US1881

Hall Latch – High Sensitivity

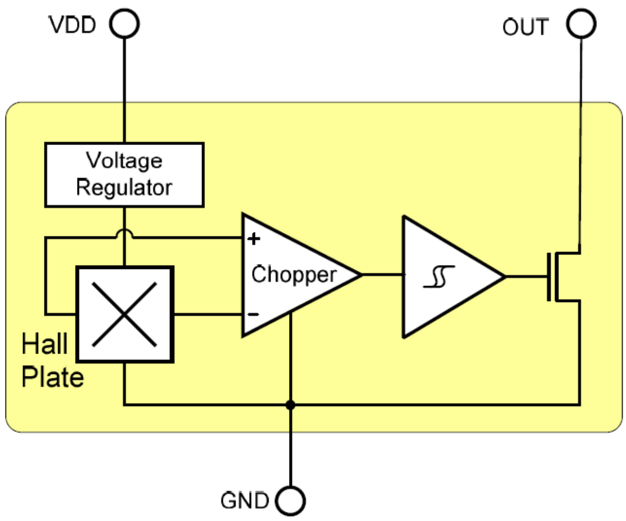
Features and Benefits

- Wide operating voltage range from 3.5V to 24V
- High magnetic sensitivity – Multi-purpose
- 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

1. Functional Diagram



2. General Description

The Melexis US1881 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.

Thanks to its wide operating voltage range and extended choice of temperature range, it is quite suitable for use in automotive, industrial and consumer applications.

The device is 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.

3. Ordering information

<table>
<tr><th>Product code</th><th>Temperature Code</th><th>Package Code</th><th>Magnetic option code</th><th>Country of Origin (COO)</th><th>Packing form code</th></tr>
<tr><td>US1881</td><td>E</td><td>SE</td><td>AA</td><td>A-000</td><td>RE</td></tr>
<tr><td rowspan="3">US1881</td><td rowspan="3">E</td><td rowspan="3">UA</td><td rowspan="3">AA</td><td>A-000</td><td rowspan="3">BU</td></tr>
<tr><td>C-000</td></tr>
<tr><td>Z-000</td></tr>
<tr><td>US1881</td><td>K</td><td>SE</td><td>AA</td><td>A-000</td><td>RE</td></tr>
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<tr><td>C-000</td></tr>
<tr><td>Z-000</td></tr>
</table>

Legend:

Temperature code:	E (-40 to 85°C)
	K (-40 to 125°C)
	L (-40 to 150°C)
Package Code:	SE = TSOT-23L
	UA = TO92-3L
COO Option Code:	Z = Dual source from China & Non-China
	C = China country of origin
	A = Non-China country of origin
Packing Form:	BU = Bulk
	RE = Reel
Ordering Example:	US1881EUA-AAC-000-BU: UA package code with China country of origin in Bulk

Contents

4. Glossary of Terms

MilliTesla (mT), Gauss	Units of magnetic flux density: 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
Operating Point (B_{OP})	Magnetic flux density applied on the branded side of the package which turns the output driver ON ($V_{OUT} = V_{DSon}$)
Release Point (B_{RP})	Magnetic flux density applied on the branded side of the package which turns the output driver OFF (V_{OUT} = high)
COO	Country of origin

5. Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Voltage	V_{DD}	28	V
Supply Current	I_{DD}	50	mA
Output Voltage	V_{OUT}	28	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

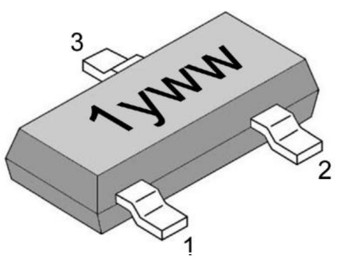
Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum- rated conditions for extended periods may affect device reliability.

Operating Temperature Range	Symbol	Value	Units
Temperature Suffix “E”	T_A	-40 to 85	°C
Temperature Suffix “K”	T_A	-40 to 125	°C
Temperature Suffix “L”	T_A	-40 to 150	°C

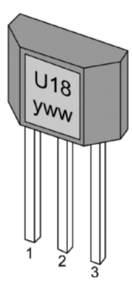
6. Pin Definitions and Descriptions

SE Pin №	UA Pin №	Name	Type	Function
1	1	V_{DD}	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

7. General Electrical Specifications

DC Operating Parameters T_A = 25°C, V_{DD} = 3.5V to 24V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Voltage	V_{DD}	Operating	3.5		24	V
Supply Current	I_{DD}	$B < B_{RP}$			5	mA
Output Saturation Voltage	V_{DSon}	I_{OUT} = 20mA, $B > B_{OP}$			0.5	V
Output Leakage Current	I_{OFF}	$B < B_{RP}$, V_{OUT} = 24V		0.3	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
Package Thermal Resistance	R_{TH}	Single layer (1S) Jedec board		301		°C/W

Table 3: Electrical specifications

8. Magnetic Specifications

DC Operating Parameters V_{DD} = 3.5V to 24V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Point	B_{OP}		0.5		9.5	mT
Release Point	B_{RP}	T_A = 85°C, E spec.	-9.5		-0.5	mT
Hysteresis	B_{HYST}		7		12	mT
Operating Point	B_{OP}		0.5		9.5	mT
Release Point	B_{RP}	T_A = 125°C, K spec.	-9.5		-0.5	mT
Hysteresis	B_{HYST}		7		12	mT
Operating Point	B_{OP}		0.5		9.5	mT
Release Point	B_{RP}	T_A = 150°C, L spec.	-9.5		-0.5	mT
Hysteresis	B_{HYST}		6		12.5	mT

