected without loss of pulses
[6] Only valid during start-up

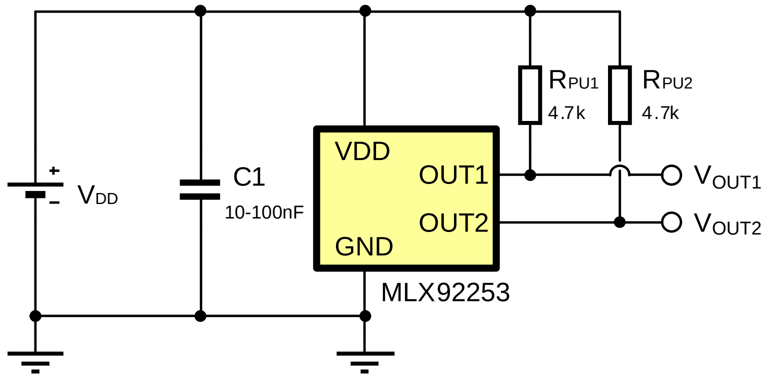
8. Magnetic Specification

Operating conditions V_{DD} 2.7V to 5.5V, T_A -40°C to 150°C (unless otherwise specified)

Parameter	Symbol	Min	Typ[1]	Max	Unit	Condition
Operating point	B_{OP}	0.2	1.5	2.8	mT	
Release point	B_{RP}	-2.8	-1.5	-0.2	mT	
Temperature coefficient [2,3]	TC	-	0	-	ppm/°C	
Symmetry [3]	B_{sym}	-1.7	-	1.7	mT	$B_{opz} + B_{rpz}$, $B_{opx} + B_{rpx}$
Operating point Symmetry [3]	B_{sym_op}	-1.7	-	1.7	mT	$B_{opz} - B_{opx}$
Release point Symmetry [3]	B_{sym_rp}	-1.7	-	1.7	mT	$B_{rpz} - B_{rpx}$

9. Detailed Description

9.1. Application schematic



Note:
For proper operation a 10-100nF bypass capacitor should be connected between the supply and ground as close to the VDD and GND pins as possible.

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[1] *Typical values are given for T_A = 25°C and V_{DD} = 5V*

[2] The temperature coefficient is calculated using the following formula:

$$TC = \frac{B_{T_2} - B_{T_1}}{B_{25°C} \times (T_2 - T_1)} \times 10^6 \left[\frac{ppm}{°C}\right]$$, Where T_1 = -40°C and T_2 = 150°C

[3] *Guaranteed by design and verified during characterization, not production tested*

9.2. Start-up feedback

The start-up feedback turns the outputs of the device into inputs during the power-on time. After t_{PON} has elapsed the chip will use the externally provided states of the outputs to configure the references of the comparators for each channel. After t_{PON} the state of each output will depend on the applied field on each axis. If the applied field is not sufficiently strong to trigger a switch, the outputs will remain in the states that were externally provided during start-up.

