

### 1. Features and Benefits

- End-of-line programmable sensor
- Ratiometric analog output
- Flexible Supply Voltage with factory selectable 5V or 3.3V mode
- Measurement range from  $\pm 12.5$  to  $\pm 400$ mT
- High speed sensing
  - DC to 400kHz bandwidth
  - 2 $\mu$ s response time
- High linearity down to  $\pm 0.5\%$  full scale
- Low noise
- AEC-Q100 – Grade 0 Automotive Qualification
- Very low thermal drift for wide temperature range
  - Offset drift (<5mV)
  - Sensitivity drift (<1%)
- Internal overcurrent detection
- RoHS compliant
- Available in SIP4-VA (MSL-1) and SOIC8 packages (MSL-3)



### 2. Application Examples

- High Voltage Traction Motor Inverter
- 48V Boost Recuperation Inverter
- DCDC Converter
- Smart Battery Junction Boxes
- Smart Fuse Overcurrent Detection
- Redundant monitoring of Battery Management System (BMS)

### 3. Description

The MLX91219 is a monolithic Hall-effect sensor which is sensitive to the flux density applied orthogonally to the IC surface. The sensor provides an analog output voltage proportional to the applied magnetic flux density.

The transfer characteristic of the MLX91219 is factory trimmed over temperature, and is programmable (offset, sensitivity, filtering, internal overcurrent threshold) during end-of-line customer calibration. With the 400kHz bandwidth and fast response time, it is particularly adapted for high speed applications such as inverters and converters where fast response time due to fast switching is required.

In a typical current sensing application, the sensor is used in combination with a ring shaped soft ferromagnetic core. This core is recommended to be laminated for high bandwidth applications. The MLX91219 is placed in a small air gap and the current conductor – a bus bar or a cable – is passed through the inner part of the ferromagnetic ring. On the one hand the ring concentrates and amplifies the magnetic flux seen by the sensor IC, and at the same time it attenuates external magnetic field disturbances.

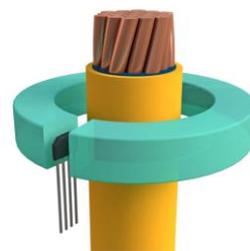


Figure 1. Typical Current Sensing Application

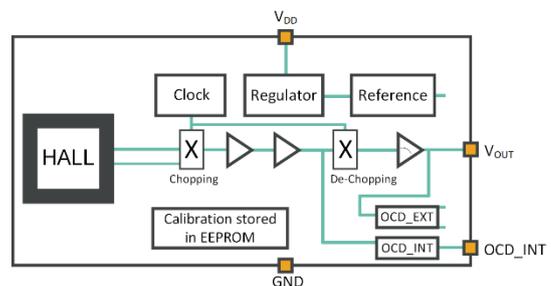


Figure 2. General Block Diagram

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## 4. Ordering Information

Product Code	Temperature	Package	Option Code	Packing Form	Typical Sensitivity	Supply Voltage	Reference Voltage	OCD Level
MLX91219	L	VA	AAA-500	CR	7 mV/mT	5V	NA	134.7 %FS
MLX91219	L	VA	AAA-501	CR	10mV/mT	5V	NA	134.7 %FS
MLX91219	L	DC	ARA-501	RE	10mV/mT	5V	NA	134.7 %FS
MLX91219	L	VA	AAA-502	CR	15mV/mT	5V	NA	134.7 %FS
MLX91219	L	VA	AAA-503	CR	25mV/mT	5V	NA	134.7 %FS
MLX91219	L	VA	AAT-505	RE	10mV/mT	5V	NA	88.2 %FS

*Table 1: Available ordering codes.*

**Legend:**

Temperature Code	<b>L</b>	from -40°C to 150°C ambient temperature
Package Code	<b>VA</b>	“VA” for SIP-4 VA package
	<b>DC</b>	“DC” for SOIC8 package
Option Code	<b>Axx-xxx</b>	“A” for Silicon revision
	<b>xAx-xxx</b>	“A” for ratiometric output (only for SIP-4 VA package)
	<b>xRx-xxx</b>	“R” for ratiometric output (only for SOIC8 package)
	<b>xFx-xxx</b>	“F” for fixed output (only for SOIC8 package)
	<b>xxA-xxx</b>	VA straight leg (see section 17.3)
	<b>xxR-xxx</b>	Trim and Form type: 90° 2x2x91.3 (h=5.34mm) Bending-STD2 (see section <b>Error! Reference source not found.</b> )
	<b>xxS-xxx</b>	Trim and Form type: 90° 2x2x91.3 (h=3.7mm) Bending-STD3 (see section <b>Error! Reference source not found.</b> )
	<b>xxT-xxx</b>	Trim and Form type: 90° 2x2x91.8 (h=1.68mm) Bending-STD4 (see section 17.6)
	<b>xxZ-xxx</b>	Trim and Form type: SMD style TFT4K1 (see section <b>Error! Reference source not found.</b> )
	<b>xxx-3xx</b>	“3” for 3.3 V supply, bipolar output
<b>xxx-5xx</b>	“5” for 5 V supply, bipolar output	
Option Code	<b>xxx-x00</b>	Typical sensitivity of 7 mV/mT and overcurrent detection of 134.7 %full scale
	<b>xxx-x01</b>	Typical sensitivity of 10 mV/mT and overcurrent detection of 134.7 %full scale
	<b>..</b>	..
Packing Form	<b>CR</b>	Carton Reel – Radial taping
	<b>RE</b>	Plastic Tape on Reel
	<b>SP</b>	Sample pack
Ordering Example	<b>“MLX91219LVA-AAA-500-CR”</b> MLX91219 Conventional Hall current sensor in SIP4-VA package, temperature range -40°C to 150°C. Sensitivity 7 mV/mT. 5V Supply, bipolar ratiometric output. Parts delivered in Carton Reel.	

*Table 2: Legend ordering codes.*

Melexis is continuously expanding its product portfolio by adding new option codes to better meet the needs of our customer’s applications. This table is being updated frequently, please go to the Melexis website to download the latest version of this datasheet. For custom transfer characteristics, please contact your local Melexis Sales representative or distributor.

## 5. Functional Diagram

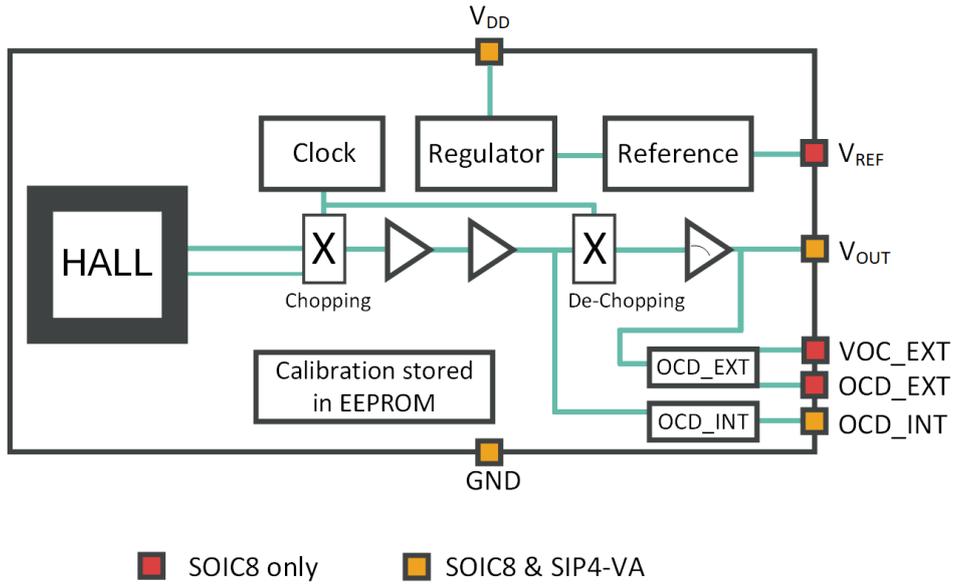


Figure 3: Block Diagram of the MLX91219.

### 5.1. Ratiometric Mode

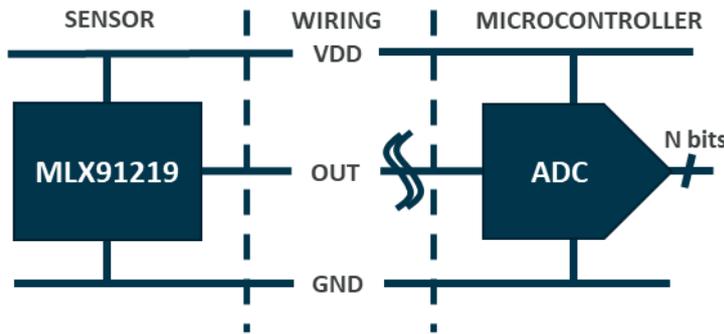


Figure 4: Schematic of ratiometric mode

No matter if the  $V_{DD}$  line is at 5V or deviating +/-10%, the ADC code for a given measured magnetic field will always be the same as the ADC is supplied by the same voltage as the sensor.

## 5.2. Differential or Fixed Mode

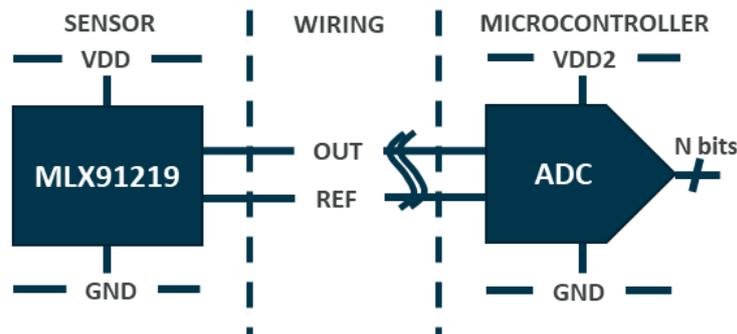


Figure 5: Schematic of fixed mode

In this particular case the ADC does not necessarily share the same supply voltage with the sensor. For this reason, the sensor is calibrated with an absolute sensitivity regardless of the actual supply voltage. The output signal can be reconstructed by taking the difference between the output and the reference voltage from the IC. The ADC gets these two signals as inputs for establishing the sensed magnetic field accurately, and is not influenced by the supply voltage differences between both sensor and microcontroller, if applicable. Only available in SOIC8 package.