Table 4: Magnetic specifications

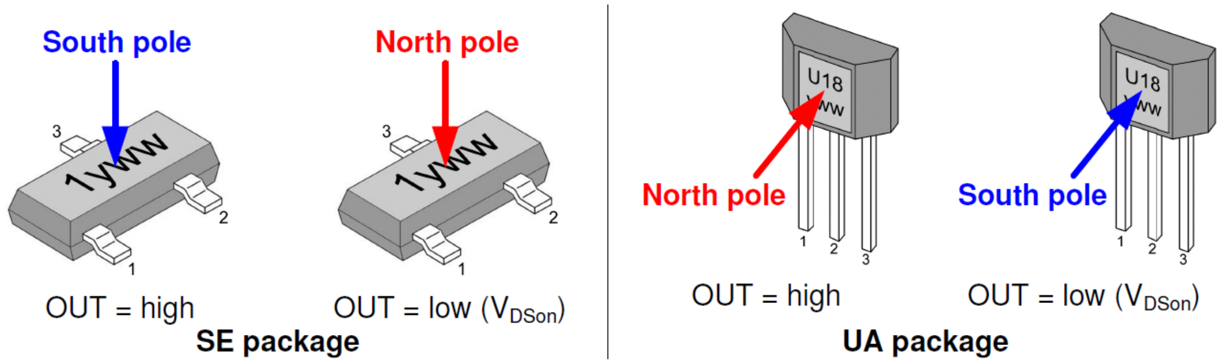
Note: For typical values, please refer to the performance graphs in section 11

9. Output Behaviour versus Magnetic Pole

DC Operating Parameters T_A = -40 °C to 150 °C, V_{DD} = 3.5V to 24V (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



10. Detailed General Description

Based on mixed signal CMOS technology, Melexis US1881 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 technique 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.

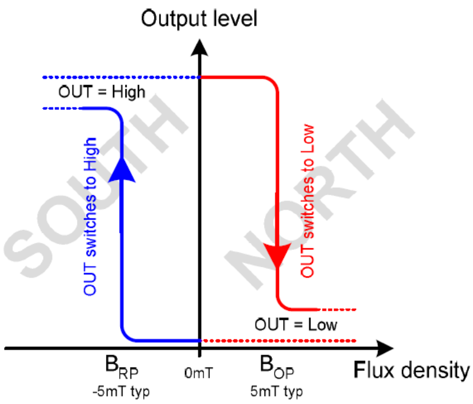
This combination results in more stable magnetic characteristics and enables faster and more precise design.

The wide operating voltage from 3.5V to 24V, 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 applications.

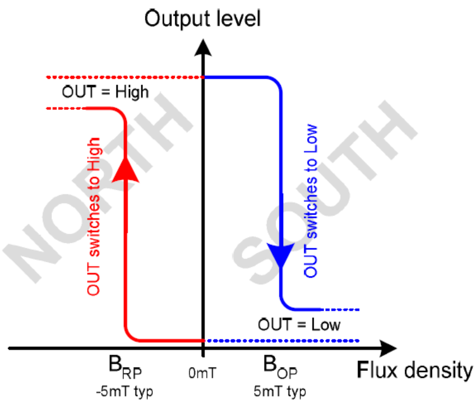
The output signal is open-drain type. Such output allows simple connectivity with TTL or CMOS logic by using a pull-up resistor tied between a pull-up voltage and the device output.

11. Unique Features

The US1881 exhibits latch magnetic switching characteristics. Therefore, it requires both south and north poles to operate properly.



SE package - Latch characteristic



UA package - Latch characteristic

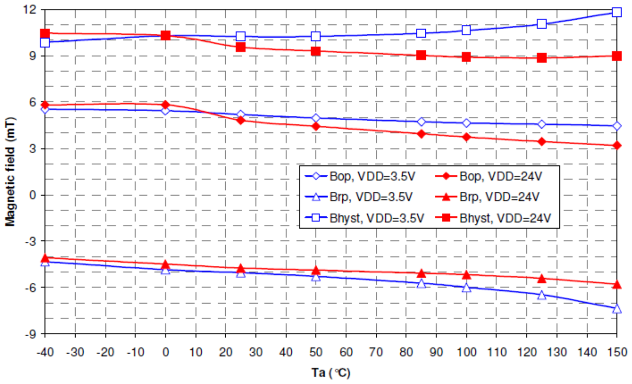
The device behaves as a latch with symmetric operating and release switching points (B_{OP}=|B_{RP}|). This means magnetic fields with equivalent strength and opposite direction drive the output high and low.

