# US3881

Hall Latch

Low Voltage & High Sensitivity

## Features and Benefits

- Wide operating voltage range from 2.2V to 18V
- Very high magnetic sensitivity
- CMOS technology
- Chopper-stabilized amplifier stage
- Low current consumption
- Open drain output
- Thin SOT23 3L and flat TO-92 3L both RoHS Compliant packages

## Applications

- Automotive, Consumer and Industrial
- Solid-state switch
- Brushless DC motor commutation
- Speed detection
- Linear position detection
- Angular position detection
- Proximity detection

## Ordering information

| Product code | Temperature Code | Package Code | Option code | Packing form code |
|---|---|---|---|---|
| US3881 | E | SE | AAA-000 | RE |
| US3881 | E | UA | AAA-000 | BU |
| US3881 | K | SE | AAA-000 | RE |
| US3881 | K | UA | AAA-000 | BU |
| US3881 | L | SE | AAA-000 | RE |
| US3881 | L | UA | AAA-000 | BU |

**Legend:**

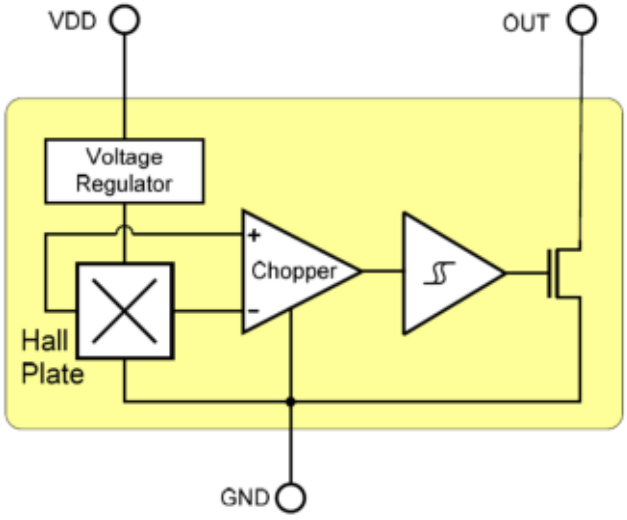
Temperature code: L(-40 to 150°C)
E(-40 to 85°C)
K (-40 to 125°C)

Package Code: SE = TSOT-23L
UA = TO92-3L

Packing Form: BU = Bulk
RE = Reel

Ordering Example: US3881ESE-AAA-000-RE

## 1. Functional Diagram




## 2. General Description

The Melexis US3881 is a Hall-effect latch designed in mixed signal CMOS technology. The device integrates a voltage regulator, Hall sensor with dynamic offset cancellation system, Schmitt trigger and an open-drain output driver, all in a single package.

The low operating voltage and extended choice of temperature range make it suitable for use in automotive, industrial and consumer low voltage applications.

The devices are delivered in a Thin Small Outline Transistor (TSOT) for surface mount process and in a Plastic Single In Line (TO-92 flat) for through-hole mount.

Both 3-lead packages are RoHS compliant.

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## 3. Glossary of Terms

| | |
|---|---|
| MilliTesla (mT), Gauss | Units of magnetic flux density:<br>1mT = 10 Gauss |
| RoHS | Restriction of Hazardous Substances |
| TSOT | Thin Small Outline Transistor (TSOT package) – also referred with the Melexis package code "SE" |
| ESD | Electro-Static Discharge |
| BLDC | Brush-Less Direct-Current |

## 4. Absolute Maximum Ratings

| Parameter | Symbol | Value | Units |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 20 | V |
| Supply Current | $I_{DD}$ | 50 | mA |
| Output Voltage | $V_{OUT}$ | 20 | V |
| Output Current | $I_{OUT}$ | 50 | mA |
| Storage Temperature Range | $T_S$ | -50 to 150 | °C |
| Maximum Junction Temperature | $T_J$ | 165 | °C |

*Table 1: Absolute maximum ratings*

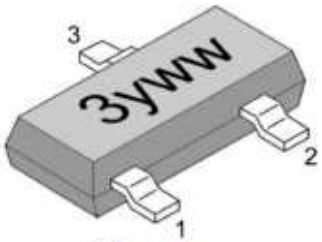
Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum- rated conditions for extended periods may affect device reliability.