Parameter	Ratiometric Mode	Differential or Fixed Mode
Output Signal	$V_{OUT} [\%V_{DD}]$  Example: output is 2.5V when supply is 5V → output is then 50% $V_{DD}$ . If the supply ( $V_{DD}$ ) increases with 5% to 5.25V the sensor output will (for the same measured input magnetic field) scale <b>proportionally</b> with the supply voltage, becoming 2.625V, but as a percentage (i.e. ratiometrically seen) it remains at 50% of $V_{DD}$ .	$V_{OUT} - V_{REF} [V]$  Example: $V_{OUT}$ and $V_{REF}$ output is 2.501V and $V_{REF}$ is 2.501V when supply is 5V. When the supply voltage is increasing to 5.1V due to supply system variation, the sensor will still maintain the same “fixed” output values $V_{OUT}$ and $V_{REF}$ equal to 2.501V.
Offset ( $V_{OUT}$ at magnetic field 0mT)	50 [% $V_{DD}$ ] (factory trimmed)	$V_{REF}$ (factory trimmed)
Offset ratiometric	Yes	No
Sensitivity	$[\%V_{DD}/mT]^1$	[mV/mT]
Sensitivity ratiometric	Yes	No
Measured magnetic field B	$B = \frac{(V_{OUT} - V_{OUT}[0mT])}{Sensitivity}$	$B = \frac{(V_{OUT} - V_{REF})}{Sensitivity}$

Table 3: Parameters of differential and fixed modes

<sup>1</sup> The sensitivity in ratiometric mode is expressed as [% $V_{DD}/mT$ ]. However, for simplicity, in the datasheet the sensitivity will be always expressed in [mV/mT]. For ratiometric devices, this corresponds to the sensitivity for  $V_{DD}=5V$  or 3.3V, depending on the settings of the sensor.

## 6. Glossary of Terms

Terms	Definition
TC	Temperature Coefficient
FS	Full Scale, output referred. Corresponds to 2V excursion around 2.5V at 5V supply or 1.25V excursion from 1.65V at 3.3V supply for bipolar designs
T, mT	Tesla, milliTesla = units for the magnetic flux density
G	Gauss = unit for the magnetic flux density [1mT = 10G]
OCD	Overcurrent Detection
MSL	Moisture Sensitivity Level

Table 4: Glossary of Terms

## 7. Pin Definitions and Descriptions

Note: MLX91219 is not pin-to-pin compatible with MLX91209 or MLX91217.

### 7.1. SIP-4 VA Package

Pin #	Name	Type	Description
1	VDD	Supply	Supply voltage
2	OUT	Analog Output	Output voltage (measurement)
3	OCD_INT	Analog Output	Overcurrent detection based on internal threshold
4	GND	Supply	Ground voltage

Table 5: Pin definitions and descriptions.

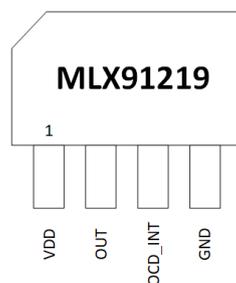


Figure 6: Pinout of SIP4-VA package.

## 7.2. SOIC8 package

Pin #	Name	Type	Description
1	VREF	Analog	Reference voltage
2	OUT	Analog Output	Output voltage (measurement)
3	GND	Supply	Ground voltage
4	VDD	Supply	Supply voltage
5	NC	-	Not connected
6	OCD_EXT	Analog Output	Overcurrent detection based on external threshold
7	OCD_INT	Analog Output	Overcurrent detection based on internal threshold
8	VOC_EXT	Analog Input	External threshold for the OCD

Table 6: Pin definitions and descriptions.

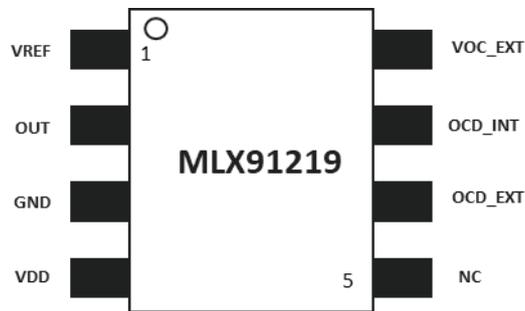


Figure 7: Pinout of SOIC8 package.

## 8. Absolute Maximum Ratings

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

Parameter	Symbol	Value	Unit
Positive Supply Voltage (overvoltage)	$V_{DD}$	+8	V
Negative Supply Voltage	$V_{DD}$	-0.3	V
Positive Pin Voltage <sup>2</sup>	$V_{PIN}$	$V_{DD} + 0.3$	V
Output Sink Current	$I_{out\_max}$	50	mA
Output Source Current	$I_{out\_source}$	25	mA
Output Short Circuit Current to GND	$I_{SHORT\_GND}$	-100	mA
Output Short Circuit Current to $V_{DD}$	$I_{SHORT\_VDD}$	60	mA
Reverse Pin Voltage <sup>2</sup>	$V_{min\_REV}$	GND-0.3	V
Maximum Junction Temperature	$T_{j\_MAX}$	165	°C
Operating Ambient Temperature Range	$T_A$	-40 to +150	°C
Storage Temperature Range	$T_S$	-55 to +165	°C
Magnetic Flux Density	$B_{MAX}$	±3	T
Human Body ESD Protection	$ESD_{HBM}$	2	kV
Charged Device Model ESD Protection	$ESD_{CDM}$ All pins	500	V
	$ESD_{CDM}$ Corner pins	750	V

Table 7: Absolute maximum ratings.

<sup>2</sup> Except for  $V_{DD}$  and GND

## 9. General Electrical Specifications

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or 3.3 V.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Nominal Supply Voltage	$V_{DD}$	MLX91219Lxx-Axx-5xx MLX91219Lxx-Axx-3xx	4.5 3.135	5 3.3	5.5 3.465	V
Positive Supply Voltage (maintaining application mode)	$V_{DD}$				6.5	V
Supply Current	$I_{DD}$	Without $R_{LOAD}$ on output, in application mode $V_{DD} = 5$ V $V_{DD} = 3.3$ V		15.5 15	19 18	mA
$V_{OUT}$ Output Resistance	$R_{OUT}$	$V_{OUT} = 50\%V_{DD}$ , $I_{LOAD} = 10$ mA		1	5	$\Omega$
Output Capacitive Load	$C_{LOAD}$	Output amplifier stability is optimized for this typical value	0	4.7	6	nF
Output Leakage current	$I_{LEAK}$	High impedance mode, $T_A=150^\circ\text{C}$		6	20	$\mu\text{A}$
Output Voltage Linear Swing	$V_{OUT\_LSW}$	Pull-down or pull-up $\geq 10$ k $\Omega$ $V_{DD} > 4.6$ V for Fixed Mode versions	10		90	$\%V_{DD}$

Table 8: General electrical parameters.

## 10. Magnetic specification

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or 3.3 V factory trimmed unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operational Magnetic Field Range	$B_{OP}$				$\pm 400$	mT
Linearity Error (Magnetic)	NL	B within $B_{OP}$ , $T_A = 25^\circ\text{C}$			$\pm 0.5$	$\%FS$
Programmable Sensitivity	$S_{PROG}$	Generic part	5		105	mV/mT
		MLX91219LVA-AAA-500	6.5	7	22.5	
		MLX91219LVA-AAA-501	6.5	10	22.5	
		MLX91219LDC-ARA-501	6.5	10	22.5	
		MLX91219LVA-AAA-502	6.5	15	22.5	
		MLX91219LVA-AAA-503	16	25	55	
MLX91219LVA-AAT-505	6.5	10	22.5			
Sensitivity accuracy (factory trimming)	$S_{RES}$	$B = B_{OP}$	-1		+1	%
Sensitivity Programming Resolution	$S_{RES}$	$B = B_{OP}$		0.5		%

Table 9: Magnetic specification.

## 11. Analog output specification

### 11.1. Definitions

#### 11.1.1. Thermal Reference Drift

The thermal reference drift is the variation of the reference voltage ( $V_{REF}$ ) over temperature. It is expressed in ppm/°C.

$$+ \Delta T_{VREF} = \left( \frac{V_{ref}[125^{\circ}\text{C}]}{V_{ref}[25^{\circ}\text{C}]} - 1 \right) \cdot \frac{1}{(125 - 25)} \cdot 10^6$$

$$- \Delta T_{VREF} = \left( \frac{V_{ref}[-40^{\circ}\text{C}]}{V_{ref}[25^{\circ}\text{C}]} - 1 \right) \cdot \frac{1}{(-40 - 25)} \cdot 10^6$$

#### 11.1.2. Voltage Output Quiescent

$V_{OQ}$  corresponds to the difference between the measured and the ideal outputs when no magnetic field is applied to the MLX91219 at  $T_A=25^{\circ}\text{C}$ .

$$V_{OQ} = V_{OUT}[0mT]_{measured} - V_{OUT}[0mT]_{ideal}$$

#### 11.1.3. Thermal Offset Drift

$\Delta T_{VOQ}$  corresponds to variation of  $V_{OQ}$  in temperature.

#### 11.1.4. Sensitivity

The sensitivity is the ratio between the output of the MLX91219 and the input magnetic field.

For ratiometric devices, as the output will scale with the supply, sensitivity is expressed as [% $V_{DD}$ ]/mT. For simplicity, in the datasheet the sensitivity will be always expressed in mV/mT. For ratiometric devices, this corresponds to the sensitivity for  $V_{DD}=5\text{V}$  or  $3.3\text{V}$ , depending on the settings of the sensor.

For fixed devices, the output does not vary with the  $V_{DD}$ , sensitivity is thus expressed as mV/mT.

#### 11.1.5. Linearity Error

The linearity error is the deviation of the output from the expected linear behaviour. To obtain the linearity error, the magnetic field is swept from  $-B_{FS}$  to  $B_{FS}$ , where  $B_{FS}$  is the full scale magnetic field. To decorrelate the thermal drift from the linearity error, the junction temperature should be fixed below  $50^{\circ}\text{C}$ .

$$NL = \frac{V_{out}[B] - BESTFIT(V_{out}[B])}{V_{out}[B_{FS}] - V_{out}[-B_{FS}]} \cdot 100 \text{ [%FS]}$$

### 11.1.6. Ratiometry Offset and Sensitivity Error

#### Ratiometric Mode

In Ratiometric mode,  $V_{OUT}$  and  $V_{REF}$  are scaled with the supply voltage.  $V_{DDnom} = 5V$

Ratiometric  $V_{OQ}$  Error:

$$\Delta R_{VOQ} = V_{OQ} [V_{DDnom}] - V_{OQ} [V_{DDnom} \pm 10\%] \cdot \frac{V_{DDnom}}{V_{DDnom} \pm 10\%} \quad [mV]$$

Ratiometric Sensitivity Error:

$$\Delta R_S = 100 \cdot \left( 1 - \frac{S[V_{DDnom \pm 10\%}]}{S[V_{DDnom}]} \cdot \frac{V_{DDnom}}{V_{DDnom \pm 10\%}} \right) \quad [\%]$$

In the datasheet, the ratiometric error is expressed as  $\frac{mV}{\%VDD}$  for the offset, and  $\frac{\%S}{\%VDD}$  for the sensitivity. For instance, if the supply voltage changes by 3%, the typical error on the sensitivity will be  $0.16 \frac{\%S}{\%VDD} \times 3\% = 0.48\%$ .