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

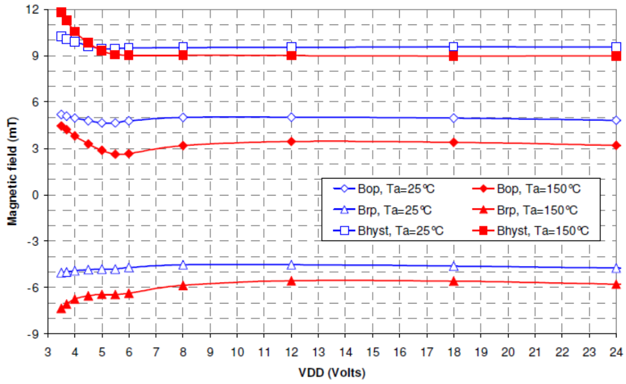
A magnetic hysteresis B_{HYST} keeps B_{OP} and B_{RP} separated by a minimal value. This hysteresis prevents output oscillation near the switching point.

12. Performance Graphs

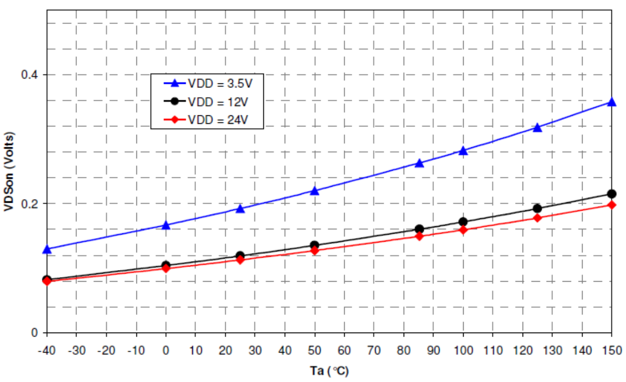
12.1. Magnetic parameters vs. T_A



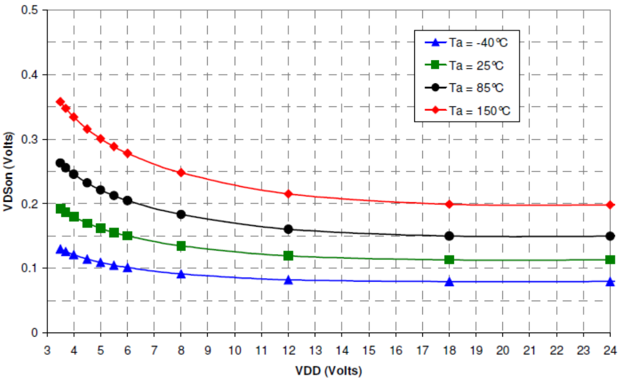
12.2. Magnetic parameters vs. V_{DD}



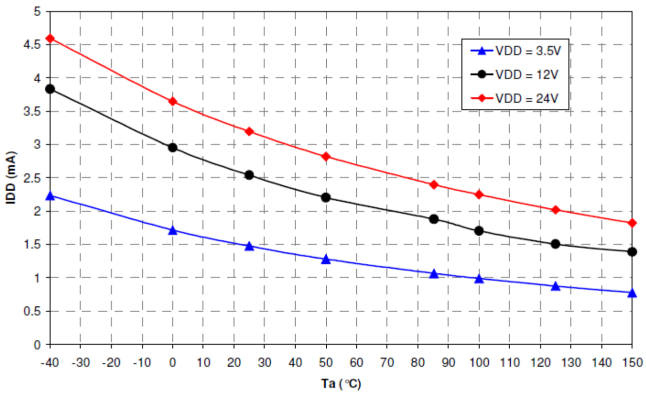
12.3. V_{DSON} vs. T_A



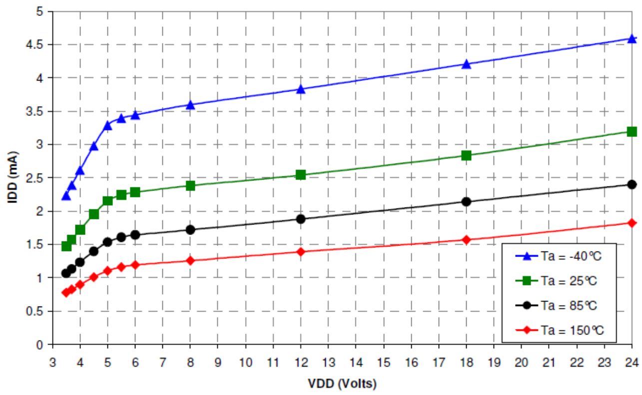
12.4. V_{DSON} vs. V_{DD}



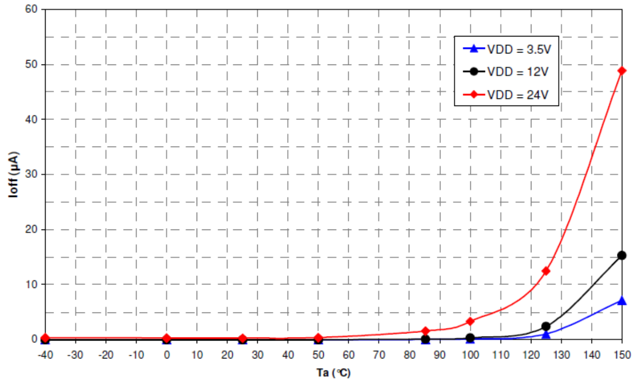
12.5. I_{DD} vs. T_A



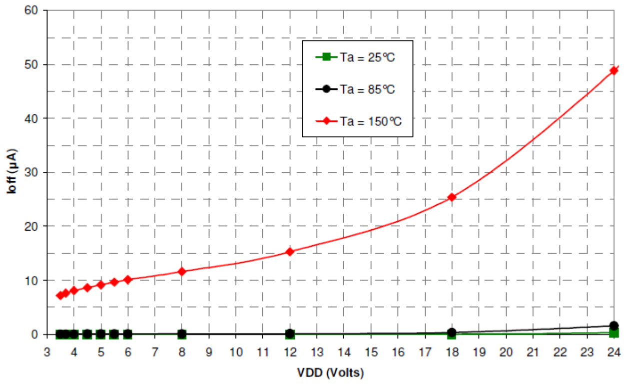
12.6. I_{DD} vs. V_{DD}



12.7. IOFF vs. TA



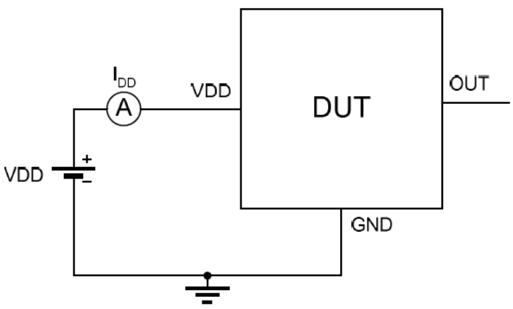
12.8. IOFF vs. VDD



13. Test Conditions

Note: DUT = Device under Test

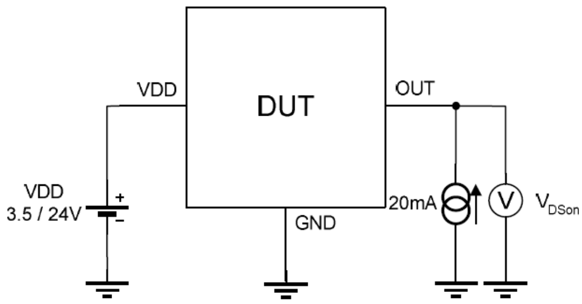
13.1. Supply Current



