MLX91219

High Speed Current Sensor IC

Datasheet

1. Features and Benefits

- End-of-line programmable sensor
- Ratiometric or Fixed (SOIC8 package only) analog output
- Flexible Supply Voltage with factory selectable 5 V or 3.3 V mode
- Measurement range from ±12.5 to ±400 mT
- High speed sensing
  - DC to 400 kHz bandwidth
  - 2 µs response time
- High linearity down to ±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 and external (SOIC8 package only) overcurrent detection
- RoHS compliant
- Available in SIP4-VA (MSL-1) and SOIC8 packages (MSL-3)





2. Application Examples

- High Voltage Traction Motor Inverter
- 48 V 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.

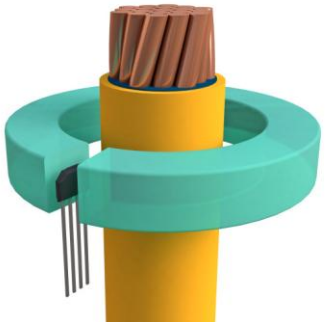


Figure 1. Typical Current Sensing Application for VA package

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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	5 V	NA	134.7 %FS
MLX91219	L	VA	AAT-500	RE	7 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	AAA-501	CR	10 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	AAT-501	RE	10 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	ABA-501	CR	10 mV/mT	5 V	NA	NA
MLX91219	L	VA	ABJ-501	RE	10 mV/mT	5 V	NA	NA
MLX91219	L	VA	ABT-501	RE	10 mV/mT	5 V	NA	NA
MLX91219	L	DC	ARA-501	RE	10 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	AAA-502	CR	15 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	ABT-502	RE	15 mV/mT	5 V	NA	NA
MLX91219	L	VA	AAA-503	CR	25 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	AAT-503	RE	25 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	DC	ARA-503	RE	25 mV/mT	5 V	NA	134.7 %FS
MLX91219	L	VA	ABT-504	RE	30 mV/mT	5 V	NA	NA
MLX91219	L	VA	AAT-511	RE	10 mV/mT	5 V	NA	88.2 %FS
MLX91219	L	VA	ABT-513	RE	13 mV/mT	5 V	NA	NA
MLX91219	L	VA	ABT-514	RE	19 mV/mT	5 V	NA	NA
MLX91219	L	VA	AAA-300	CR	7 mV/mT	3.3 V	NA	124.9 %FS

Table 1: Available ordering code

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Legend:

Temperature Code	**L**	from -40°C to 150°C ambient temperature
Package Code	**VA**	"VA" for SIP-4 VA package
	DC	"DC" for SOIC8 package
Option Code	**Axx-xxx**	"A" for Silicon revision
	xAx-xxx	SIP-4 VA package: "A" for variant with OCD *(always ratiometric output)*
	xBx-xxx	SIP-4 VA package: "B" for variant without OCD *(always ratiometric output)*
	xRx-xxx	SOIC-8 package: "R" for ratiometric output
	xFx-xxx	SOIC-8 package: "F" for fixed output
	xxA-xxx **xxJ-xxx** **xxR-xxx** **xxS-xxx** **xxT-xxx** **xxZ-xxx** **xxV-xxx**	VA straight leg (see section 17.3) Trim and Form shape: THT 2.54mm pitch (see chapter 17.4) Trim and Form type: 90° 2x2x91.3 (h=5.34mm) Bending-STD2 (see section 17.5) Trim and Form type: 90° 2x2x91.3 (h=3.7mm) Bending-STD3 (see section 17.6) Trim and Form type: 90° 2x2x91.8 (h=1.68mm) Bending-STD4 (see section 17.7) Trim and Form type: SMD style TFT4K1 (see section 17.8) Trim and Form type: 25° 2x2x92.3 (h=5.34mm) (see section 17.9)
	xxx-3xx **xxx-5xx**	"3" for 3.3 V supply, bipolar output "5" for 5 V supply, bipolar output
	xxx-x00 **xxx-x01** **..**	Typical sensitivity of 7 mV/mT and overcurrent detection of 134.7 %full scale Typical sensitivity of 10 mV/mT and overcurrent detection of 134.7 %full scale ..
Packing Form	**CR** **RE** **SP**	Carton Reel – Radial taping Plastic Tape on Reel Sample pack
Ordering Example	"**MLX91219LVA-AAA-500-CR**" MLX91219 Conventional Hall current sensor in SIP4-VA package, temperature range -40°C to 150°C, sensitivity 7 mV/mT, 5 V 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.

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5. Functional Diagram

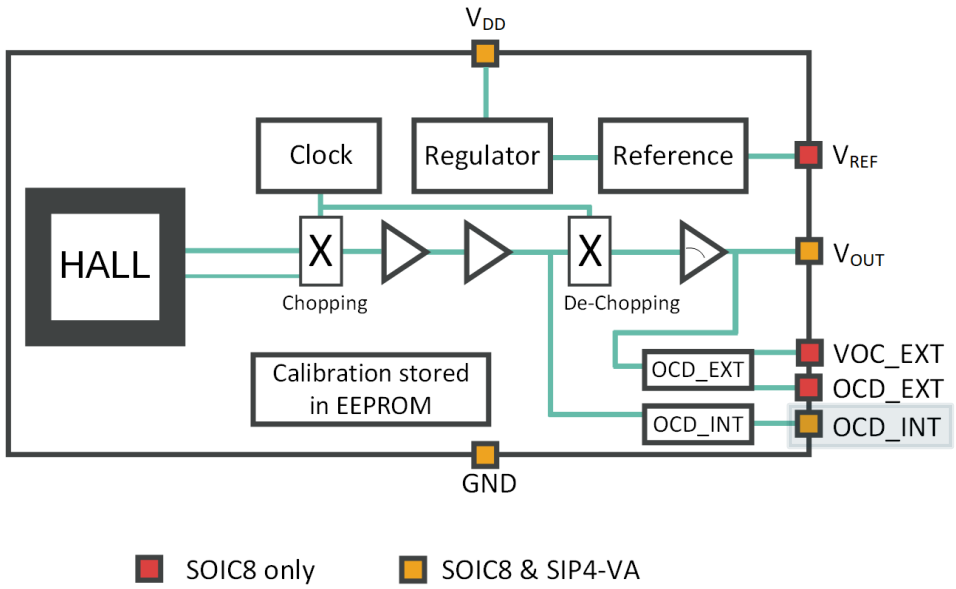


Figure 2: Block Diagram of the MLX91219. OCD_INT is not available in SIP-4 VA Package variant B.

5.1. Ratiometric Mode

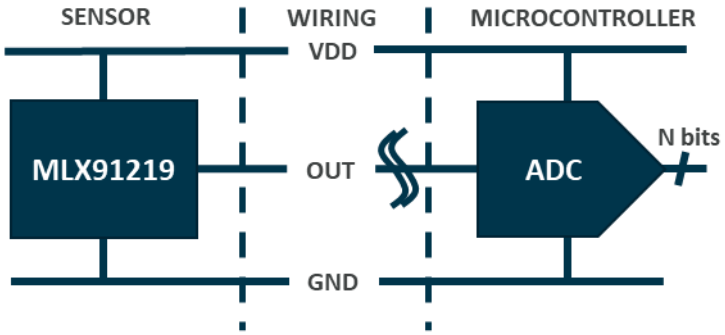


Figure 3: Schematic of ratiometric mode

The sensor's output signal is proportional to V_{DD}. In case both sensor and microcontroller share the same VDD, the ADC will return the same ADC code for a given magnetic field even when V_{DD} is deviating.

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5.2. Fixed Mode

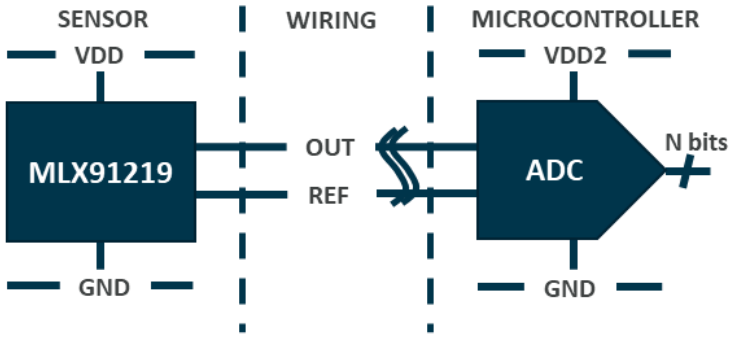


Figure 4: Schematic of fixed mode

The sensor's output signal is independent from V_{DD}. Supply voltage differences will not influence the sensor's output signal. Only available in SOIC8 package.

