MLX91217

High Speed Current Sensor IC

Datasheet

1. Features and Benefits

- End-of-line programmable sensor
- Selectable analog ratiometric output
- Measurement range from ±15 to ±450mT
- Wideband sensing: DC to 250kHz
- Very short response time (2µs)
- High linearity down to ±0.2% full scale
- Very low thermal drift
  - Offset drift (<5mV)
  - Sensitivity drift (<1%)
- Programmable output clamping levels
- Broken wire detection and diagnostics
- AEC-Q100 – Grade 0 Automotive Qualified
- RoHS compliant
- SIP4-VA package
- MSL-1



2. Application Examples

- High Voltage Traction Motor Inverter
- 48V Boost Recuperation Inverter
- DCDC Converter
- Smart Battery Junction Boxes
- Smart Fuse Overcurrent Detection

3. Description

The MLX91217 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 MLX91217 is factory trimmed over temperature, and is programmable (offset, sensitivity, clamping, filtering) during end-of-line customer calibration. The output clamping levels and on-chip filtering are also programmable as a function of application needs. With the 250kHz 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 MLX91217 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.

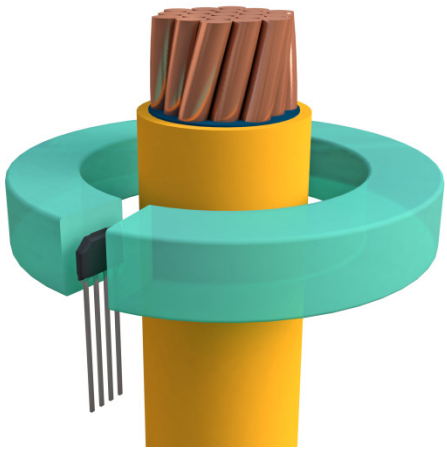


Figure 1. Typical Current Sensing Application

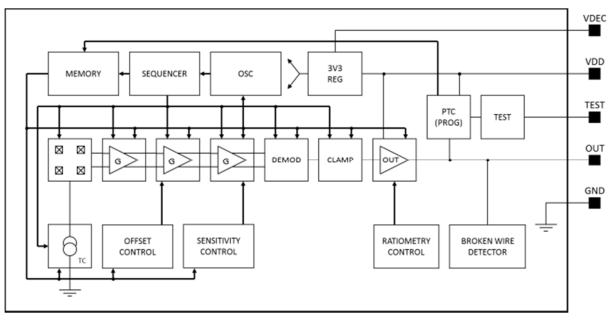


Figure 2. General Block Diagram

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4. Ordering Information

Product	Temperature	Package	Option Code	Packing Form	Typical Sensitivity
MLX91217	L	VA	ACA – 000	BU/CR	10mV/mT (prog: 5..150mV/mT)
MLX91217	L	VA	ACA – 001	BU/CR	15 mV/mT (prog: 5..150mV/mT)
MLX91217	L	VA	ACA – 002[1]	BU/CR	17 mV/mT (prog: 5..150mV/mT)
MLX91217	L	VA	ACA – 003	BU/CR	9 mV/mT (prog: 5..150mV/mT)
MLX91217	L	VA	ACA – 005	BU/CR	13 mV/mT (prog: 5..150mV/mT)

Table 1: Available ordering codes.

Legend:

Temperature Code:	**L**	from -40°C to 150°C ambient temperature
Package Code:	**VA**	SIP4-VA package, refer to *Chapter 17* for detailed drawings
Option Code:	**ACx-000** **ACx-001** **ACx-002**[1] **ACx-003** **ACx-005**	for factory trimmed sensitivity 10mV/mT; for factory trimmed sensitivity 15mV/mT; for factory trimmed sensitivity 17mV/mT; for factory trimmed sensitivity 9mV/mT; for factory trimmed sensitivity 13mV/mT;
	ACA-xxx **ACR-xxx** **ACS-xxx** **ACZ-xxx**	default straight leads *(see chapter 17)* for Trim and Form shape: 90° 2x2x91.3 (h=5.34mm) Bending-STD2 *(see chapter 17)* for Trim and Form shape: 90° 2x2x91.3 (h=3.7mm) Bending-STD3 *(see chapter 17)* for Trim and Form shape: SMD style TFT4K1 *(see chapter 17)*
Packing Form:	**BU** **CR** **CA** **RE**	for Bulk, for Carton Reel - Radial taping – available for straight leads only for Carton Reel – Ammopack – available for straight leads only for Plastic Reel – available for selected Trim & Form options only
Ordering Example:	"**MLX91217LVA-ACA-005-CR**" MLX91217 Conventional Hall current sensor in SIP4 VA package, temperature range -40°C to 150°C. Sensitivity 13mV/mT. Parts delivered in Carton Reel (Radial Taping)	

Melexis is continuously expanding its portfolio to serve our customer's needs. Please contact your local sales representative in case your desired ordering code is not part of the above table.