Note 1 - The supply current I_{DD} represents the static supply current. OUT is left open during measurement.

Note 2 - The device is put under magnetic field with $B<B_{RP}$.

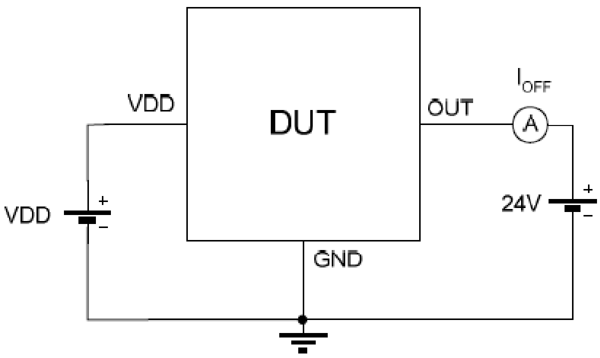
13.2. Output Saturation Voltage



Note 1 - The output saturation voltage V_{DSon} is measured at V_{DD} = 3.5V and V_{DD} = 24V.

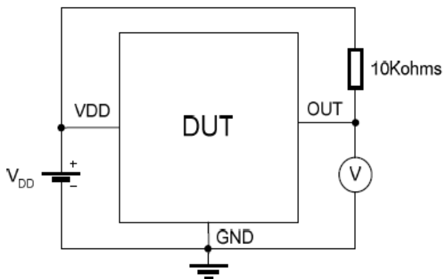
Note 2 - The device is put under magnetic field with $B>B_{OP}$.

13.3. Output Leakage Current



Note 1 - The device is put under magnetic field with $B<B_{RP}$

13.4. Magnetic Thresholds

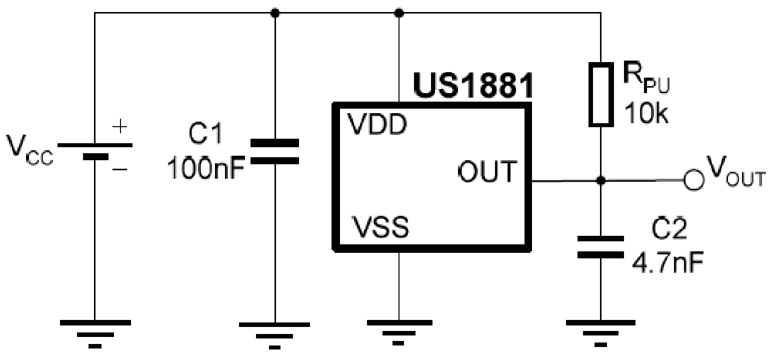


Note 1 - B_{OP} is determined by putting the device under magnetic field swept from B_{RPmin} up to B_{OPmax} until the output is switched on.

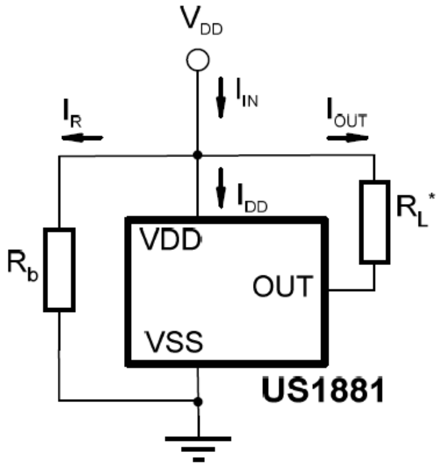
Note 2 - B_{RP} is determined by putting the device under magnetic field swept from B_{OPmax} down to B_{RPmin} until the output is switched off.