Parameter	Ratiometric Mode	Fixed Mode
Output Signal	V_{OUT} [%V_{DD}] - Reference[%V_{DD}] For a given field with V_{DD} variations, V_{OUT} remains at the same % V_{DD} Example: If V_{OUT} =2.5 V for V_{DD} = 5 V, V_{OUT} will be 2.625 V for V_{DD} = 5.25 V	V_{OUT} - Reference [V] For a given field with V_{DD} variations, V_{OUT} - V_{REF} remains constant Example: If V_{OUT} - V_{REF} = 1 V for V_{DD} = 5 V, V_{OUT} - V_{REF} will remain 1 V for V_{DD} = 5.25 V
Reference	50 [%V_{DD}] (factory trimmed)	V_{REF} (factory trimmed)
Sensitivity	[%V_{DD}/mT][1]	[mV/mT]
Measured magnetic field B	$B = \frac{(V_{OUT} - V_{OUT}[0mT])}{Sensitivity}$	$B = \frac{(V_{OUT} - V_{REF})}{Sensitivity}$

Table 3: Parameters of Ratiometric and Fixed Mode

6. Glossary of Terms

Terms	Definition
FS	**F**ull **S**cale, Output voltage full scale: • Ratiometric mode: 10% (Minimum) to 90% (Maximum) [%V_{DD}] • Fixed mode ○ 5 V: 0.5 (Minimum) to 4.5 (Maximum) [V] ○ 3.3 V: 0.4 (Minimum) to 2.9 (Maximum) [V]
mT	**m**ili**T**esla= units for the magnetic flux density, 1 mT = 10 Gauss
OCD	**O**ver**C**urrent **D**etection

Table 4: Glossary of Terms

[1] *The sensitivity in ratiometric mode is expressed as [%VDD/mT]. In the datasheet the sensitivity is always expressed in [mV/mT]. This corresponds to the sensitivity at typical nominal supply voltage for ratiometric devices.*

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7. Pin Definition[2] and Description

7.1. SIP-4 VA Package variant A

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

Table 5: Pin definition and description

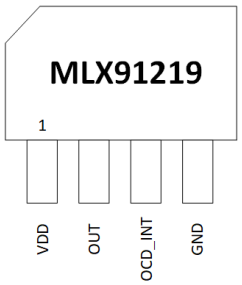


Figure 5: Pinout of SIP4-VA package variant A

7.2. SIP-4 VA Package variant B

Pin #	Name	Type	Description
1	NC	-	Not connected
2	OUT	Analog Output	Output voltage (measurement)
3	GND	Supply	Ground voltage
4	VDD	Supply	Supply voltage

Table 6: Pin definition and description

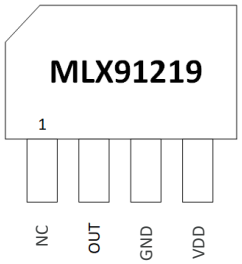


Figure 6: Pinout of SIP4-VA package variant B

[2] *The MLX91219 is not pin-to-pin compatible with MLX91207 and MLX91209*

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7.3. 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 7: Pin definitions and description

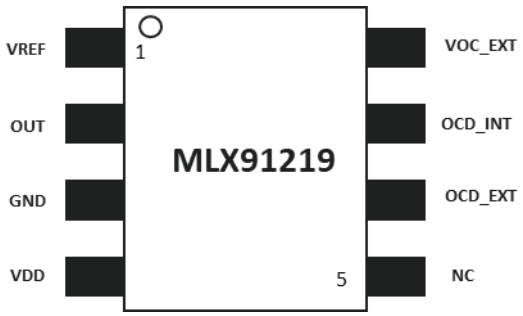


Figure 7: Pinout of SOIC8 package

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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 [3]	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[3]	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 ESD_{CDM} Corner pins	500 750	V V

Table 8: Absolute maximum ratings

[3] *Except for V_{DD} and GND*

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9. General Electrical Specification

Operating Parameters T_A = -40 to 150°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	Ω
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°C		6	20	µA
Output Voltage Linear Swing	V_{OUT_LSW}	Pull-down or pull-up ≥ 10 kΩ V_{DD} > 4.6 V for Fixed Mode versions	10		90	%V_{DD}

Table 9: General electrical parameters

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10. Magnetic Specification

Operating Parameters T_A = -40 to 150°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}				±400	mT
Linearity Error (Magnetic)	NL	B within B_{OP}, T_A = 25°C			±0.5	%FS
Programmable Sensitivity	S_{PROG}	Generic part	5		105	mV/mT
		MLX91219LVA-AAA-500	6.5	7	22.5	
		MLX91219Lxx-Axx-501	6.5	10	22.5	
		MLX91219LVA-Axx-502	6.5	15	22.5	
		MLX91219Lxx-AxA-503	16	25	55	
		MLX91219LVA-ABT-504	16	30	55	
		MLX91219LVA-AAT-511	6.5	10	22.5	
		MLX91219LVA-ABT-513	6.5	13	22.5	
		MLX91219LVA-ABT-514	6.5	19	22.5	
Sensitivity accuracy (factory trimming)	S_{RES}	B = B_{OP}	-1		+1	%
Sensitivity Programming Resolution	S_{RES}	B = B_{OP}		0.5		%

Table 10: Magnetic specification

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11. Analog Output Specification

11.1. Definitions

11.1.1. Sensitivity

The sensitivity S is the ratio between the output signal and the input magnetic field (in the absence of offset error).

For ratiometric devices, the output scales with the supply V_{DD}, sensitivity is expressed in [%V_{DD}]/mT[4].
For fixed devices, the output does not vary with the supply V_{DD}, sensitivity is expressed in mV/mT.

11.1.2. Voltage Output Quiescent

V_{OQ} corresponds to the difference between the measured and the ideal output when no magnetic field is applied to the sensor at T_A=25°C.

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

11.1.3. Thermal Sensitivity Drift

$\Delta^T S$ corresponds to variation of S in temperature.

11.1.4. Thermal Offset Drift

$\Delta^T V_{OQ}$ corresponds to variation of V_{OQ} in temperature.

11.1.5. Thermal Reference Drift

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

$$+\Delta T_{VREF} = \left(\frac{Vref[125°C]}{Vref[25°C]} - 1\right).\frac{1}{(125-25)}.10^6$$

$$-\Delta T_{VREF} = \left(\frac{Vref[-40°C]}{Vref[25°C]} - 1\right).\frac{1}{(-40-25)}.10^6$$

11.1.6. 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 is fixed below 50°C.

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

[4] *In the datasheet the sensitivity will be always expressed in mV/mT. This corresponds to the sensitivity at typical nominal supply voltage for ratiometric devices.*

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11.1.7. Ratiometry Sensitivity and Offset Error

Ratiometric Mode

In Ratiometric mode, V_{OUT} and V_{REF} are scaled with the supply voltage.

Ratiometric Sensitivity Error:

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

Ratiometric V_{OQ} Error:

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

The ratiometric error is expressed as $\frac{\%S}{\%VDD}$ for the sensitivity, and $\frac{mV}{\%VDD}$ for the offset.

Example: 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.

Non-Ratiometric Sensitivity Error:

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

Non-Ratiometric V_{OQ} Error:

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

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11.2. SIP-4 VA Accuracy Specification

Operating Parameters T_A = -40 to 150°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, T_A=25°C	-5		5	mV
Ratiometric Offset Error[5]	$\Delta^R V_{OQ}$	V_{DD} = 5 V V_{DD} = 3.3 V		1.6 1		mV/%V_{DD}
Thermal Offset Drift[6]	$\Delta^T V_{OQ}$	T_A = -40 to 125°C T_A = -40 to 150°C[7]	-5	 ±5	5	mV
Total Offset drift[8]	ΔV_{OQ}			±6		mV
Ratiometric Sensitivity Error[5]	$\Delta^R S$			0.16		%S/%V_{DD}
Thermal Sensitivity Drift[6]	$\Delta^T S$	T_A =-40°C to 125°C T_A =-40°C to 150°C[7]	-1	 ±1	1	%S
Total Sensitivity Drift[8]	ΔS			±1.5		%S
Input referred noise spectral density	N_{SD}	within BW = 1 .. 400kHz, Max Gain		210		nT/√Hz

Table 11: Accuracy specifications – analog parameters

The accuracy specification is 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.

[5] Ratiometry Error is verified at maximum V_{DD} deviation (5%V_{DD} at 3.3 V and 10%V_{DD} at 5 V) over temperature in production. Typical values are the maximum mean ±3σ out of all characterized lots.

[6] Performance after factory trimming.

[7] Based on results from AEC-Q003 Characterization. Typical values are the maximum mean ±3σ out of all characterized lots.

[8] After 1000h HTOL at TA = 155°C with respect to after pre-conditioning at TA = 35°C. Pre-conditioning is performed with MSL level 3 based on J-STD-020. Typical values are the highest average ±3 sigma across all qualification lots.

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11.3. SOIC8 Accuracy Specification

Operating Parameters T_A = -40 to 150°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°C, AFx-5xx versions, RS=0 T_A=25°C, AFx-3xx versions, RS=1 T_A=25°C, AFx-3xx versions, RS=2 T_A=25°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	ΔT_{VREF}	Variation versus 25°C, for fixed output			±150	ppm/°C
Non-ratiometric VREF Error	ΔV_{REF}	Fixed mode devices (only SOIC8)	-3		3	mV
Voltage Output Quiescent	V_{OQ}	No magnetic field applied, T_A=25°C	-5		5	mV
Ratiometric Offset Error[5]	$\Delta^R V_{OQ}$	V_{DD} = 5 V V_{DD} = 3.3 V		1.6 1		mV/%V_{DD}
Non-Ratiometric Offset Error	$\Delta^R V_{OQ}$	V_{DD} = 5 V V_{DD} = 3.3 V		5 5		mV
Thermal Offset Drift[6]	$\Delta^T V_{OQ}$	T_A = -40 to 125°C T_A = -40 to 150°C[7]	-5	 ±6	5	mV
Total Offset drift[8]	ΔV_{OQ}			±6		mV
Ratiometric Sensitivity Error[5]	$\Delta^R S$			0.16		%S/%V_{DD}
Non-Ratiometric Sensitivity Error	$\Delta^R S$		-0.6		0.6	%S
Thermal Sensitivity Drift[6]	$\Delta^T S$	T_A =-40°C to 125°C T_A =-40°C to 150°C[7]	-1.5	 ±1.3	1.5	%S
Total Sensitivity Drift[8]	ΔS			±1.5		%S
Input referred noise spectral density	N_{SD}	within BW = 1 .. 400kHz, Max Gain		210		nT/√Hz

Table 12: 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.