#### Fixed Mode

In Fixed mode,  $V_{OUT}$  and  $V_{REF}$  are not scaled with the supply voltage. Ideally, they do not vary.  $V_{DDnom} = 5V$

Non-Ratiometric  $V_{OQ}$  Error:

$$\Delta R_{VOQ} = V_{OQ} [V_{DDnom} \pm 10\%] - V_{OQ} [V_{DDnom}] \quad [mV]$$

Non-Ratiometric Sensitivity Error:

$$\Delta R_S = \left( \frac{S[V_{DDnom \pm 10\%}]}{S[V_{DDnom}]} - 1 \right) \cdot 100 \quad [\%]$$

## 11.2. SIP-4 VA Accuracy specifications

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or  $3.3$  V factory trimmed unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Voltage Output Quiescent	$V_{OQ}$	No magnetic field applied, $T_A=25^\circ\text{C}$	-5		5	mV
Ratiometric Offset Error <sup>3</sup>	$\Delta R_{VOQ}$	$V_{DD} = 5\text{V}$ $V_{DD} = 3.3\text{V}$		1.6 1		mV/% $V_{DD}$
Thermal Offset Drift <sup>4</sup>	$\Delta^{TV}_{OQ}$	$T_A = -40$ to $125^\circ\text{C}$ $T_A = -40$ to $150^\circ\text{C}$ <sup>5</sup>	-5	$\pm 5$	5	mV
Total Offset drift <sup>6</sup>	$\Delta V_{OQ}$			$\pm 6$		mV
Ratiometric Sensitivity Error <sup>3</sup>	$\Delta^RS$			0.16		%S/% $V_{DD}$
Thermal Sensitivity Drift <sup>4</sup>	$\Delta^TS$	$T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $150^\circ\text{C}$ <sup>5</sup>	-1	$\pm 1$	1	%S
Total Sensitivity Drift <sup>6</sup>	$\Delta S$			$\pm 1.5$		%S
Input referred noise spectral density	$N_{SD}$	within BW = 1 .. 400kHz, Max Gain		210		nT/√Hz

Table 10: Accuracy specifications – analog parameters.

The accuracy specifications are defined for the factory calibrated sensitivity. The achievable accuracy is dependent on the user’s end-of-line calibration. Resolution for offset and offset drift calibration is better than  $0.05\%V_{DD}$ . Trimming capability is higher than measurement accuracy. End-user calibration can therefore increase the accuracy of the system.

<sup>3</sup> Ratiometry Error is verified at maximum  $V_{DD}$  deviation ( $5\%V_{DD}$  at  $3.3\text{V}$  and  $10\%V_{DD}$  at  $5\text{V}$ ) over temperature in production. Typical values are the maximum mean  $\pm 3$  sigma out of all characterized lots.

<sup>4</sup> Performance after factory trimming.

<sup>5</sup> Based on results from AEC-Q003 Characterization. Typical values are the maximum mean  $\pm 3$  sigma out of all characterized lots.

<sup>6</sup> After 1000h HTOL at  $T_A = 155^\circ\text{C}$  with respect to after pre-conditioning at  $T_A = 35^\circ\text{C}$ . Pre-conditioning is performed with MSL level 3 based on J-STD-020. Typical values are the highest average  $\pm 3$  sigma across all qualification lots.

### 11.3. SOIC8 Accuracy specifications

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or 3.3 V factory trimmed unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Voltage Reference	$V_{REF}$	$T_A=25^\circ\text{C}$ , AFx-5xx versions, RS=0 $T_A=25^\circ\text{C}$ , AFx-3xx versions, RS=1 $T_A=25^\circ\text{C}$ , AFx-3xx versions, RS=2 $T_A=25^\circ\text{C}$ , AFx-2xx/AFx-4xx, RS=3	2.48 1.64 1.492 0.495	2.5 1.65 1.5 0.5	2.52 1.66 1.508 0.505	V
Thermal Reference Drift	$\Delta T_{VREF}$	Variation versus $25^\circ\text{C}$ , for fixed output			$\pm 150$	ppm/ $^\circ\text{C}$
Non-ratiometric VREF Error	$\Delta V_{REF}$	Fixed mode devices (only SOIC8)	-3		3	mV
Voltage Output Quiescent	$V_{OQ}$	No magnetic field applied, $T_A=25^\circ\text{C}$	-5		5	mV
Ratiometric Offset Error <sup>7</sup>	$\Delta R_{VOQ}$	$V_{DD} = 5\text{V}$ $V_{DD} = 3.3\text{V}$		1.6 1		mV/ $\%V_{DD}$
Non-Ratiometric Offset Error	$\Delta^R V_{OQ}$	$V_{DD} = 5\text{V}$ $V_{DD} = 3.3\text{V}$		5 5		mV
Thermal Offset Drift <sup>8</sup>	$\Delta^T V_{OQ}$	$T_A = -40$ to $125^\circ\text{C}$ $T_A = -40$ to $150^\circ\text{C}$ <sup>9</sup>	-5	$\pm 6$	5	mV
Total Offset drift <sup>10</sup>	$\Delta V_{OQ}$			$\pm 6$		mV
Ratiometric Sensitivity Error <sup>3</sup>	$\Delta^R S$			0.16		$\%S/\%V_{DD}$
Non-Ratiometric Sensitivity Error	$\Delta^R S$		-0.6		0.6	$\%S$
Thermal Sensitivity Drift <sup>4</sup>	$\Delta^T S$	$T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $150^\circ\text{C}$ <sup>5</sup>	-1	$\pm 1.3$	1	$\%S$
Total Sensitivity Drift <sup>6</sup>	$\Delta S$			$\pm 1.5$		$\%S$
Input referred noise spectral density	$N_{SD}$	within BW = 1 .. 400kHz, Max Gain		210		nT/ $\sqrt{\text{Hz}}$

Table 11: Accuracy specifications – analog parameters.

The accuracy specifications are defined for the factory calibrated sensitivity. The achievable accuracy is dependent on the user's end-of-line calibration. Resolution for offset and offset drift calibration is better than  $0.05\%V_{DD}$ . Trimming capability is higher than measurement accuracy. End-user calibration can therefore increase the accuracy of the system.

<sup>7</sup> Ratiometry Error is verified at maximum  $V_{DD}$  deviation ( $5\%V_{DD}$  at 3.3V and  $10\%V_{DD}$  at 5V) over temperature in production. Typical values are the maximum mean  $\pm 3$  sigma out of all characterized lots.

<sup>8</sup> Performance after factory trimming.

<sup>9</sup> Based on results from AEC-Q003 Characterization. Typical values are the maximum mean  $\pm 3$  sigma out of all characterized lots.

<sup>10</sup> After 1000h HTOL at  $T_A = 155^\circ\text{C}$  with respect to after pre-conditioning at  $T_A = 35^\circ\text{C}$ . Pre-conditioning is performed with MSL level 3 based on J-STD-020. Typical values are the highest average  $\pm 3$  sigma across all qualification lots.

### 11.4. Timing specifications

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or 3.3 V factory trimmed unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Step Response Time	$T_{RESP}$	Delay between the input signal reaching 90% and the output reaching 90% (see Figure 8) SF=1 (default) SF=2 SF=3			2 3.5 6	$\mu\text{s}$
Bandwidth	BW	-3dB, $T_A = 25^\circ\text{C}$ , SF=1 (default) SF=2 SF=3		400 200 100		kHz
Power on Delay <sup>11</sup>	$T_{POD}$				1	ms

Table 12: Timing specifications of the high-speed analog output

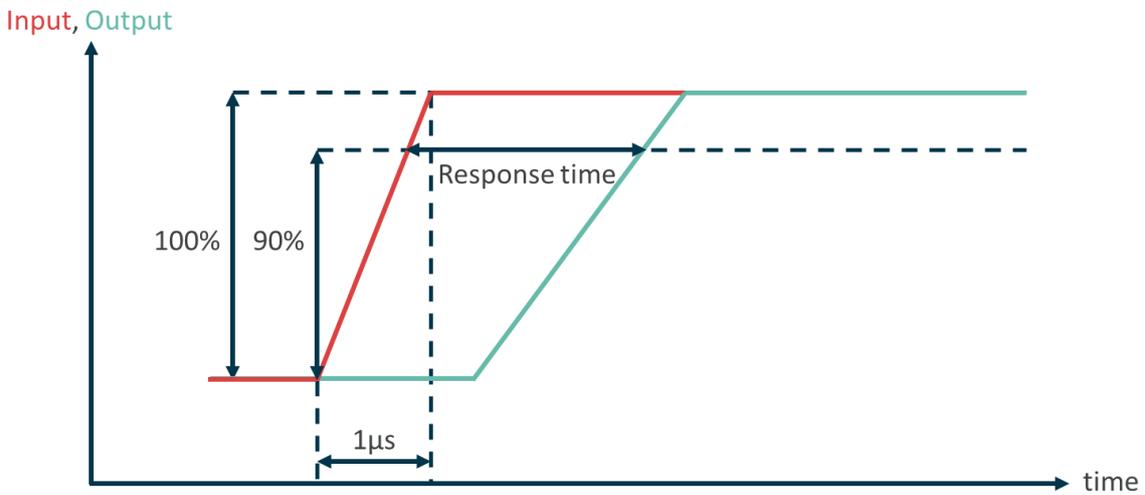


Figure 8: Response Time definition

<sup>11</sup>During the power on, the output follows a routine and is not valid (i.e. it is not related to magnetic field) for  $T_{POD}=1\text{ms}$ .

## 12. Diagnostics

It is possible to take advantage of diagnostic features, with the help of adding a pull-down resistor (see Section 14). If a failure event occurs, the measured output will be set to ground. This can be interpreted as failure by the microcontroller unit.