[1] MLX91217-LVA-ACA-002 : customized sensitivity drift, VOQ = 1V

5. Functional Diagram

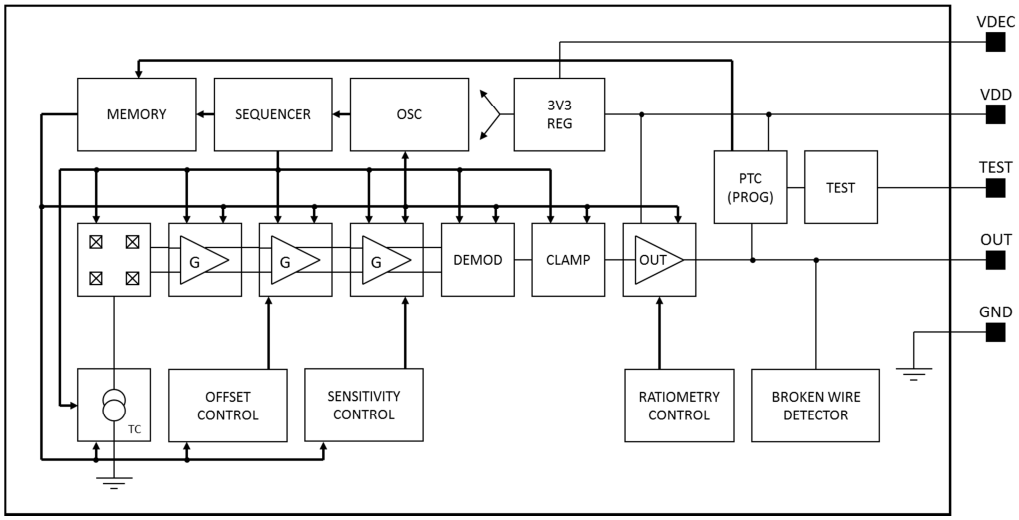


Figure 3: Block Diagram of the MLX91217:

6. Glossary of Terms

Terms	Definition
TC	Temperature Coefficient
FS	Full Scale, output referred. Corresponds to 2V excursion around 2.5V VOQ point
T, mT	Tesla, milliTesla = units for the magnetic flux density
G	Gauss = unit for the magnetic flux density [1mT = 10G]
PTC	Programming Through Connector
IMC	Integrated Magnetic Concentrator (IMC-Hall®)

Table 2: Glossary of Terms

7. Pin Definitions and Descriptions

Note: MLX91217 is pin-to-pin compatible with MLX91209.

Pin #	Name	Type	Description
1	VDD	Supply	Supply Voltage
2	OUT	Analog	Current Sensor Output
3	TEST	Digital	Test and Factory Calibration
4	GND	Ground	Supply Voltage

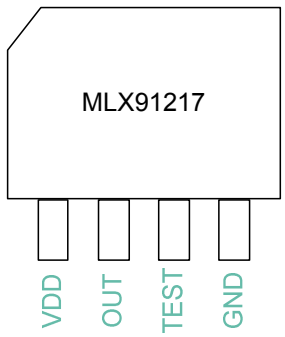


Table 3: Pin definitions and descriptions

For optimal EMC results, it is recommended to connect the TEST pin to the Ground (see section 13).

8. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Positive Supply Voltage (overvoltage)	V_{DD}	+10	V
Reverse Voltage Protection	VS_{REV}	-0.3	V
Positive Output Voltage	V_{OUT}	+10	V
Output Current	I_{OUT}	±70	mA
Reverse Output Voltage	VO_{REV}	-0.3	V
Reverse Output Current	IO_{REV}	-50	mA
Operating Ambient Temperature Range	T_A	-40 to +150	°C
Maximum Junction Temperature	$T_{j,max}$	-55 to +155	°C
Package Thermal Resistance *(junction-to-ambient)* θ_{ja} *is defined according JEDEC 1s0p board*	θ_{ja}	205	°C
Storage Temperature Range	T_S	-55 to +165	°C
Magnetic Flux Density	B_{MAX}	±3	T
ESD – Human Body Model	ESD_{HBM}	2	kV

Table 4: 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.