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11.4. Timing Specification

Operating Parameters T_A = -40 to 150°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[9]	T_{RESP}	SF=1 (default) SF=2 SF=3			2 3.5 6	µs
Bandwidth	BW	-3dB, TA =25°C, SF=1 (default) SF=2 SF=3		400 200 100		kHz
Power on Delay[10]	T_{POD}				1	ms

Table 13: Timing specifications of the high-speed analog output

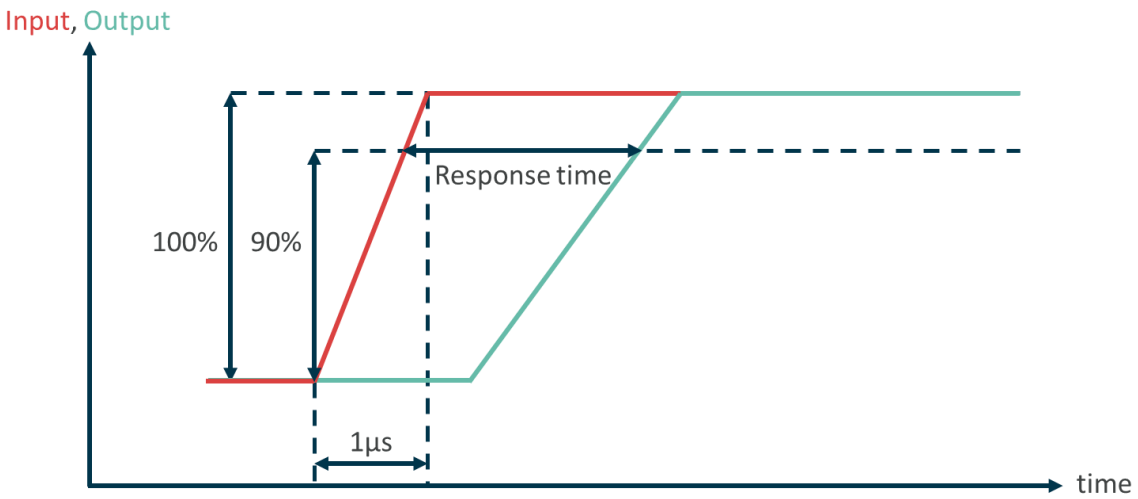


Figure 8: Response Time definition

[9] *Delay between the input signal reaching 90% and the output reaching 90% (see Figure 8)*

[10] *During the power on, the output is not valid (i.e. it is not related to magnetic field) for T_{POD}=1ms.*

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12. Diagnostics

It is possible to take advantage of diagnostic features, with the help of adding a pull-down resistor (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 Undervoltage Thresholds: • Power-up: V_{DD} < 2.8 V • Power-down: V_{DD} < 2.5 V	Output is pulled to GND with a 2kΩ resistance, until V_{DD} is inside the specified ranges, depending if the device is powering on or off.
Broken OUT	Pull-down external resistor allows to measure a voltage equal to GND.

Table 14: Description of the diagnostic modes in MLX91219

13. Overcurrent Detection Specification

13.1. General

The MLX91219 provides two OCD features (internal and external) that allow the detection of overcurrent events. The internal OCD (OCD_{INT}) is available in both packages SIP4-VA variant A and SOIC8, while the external OCD (OCD_{EXT}) 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_{DD}. 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 15 offers a comparison between OCD_{INT} and OCD_{EXT}:

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

Table 15: Comparison between OCD_{INT} and OCD_{EXT}

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13.2. Electrical Specification

Operating Parameters T_A = -40 to 150°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	Ω
OCD_EXT Internal ON Resistance	$R_{ON_OCD_EXT}$	I_{SINK} = 1 mA	160	190	280	Ω
VOC_EXT Voltage Range[11] V_{DD}= 5 V	VOC_{EXT_5V}	RS = 0, Bidirectional RS = 3, Unidirectional	0.5 0.9		2.0 4.5	V
VOC_EXT Voltage Range[11] V_{DD}= 3.3 V	VOC_{EXT_3V3}	RS = 1, Bidirectional RS = 3, Unidirectional	0.5 0.74		1.525 2.9	V
OCD_{INT} accuracy	OCD_{INT}	Ratiometric output[12]		±10		%Thr[13]
OCD_{EXT} accuracy	OCD_{EXT}			±1.5		%FS

Table 16: Electrical Specification OCD

13.3. Timing Specification

Operating Parameters T_A = -40 to 150°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		µs
OCD_{EXT} response time			10		µs
OCD_{INT} required Input holding time			0.5		µs
OCD_{EXT} required Input holding time			10		µs
OCD_{INT} output dwell time		7		14	µs
OCD_{EXT} output dwell time			10		µs

Table 17: OCD_{INT} and OCD_{EXT} timing specifications

[11] VOC_EXT defines the OCD_{EXT} threshold. In case of a ratiometric device, VOC_EXT should change with Vdd to avoid additional errors.

[12] 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.

[13] 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 310.2mT

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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
MLX91219LDC-ARA-503	25	134.7
MLX91219LVA-AAT-511	10	88.2

Table 18: OCD_{INT} thresholds

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

Table 19: 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.

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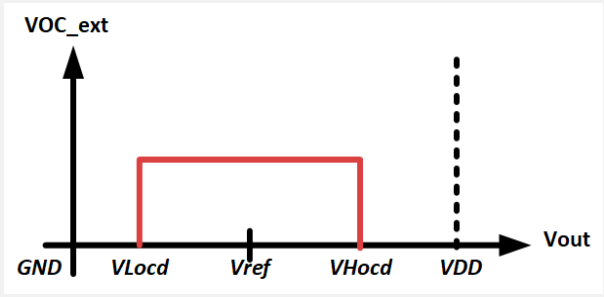
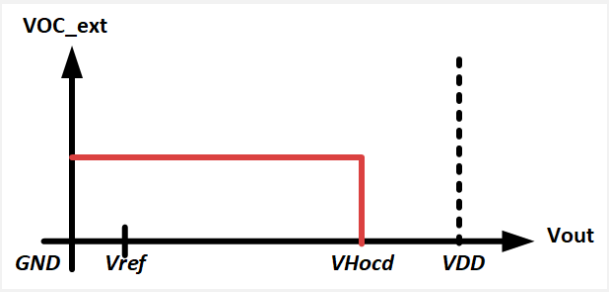
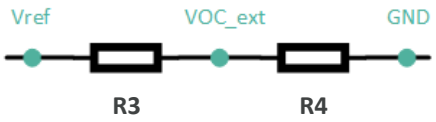
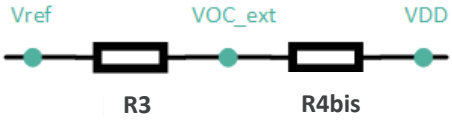
Bidirectional configuration	Unidirectional configuration
	
	
$VOC_{EXT} = V_{REF} * \frac{R_4}{R_3 + R_4}$ $VLocd = VOC_{EXT}$ $VHocd = 2 * V_{REF} - VLocd$	$VOC_{EXT} = V_{REF} + (V_{DD} - V_{REF}) * \frac{R_3}{R_3 + R_{4bis}}$ $VHocd = VOC_{EXT}$

Table 20: External OCD, bidirectional and unidirectional configuration

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14. Recommended Application Diagram