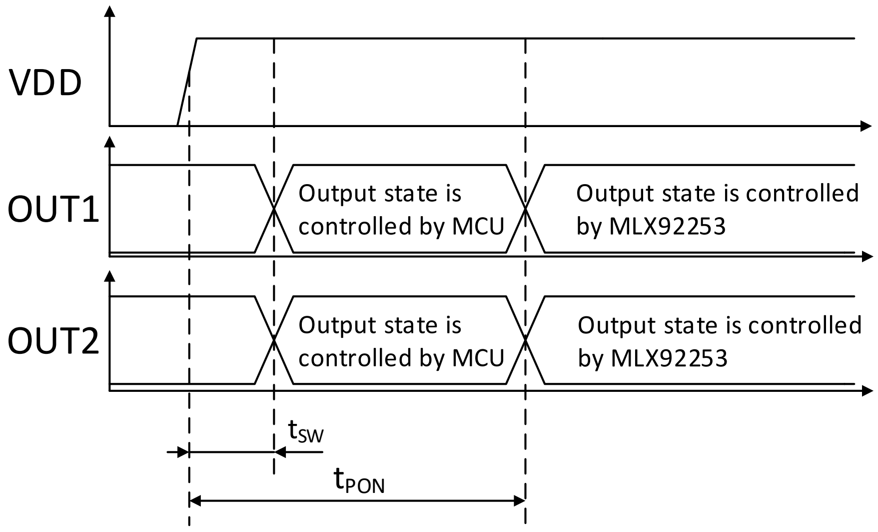


Figure 3

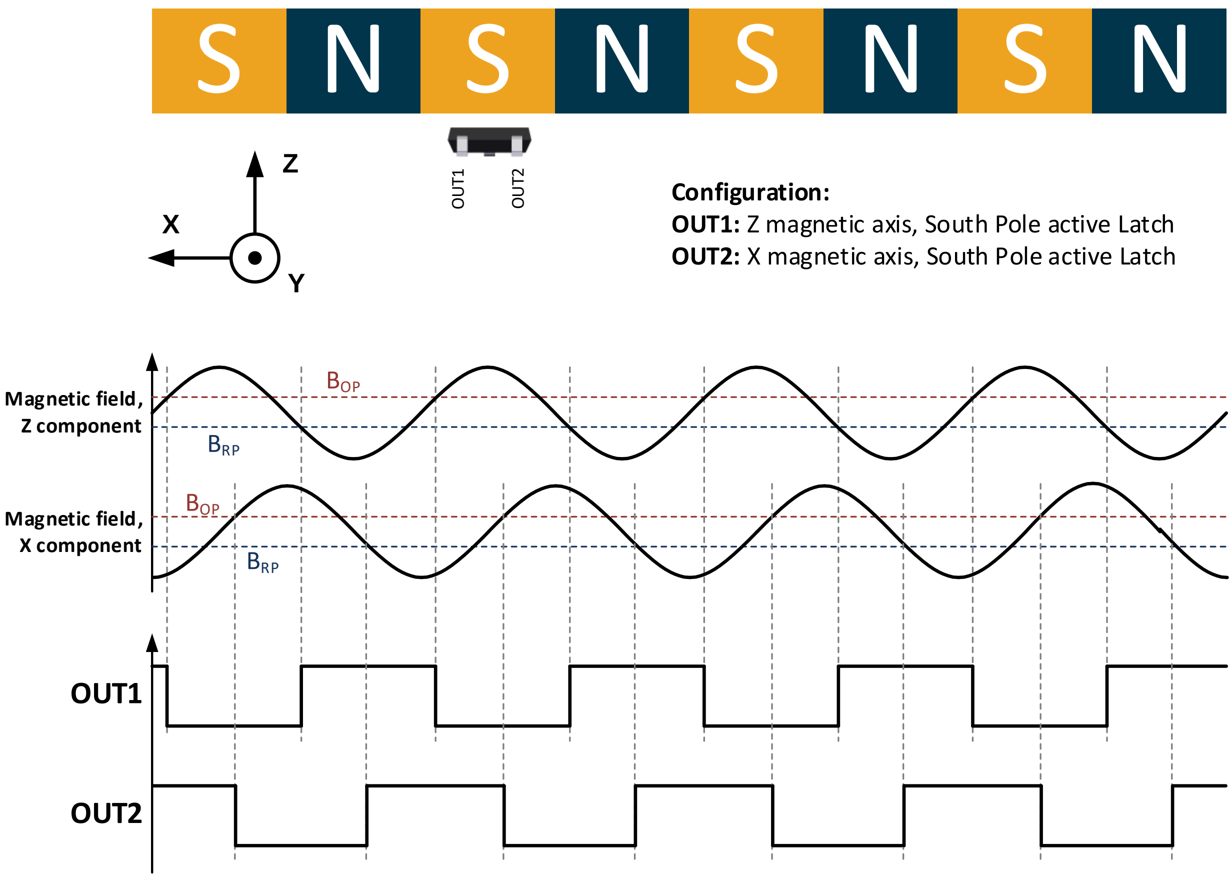
Shown in *Figure 3* is a timing diagram of a typical start-up procedure. Where t_{SW} is the time from providing power to the chip to providing valid start-up state on the output pins, t_{PON} is the time from the moment $V_{DD} = V_{POR}$ until the first update of the output state. The duration of t_{SW} should not exceed 5µs, exceeding this time could lead to unsuccessful configuration of the device. t_{SW} can be 0µs or even have a negative value. Therefore, the state of the outputs can be provided to the chip simultaneously with the VDD or even before applying the VDD. The start-up state should be provided for the full duration of t_{PON}. For more information about t_{PON} refer the chapter "7. General electrical specifications".