9. General Electrical Specifications

Operating Parameters T_A = -40 to 150°C, V_{DD} = 5V±10%, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Nominal Supply Voltage	V_{DD}		4.5	5	5.5	V
Supply Current	I_{DD}	No OUT load LOW_POWER_MODE=0[2] LOW_POWER_MODE=1		12.5 10	15 13	mA mA
Output Impedance	R_{OUT}	Vout = 50% Vdd, RL = 6kΩ		1	5	Ω
Output Capacitive Load	C_L	OUT_MODE=0 OUT_MODE=1	1 10		10 47	nF nF
Output Resistive Load	R_L	Output resistive load for high linearity and diagnostic band.	10	25	200	kΩ
Output Short Circuit Current	I_{SHORT}	Output shorted permanent to VDD. Output shorted permanent to GND.		Not Destroyed Not Destroyed		
Linear Output Range	VO_{LIN}	pull-down ≥ 10 kΩ	10		90	%Vdd
Diagnostic Band[3]	DIAG	R_L ≥ 10kΩ, R_L ≤ 200 kΩ, V_{DD} =5V DIAG_LEVEL = 0 DIAG_LEVEL = 1	 0 96		 4 100	 %Vdd %Vdd
BrokenGND Output Level[3]		R_L ≥ 10kΩ, V_{DD} = 5V	96		100	%Vdd
BrokenVDD Output Level[3]		R_L ≥ 10kΩ, V_{DD} = 5V	0		4	%Vdd
Under-voltage detection[3]	V_{DD_UVD}	Detected Voltage (Low to High)	4.0		4.5	V
	V_{DD_UVH}	Hysteresis	0.01		0.2	V
Over-voltage detection 1[3]	V_{DD_OVD1}	Detected Voltage (Low to High)	6.7		7.4	V
	V_{DD_OVH1}	Hysteresis	0.37		0.66	V
Over-voltage detection 2[3]	V_{DD_OVD2}	Detected Voltage (Low to High)	8.3		9.5	V
	V_{DD_OVH2}	Hysteresis	0.2		0.8	V
Clamped Output Level	Clamp_lo0	CLAMP_LEVEL=0	5	6	7	%Vdd
	Clamp_hi0	CLAMP_LEVEL=0	92	93	94	%Vdd
	Clamp_lo1	CLAMP_LEVEL=1	5	6	7	%Vdd
	Clamp_hi1	CLAMP_LEVEL=1	93	94	95	%Vdd
	Clamp_lo2	CLAMP_LEVEL=2	7	8	9	%Vdd
	Clamp_hi2	CLAMP_LEVEL=2	91	92	93	%Vdd
	Clamp_lo3	CLAMP_LEVEL=3	9	10	11	%Vdd
	Clamp_hi3	CLAMP_LEVEL=3	89	90	91	%Vdd

Table 5: General electrical parameters

[2] *Default Factory Calibration*
[3] *Please refer to section 12 for more information on self-diagnostic modes.*

10. Magnetic specification

Operating Parameters T_A = -40 to 150°C, V_{DD} = 5V±10%, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operational Magnetic Field Range	B_{OP}		±15	±130	±450	mT
Linearity Error	NL	V_{OUT} in [10%V_{DD}, 90%V_{DD}], T_A = 25°C LOW_POWER_MODE=0 LOW_POWER_MODE=1			 ±0.4 ±0.2	 %FS %FS
Programmable Sensitivity	S		5	15	150	mV/mT
Sensitivity programming Resolution	S_{RES}	B = B_{OP}		0.1		%

Table 6: Magnetic specification

11. Analog output specification

11.1. Accuracy specifications

Operating Parameters T_A = -40 to 150°C, V_{DD} = 5V±10%, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Thermal Offset Drift	$\Delta^T V_{OQ}$	T_A = -40 to 125°C T_A = -40 to 150°C			±5 ±8	mV mV
Thermal Sensitivity Drift[4]	$\Delta^T S$	T_A = -40 to 125°C T_A = -40 to 150°C			±1.0 ±1.2	%S %S
RMS Output Noise	N_{RMS}	Values for 50mV/mT sensitivity Scales with typical sensitivity of Table 1 NOISE_FILTER=0 NOISE_FILTER=1 NOISE_FILTER=2 NOISE_FILTER=3		 10 7 5 3		 mV_{RMS} mV_{RMS} mV_{RMS} mV_{RMS}
V_{OQ} Ratiometry	$\Delta^R V_{OQ}$	V_{DD} = 5V±5%, (for all option codes) V_{OQ} = 20%V_{DD} MLX91217LVA-ACA-002) V_{OQ} = 50%V_{DD} – (all other option codes)			 ±0.4 ±0.4	 %V_{OQ} %V_{OQ}
Sensitivity Ratiometry	$\Delta^R S$	V_{DD} = 5V±5%, B = B_{OP}			±0.4	%S
Clamped output accuracy	CL_{ACC}				±1	%Vdd