14.1. SIP-4 VA Package variant A

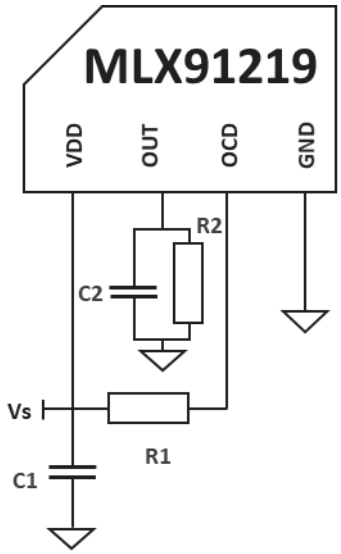


Figure 9: Application Diagram for SIP-4 VA package variant A

14.2. SIP-4 VA Package variant B

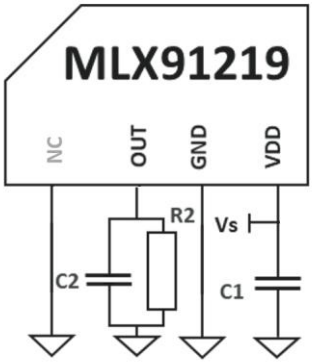


Figure 10: Application Diagram for SIP-4 VA package variant B

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

Table 21: Resistor and capacitor values for SIP-4 VA package

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14.3. SOIC8 package

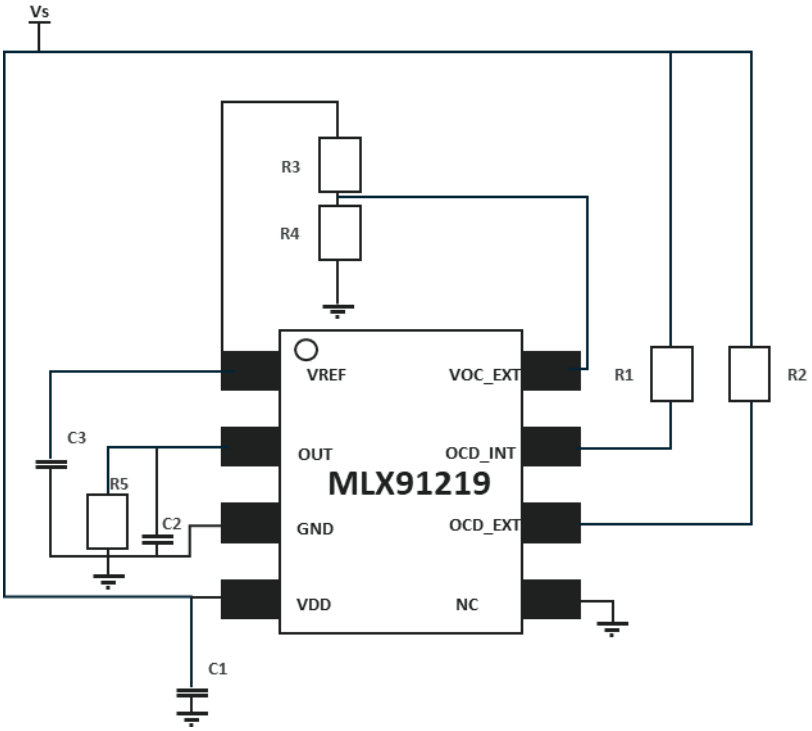


Figure 11: Application Diagram for SOIC8 package, bidirectional OCD_{EXT}.

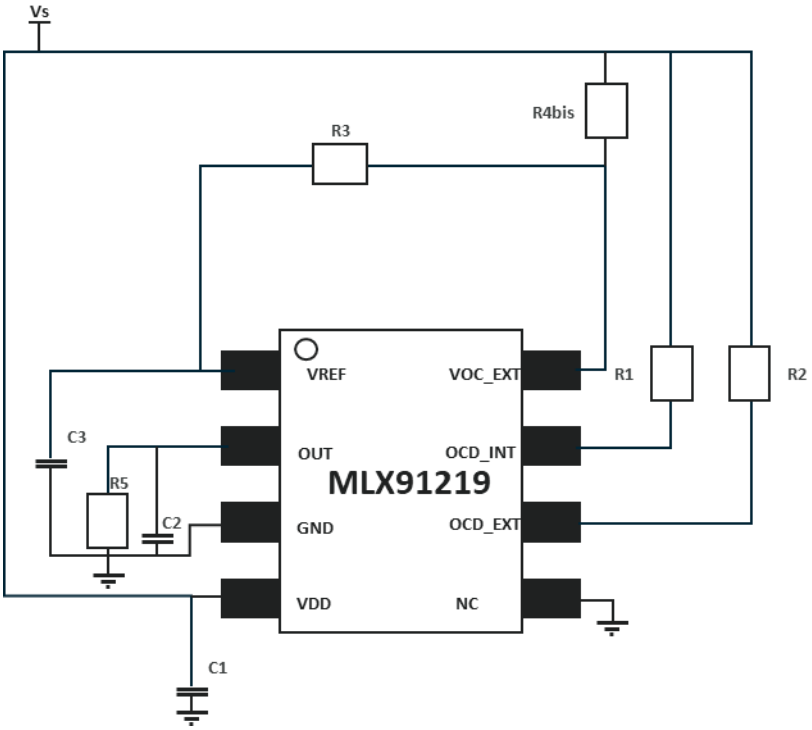


Figure 12: Application Diagram for SOIC8 package, unidirectional OCD_{EXT}.

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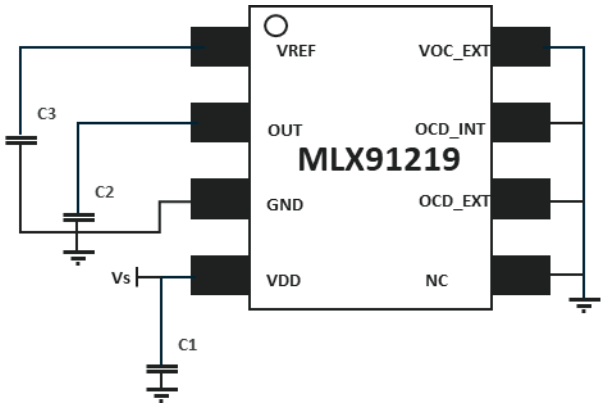


Figure 13: Application Diagram for SOIC8 package, without use of OCD_int or OCD_ext.

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	kΩ
R2	External OCD resistor	10	kΩ
$R_3 + R_4 / R_{4_BIS}$	External OCD Resistor	>200	kΩ
R_4 or R_{4_BIS}	External OCD Resistor	custom	-
R5	Output pull-down resistor	>10	kΩ

Table 22: Resistor and capacitor values for SOIC8 package

14.4. Resistance on reference voltage pin

The resistance connected to the reference pin should be large enough to limit the current. Figure 14 shows an example of the case when the resistance on the reference pin is too low. The measured V_{REF} will be equal to $V_{REF} = V_{REF_INT} \times \frac{R_{EXT}}{R_{EXT}+R_{REF}} = 1.25V$. 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.

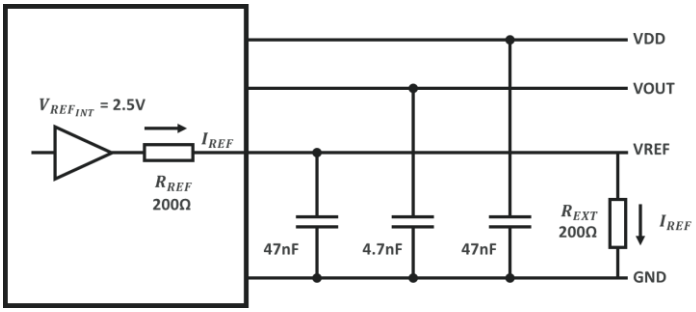


Figure 14: Case when the external resistance on reference pin is low.

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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.

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17. Packaging information: SIP4-VA

17.1. Sensor active measurement direction and magnetic center

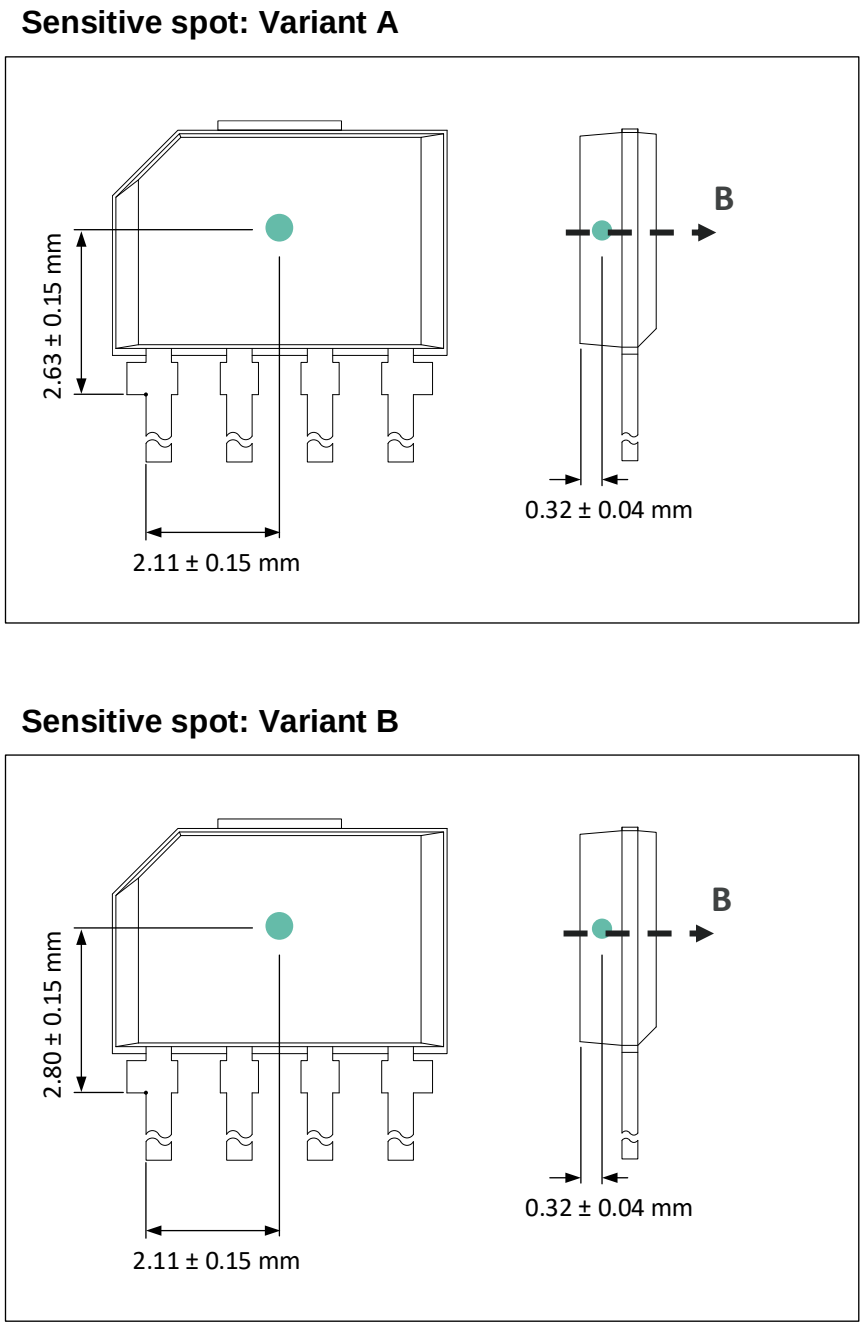
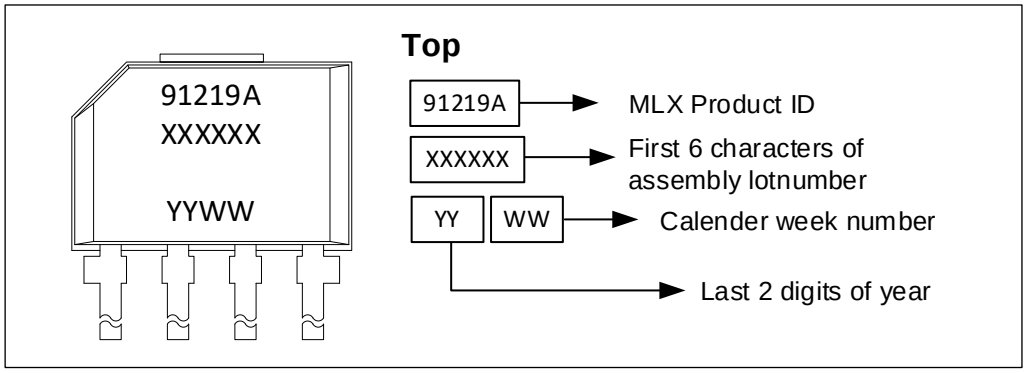


