Melexis Microelectronic Integrated Systems

US2884

Bipolar Hall Switch – Very High Sensitivity

Features and Benefits

- Wide operating voltage range from 3.5V to 24V
- Very high magnetic sensitivity
- CMOS technology
- Chopper-stabilized amplifier stage
- Low current consumption
- Open drain output
- Thin SOT23 3L RoHS Compliant package

Application Examples

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

Ordering Code

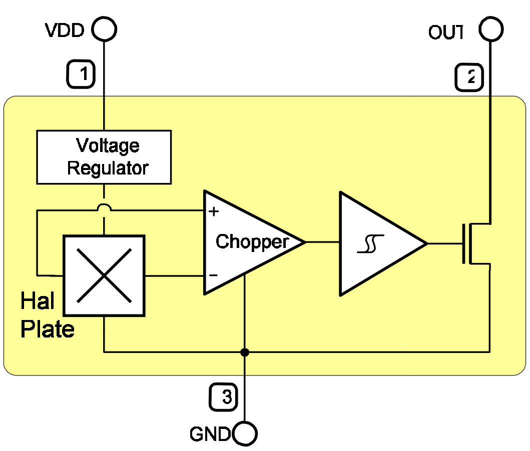
Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
US2884	L	SE	AAA-000	RE

Legend:

Temperature Code: L for Temperature Range -40°C to 150°C
Package Code: SE for TSOT
Option Code: xxx-000: Standard version
Packing Form: RE for Reel

Ordering example: US2884LSE-AAA-000-RE

1 Functional Diagram



2 General Description

The Melexis US2884 is a bipolar Hall-effect switch 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.

Due to its wide operating voltage range and temperature range it is particularly suitable for use in automotive and BLDC motor applications.

The device is delivered in a Thin Small Outline Transistor (TSOT) RoHS compliant 3-lead package.

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3 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

4 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
Operating Temperature Range	T_A	-40 to 150	°C
Storage Temperature Range	T_S	-50 to 150	°C
Maximum Junction Temperature	T_J	165	°C

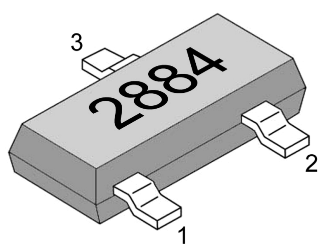
Table 1: Absolute maximum ratings

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

5 Pin Definitions and Descriptions

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

Table 2: Pin definitions and descriptions



6 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		0.01	10	µA
Output Rise Time	t_r	V_{DD}=12V, R_L = 1kΩ, C_L = 20pF		0.25		µs
Output Fall Time	t_f	V_{DD}=12V, 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

7 Magnetic Specifications

DC Operating Parameters T_A = -40°C to 150°C, V_{DD} = 4V to 24V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Point	B_{OP}		-2		6	mT
Release Point	B_{RP}		-6		2	mT
Hysteresis	B_{HYST}		1		6	mT

Table 4: Magnetic specifications

Note 1: For typical values, please refer to the performance graphs in section 11

8 Output Behaviour versus Magnetic Pole

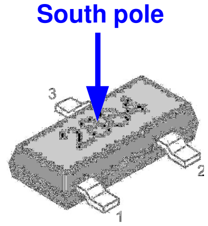
DC Operating Parameters T_A = -40°C to 150°C, V_{DD} = 3.5V to 24V (unless otherwise specified)

Parameter	Test Conditions	OUT
South pole	$B > B_{OP}$	Low
North pole	$B < B_{RP}$	High

Table 5: Output behaviour versus magnetic pole

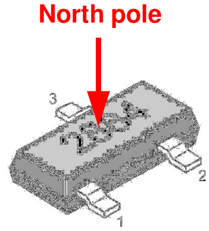
Note 1: The magnetic pole is applied facing the branded side of the package

South pole



OUT = low (V_{DSon})

North pole



OUT = high

9 Detailed General Description

Based on mixed signal CMOS technology, Melexis US2884 is a Hall-effect device with very high magnetic sensitivity. It allows using generic magnets, weak magnets or larger air gap.