Table 6: 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

[4] Except MLX91217-LVA-ACA-002

than 0.02%V_{DD}. Trimming capability is higher than measurement accuracy. End-user calibration can therefore increase the accuracy of the system.

11.2. Timing specifications

Operating Parameters T_A = -40 to 150°C, Vdd = 5V±10%, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Refresh rate	Trr		0.8	1	2	µs
Step Response Time	T_R	C_L=10nF NOISE_FILTER=0, LOW_POWER_MODE=0		2	3	µs
		NOISE_FILTER=0, LOW_POWER_MODE=1		3	4	µs
		NOISE_FILTER=1, LOW_POWER_MODE=0		3	4	µs
		NOISE_FILTER=1, LOW_POWER_MODE=1		5	6	µs
		NOISE_FILTER=2, LOW_POWER_MODE=0		4	5	µs
		NOISE_FILTER=2, LOW_POWER_MODE=1		6	7	µs
		NOISE_FILTER=3, LOW_POWER_MODE=0		8	9	µs
		NOISE_FILTER=3, LOW_POWER_MODE=1		10	11	µs
Power on Delay	T_{POD}	Vout =100% of F.S.			1	ms
Ratiometry Cut-off Frequency	F_{RAT}			250		Hz

Table 7: Timing specifications of the high-speed analog output

12. Self-diagnostic

MLX91217 provides several self-diagnostic features, which prevent the IC from providing erroneous output signal in case of internal or external failure modes.

Error	Effect on Output	Remarks
Calibration data CRC Error	DIAG_LEVEL=0 → active pull-down to GND DIAG_LEVEL=1 → active pull-up to VDD	at power up and in normal mode
Power-On Delay	Pull-down to GND	1ms max followed by settling
Over-voltage Mode 1	Active pull-down to GND	
Over-voltage Mode 2	DIAG_LEVEL=0 → active pull-down to GND DIAG_LEVEL=1 → active pull-up to VDD	
Under-voltage Mode	DIAG_LEVEL=0 → active pull-down to GND DIAG_LEVEL=1 → active pull-up to VDD	Valid with enabled ratiometry (Default: RATIOEN = 1)
Broken OUT	Active pull-down to GND	
Broken GND	Output pulled up to VDD	IC is switched off
Broken VDD	Output pulled down to GND	IC is switched off

Table 8: Description of the self-diagnostic modes in MLX91217

13. Programmable Parameters

Customers can re-program the parameters described in the table below by using the PTC-04 hardware and the Product Specific Functions (PSF) libraries provided by Melexis. We recommend using the latest version of the PSF and the firmware, with a communication speed of 10kbps (maximum output capacitor of 47nF). Please contact your sales representative to get access to Melexis SoftDist platform and download the latest software.

Parameter	Bits	Factory Setting	Function
ROUGHGAIN	3	Trimmed	Rough gain trimming
FINEGAIN	10	Trimmed	Fine gain trimming
VOQ	12	Trimmed	Offset trimming
OUT_MODE	1	0	0: low capacitive load (see section 14) 1: high capacitive load (see section 14)
DIAG_LEVEL	1	0	0: in diagnostic, output is pulled down to GND 1: in diagnostic, output is pulled up to Vdd
LOW_POWER_MODE	1	0	0: normal mode 1: low power mode with slower response time
CLAMP_LEVEL	2	1	Select clamping level (%VDD) 0: 6%/93%, 1: 6%/94%, 2: 8%/92%, 3: 10%/90%
NOISE FILTER	2	0/1[5]	0: Noise filter: deactivated 1: Noise filter: 120kHz 2: Noise filter: 60kHz 3: Noise filter: 15kHz
CSTID	17	N/A	Customer ID

[5] The Noise Filter parameter is set to 1 for MLX91216LDC-ACV-002 IC version. The Noise Filter is deactivated for all other option codes.