Figure 15: VA/SIL-4L Magnetic center and sensor's active measurement direction B

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17.2. Package marking

Marking: Variant A



Marking: Variant B

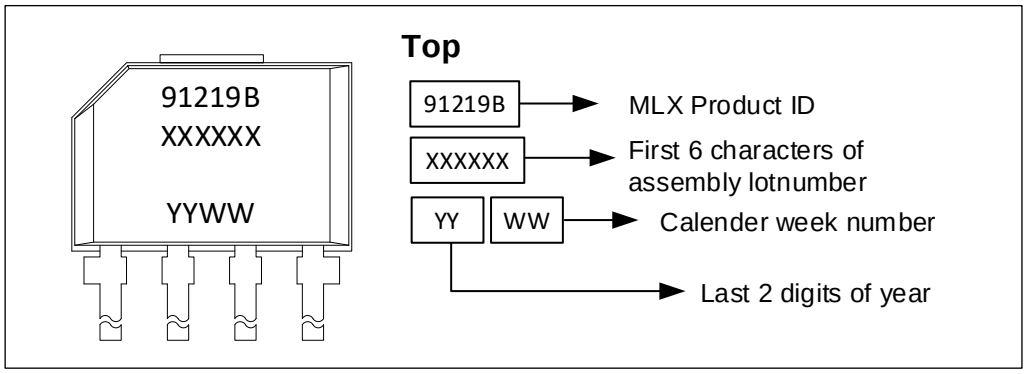
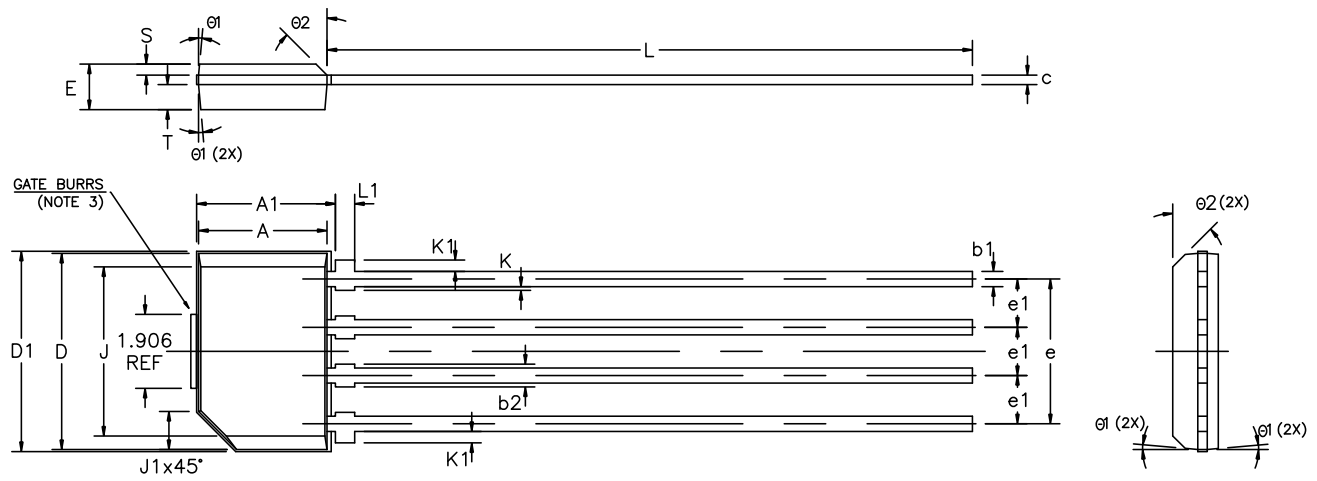


Figure 16: VA Package Marking

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17.3. VA Straight leg (xxA)



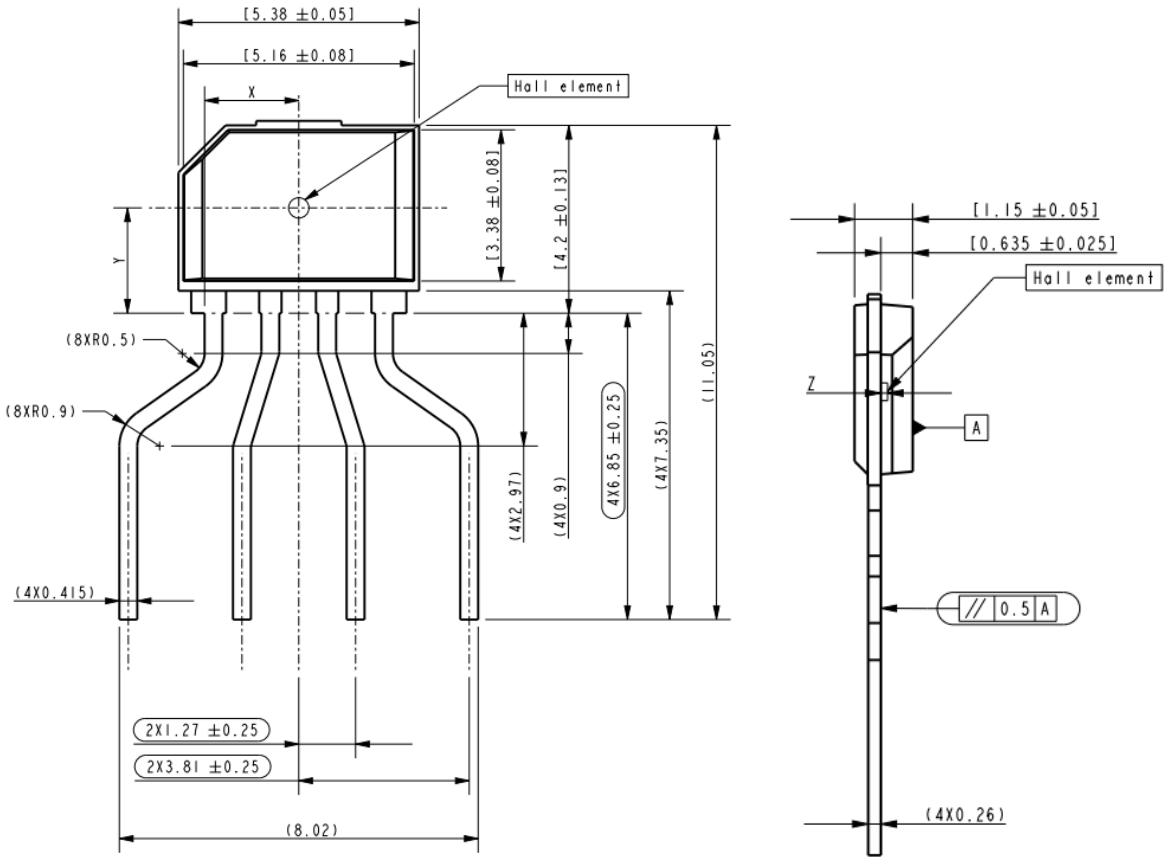
SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	3.30	3.38	3.46
A1	3.63	3.71	3.79
D	5.08	5.16	5.24
D1	5.33	5.38	5.43
E	1.10	---	1.20
J	4.10	4.30	4.50
J1		1.00 REF	
K	0.00	---	0.15
K1	0.25	0.30	0.35
L	17.5	18.0	18.5
L1	0.48	0.53	0.58
S	0.24	---	0.29
T	0.61	---	0.66
b1	0.35	---	0.48
b2	0.40	---	0.60
c	0.18	---	0.34
e	3.76	---	3.86
e1	1.22	1.27	1.32
θ1		5° REF	
θ2		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 um.
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 17: VA Straight leg (xxA)