9.3. Output function

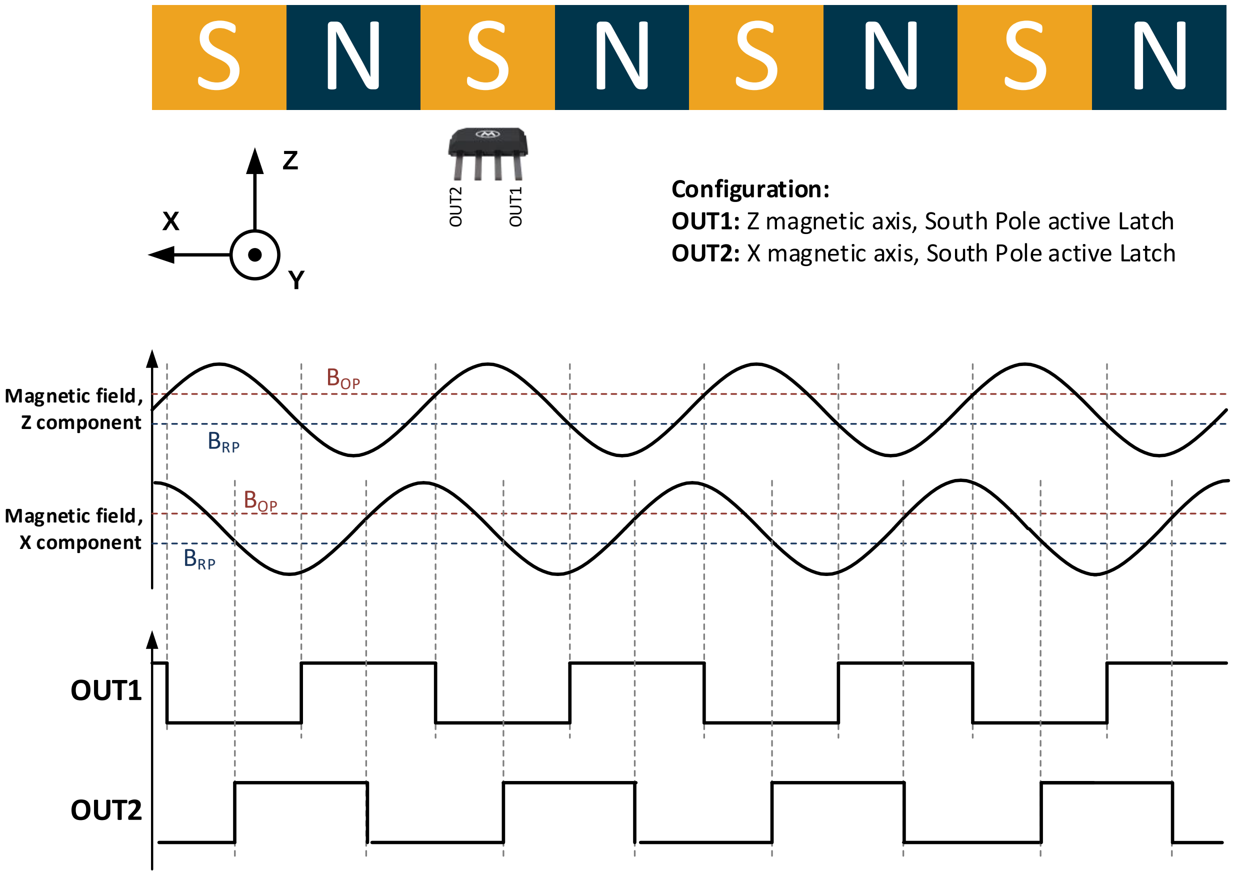
Shown in the diagram below is the output behavior with respect to the position of a magnet. The direction of movement/rotation, the position (number of magnetic poles passed by) and speed can all be extracted from the two output signals.