14. Application Information

14.1. Typical Three-Wire Application Circuit



14.2. Two-Wire Circuit



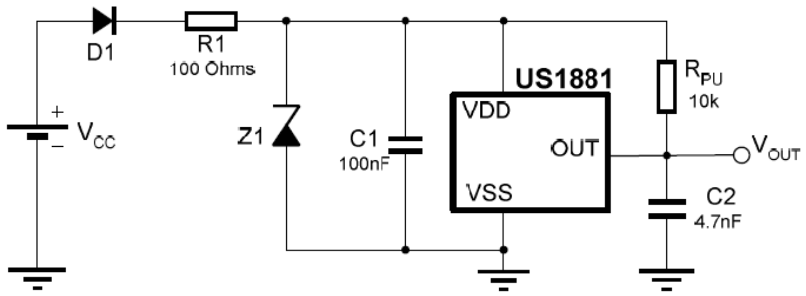
Note:

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} : $I_{ON} = I_{OFF} + I_{OUT} = I_{OFF} + V_{DD}/R_L$

14.3. Automotive and Harsh, Noisy Environments Three-Wire Circuit



15. 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 ($P_D = V_{CC}{}^2 / R1$)

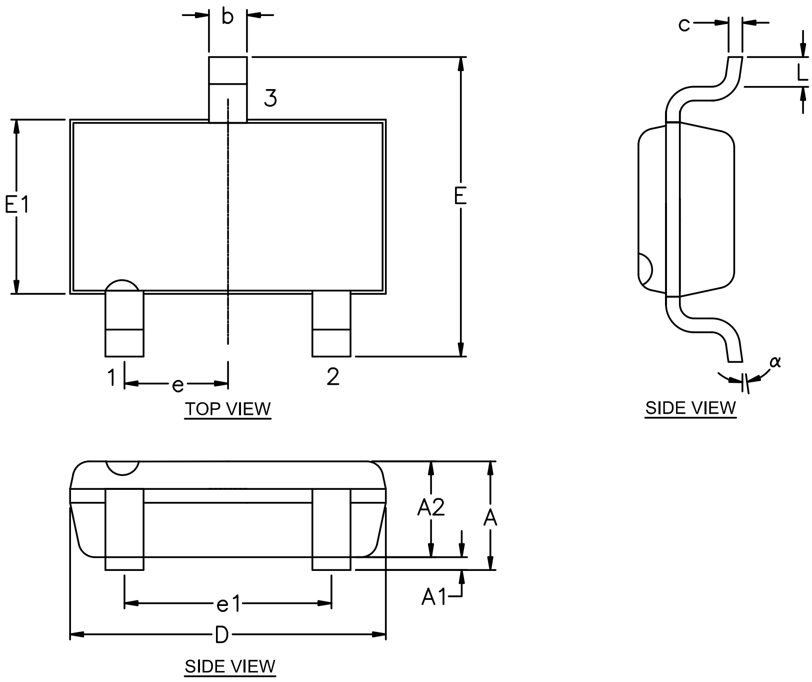
When using a diode, a reverse current cannot flow and the voltage drop is almost constant (≈0.7V).
Therefore, a 100Ω/0.25W resistor for 5V application and a diode for higher supply voltage are recommended. Both solutions provide the required reverse voltage protection.

When a weak power supply is used or when the device is intended to be used in noisy environment, it is recommended that figure 13.3 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.

16. Package Information

16.1. TSOT-3L (SE Package)

16.1.1. TSOT-3L – package dimensions

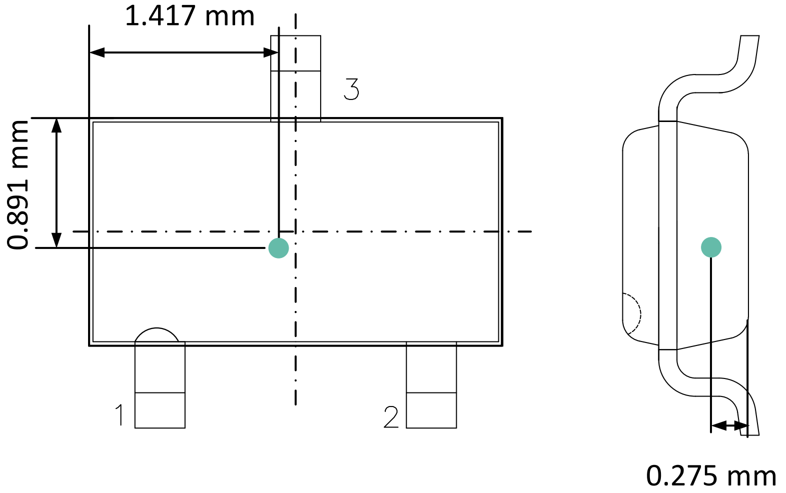


SYMBOL	MINIMUM	MAXIMUM
A	---	1.00
A1	0.025	0.10
A2	0.85	0.90
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
L	0.30	0.50
b	0.30	0.45
c	0.10	0.20
e	0.95 BSC	
e1	1.90 BSC	
α	0°	8°