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17.4. Trim and Form shape: THT 2.54mm pitch (xxJ)



Notes:
1. All controlling dimensions are in milimeters
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 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

Figure 18: Trim and Form shape: THT 2.54mm pitch (xxJ)

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17.5. Trim and Form type: 90° 2x2x91.3 (h=5.34mm) Bending-STD2 (xxR)

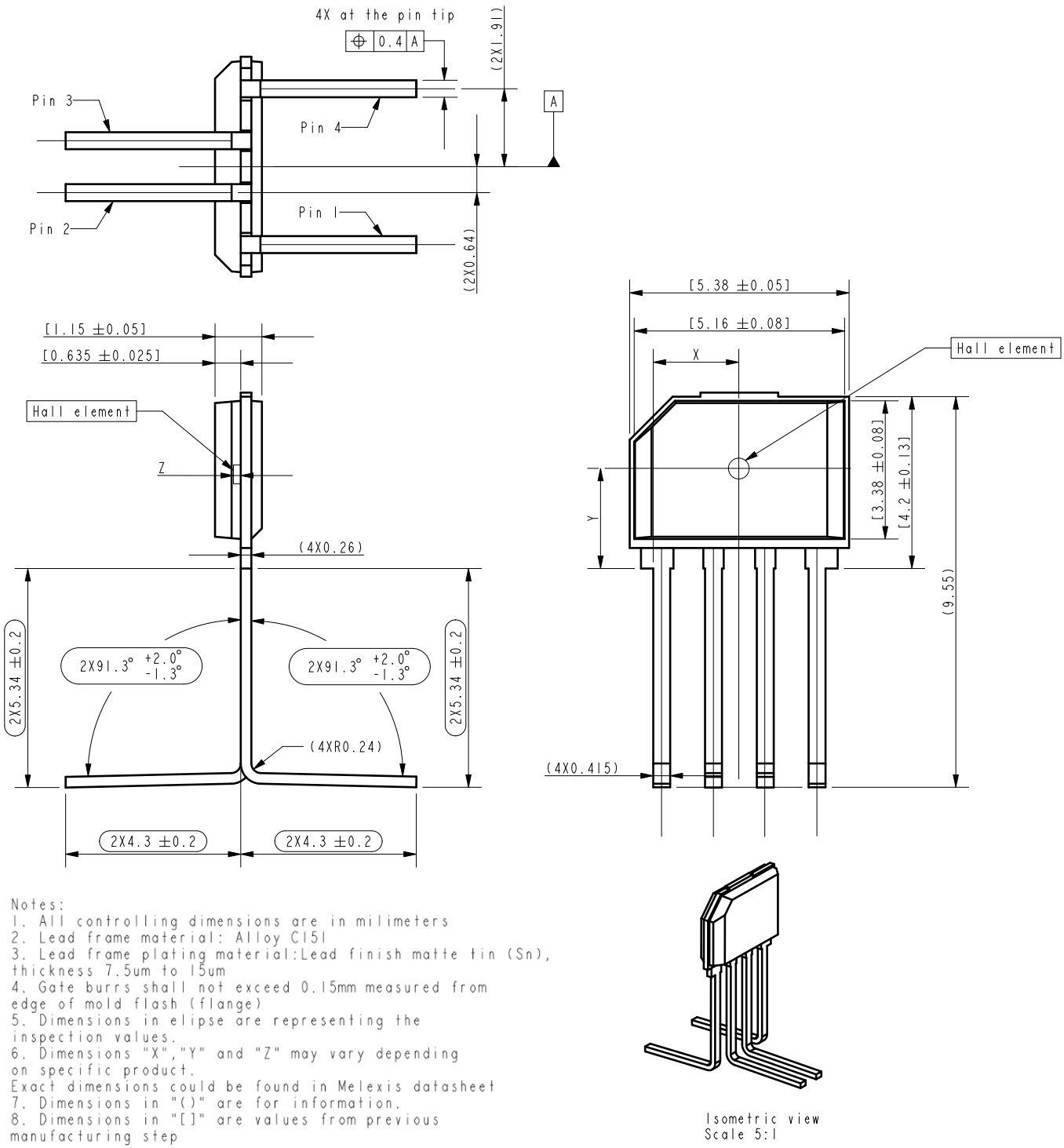


Figure 19: Trim and Form type: 90° 2x2x91.3 (h=5.34mm) Bending-STD2 (xxR)

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17.6. Trim and Form type: 90° 2x2x91.3 (h=3.7mm) Bending-STD3 (xxS)

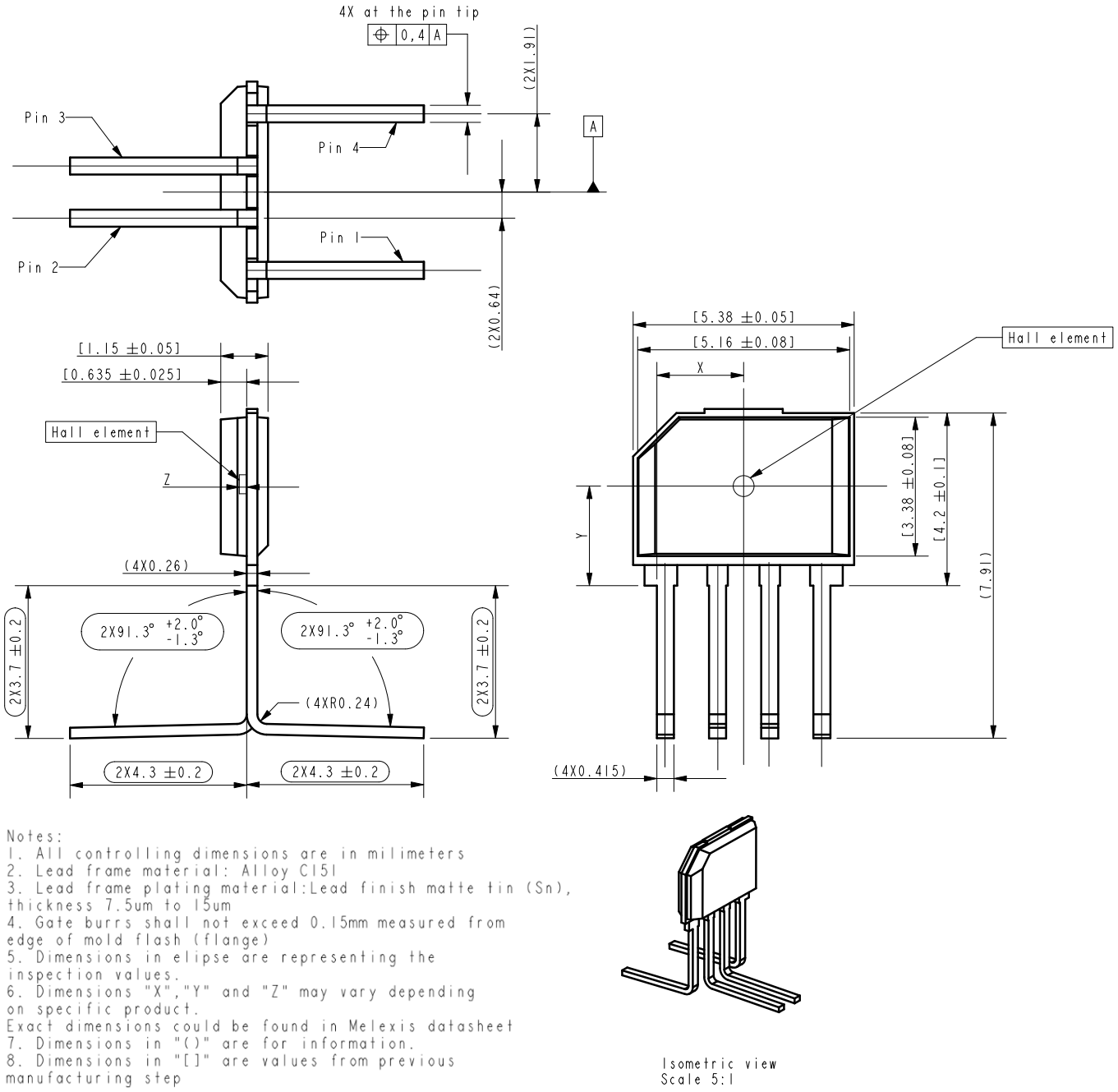
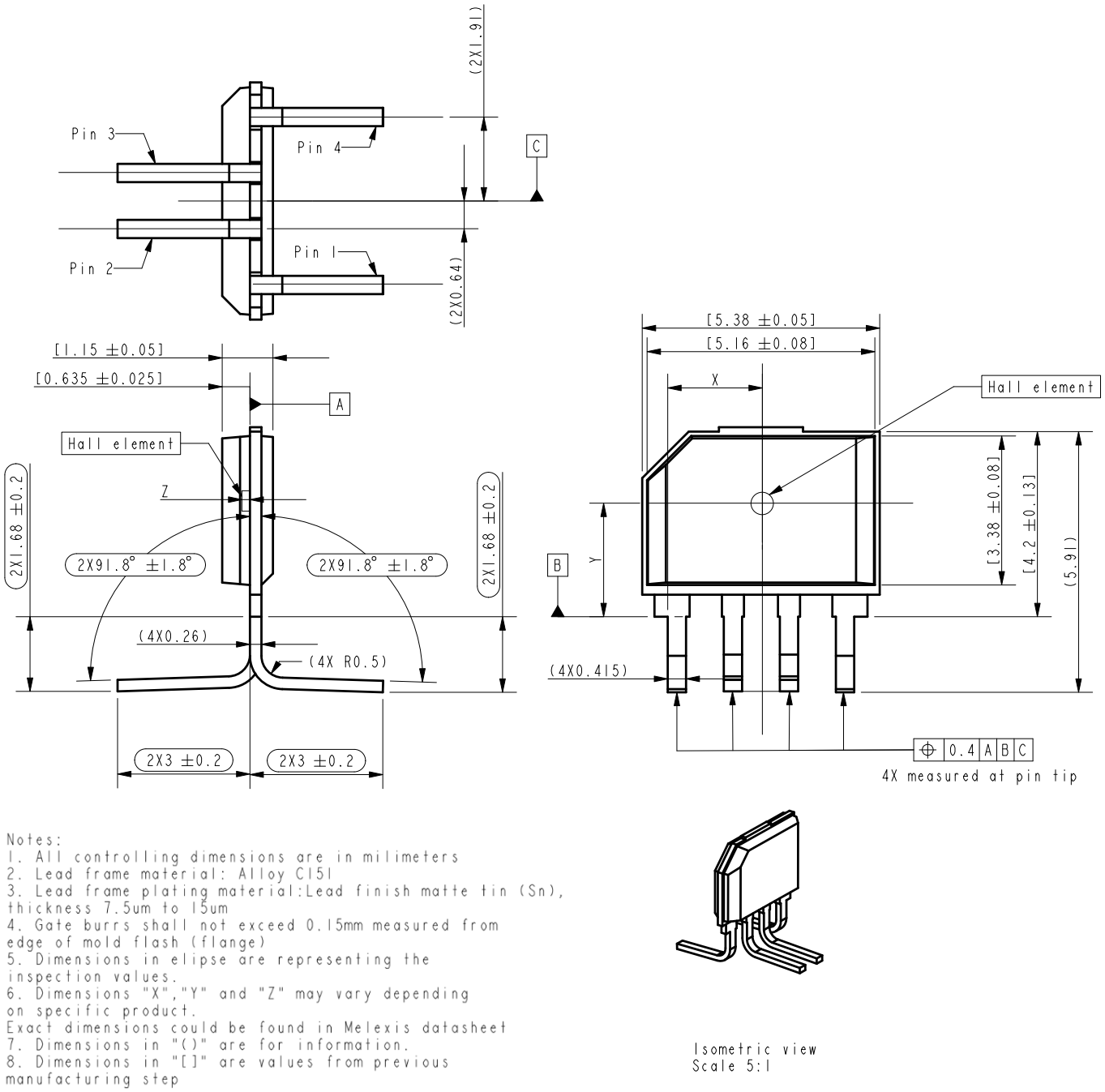