Error	Effect on Output
Calibration data CRC Error	Output stage in high-Z mode. A pull-down resistor to ground will result in output equal to ground.
VDD Under voltage	
Thresholds:	Output is pulled to GND with a 2kΩ resistance, until VDD is inside the specified ranges, depending if the device is powering on or off.
<ul style="list-style-type: none"> <li>Power-up: VDD &lt; 2.8V</li> <li>Power-down: VDD &lt; 2.5V</li> </ul>	
Broken OUT	Pull-down external resistor allows to measure a voltage equal to GND.

Table 13: Description of the diagnostic modes in MLX91219

## 13. Overcurrent Detection Specification

### 13.1. General

The MLX91219 provides two OCD features (called internal and external) that allow the detection of overcurrent events. The internal OCD (OCD<sub>INT</sub>) is available in both packages SIP4-VA and SOIC8, while the external OCD (OCD<sub>EXT</sub>) is only available in SOIC8 package. When an overcurrent event occurs, the OCD pins are pulled to ground. During normal operation the OCD voltage remains at V<sub>DD</sub>. If not used, OCD pins can be connected to GND.

The two OCD functions are able to react to an overcurrent event within few μs of response time. To avoid false alarm, the overcurrent has to be maintained for at least 1μs for the detection to occur. After detection by the sensor the output flag is maintained for 10μs of dwell time. This allows the overcurrent to be easily detected at microcontroller level. Table 14 offers a comparison between OCD<sub>INT</sub> and OCD<sub>EXT</sub>:

Description	OCD <sub>INT</sub>	OCD <sub>EXT</sub>
Typical Application	Short-circuit detection	Out-of-range detection
Overcurrent effect	OCD <sub>INT</sub> pin to GND	OCD <sub>EXT</sub> pin to GND
Detection mode	Bidirectional	Unidirectional / bidirectional
Threshold trimming	EEPROM	Voltage divider on VOC <sub>EXT</sub>
Availability in package	SIP4-VA, SOIC8	SOIC8

Table 14: Comparison between OCD<sub>INT</sub> and OCD<sub>EXT</sub>

## 13.2. Electrical Specifications

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or 3.3 V factory trimmed unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
OCD_INT Internal ON Resistance	$R_{ON\_OCD\_INT}$	$I_{SINK} = 1$ mA	60	90	150	$\Omega$
OCD_EXT Internal ON Resistance	$R_{ON\_OCD\_EXT}$	$I_{SINK} = 1$ mA	160	190	280	$\Omega$
VOC_EXT Voltage Range <sup>12</sup> $V_{DD}= 5$ V, 5xx versions	$VOC_{EXT\_5V}$	RS = 0 , Bidirectional RS = 3, Unidirectional	0.5 0.9		2.0 4.5	V
VOC_EXT Voltage Range <sup>12</sup> $V_{DD}= 3.3$ V, 3xx versions	$VOC_{EXT3V3}$	RS = 1, Bidirectional RS = 3, Unidirectional	0.5 0.74		1.525 2.9	V
OCD_INT accuracy	OCD_INT	Ratiometric output <sup>13</sup>		$\pm 10$		%Thr <sup>14</sup>
OCD_EXT accuracy	OCD_EXT			$\pm 1.5$		%FS

Table 15: Electrical Specifications OCD

## 13.3. Timing Specifications

Operating Parameters  $T_A = -40$  to  $150^\circ\text{C}$ ,  $V_{DD}=5$  V or 3.3 V factory trimmed unless otherwise specified.

Parameter	Test Conditions	Min	Typ	Max	Units
OCD_INT response time	programmable		1.4 2.1		$\mu\text{s}$
OCD_EXT response time			10		$\mu\text{s}$
OCD_INT required Input holding time			0.5		$\mu\text{s}$
OCD_EXT required Input holding time			10		$\mu\text{s}$
OCD_INT output dwell time		7		14	$\mu\text{s}$
OCD_EXT output dwell time			10		$\mu\text{s}$

Table 16: OCD\_INT and OCD\_EXT timing specifications

<sup>12</sup> VOC\_EXT defines the OCD\_EXT threshold. In case of a ratiometric device, VOC\_EXT should change with Vdd to avoid additional errors.

<sup>13</sup> OCD\_INT threshold will not scale with VDD variation (in ratiometric output mode) therefore at lower supply voltage results in a higher OCD\_INT threshold and vice versa. VDD variation should be accounted for when defining the OCD threshold.

<sup>14</sup> The error of OCD\_INT is expressed as percentage of the threshold value. Example: if the nominal threshold is 282mT, the typical threshold of OCD\_INT will be in the range between 253.8mT and 310.2

### 13.4. Internal Overcurrent Detection Principle

The internal OCD takes the threshold voltage values predefined in the EEPROM and does not require any extra components. The  $OCD_{INT}$  implementation allows detecting overcurrent outside of the output measurement range of the sensor and is therefore suitable for large current peaks as occurring during short-circuit. If the theoretical sensor output overcomes the  $OCD_{INT}$  voltage threshold, the overcurrent event is flagged on  $OCD_{INT}$  pin. The default OCD threshold voltages are defined as follows, but other values can be set on request.

Sensor reference	Typical Sensitivity [mV/mT]	$OCD_{INT}$ Threshold Current [%FS]
MLX91219LVA-AAA-500	7	134.7
MLX91219LVA-AAA-501	10	134.7
MLX91219LDC-ARA-501	10	134.7
MLX91219LVA-AAA-502	15	134.7
MLX91219LVA-AAA-503	25	134.7
MLX91219LVA-AAT-505	10	88.2

Table 17:  $OCD_{INT}$  thresholds

	Sensor configuration	Min [% FS]	Max [% FS]
$OCD_{INT}$ Threshold	$V_{DD} = 5V / V_{REF} = 2.5V$	25.5	215.8

Table 18:  $OCD_{INT}$  factory programmable range

### 13.5. External Overcurrent Detection Principle

The external OCD uses the voltage applied on  $VOC_{EXT}$  pin as threshold voltage. This translates into an overcurrent threshold depending on the sensitivity of the sensor. A voltage divider on  $VOC_{EXT}$  allows defining the threshold voltage in a custom way. Depending on the voltage divider configuration, the  $OCD_{EXT}$  can be used either in bidirectional or unidirectional mode. The External OCD threshold is defined within the measurement range of the sensor output. This feature is then suitable for out-of-range detection where the OCD threshold remains close to the nominal current. It offers a better accuracy than  $OCD_{INT}$  but the response is slower. The below table presents the unidirectional and bidirectional external OCD configurations. Please refer to section 14 for more details about the application diagram and the recommended resistances.

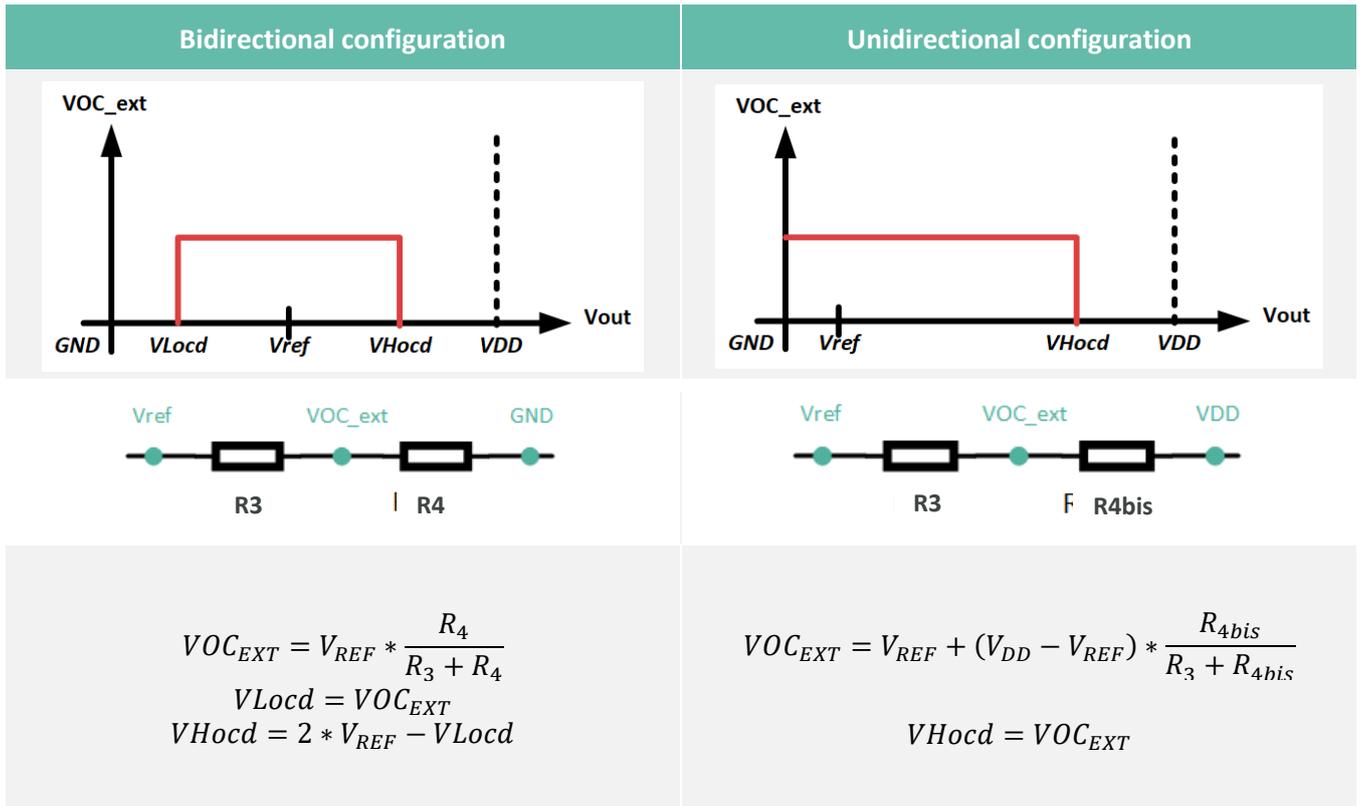


Table 19: External OCD, bidirectional and unidirectional configurations

## 14. Recommended Application Diagram

### 14.1. SIP-4 VA Package

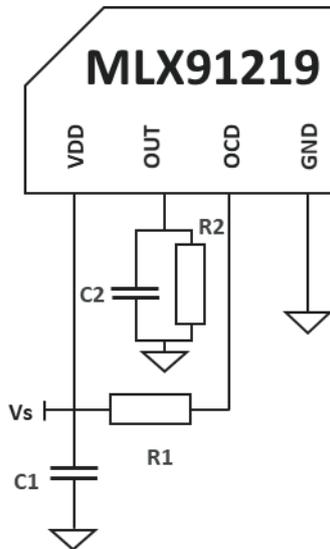


Figure 9: Application Diagram for SIP-4 VA package

Part	Description	Value	Unit
C1	Supply capacitor, EMI, ESD	47	nF
C2	Decoupling, EMI, ESD	4.7	nF
R1	Internal OCD resistor	10	k $\Omega$
R2	Output pull-down resistor	>10	k $\Omega$