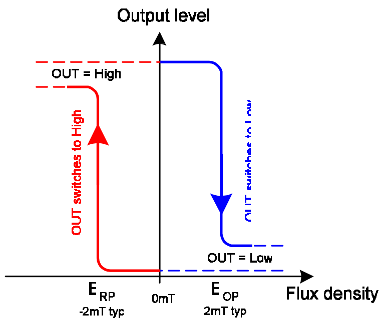
The chopper-stabilized amplifier uses switched capacitor technique to suppress the offset generally observed with Hall sensors and amplifiers. The CMOS technology makes this advanced technique possible and contributes to smaller chip size and lower current consumption than bipolar technology. The small 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, wide operating temperature according to “L” specification and low current consumption make this device especially suitable for automotive and BLDC motor 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 US2884 exhibits bipolar magnetic switching characteristics. Therefore, it operates with both south and north poles.

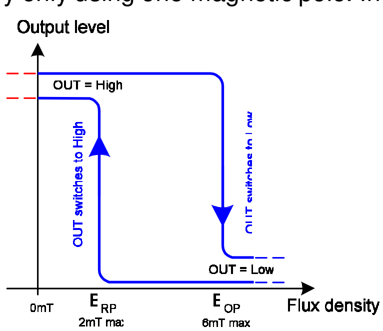


Latch characteristic

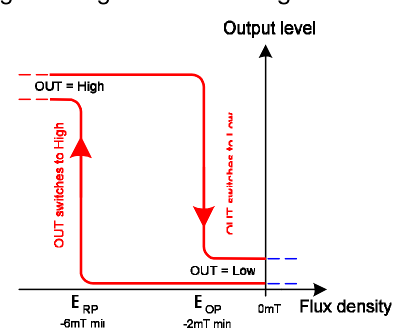
Typically, the device behaves as a latch with symmetric operating and release switching points ($B_{OP}=|B_{RP}|$). This means magnetic fields with equivalent strength and opposite direction drive the output high and low.

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

Depending on the magnetic switching points, the device may also behave as a unipolar positive switch (B_{OP} and B_{RP} strictly positive) or negative switch (B_{OP} and B_{RP} strictly negative). That is the output can be set high and low by only using one magnetic pole. In such case, removing the magnetic field changes the output level.



Unipolar positive switch characteristic

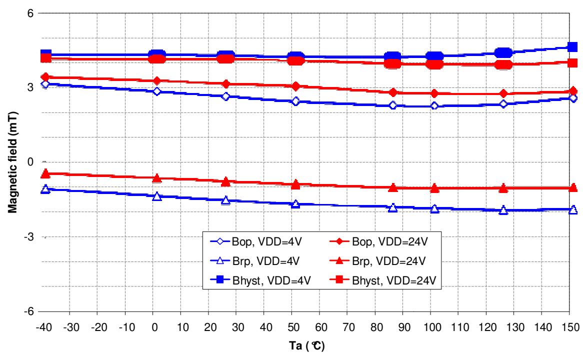


Unipolar negative switch characteristic

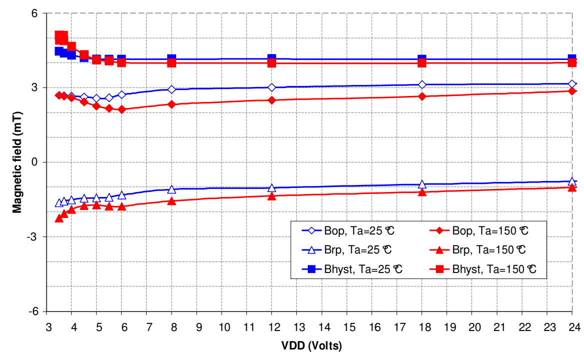
In latch, positive or negative switch behaviour, a magnetic hysteresis B_{HYST} keeps B_{OP} and B_{RP} separated by a minimal value. This hysteresis prevents output oscillation near the switching point.