Figure 20: Trim and Form type: 90° 2x2x91.3 (h=3.7mm) Bending-STD3 (xxS)

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17.7. Trim and Form type: 90° 2x2x91.8 (h=1.68mm) Bending-STD4 (xxT)



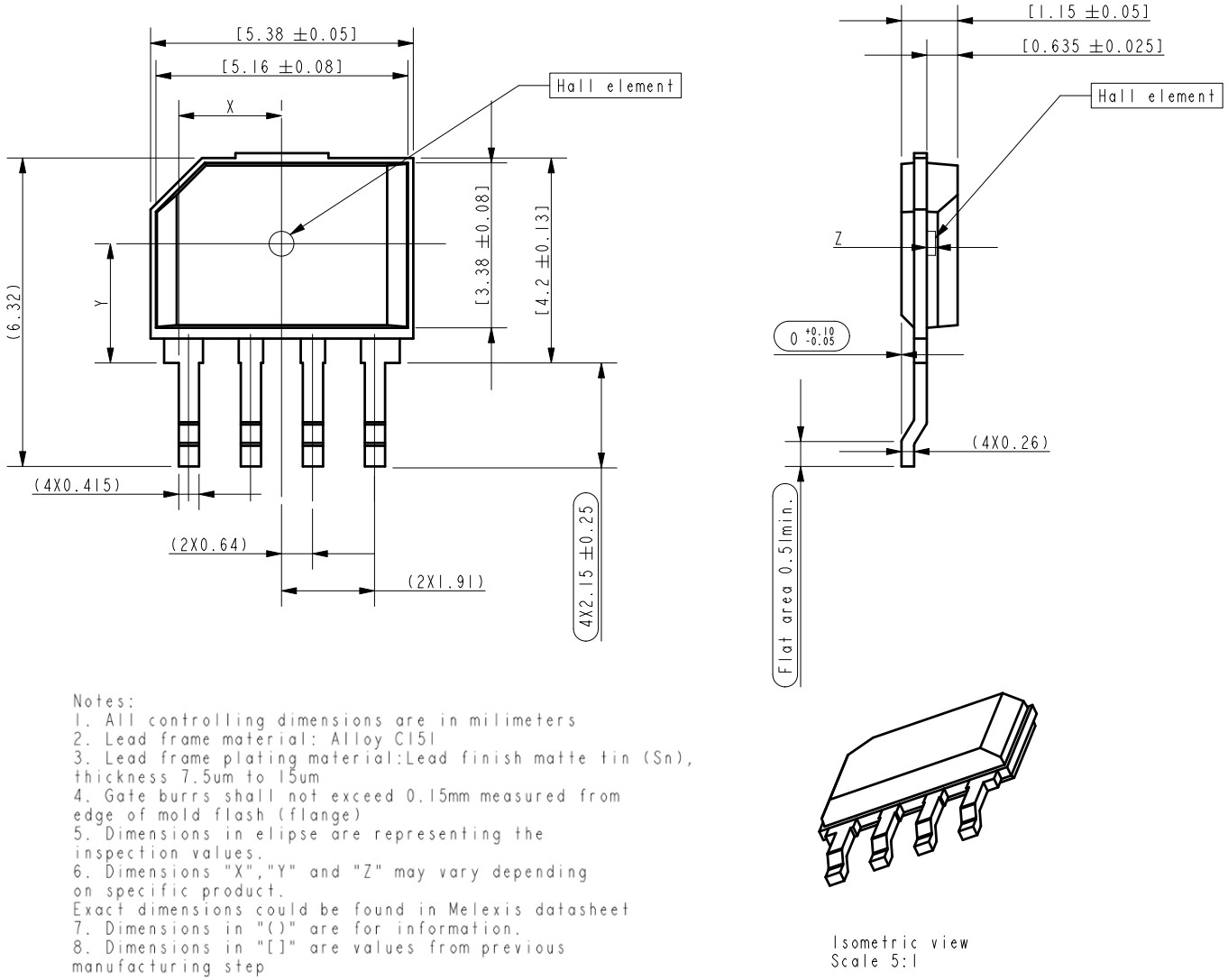
Notes:
1. All controlling dimensions are in milimeters
2. Lead frame material: Alloy C151
3. Lead frame plating material:Lead finish matte tin (Sn), thickness 7.5um to 15um
4. Gate burrs shall not exceed 0.15mm measured from edge of mold flash (flange)
5. Dimensions in elipse are representing the inspection 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 21: Trim and Form type: 90° 2x2x91.8 (h=1.68mm) Bending-STD4 (xxT)

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17.8. Trim and Form type: SMD style TFT4K1 (xxZ)