| Operating Temperature Range | Symbol | Value | Units |
|---|---|---|---|
| Temperature Suffix "E" | $T_A$ | -40 to 85 | °C |
| Temperature Suffix "K" | TA | -40 to 125 | °C |
| Temperature Suffix "L" | $T_A$ | -40 to 150 | °C |

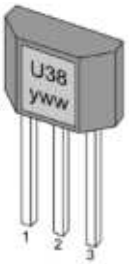
## 5. Pin Definitions and Descriptions

| SE Pin № | UA Pin № | Name | Type | Function |
|---|---|---|---|---|
| 1 | 1 | VDD | Supply | Supply Voltage pin |
| 2 | 3 | OUT | Output | Open Drain Output pin |
| 3 | 2 | GND | Ground | Ground pin |

*Table 2: Pin definitions and descriptions*



SE package



UA package

## 6. General Electrical Specifications

DC Operating Parameters $T_A$ = 25°C, $V_{DD}$ = 2.2V to 18V (unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | Operating | 2.2 | | 18 | V |
| Supply Current | $I_{DD}$ | B < $B_{RP}$ | 1.5 | 2.5 | 5 | mA |
| Output Saturation Voltage | $V_{DSon}$ | $I_{OUT}$ = 20mA, B > $B_{OP}$ | | 0.4 | 0.5 | V |
| Output Leakage Current | $I_{OFF}$ | B < $B_{RP}$, $V_{OUT}$ = 24V | | 0.01 | 10 | µA |
| Output Rise Time | $t_r$ | $R_L$ = 1kΩ, $C_L$ = 20pF | | 0.25 | | µs |
| Output Fall Time | $t_f$ | $R_L$ = 1kΩ, $C_L$ = 20pF | | 0.25 | | µs |
| Maximum Switching Frequency | $F_{SW}$ | | | 10 | | KHz |
| SE Package Thermal Resistance | $R_{TH}$ | Single layer (1S) Jedec board | | 301 | | °C/W |
| UA Package Thermal Resistance | $R_{TH}$ | | | 200 | | °C/W |

*Table 3: Electrical specifications*

## 7. Magnetic Specifications

DC Operating Parameters $T_A$ = 25°C, $V_{DD}$ = 2.2V to 18V (unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Operating Point | $B_{OP}$ | $T_A$ = 85°C, E spec. | 1 | 5 | 9 | mT |
| Release Point | $B_{RP}$ | | -9 | -5 | -1 | mT |
| Hysteresis | $B_{HYST}$ | | 5.5 | 10 | 12 | mT |
| Operating Point | $B_{OP}$ | $T_A$ = 150°C, L spec. | 1 | 5 | 9 | mT |
| Release Point | $B_{RP}$ | | -9 | -5 | -1 | mT |
| Hysteresis | $B_{HYST}$ | | 5.5 | 10 | 12 | mT |

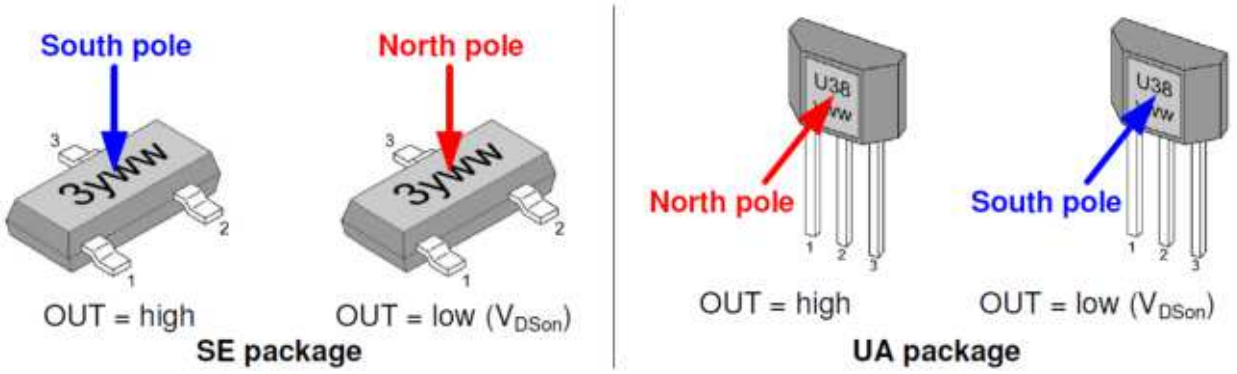
*Table 4: Magnetic specifications*

## 8. Output Behaviour versus Magnetic Pole

DC Operating Parameters $T_A$ = -40 C to 150 C, $V_{DD}$ = 2.2V to 18V (unless otherwise specified)

| Parameter | Test Conditions (SE) | OUT (SE) | Test Conditions (UA) | OUT (UA) |
|---|---|---|---|---|
| South pole | B < $B_{RP}$ | High | B > $B_{OP}$ | Low |
| North pole | B > $B_{OP}$ | Low | B < $B_{RP}$ | High |