As noticed in the graphs below, the output relation of the TSOT-5L compared to VA is different due to the magnet pole definition of the X-axis. Please refer to chapter 10.1 for the magnetic pole definition. Changing the orientation of the sensor's package towards the magnet can result in a different output behavior.

9.3.1. TSOT-5L output function

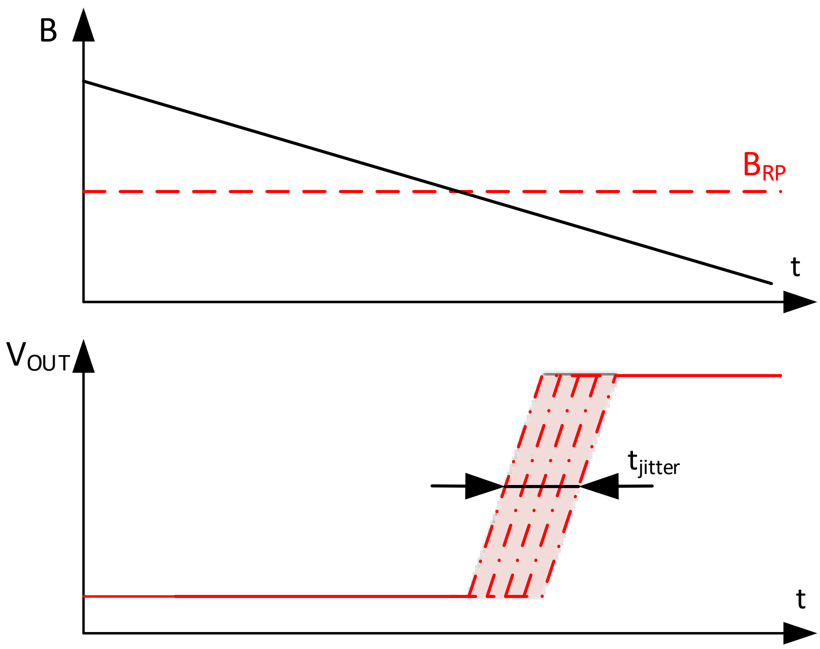


9.3.2. VA output function



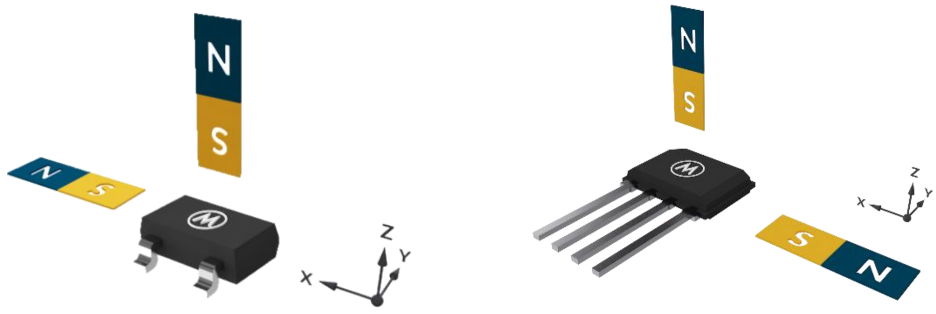
9.4. Output jitter

Output jitter is measured over a period of 1000 consecutive switching events. A magnetic field with triangular form, switching frequency F = 10kHz and amplitude B_{PEAK} = ±30mT is applied. The parameter $\mathbf{t_{jitter}}$ is calculated as the difference between the maximum and minimum reaction times of the device.