11 Performance Graphs

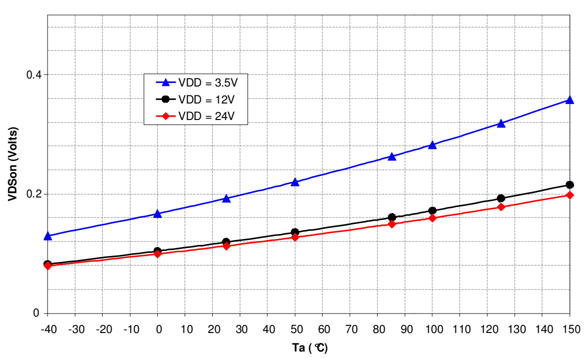
11.1 Magnetic parameters vs. T_A



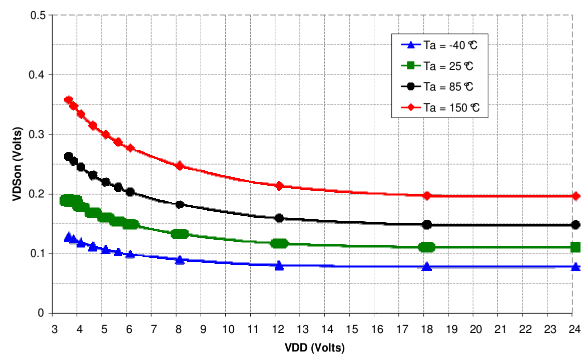
11.2 Magnetic parameters vs. V_{DD}



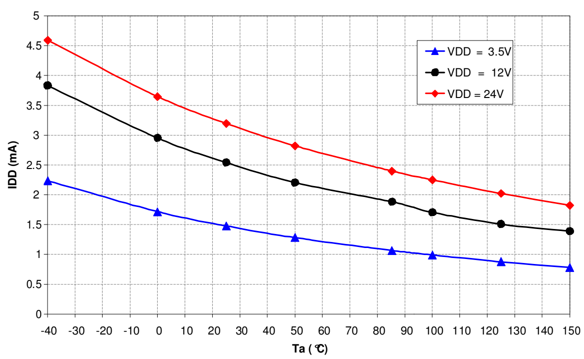
11.3 V_{DSon} vs. T_A



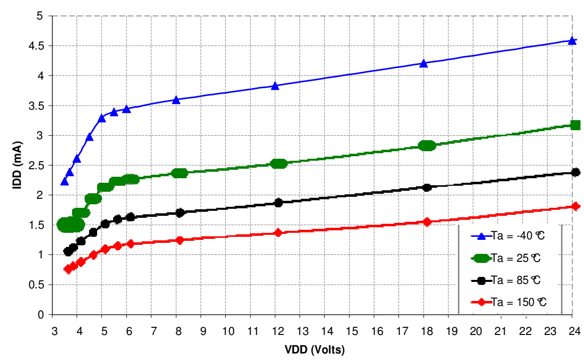
11.4 V_{DSon} vs. V_{DD}



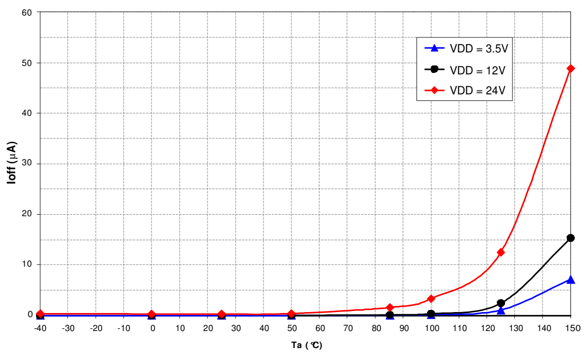
11.5 I_{DD} vs. T_A



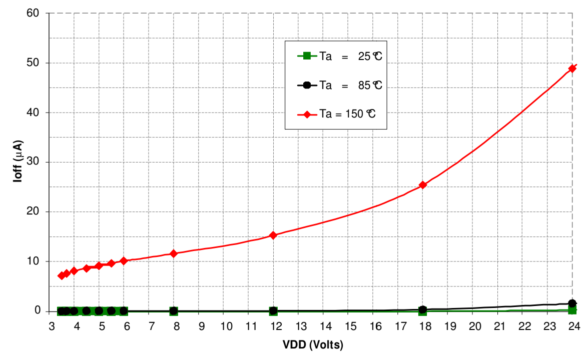
11.6 I_{DD} vs. V_{DD}



11.7 I_{OFF} vs. T_A



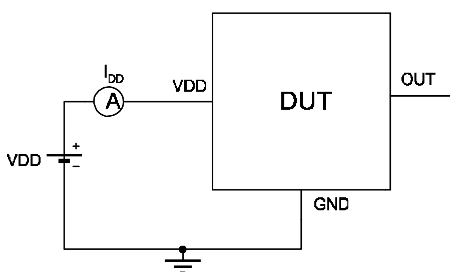
11.8 I_{OFF} vs. V_{DD}



12 Test Conditions

Note : DUT = Device Under Test

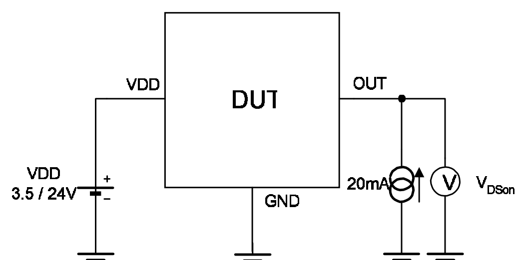
12.1 Supply Current



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 $B<B_{RP}$.