*Table 5: Output behaviour versus magnetic pole*



## 9. Detailed General Description

Based on mixed signal CMOS technology, Melexis US3881 is a Hall-effect device with high magnetic sensitivity. This multi-purpose latch suits most of the application requirements.

The chopper-stabilized amplifier uses switched capacitor techniques to suppress the offset generally observed with Hall sensors and amplifiers. The CMOS technology makes this advanced technique possible and contributes to smaller chip size and lower current consumption than bipolar technology. The small chip size is also an important factor to minimize the effect of physical stress.

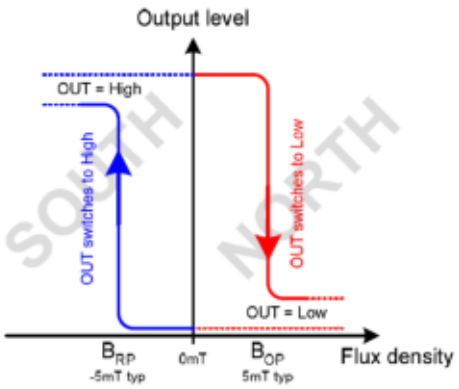
This combination results in more stable magnetic characteristics and enables faster and more precise design.

The operating voltage from 2.2V to 18V, low current consumption and large choice of operating temperature range according to “L”, “K” and “E” specification make this device suitable for automotive, industrial and consumer low voltage applications.

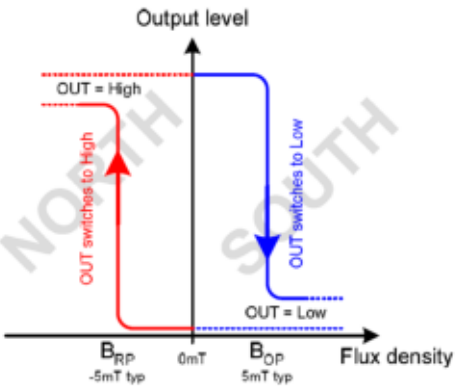
The output signal is open-drain type. Such output allows simple connectivity with TTL or CMOS logic by using a pull-up resistor tied between a pull-up voltage and the device output..

## 10. Unique Features

The US3881 exhibits latch magnetic switching characteristics. Therefore, it requires both south and north poles to operate properly.