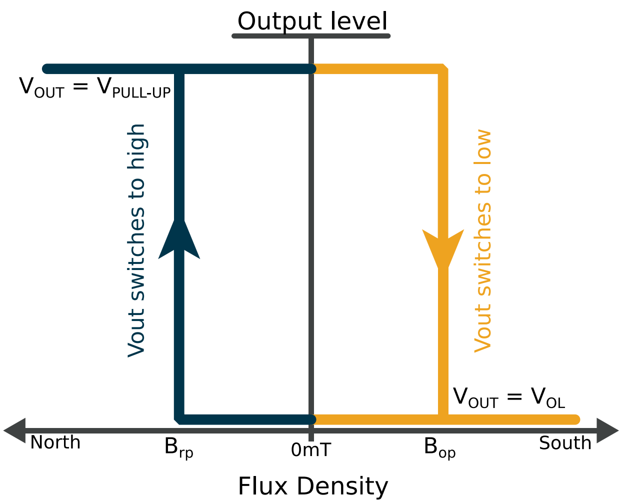


10. Magnetic Behavior

10.1. Active magnetic pole definition



10.2. Output characteristics

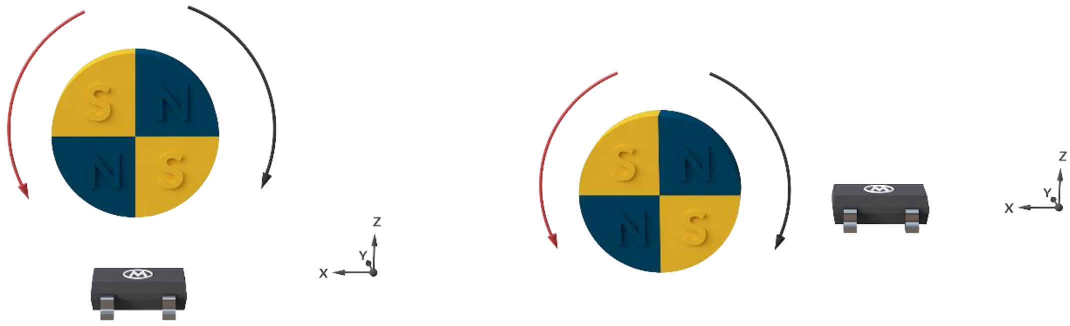


Magnetic Pole	Output state	Condition
South pole	LOW	$B > B_{OP}$
North pole	HIGH[1]	$B < B_{RP}$

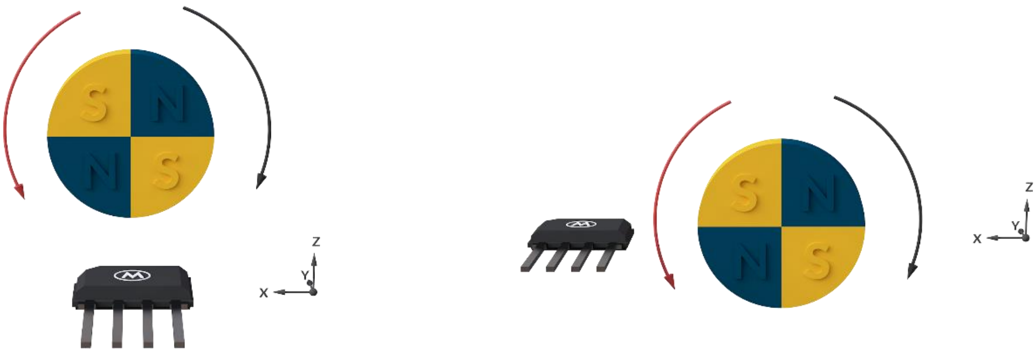
[1] *Default start-up state when the start-up feedback is not used.*

10.3. Indexing magnet position

The output relation of the TSOT-5L compared to VA is different due to the magnet pole definition of the X-axis. Please refer to chapter 10.1 for the magnetic pole definition. Positioning the sensor in different orientations will define the output behavior. The pictures below are examples of how the magnet can be positioned.