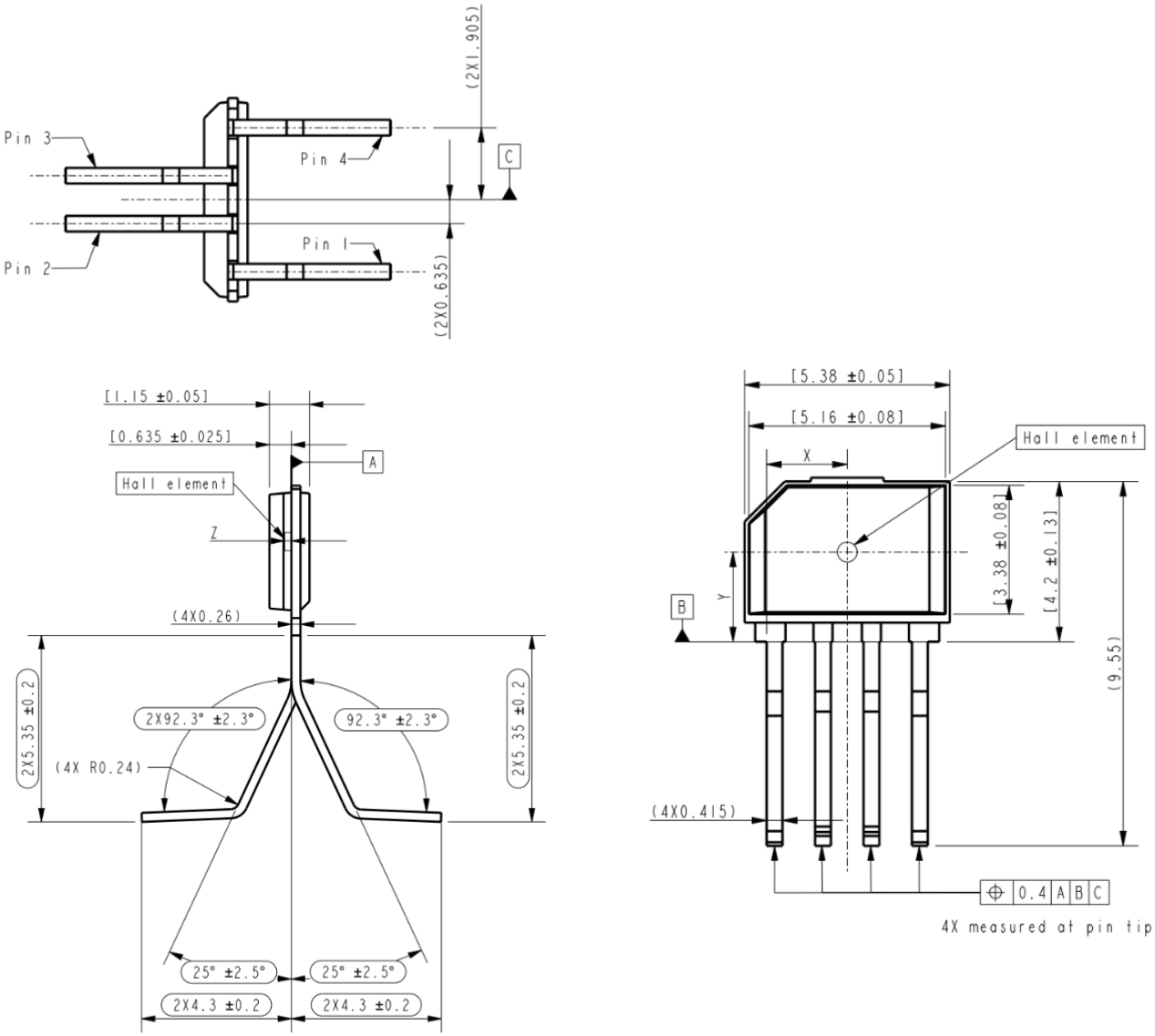


Notes:
1. All controlling dimensions are in milimeters
2. Lead frame material: Alloy C151
3. Lead frame plating material:Lead finish matte tin (Sn), thickness 7.5um to 15um
4. Gate burrs shall not exceed 0.15mm measured from edge of mold flash (flange)
5. Dimensions in elipse are representing the inspection 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

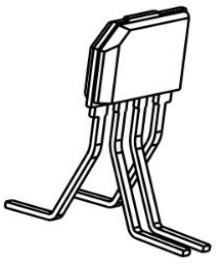
Figure 22: Trim and Form type: SMD style TFT4K1 (xxZ)

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17.9. Trim and Form type: 25° 2x2x92.3 (h=5.34mm) (xxV)



Notes:
1. All controlling dimensions are in milimeters
2. Lead frame material: Alloy C151
3. Lead frame plating material:Lead finish matte tin (Sn), thickness 7.5um to 15um
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 5.000

Figure 23: Trim and Form type: 25° 2x2x92.3 (h=5.34mm) (xxV)

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18. Packaging information: SOIC8

18.1. Sensor active measurement direction and magnetic center

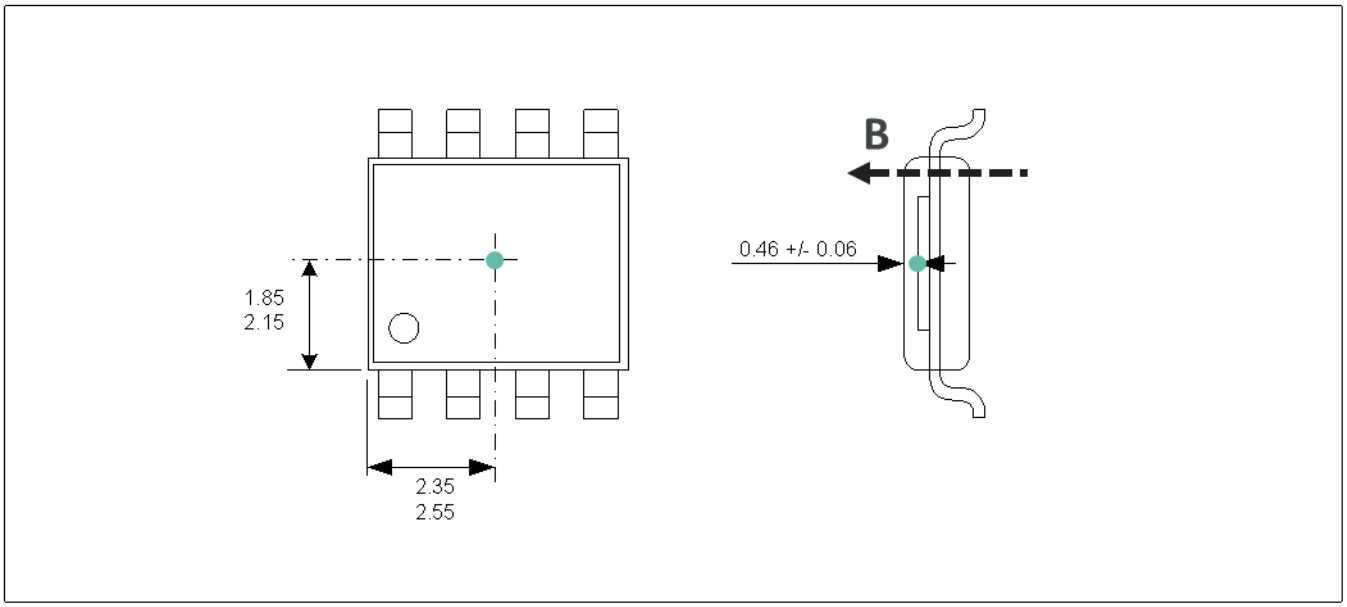


Figure 24: VA/SIL-4L Magnetic center and sensor's active measurement direction B

18.2. Package marking

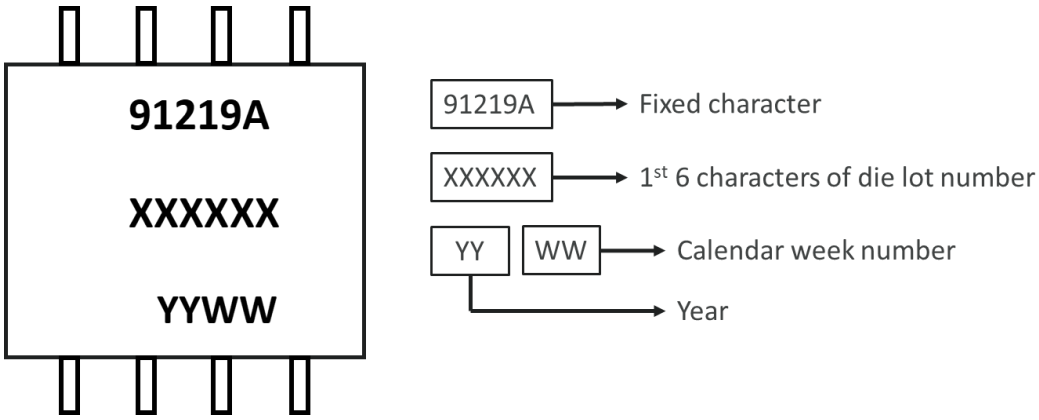
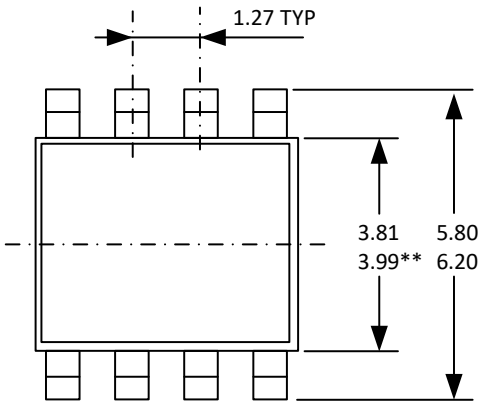


Figure 25. SOIC8 package marking

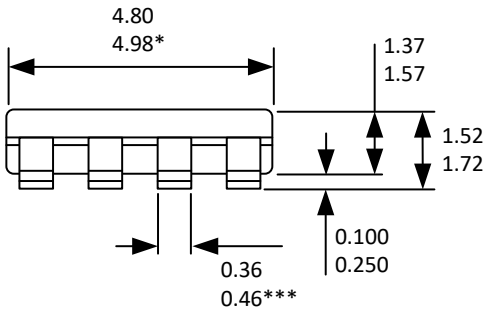
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18.3. Package dimensions



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.



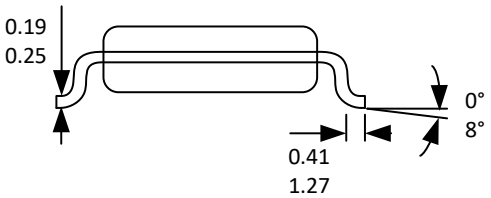


Figure 26: SOIC8 package

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19. Contact

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

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