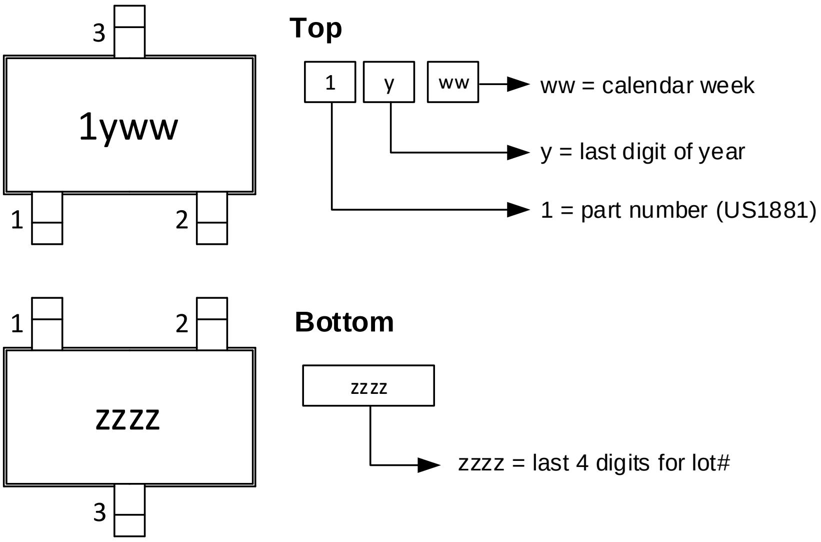
NOTE :

1. ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS OTHERWISE STATED.
2. DIMENSION D DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS OF MAX 0.15 mm PER SIDE.
3. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS OF MAX 0.25 mm PER SIDE.
4. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION OF MAX 0.07 mm.
5. DIMENSION L IS THE LENGTH OF THE TERMINAL FOR SOLDERING TO A SUBTRATE.
6. FORMED LEAD SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITH 0.076 mm SEATING PLANE.

16.1.2. TSOT-3L – Sensitive spot

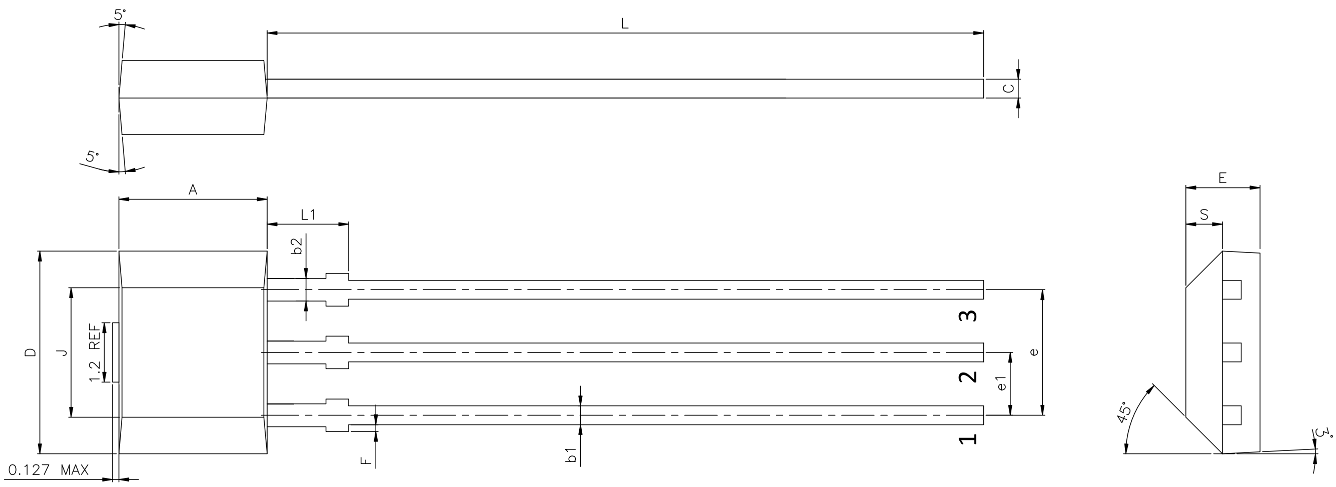


16.1.3. TSOT-3L – Package marking



16.2. TO-92 (UA Package) – Non-China COO

16.2.1. TO-92 – Non-China COO – package dimensions

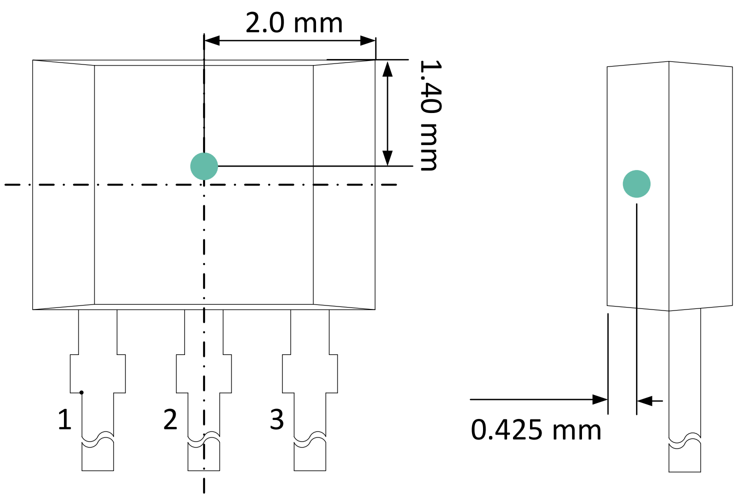


SYMBOL	MINIMUM	MAXIMUM
A	2.80	3.20
D	3.90	4.30
E	1.40	1.60
F	0.00	0.20
J	2.51	2.72
L	14.00	15.00
L1	1.55	1.75
S	0.63	0.84
b1	0.35	0.44
b2	0.43	0.52
c	0.35	0.44
e	2.51	2.57
e1	1.24	1.30