*SE package - Latch characteristic*



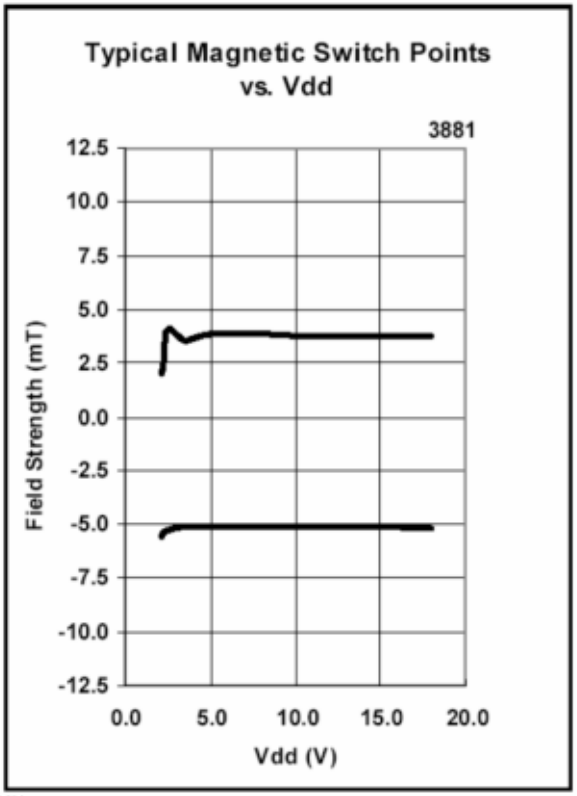

*UA package - Latch characteristic*

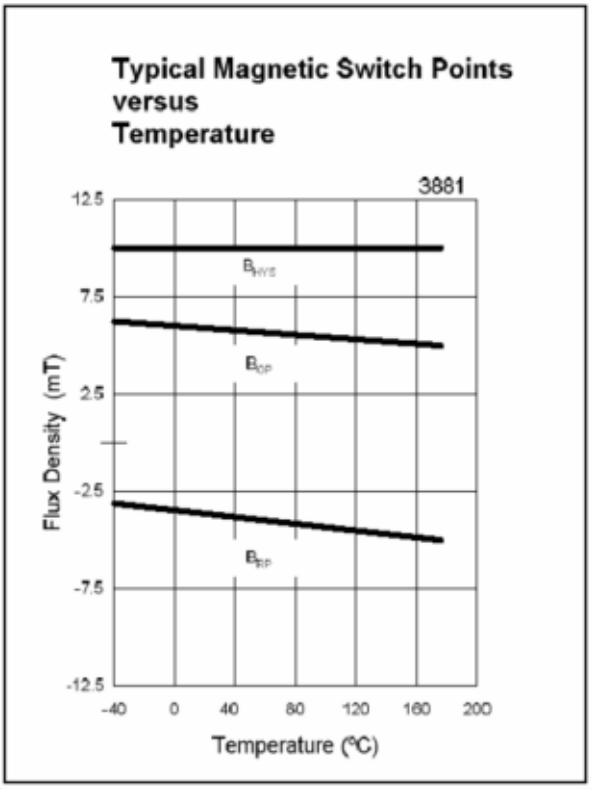
The device behaves as a latch with symmetric operating and release switching points (BOP=|BRP|). This means magnetic fields with equivalent strength and opposite direction drive the output high and low.

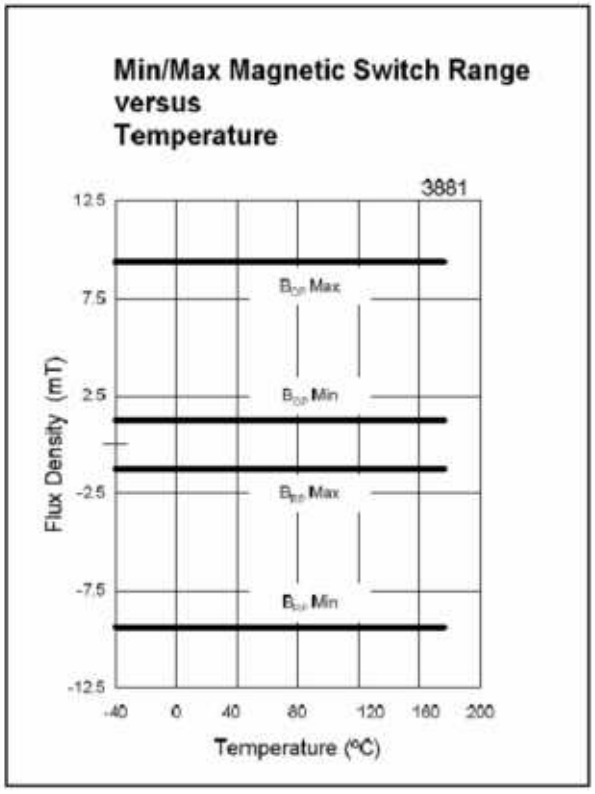
Removing the magnetic field (B→0) keeps the output in its previous state. This latching property defines the device as a magnetic memory.