14. Recommended Application Diagram

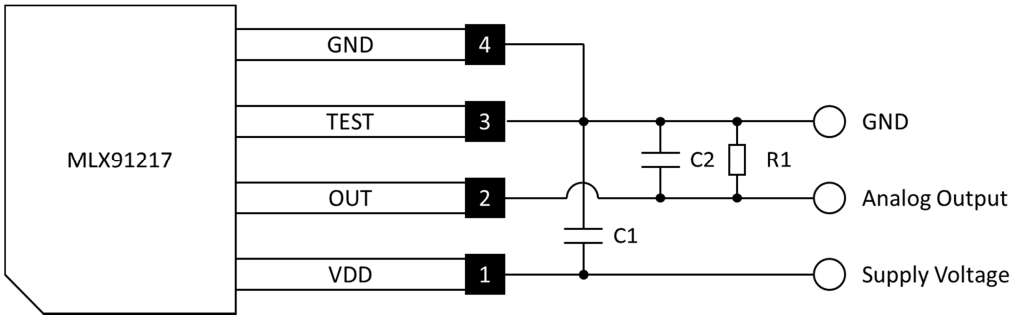


Figure 4: Application Diagram with external Pull-Down resistance

Part	Description	Value	Unit
C1	Supply capacitor, EMI, ESD	100	nF
C2	Decoupling, EMI, ESD, OUT_MODE=0	1-10	nF
	Decoupling, EMI, ESD, OUT_MODE=1	8-47	nF
R1	Pull down resistor	10-200	kΩ

Table 7: Resistor and capacitor values

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.

Reflow Soldering SMD's (Surface Mount Devices)

- IPC/JEDEC J-STD-020
  Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
  (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113
  Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing
  (reflow profiles according to table 2)

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

- EN60749-20
  Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

Iron Soldering THD's (Through Hole Devices)

- EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

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

- EIA/JEDEC JESD22-B102 and EN60749-21
  Solderability

For further details about test method references and for compliance verification of selected soldering method for product integration, Melexis recommends reviewing on our web site the General Guidelines soldering recommendation. For all soldering technologies deviating from the one mentioned in above document (regarding peak temperature, temperature gradient, temperature profile etc), additional classification and qualification tests have to be agreed upon with Melexis.

For package technology embedding trim and form post-delivery capability, Melexis recommends to consult the dedicated trim&form recommendation application note: lead trimming and forming recommendations.

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: http://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

17.1. Sensor active measurement direction

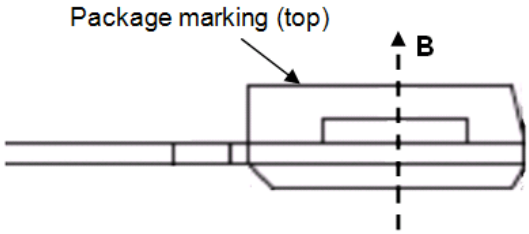
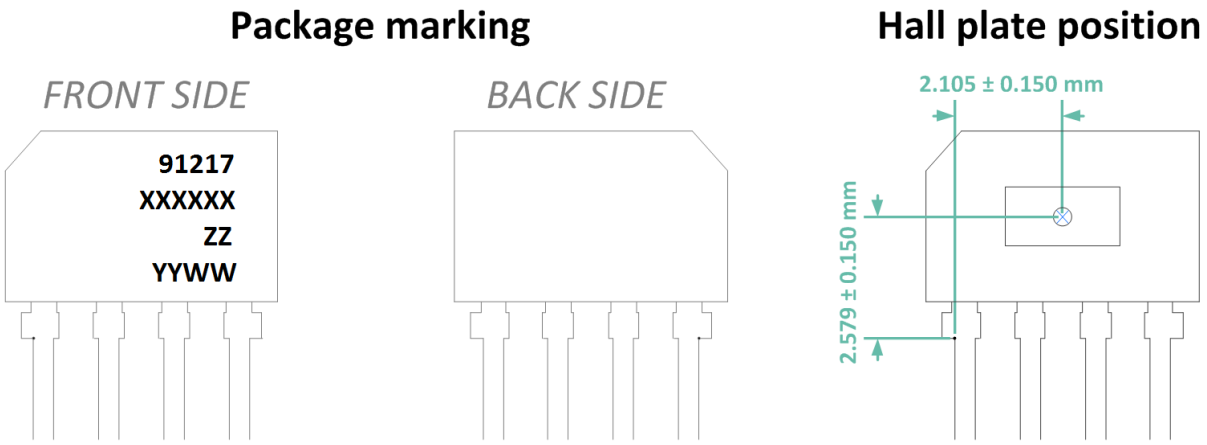