ZX configuration TSOT-5L

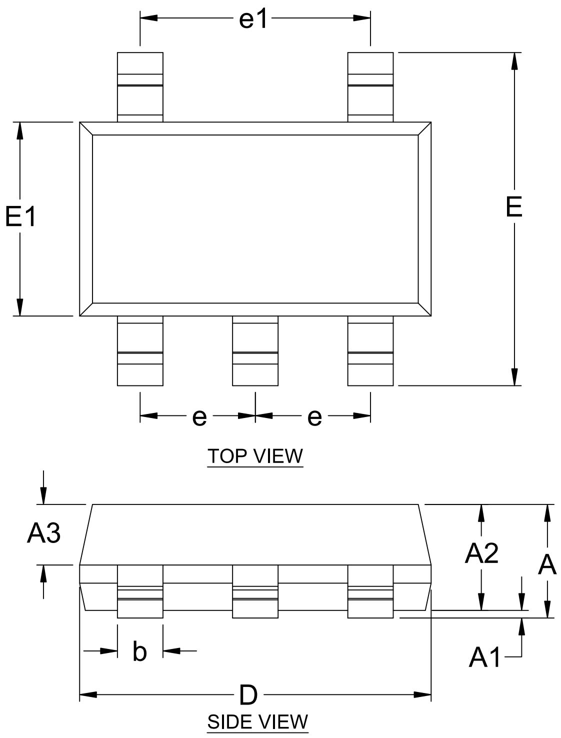


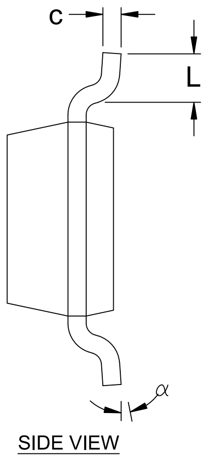
ZX configuration VA

11. Package Information

11.1. TSOT-5L (SE Package)

11.1.1. TSOT-5L – Package dimensions



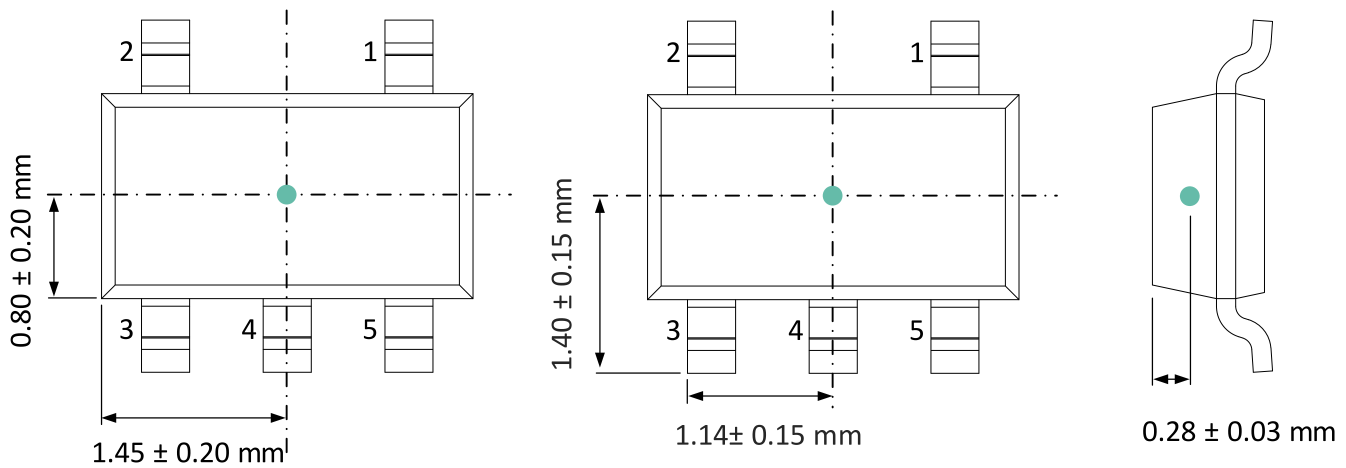


SYMBOL	MINIMUM	MAXIMUM
A	– – –	1.00
A1	0.025	0.10
A2	0.85	0.90
A3	0.50 BSC	
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
L	0.30	0.50
b	0.30	0.45
c	0.10	0.20
e	0.95 BSC	
e1	1.90 BSC	
α	0°	8°