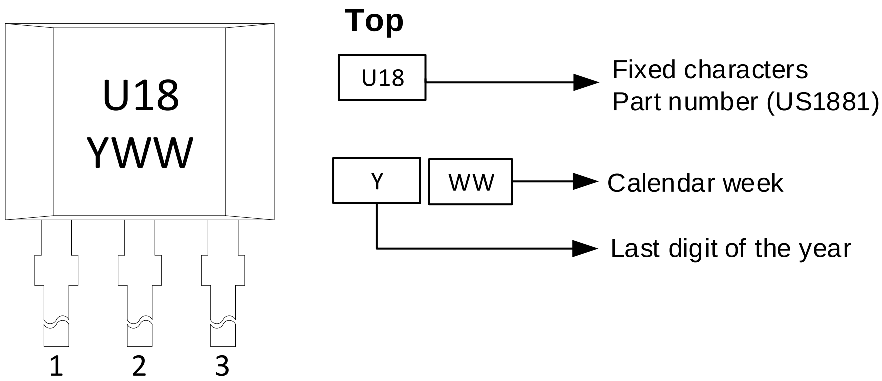
NOTE :

1. DIMENSIONS IN MILLIMETERS (mm) UNLESS NOTED OTHERWISE.
2. PACKAGE DIMENSIONS DO NOT INCLUDE MOLD FLASHES AND PROTRUSIONS.
3. DIMENSION A AND D DO NOT INCLUDE MOLD GATE AND SIDE FLASH (PROTRUSION) of MAXIMUM 0.127 mm PER SIDE.
4. 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.