Figure 5. VA/SIP 4L Package. Sensor's active measurement direction

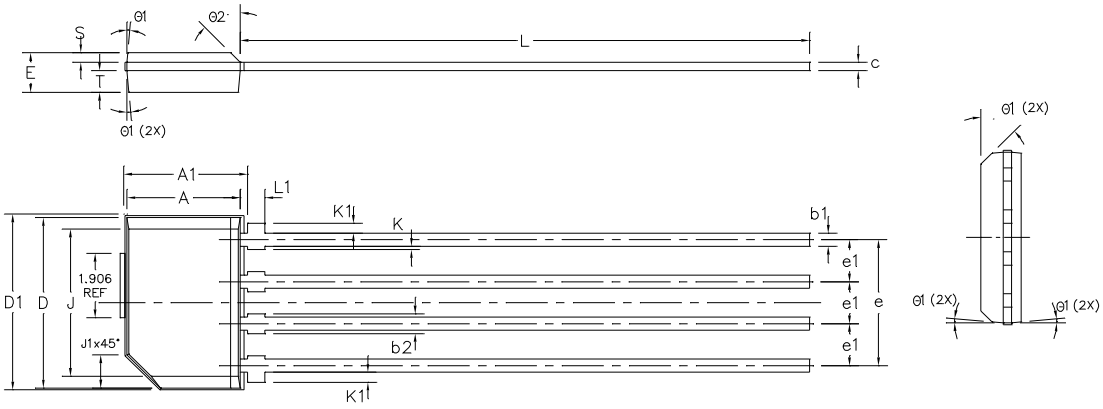
17.2. Package Marking & Hall Plate Position



Line 1: Product ID
Line 2: Wafer Lot Number
Line 3: IC Revision
Line 4: Assembly Date Code (year = yy; week = ww)

Figure 6. VA/SIP 4L (single in-line package) / 18mm lead length - Package Information

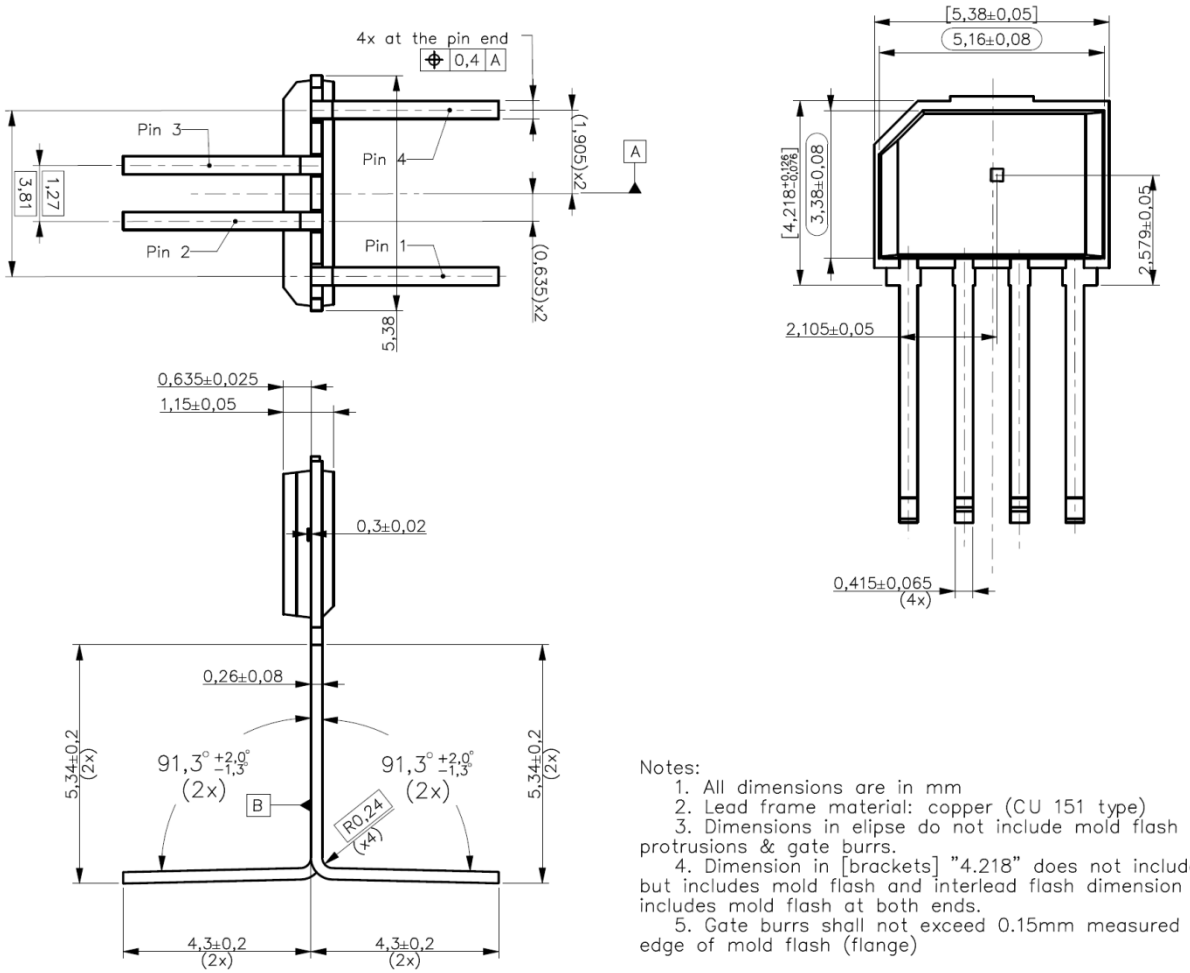
17.3. VA Straight leads (ACA-xxx)



