

MLX91217 High Speed Current Sensor IC

Datasheet

1. Features and Benefits

- End-of-line programmable sensor
- Selectable analog ratiometric output
- Measurement range from ± 5 to ± 450 mT
- Wideband sensing: DC to 250kHz
- Very short response time (2 μ s)
- High linearity down to $\pm 0.2\%$ 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

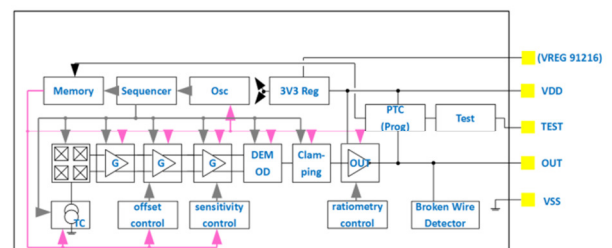


Figure 2. General Block Diagram

Contents

| | |
|--|----|
| 1. Features and Benefits..... | 1 |
| 2. Application Examples..... | 1 |
| 3. Description | 1 |
| 4. Ordering Information | 3 |
| 5. Functional Diagram | 4 |
| 6. Glossary of Terms..... | 4 |
| 7. Pin Definitions and Descriptions | 4 |
| 8. Absolute Maximum Ratings | 5 |
| 9. General Electrical Specifications | 5 |
| 10. Magnetic specification..... | 6 |
| 11. Analog output specification | 7 |
| 11.1. Accuracy specifications | 7 |
| 11.2. Timing specifications | 7 |
| 12. Self-diagnostic | 8 |
| 13. Recommended Application Diagram | 8 |
| 14. Standard Information | 9 |
| 15. ESD Precautions..... | 9 |
| 16. Packaging information | 10 |
| 16.1. Sensor active measurement direction..... | 11 |
| 17. Contact..... | 13 |
| 18. Disclaimer..... | 13 |

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 – 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” for SIP4-VA package, refer to Chapter 16 for detailed drawings |
| Option Code: | ACA-x00: 10mV/mT sensitivity (5-150mV/mT programmable range) ACA-x01: 15mV/mT sensitivity (5-150mV/mT programmable range) ACA-x03: 9mV/mT sensitivity (5-150mV/mT programmable range) ACA-x05: 13mV/mT sensitivity (5-150mV/mT programmable range) ACA-0xx: Straight leg ACA-1xx: SMD style TFT4K1 ACA-2xx: 90deg 2x2x91.3 Bending-STD2 |
| Packing Form: | “BU” for Bulk, “CR” for Carton Reel, radial taping, “CA” for Carton Reel, ammopack, “RE” for Plastic Reel. |
| 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) |

5. Functional Diagram

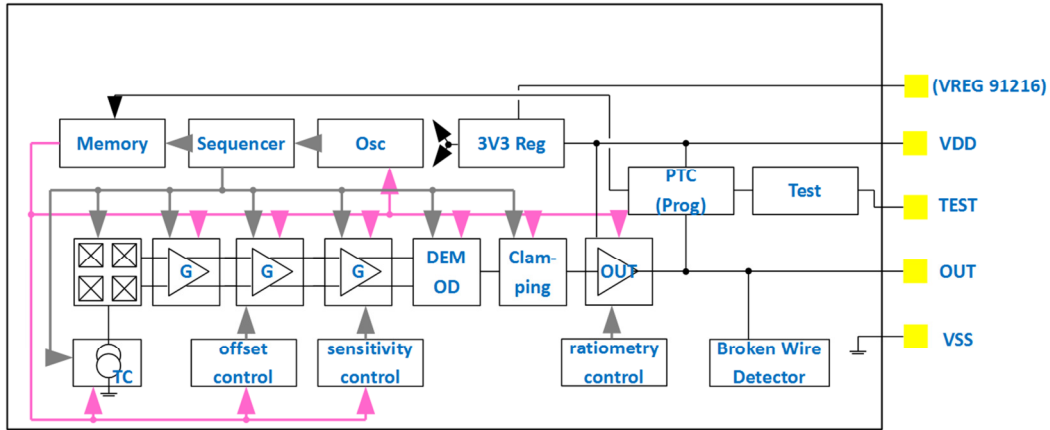


Figure 3: Block Diagram of the MLX91217:

6. Glossary of Terms

| Terms | Definition |
|-------|---|
| TC | Temperature Coefficient |
| FS | Full Scale, output referred. Corresponds to 2V excursion around 2.5V V_{OQ} 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 |

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 |

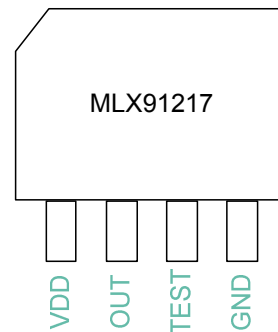


Table 3: Pin definitions and descriptions

For optimal EMC results, it is recommended to connect the unused pins 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 | $V_{S_{REV}}$ | -0.3 | V |
| Positive Output Voltage | V_{OUT} | +10 | V |
| Output Current | I_{OUT} | +70 | mA |
| Reverse Output Voltage | $V_{O_{REV}}$ | -0.3 | V |
| Reverse Output Current | $I_{O_{REV}}$ | -50 | mA |
| 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 |
| 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 , $V_{DD} = 5\text{V} \pm 10\%$, 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 | | 12.5 | 15 | mA |
| | | LOW_POWER_MODE=0 ¹ LOW_POWER_MODE=1 | | 10 | 13 | mA |
| Output Impedance | R_{OUT} | Normal Operation | | 1 | 5 | Ω |
| Output Capacitive Load | C_L | OUT_MODE=0 ¹ | 2 | | 10 | nF |
| | | OUT_MODE=1 | 10 | | 47 | nF |
| Output Resistive Load | R_L | | 10 | 25 | 200 | k Ω |
| Output Short Circuit Current | I_{SHORT} | Output shorted to VDD – Permanent Output shorted to GND – Permanent | | Not Destroyed | | |

¹ Default Factory Calibration

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------------|----------------------|---|------|------|------|------------------|
| Linear Output Range | VO _{LIN} | pull-down ≥ 10 kΩ | 10 | | 90 | %V _{DD} |
| Diagnostic Band ² | DIAG | R _L ≥ 10kΩ, R _L ≤ 200 kΩ, V _{DD} =5V DIAG_LEVEL = 0 | 0 | | 4 | %V _{DD} |
| | | DIAG_LEVEL = 1 | 96 | | 100 | %V _{DD} |
| BrokenGND Output Level ² | | R _L ≥ 10kΩ, V _{DD} = 5V | 96 | | 100 | %V _{DD} |
| BrokenVDD Output Level ² | | R _L ≥ 10kΩ, V _{DD} = 5V | 0 | | 4 | %V _{DD} |
| Under-voltage detection ² | V _{DD_UVD} | Detected Voltage (Low to High) | 4.0 | | 4.4 | V |
| | V _{DD_UVH} | Hysteresis | 0.00 | | 0.15 | V |
| Over-voltage detection 1 ² | 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 ² | V _{DD_OVD2} | Detected Voltage (Low to High) | 8.4 | | 9.3 | V |
| | V _{DD_OVH2} | Hysteresis | 0.32 | | 0.68 | V |
| Clamped Output Level | Clamp_lo0 | CLAMP_LEVEL=0 | 5 | 6 | 7 | %V _{DD} |
| | Clamp_hi0 | CLAMP_LEVEL=0 | 92 | 93 | 94 | %V _{DD} |
| | Clamp_lo1 | CLAMP_LEVEL=1 | 5 | 6 | 7 | %V _{DD} |
| | Clamp_hi1 | CLAMP_LEVEL=1 | 93 | 94 | 95 | %V _{DD} |
| | Clamp_lo2 | CLAMP_LEVEL=2 | 7 | 8 | 9 | %V _{DD} |
| | Clamp_hi2 | CLAMP_LEVEL=2 | 91 | 92 | 93 | %V _{DD} |
| | Clamp_lo3 | CLAMP_LEVEL=3 | 9 | 10 | 11 | %V _{DD} |
| | Clamp_hi3 | CLAMP_LEVEL=3 | 89 | 90 | 91 | %V _{DD} |