16.2.2. TO-92 – Non-China COO – Sensitive spot

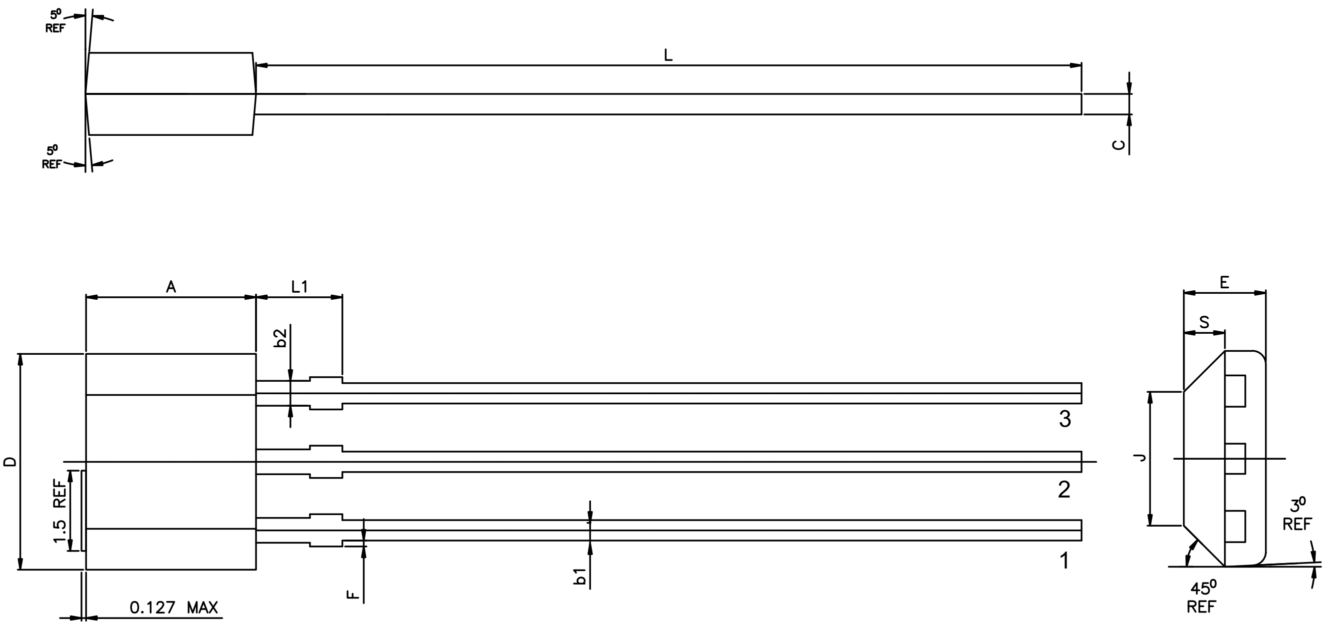


16.2.3. TO-92 – Non-China COO – Package marking



16.3. TO-92 (UA Package) – China COO

16.3.1. TO-92 – China COO – package dimensions



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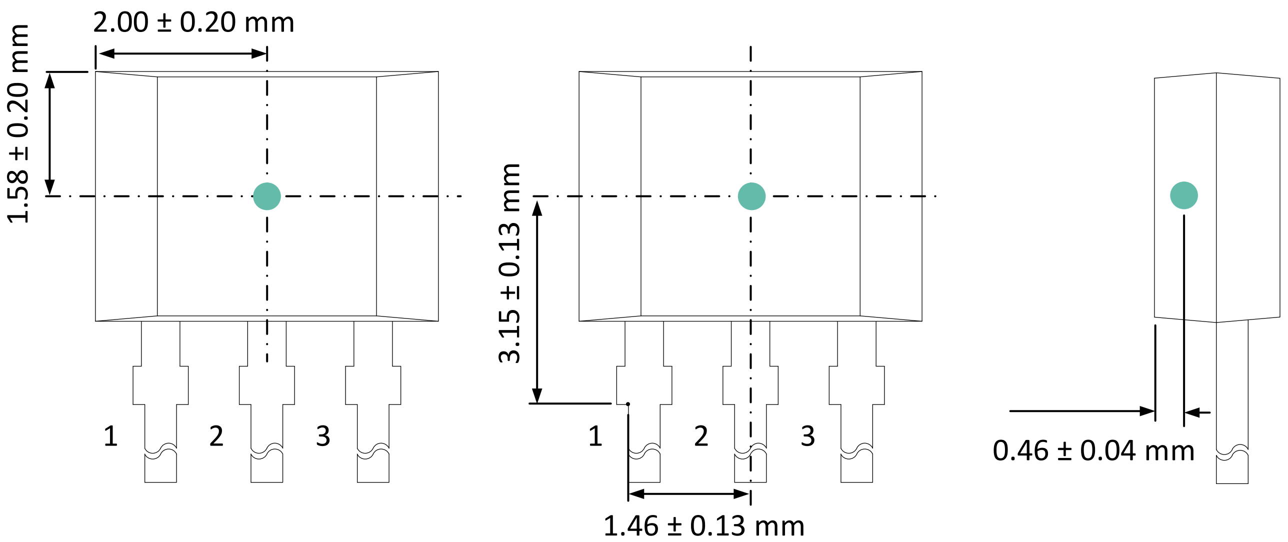
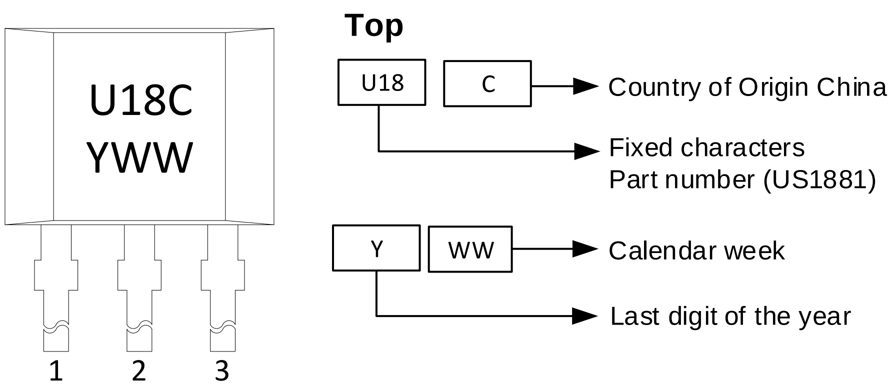
SYMBOL	MINIMUM	MAXIMUM
A	3.05	3.25
D	3.90	4.10
E	1.42	1.62
F	---	0.15
J	2.48 REF	
L	15.10	15.50
L1	---	1.75
S	0.66	0.86
b1	0.33	0.48
b2	0.40	0.53
c	0.38	0.43
e	2.54 BSC	
e1	1.27 BSC	

16.3.2. TO-92 – China COO – Sensitive spot



16.3.3. TO-92 – China COO – Package marking



17. IC handling and assembly

17.1. Storage and handling of plastic encapsulated ICs

Plastic encapsulated ICs shall be stored and handled according to their MSL categorization level (specified in the packing label) as per J-STD-033.

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). The component assembly shall be handled in EPA (Electrostatic Protected Area) as per ANSI S20.20

For more information refer to Melexis *Guidelines for storage and handling of plastic encapsulated ICs*(1)

17.2. Assembly of encapsulated ICs

For Surface Mounted Devices (SMD, as defined according to JEDEC norms), the only applicable soldering method is reflow.

For Through Hole Devices (THD), the applicable soldering methods are reflow, wave, selective wave and robot point-to-point. THD lead pre-forming (cutting and/or bending) is applicable under strict compliance with Melexis *Guidelines for lead forming of SIP Hall Sensors*(1).

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.

For PCB-less assembly refer to the relevant application notes (1) or contact Melexis.

Electrical resistance welding or laser welding can be applied to Melexis products in THD and specific PCB-less packages following the *Guidelines for welding of PCB-less devices*(1).

Environmental protection of customer assembly with Melexis products for harsh media application, is applicable by means of coating, potting or overmolding considering restrictions listed in the relevant application notes (1)

For other specific process, contact Melexis via www.melexis.com/technical-inquiry

17.3. Environment and sustainability

Melexis is contributing to global environmental conservation by promoting non-hazardous solutions. For more information on our environmental policy and declarations (RoHS, REACH…) visit www.melexis.com/environmental-forms-and-declarations

[1] *www.melexis.com/ic-handling-and-assembly*

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