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		

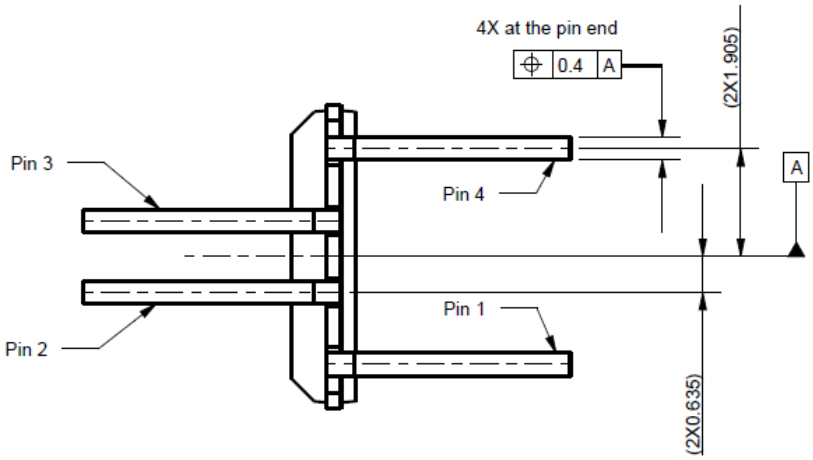
Note:
1. DIMENSIONS "A" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS AND GATE BURRS.
2. DIMENSIONS "A1" DOES NOT INCLUDE GATE BURRS BUT INCLUDES MOLD FLASH AT BOTH ENDS.
3. MOLD GATE BURRS SHALL NOT EXCEED 0.15 mm MEASURED FROM EDGE OF MOLD FLASH (FLANGE).
4. DIMENSION "D1" INCLUDES MOLD FLASH AT BOTH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