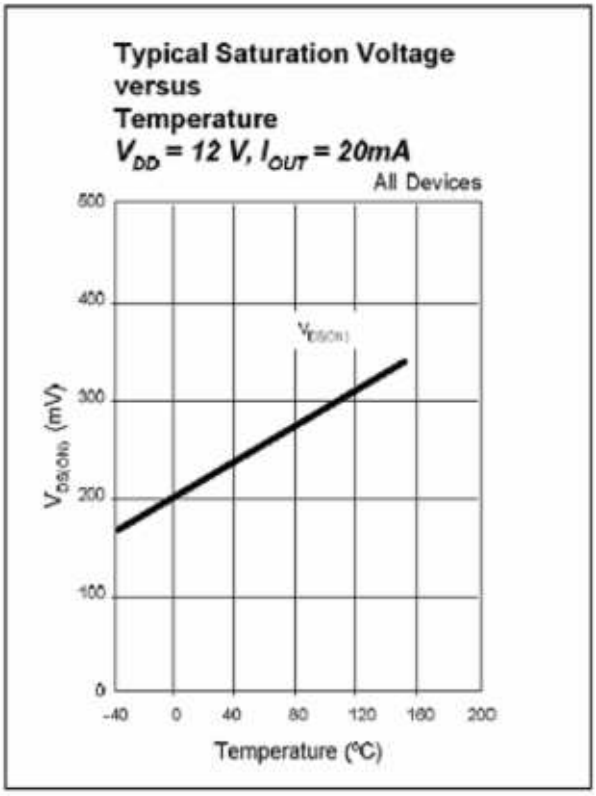
A magnetic hysteresis BHYST keeps BOP and BRP separated by a minimal value. This hysteresis prevents output oscillation near the switching point

## 11. Performance Graphs



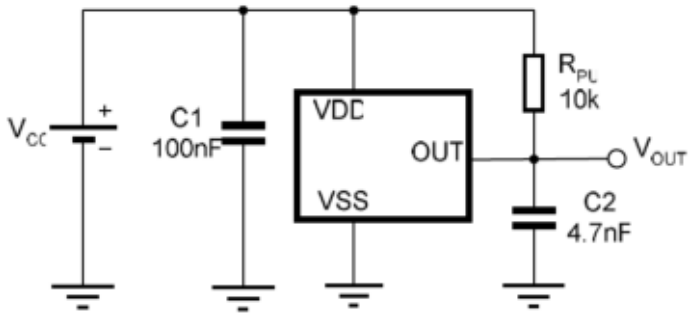



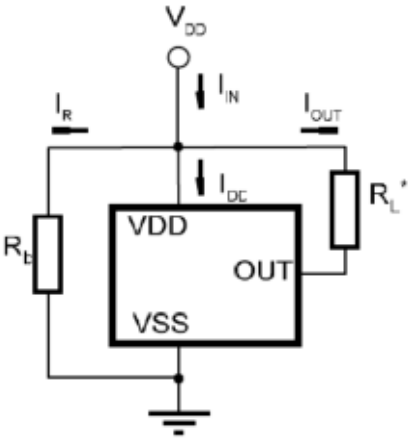



# 12. Application Information

## 12.1. Typical Three-Wire Application Circuit




## 12.2. Two-Wire Circuit



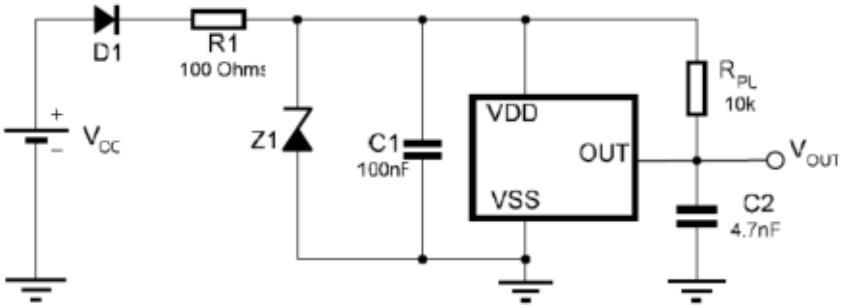

Note:

With this circuit, precise ON and OFF currents can be detected using only two connecting wires.

The resistors RL and Rb can be used to bias the input current. Refer to the part specifications for limiting values.

$B_{RP}$ : $I_{OFF} = I_R + I_{DD} = V_{DD}/R_b + I_{DD}$
$B_{OP}$ : $I_{ON} = I_{OFF} + I_{OUT} = I_{OFF} + V_{DD}/R_L$

## 12.3. Automotive and Harsh, Noisy Environments Three-Wire Circuit




# 13. Application Comments

For proper operation, a 100nF bypass capacitor should be placed as close as possible to the device between the $V_{DD}$ and ground pin.