Table 20: Resistor and capacitor values for SIP-4 VA package

### 14.2. SOIC8 package

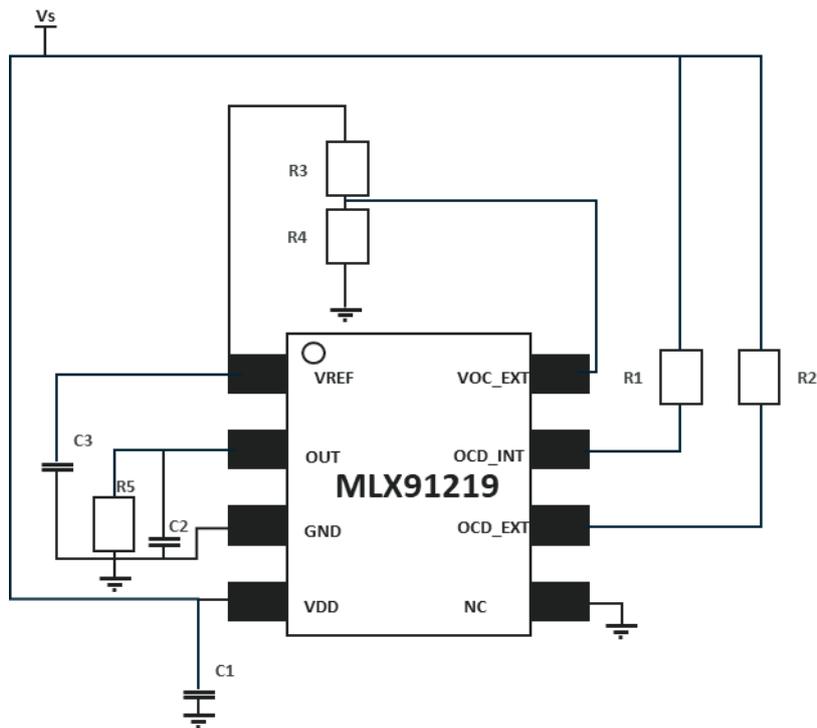


Figure 10: Application Diagram for SOIC8 package, bidirectional  $OCD_{EXT}$ .

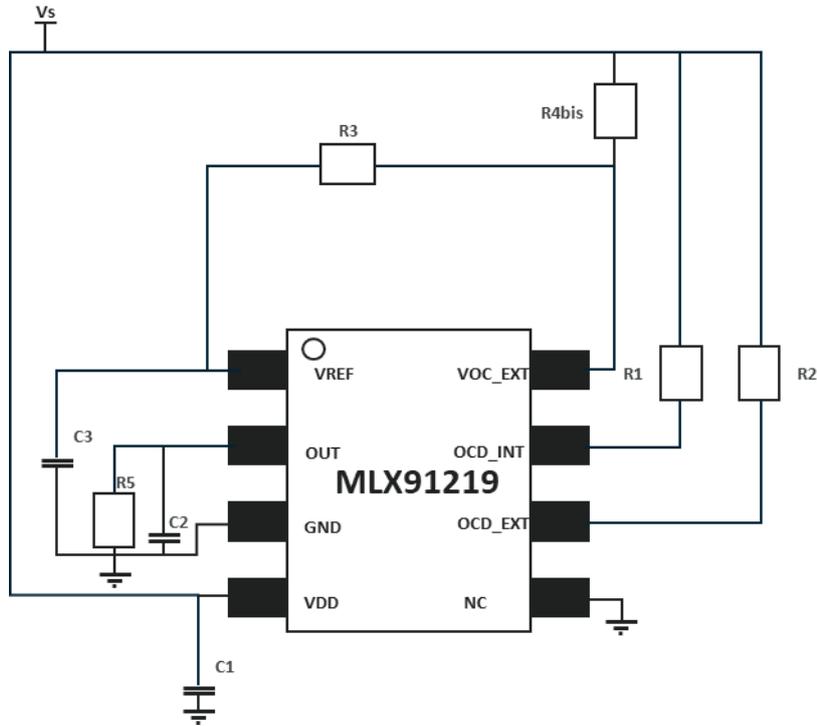


Figure 11: Application Diagram for SOIC8 package, unidirectional  $OCD_{EXT}$ .

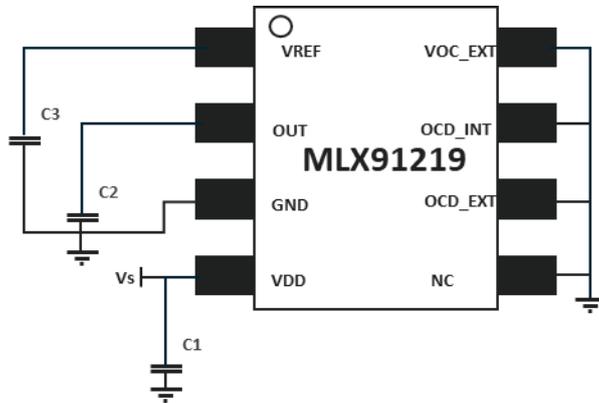


Figure 12: Application Diagram for SOIC8 package, bidirectional  $OCD_{EXT}$ .

Part	Description	Value	Unit
C1	Supply capacitor, EMI, ESD	47	nF
C2	Decoupling, EMI, ESD	4.7	nF
C3	Decoupling, EMI, ESD	47	nF
R1	Internal OCD resistor	10	k $\Omega$
R2	External OCD resistor	10	k $\Omega$
$R_3 + R_4 / R_{4\_BIS}$	External OCD Resistor	>200	k $\Omega$
$R_4$ or $R_{4\_BIS}$	External OCD Resistor	custom	-

R5	Output pull-down resistor	>10	kΩ
----	---------------------------	-----	----

Table 21: Resistor and capacitor values for SOIC8 package

### 14.3. Resistance on reference voltage pin

The resistance connected to the reference pin should be large enough to limit the current. Figure 13 shows an example of the case when the resistance on the reference pin is too low. The measured  $V_{REF}$  will be equal to  $V_{REF} = V_{REFINT} \times \frac{R_{EXT}}{R_{EXT} + R_{REF}} = 1.25V$ . Therefore, the current  $I_{REF}$  will be equal to  $I_{REF} = \frac{V_{REF}}{R_{EXT}} = 6.25mA$ . The maximum source current on the reference pin is 0.6mA (typical value). Therefore, the current flowing will be 0.6mA, and the measured  $V_{REF}$  will be  $V_{REF} = 0.6mA \times 200\Omega = 0.12V$ . To conclude, to measure the correct reference voltage, it is important to have the resistance on the reference pin larger than the internal resistance, normally larger than 200kΩ.

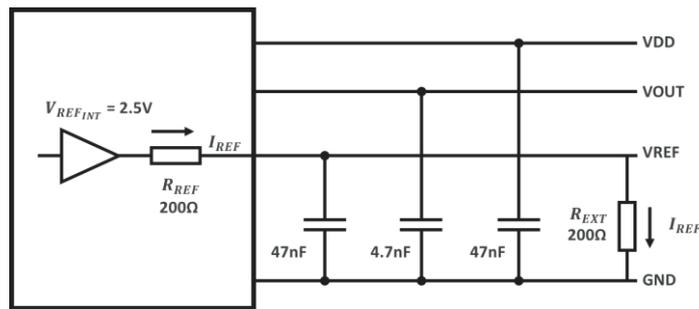


Figure 13: Case when the external resistance on reference pin is low.

## 15. Standard Information

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to standards in place in Semiconductor industry.

### Soldering of SMDs (Surface Mount Devices)

For Surface Mounted Devices (SMD, as defined according to JEDEC norms), the only applicable soldering method is reflow. For more information, read the application note **Soldering for Surface Mount Technology (SMT)** at the link <https://media.melexis.com/-/media/files/documents/application-notes/handling-and-assembly/guidelines-surface-mount-technology-smt-soldering-application-note-melexis.pdf>.

### Lead pre-forming of THDs (Surface Mount Devices)

THD lead pre-forming (cutting and/or bending) is applicable under strict compliance with Melexis Guidelines for lead forming of SIP Hall Sensors. For more information, read the application note **Lead forming of Hall sensors in SIP packages** at the link <https://www.melexis.com/en/tech-info/ic-handling-and-assembly/lead-forming>.

### Soldering of THDs (Surface Mount Devices)

For Through Hole Devices (THD), the applicable soldering methods are reflow, wave, selective wave and robot point-to-point. For more information, read the application note **Soldering of Through Hole Devices (THD)** at the link <https://media.melexis.com/-/media/files/documents/application-notes/handling-and-assembly/guidelines-through-hole-device-thd-soldering-application-note-melexis.pdf?ts=20211210t1158483507>.

### Soldering on PCB

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.