Table 5: General electrical parameters

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 (Magnetic) | NL | V _{OUT} in [10%V _{DD} , 90%V _{DD}], T _A = 25°C | | | ±0.4 | %FS |
| | | LOW_POWER_MODE=0 LOW_POWER_MODE=1 | | | ±0.2 | %FS |
| Programmable Sensitivity | S | | 5 | 15 | 150 | mV/mT |
| Sensitivity programming Resolution | S _{RES} | B = B _{OP} | | 0.1 | | % |

Table 6: Magnetic specification

² Please refer to section 12 for more information on self-diagnostic modes.

11. Analog output specification

11.1. Accuracy specifications

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

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---------------------------|-------------------|--|-----|-----|-----------|-------------------|
| Thermal Offset Drift | $\Delta^T V_{OQ}$ | $T_A = -40$ to 125°C | | | ± 5 | mV |
| | | $T_A = -40$ to 150°C | | | ± 8 | mV |
| Thermal Sensitivity Drift | $\Delta^T S$ | $T_A = -40$ to 125°C | | | ± 1.0 | %S |
| | | $T_A = -40$ to 150°C | | | ± 1.2 | %S |
| RMS Output Noise | N_{RMS} | Values for 50mV/mT sensitivity Scales with typical sensitivity of Table 1 | | 10 | | mV _{RMS} |
| | | NOISE_FILTER=0 | | 7 | | mV _{RMS} |
| | | NOISE_FILTER=1 | | 5 | | mV _{RMS} |
| | | NOISE_FILTER=2 | | 3 | | mV _{RMS} |
| V_{OQ} Ratiometry | $\Delta^R V_{OQ}$ | $V_{DD} = 5V \pm 5\%$, $V_{OQ} = 50\%V_{DD}$ | | | ± 0.4 | % V_{OQ} |
| Sensitivity Ratiometry | $\Delta^R S$ | $V_{DD} = 5V \pm 5\%$, $B = B_{OP}$ | | | ± 0.4 | %S |
| Clamped output accuracy | CL_{ACC} | | | | ± 1 | %V _{DD} |

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. For application notes on sensor programming and calibration, Resolution for offset and offset drift calibration is better 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 , $V_{DD} = 5V \pm 10\%$, unless otherwise specified.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|----------------------------------|-----------|----------------------------------|-----|---------------|-----|---------------|
| Step Response Time | T_R | $C_L = 10\text{nF}$ | | | | |
| | | 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} | $V_{out} = 100\%$ 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. 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

14. 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 Device)s)

- 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 Device)s) and THD's (Through Hole Device)s)

- 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 Device)s)