For reverse voltage protection, it is recommended to connect a resistor or a diode in series with the $V_{DD}$ pin. When using a resistor, three points are important:

- the resistor has to limit the reverse current to 50mA maximum ($V_{CC}$ / R1 ≤ 50mA)
- the resulting device supply voltage $V_{DD}$ has to be higher than $V_{DD}$ min ($V_{DD} = V_{CC} – R1.I_{DD}$)
- the resistor has to withstand the power dissipated in reverse voltage condition ($P_D = V_{CC}^2$ / R1)

When using a diode, a reverse current cannot flow and the voltage drop is almost constant (≈0.7V).
Therefore, a 100Ω/0.25W resistor for 5V application and a diode for higher supply voltage are recommended. Both solutions provide the required reverse voltage protection.

When a weak power supply is used or when the device is intended to be used in noisy environment, it is recommended that figure 12.3 from the Application Information section is used.
The low-pass filter formed by R1 and C1 and the zener diode Z1 bypass the disturbances or voltage spikes occurring on the device supply voltage $V_{DD}$. The diode D1 provides additional reverse voltage protection.

## 14. Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

**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 all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

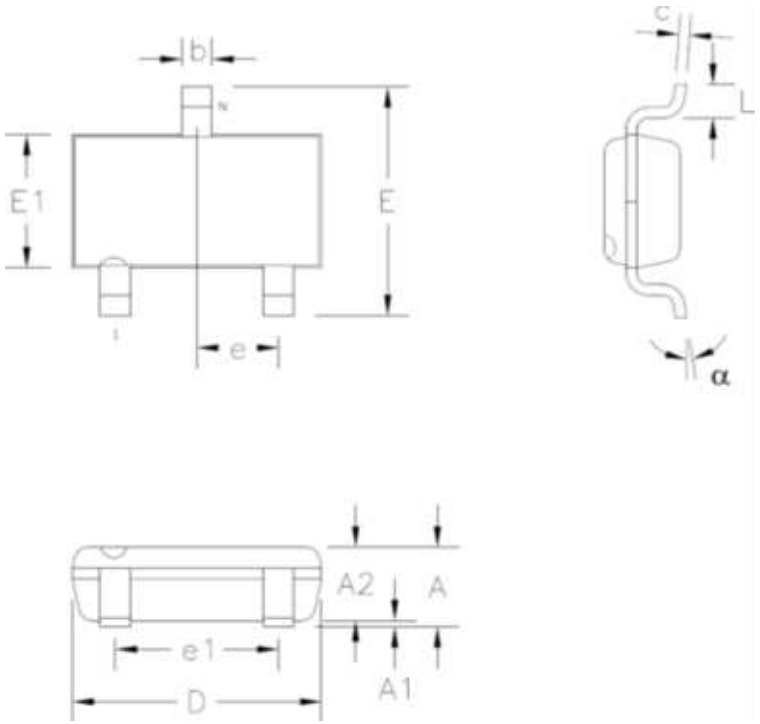
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: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

## 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. Package Information

## 16.1. SE Package (TSOT-3L)




Notes:

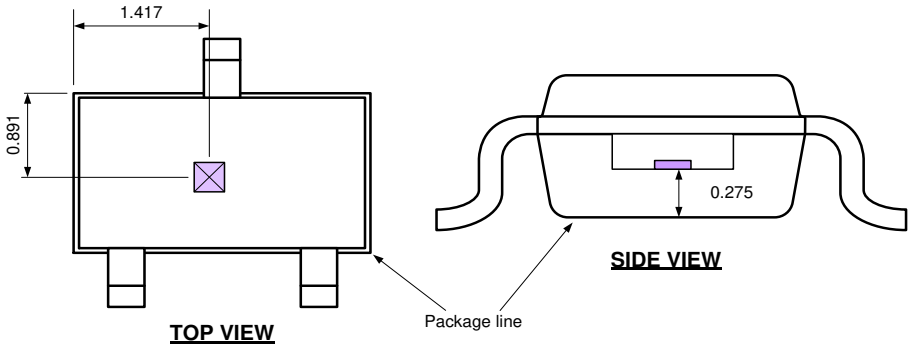
1. Dimension "D" and "E1" do not include mold flash or protrusions. Mold flash or protrusion shall not exceed 0.15mm on "D" and 0.25mm on "E" per side.
2. Dimension "b" does not include dambar protrusion.