### Environmental information

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

## 16. ESD Precautions

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

## 17. Packaging information: SIP4-VA

### 17.1. Sensor active measurement direction and magnetic center

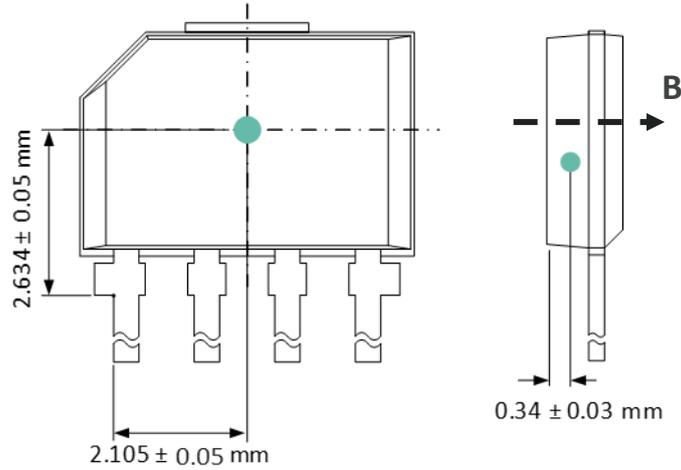


Figure 14: VA/SIL-4L Magnetic center and sensor's active measurement direction B

### 17.2. Package marking & Hall plate position

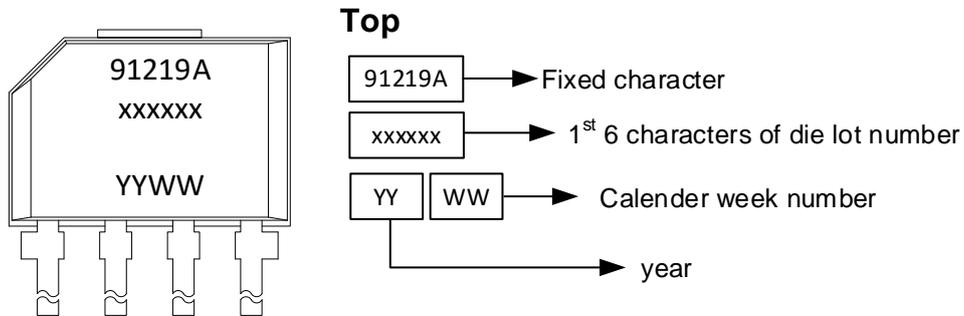
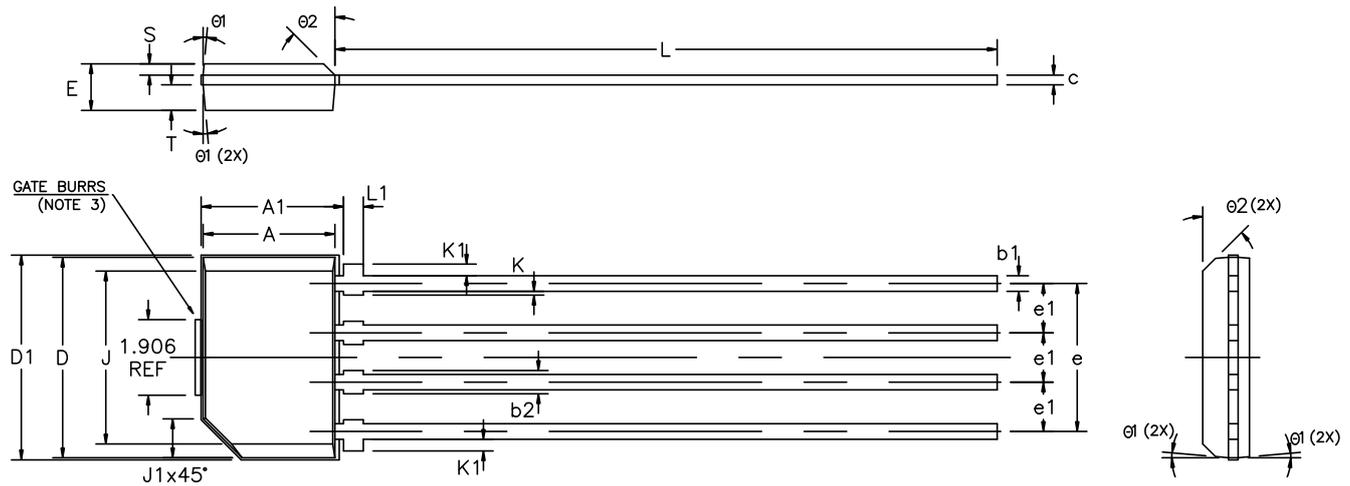


Figure 15. VA/SIP 4L (single in-line package) / 18mm lead length - Package Information

### 17.3. VA Straight leg (MLX91219LVA-AAA-xxx-xx)



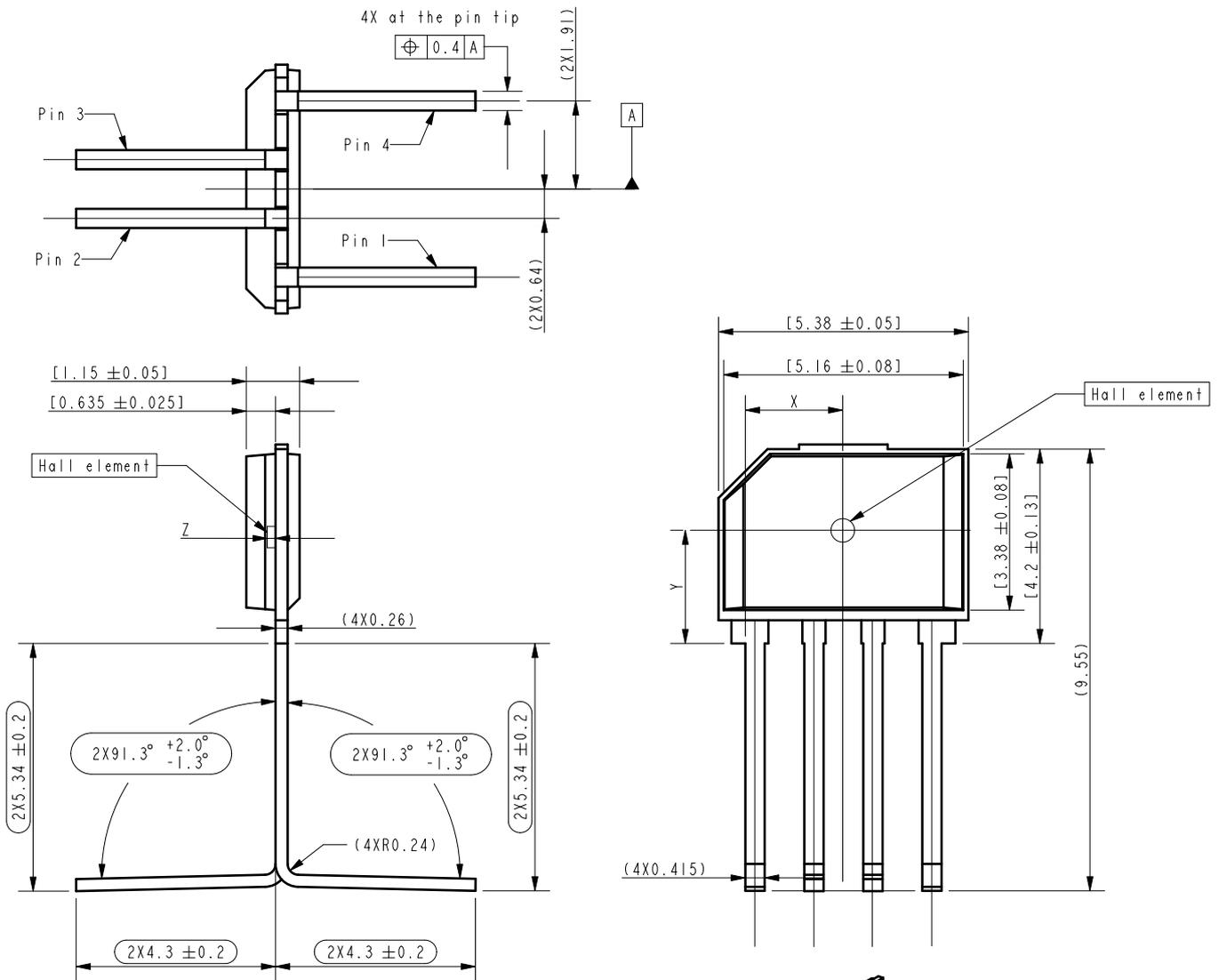
SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	3.30	3.38	3.46
A1	3.63	3.71	3.79
D	5.08	5.16	5.24
D1	5.33	5.38	5.43
E	1.10	---	1.20
J	4.10	4.30	4.50
J1	1.00 REF		
K	0.00	---	0.15
K1	0.25	0.30	0.35
L	17.5	18.0	18.5
L1	0.48	0.53	0.58
S	0.24	---	0.29
T	0.61	---	0.66
b1	0.35	---	0.48
b2	0.40	---	0.60
c	0.18	---	0.34
e	3.76	---	3.86
e1	1.22	1.27	1.32
Ø1	5° REF		
Ø2	45° REF		

Note:

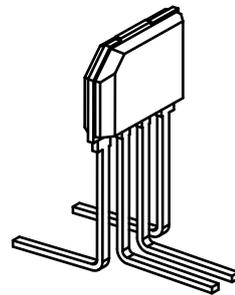
1. DIMENSIONS "A" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS AND GATE BURRS.
2. DIMENSIONS "A1" DOES NOT INCLUDE GATE BURRS BUT INCLUDES MOLD FLASH AT BOTH ENDS.
3. MOLD GATE BURRS SHALL NOT EXCEED 0.15 mm MEASURED FROM EDGE OF MOLD FLASH (FLANGE).
4. DIMENSION "D1" INCLUDES MOLD FLASH AT BOTH ENDS.
5. LEAD PLATING; MATTE TIN PLATING THICKNESS 7.62 – 15.42  $\mu$ m.
6. 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.

Figure 16: VA Straight leg

17.4. Trim and Form type: 90° 2x2x91.3 (h=5.34mm) Bending-STD2 (MLX91219LVA-AAR-xxx-xx)



- Notes:
1. All controlling dimensions are in millimeters
  2. Lead frame material: Alloy C151
  3. Lead frame plating material: Spot silver
  4. Gate burrs shall not exceed 0.15mm measured from edge of mold flash (flange)
  5. Dimensions in ellipse are representing the inspection values.
  6. Dimensions "X", "Y" and "Z" may vary depending on specific product.
  7. Exact dimensions could be found in Melexis datasheet
  8. Dimensions in "()" are for information.
  8. Dimensions in "[ ]" are values from previous manufacturing step



Isometric view  
 Scale 5:1

Figure 17: Trim and form type: 90° 2x2x91.3 (h=5.34), bending-STD2 (AAR-xxx)