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

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

- 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>

15. ESD Precautions

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

16. Packaging information

16.1. VA Straight leg (0xx)

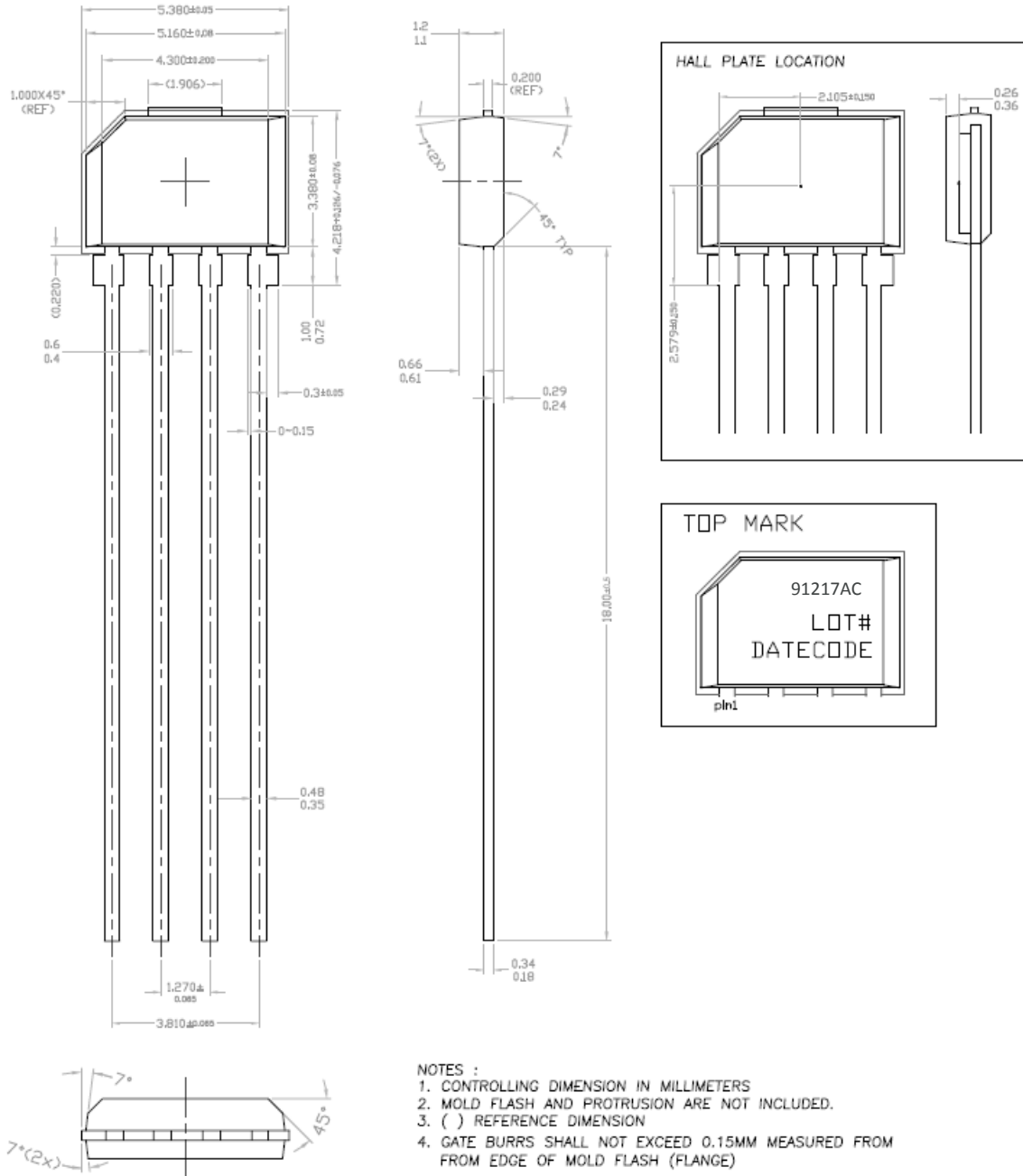
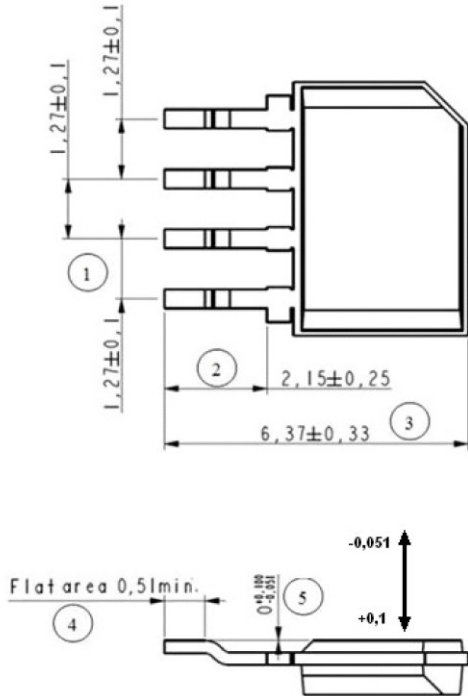