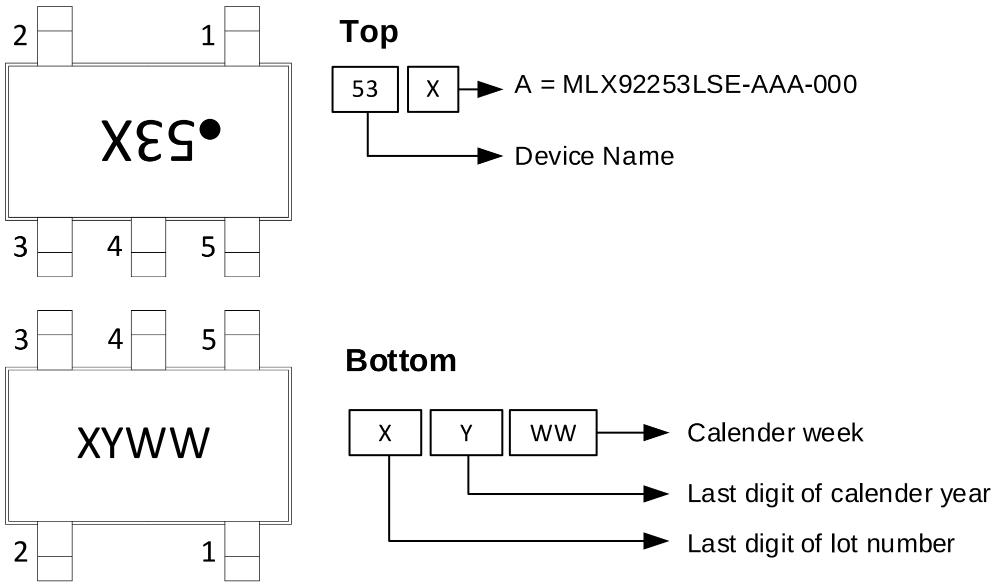
NOTE :