Marking:

Top side : 3yww

3 = part number (US3881)
y = last digit of year
ww = calendar week

**Hall plate location**



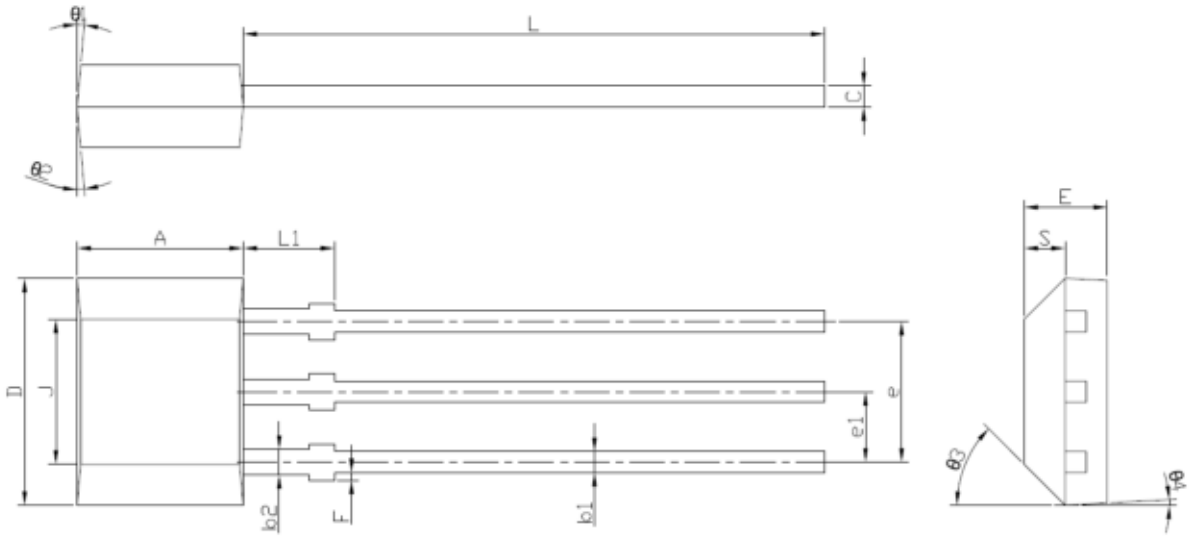

Notes:

1. All dimensions are in millimeters

This table in mm

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

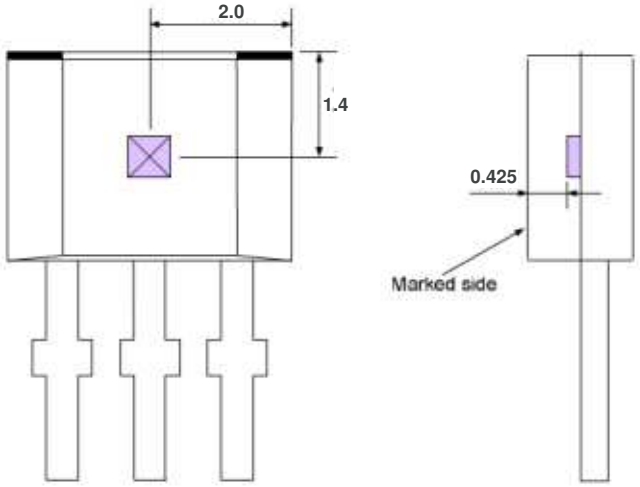
## 16.2. UA Package (TO-92 flat)




Notes:

1. Mold flashes and protrusion are not included.
2. Gate burrs shall not exceed 0.127mm on the top side.

**Hall plate location**




Notes:

1. All dimensions are in millimeters

Marking:

1st Line : U38 - Part number (US3881)

2nd Line : yww

y - last digit of year
ww - calendar week

This table in mm

| | A | D | E | F | J | L | L1 | S | b1 | b2 | c | e | e1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| min | 2.80 | 3.90 | 1.40 | 0.00 | 2.51 | 14.0 | 1.55 | 0.63 | 0.35 | 0.43 | 0.35 | 2.51 | 1.24 |
| max | 3.20 | 4.30 | 1.60 | 0.20 | 2.72 | 15.0 | 1.75 | 0.84 | 0.44 | 0.52 | 0.44 | 2.57 | 1.30 |
| | θ1 | θ2 | θ3 | θ4 | | | | | | | | | |
| min | 5° | 5° | 45° | 3° | | | | | | | | | |
| max | MAX | REF | REF | REF | | | | | | | | | |

## 17. Contact

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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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