17.4. Trim and form type: 90° 2x2x91.3 (h=5.34mm); Bending-STD2 (ACR-xxx)

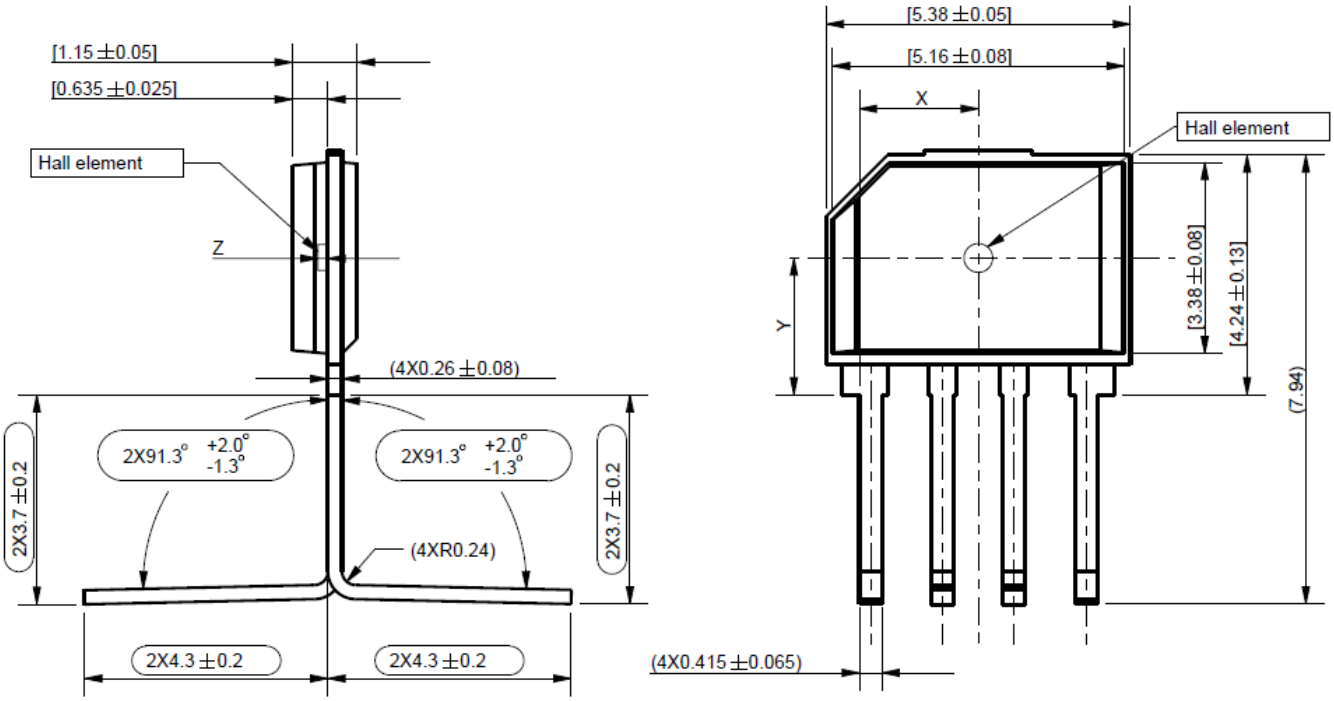


Notes:
1. All dimensions are in mm
2. Lead frame material: copper (CU 151 type)
3. Dimensions in elipse do not include mold flash protrusions & gate burrs.
4. Dimension in [brackets] "4.218" does not include gate burrs, but includes mold flash and interlead flash dimension "5.38" includes mold flash at both ends.
5. Gate burrs shall not exceed 0.15mm measured from edge of mold flash (flange)

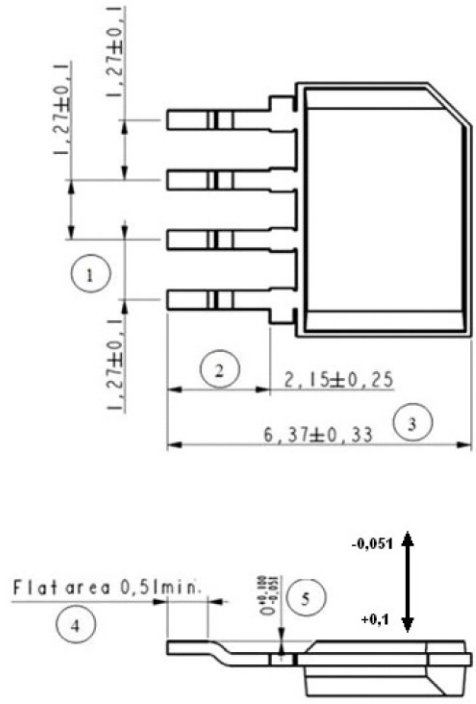
17.5. Trim and form type: 90° 2x2x91.3 (h=3.7mm); Bending-STD3 (ACS-xxx)



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



17.6. Trim and form type: SMD style TFT4K1 (ACZ-xxx)



Parameter				
Dim# 1 [mm]	Dim# 2 [mm]	Dim# 3 [mm]	Dim# 4 [mm]	Dim# 5 [mm]
1.27 +/- 0.10	2.15 +/- 0.25	6.37 +/- 0.33	min. 0.51	0 -0.051/+0.10

18. Contact

For the latest version of this document, go to our website at www.melexis.com.

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

Europe, Africa	Telephone: +32 13 67 04 95
	Email : sales_europe@melexis.com
Americas	Telephone: +1 603 223 2362
	Email : sales_usa@melexis.com
Asia	Email : sales_asia@melexis.com

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