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

11.2. TSOT-5L – Sensitive spot

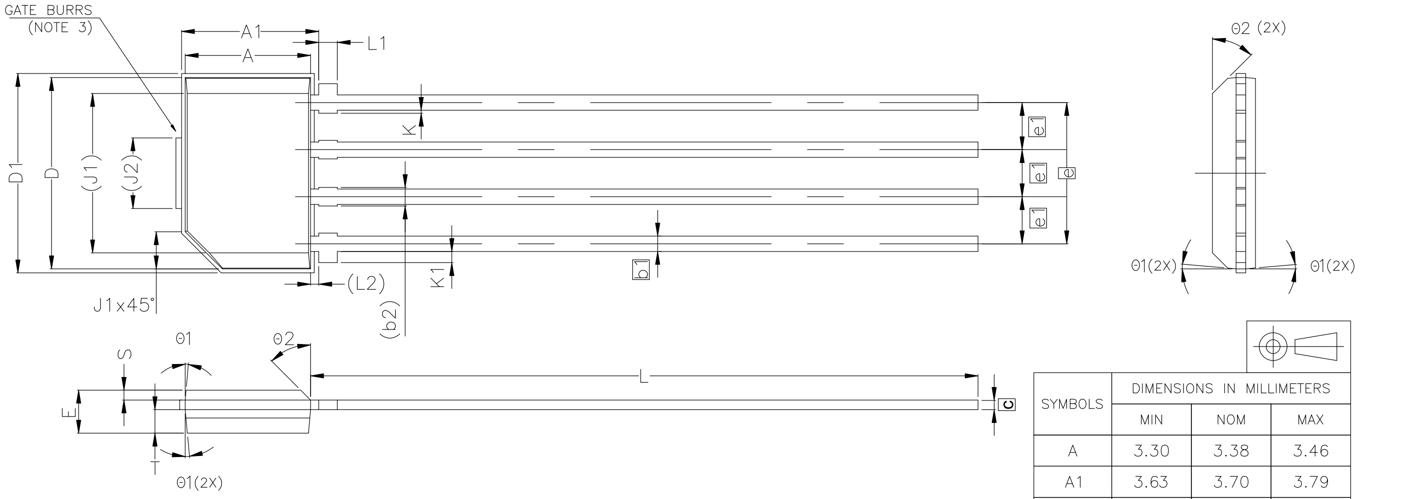


11.2.1. TSOT-5L – Package marking



11.3. VA Package (engineering samples available)

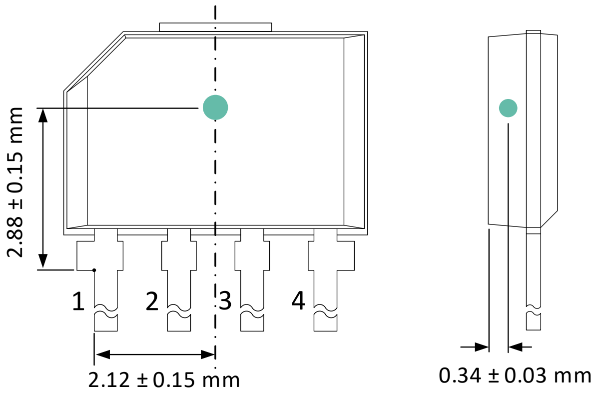
11.3.1. VA – Package dimensions



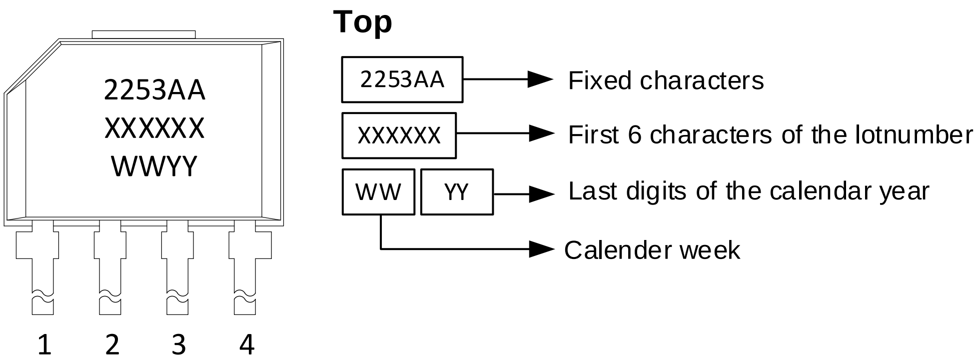
Note:
1. DIMENSIONS "A" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS AND GATE BURRS.
2. DIMENSIONS "A1" DOES NOT INCLUDE GATE BURRS BUT INCLUDES MOLD FLASH AT BOTH ENDS.
3. MOLD GATE BURRS SHALL NOT EXCEED 0.15 mm MEASURED FROM EDGE OF MOLD FLASH (FLANGE).
4. DIMENSION "D1" INCLUDES MOLD FLASH AT BOTH ENDS.
5. LEAD PLATING; MATTE TIN PLATING THICKNESS 7.62 – 15.42 um.

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	3.30	3.38	3.46
A1	3.63	3.70	3.79
D	5.08	5.16	5.24
D1	5.33	5.38	5.43
E	1.10	---	1.20
J	4.10	4.30	4.50
J1	1.00 REF		
J2	1.906 REF		
K	0.00	---	0.15
K1	0.25	0.30	0.35
L	17.5	18.0	18.5
L1	0.45	0.50	0.55
L2	0.22 REF		
S	0.24	---	0.29
T	0.61	---	0.66
b1	0.42 BSC		
b2	0.50 REF		
c	0.25 BSC		
e	3.81 BSC		
e1	1.27 BSC		
Θ1	5° REF		
Θ2	45° REF		

11.3.2. VA – Sensitive spot



11.3.3. VA – package marking



12. Standard Information

12.1. 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]

12.2. 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*.

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 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*.

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 [16].

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

12.3. 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

13. ESD Precautions

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

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

14. Contact

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