17.5. Trim and Form type: 90° 2x2x91.3 (h=3.7mm) Bending-STD3 (MLX91219LVA-AAS-xxx-xx)

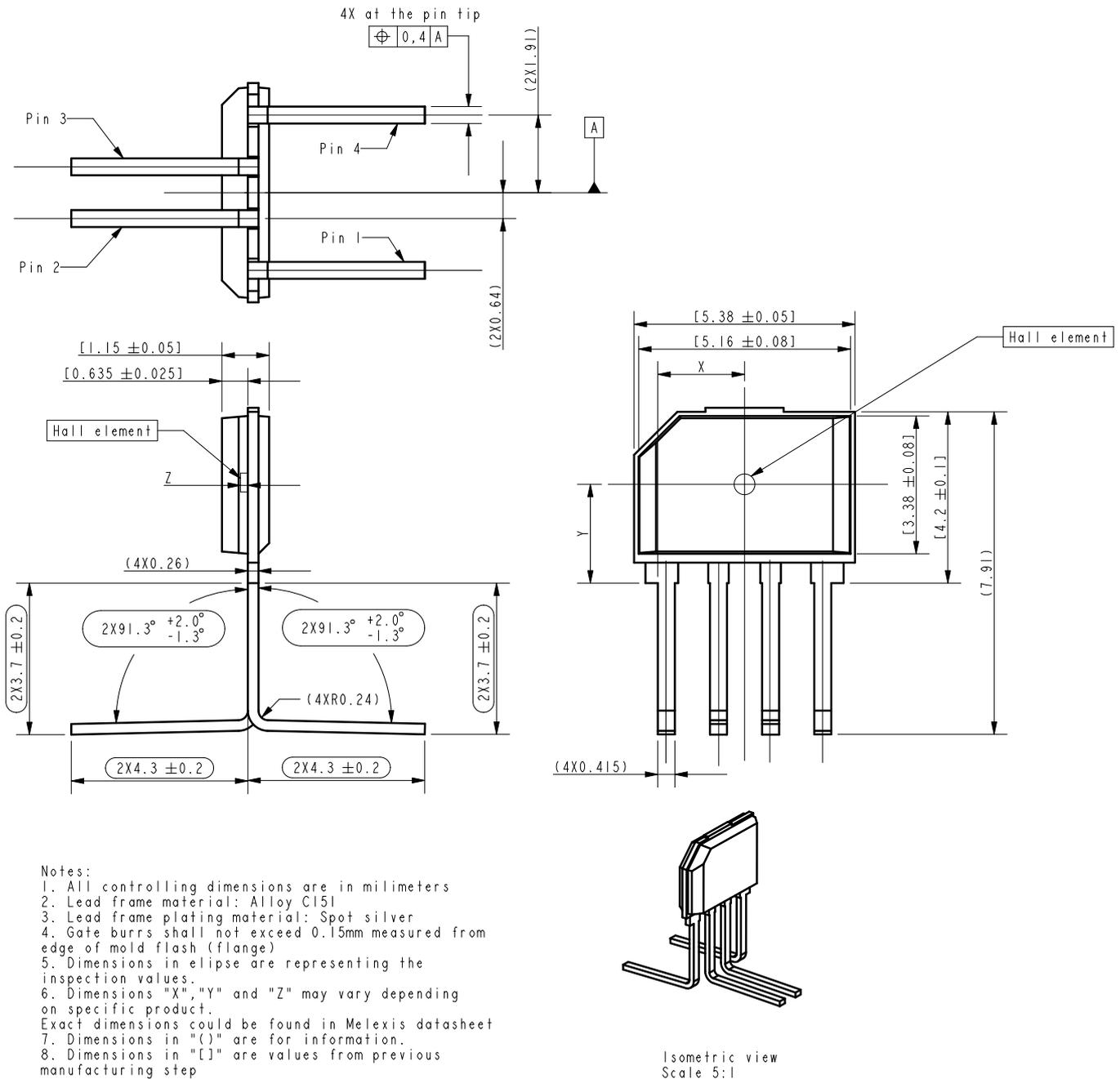
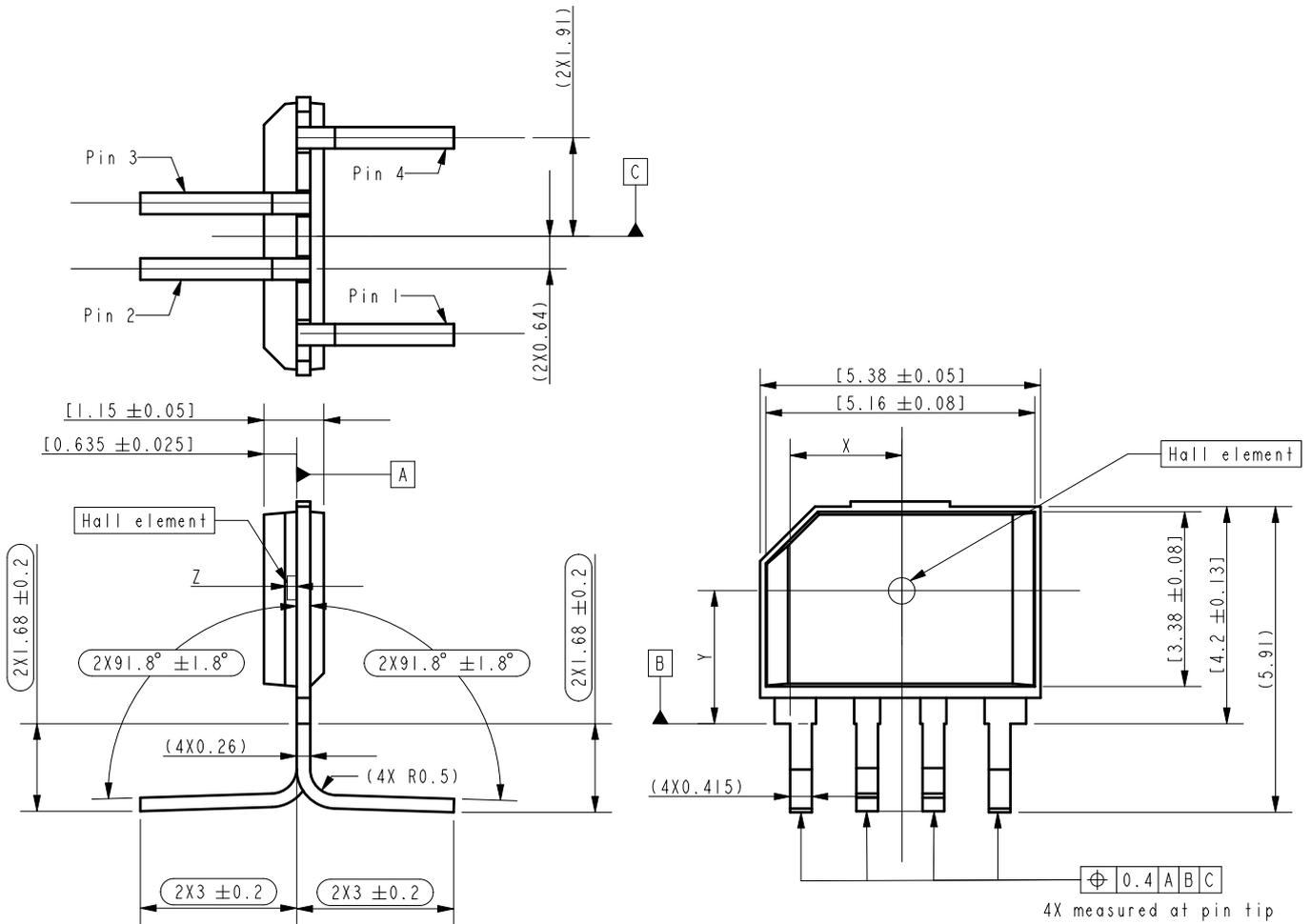


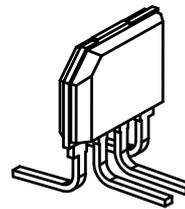
Figure 18: Trim and form type: 90° 2x2x91.3 (h=3.7), bending-STD3 (AAS-xxx)

17.6. Trim and Form type: 90° 2x2x91.8 (h=1.68mm) Bending-STD4 (MLX91219LVA-AAT-xxx-xx)



Notes:

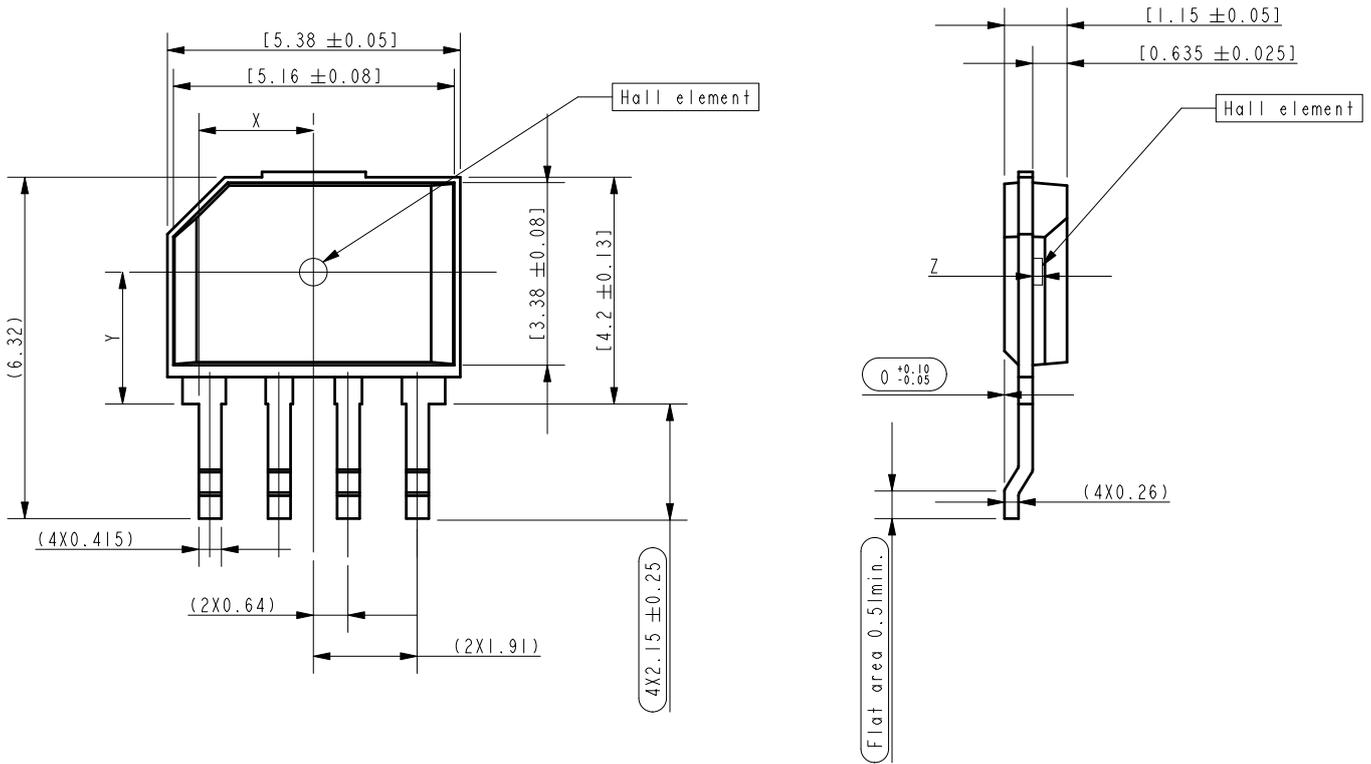
1. All controlling dimensions are in millimeters
2. Lead frame material: Alloy Cl5l
3. Lead frame plating material: Spot silver
4. Gate burrs shall not exceed 0.15mm measured from edge of mold flash (flange)
5. Dimensions in ellipse are representing the inspection values.
6. Dimensions "X", "Y" and "Z" may vary depending on specific product. Exact dimensions could be found in Melexis datasheet
7. Dimensions in "( )" are for information.
8. Dimensions in "[ ]" are values from previous manufacturing step