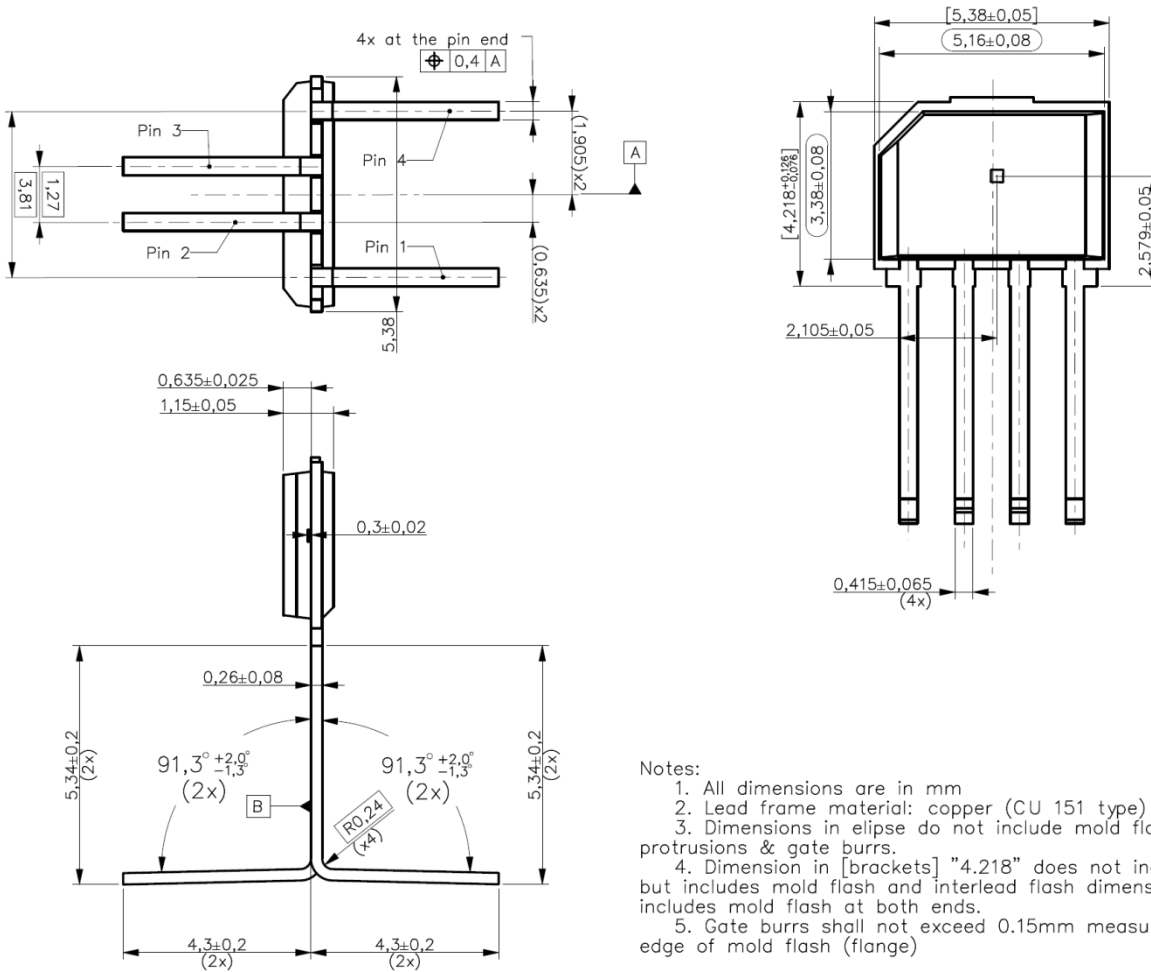
Figure 5. VA/SIP 4L (single in-line package) / 18mm lead length - Package Information

16.2. SMD style TFT4K1 (1xx)



| 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 |

16.3. 90° 2x2x91.3 Bending-STD2 (2xx)



16.4. Sensor active measurement direction



Figure 6. VA/SIP 4L Package. Sensor's active measurement direction

17. Contact

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