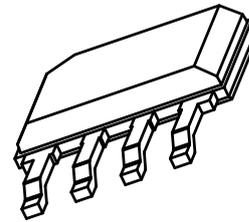
Isometric view  
 Scale 5:1

Figure 19: Trim and form type: 90° 2x2x91.8 (h=1.68), bending-STD4 (AAT-xxx)

17.7. Trim and Form type: SMD style TFT4K1 (MLX91219LVA-AAZ-xxx-xx)



- Notes:
1. All controlling dimensions are in millimeters
  2. Lead frame material: Alloy Cl5l
  3. Lead frame plating material: Spot silver
  4. Gate burrs shall not exceed 0.15mm measured from edge of mold flash (flange)
  5. Dimensions in elipse are representing the inspection values.
  6. Dimensions "X", "Y" and "Z" may vary depending on specific product. Exact dimensions could be found in Melexis datasheet
  7. Dimensions in "( )" are for information.
  8. Dimensions in "[ ]" are values from previous manufacturing step



Isometric view  
 Scale 5:1

Figure 20: Trim and form SMD style TFT4K1 (AAZ-xxx)

## 18. Packaging information: SOIC8

### 18.1. Sensor active measurement direction and magnetic center

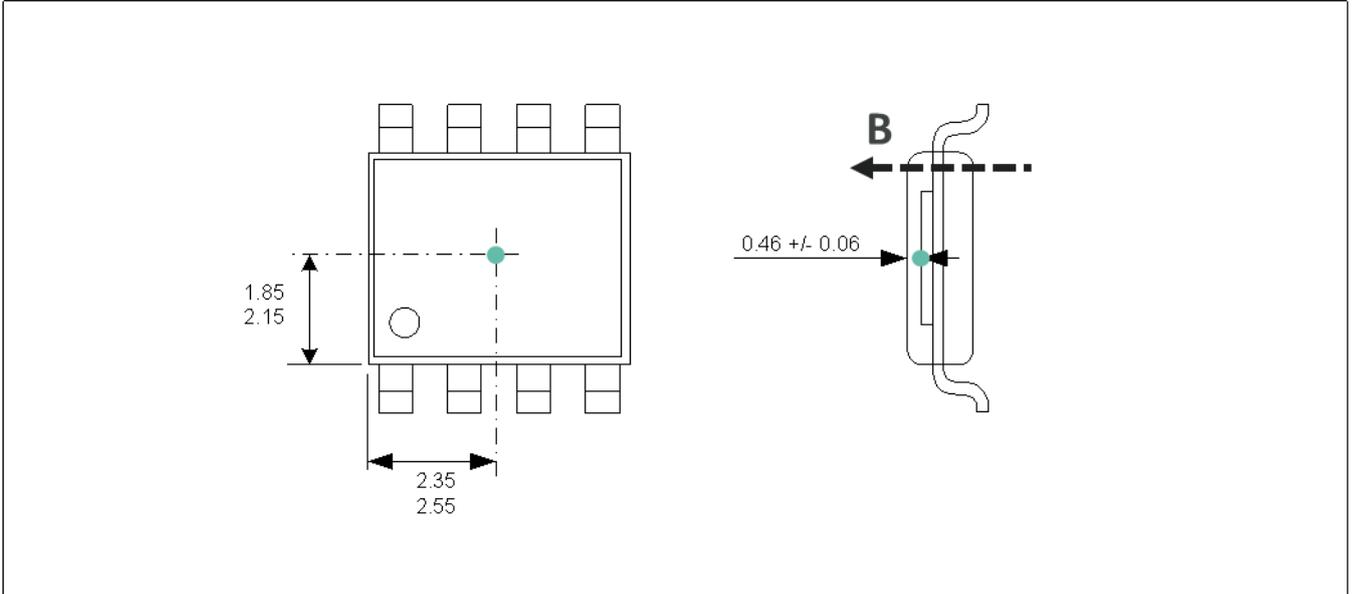


Figure 21: VA/SIL-4L Magnetic center and sensor's active measurement direction B

### 18.2. Package marking

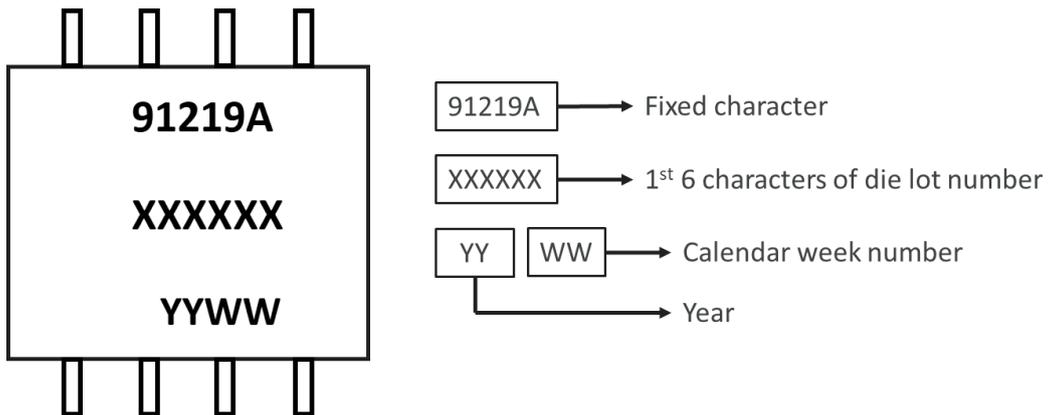
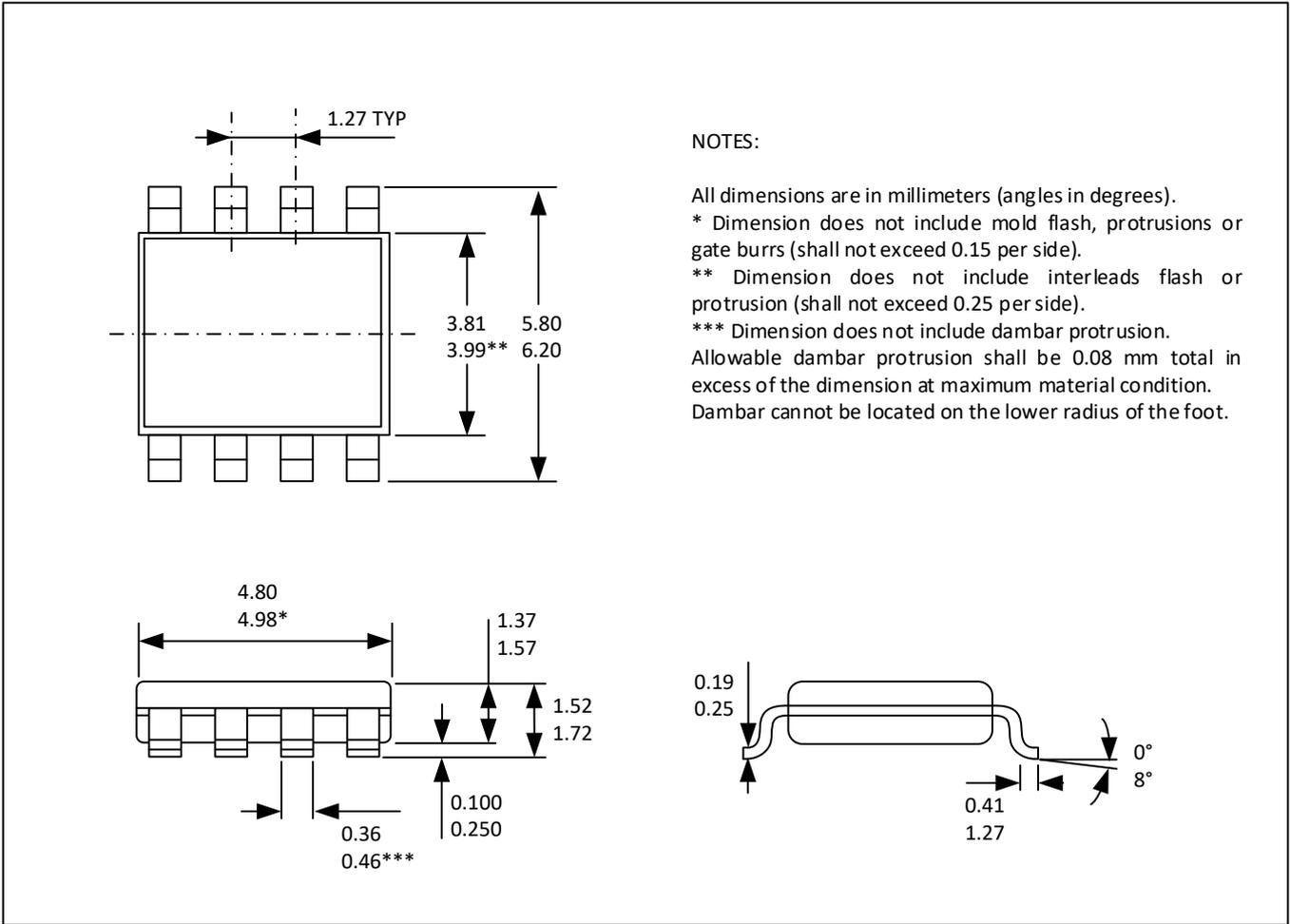


Figure 22. SOIC8 package marking

### 18.3. Package dimensions



**NOTES:**

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

Figure 23: SOIC8 package

## 19. Contact

For additional information, please contact our Direct Sales team and get help for your specific needs:

Europe, Africa	Email : <a href="mailto:sales_europe@melexis.com">sales_europe@melexis.com</a>
Americas	Email : <a href="mailto:sales_usa@melexis.com">sales_usa@melexis.com</a>
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