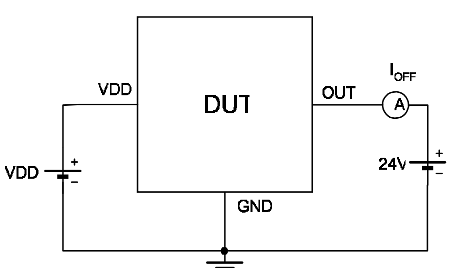
12.2 Output Saturation Voltage



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

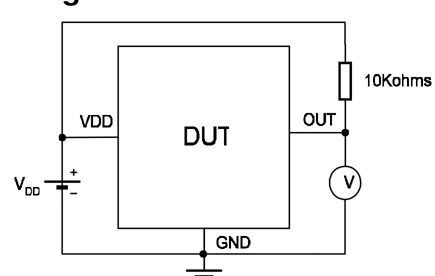
Note 2 - The device is put under magnetic field with $B>B_{OP}$.

12.3 Output Leakage Current



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

12.4 Magnetic Thresholds

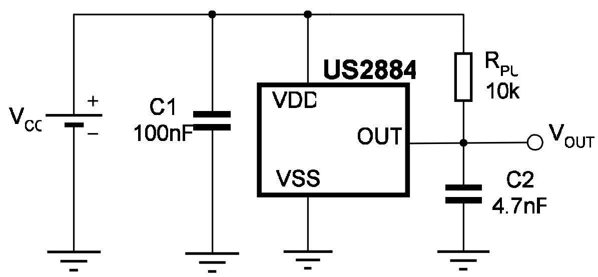


Note 1 - B_{OP} is determined by putting the device under magnetic field swept from E_{RPmin} up to B_{OPmax} until the output is switched on.

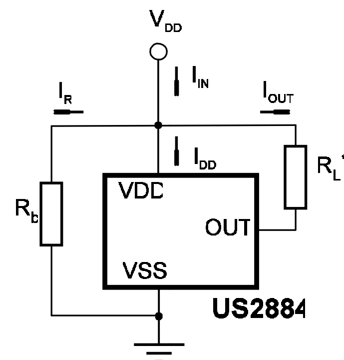
Note 2 - B_{RP} is determined by putting the device under magnetic field swept from E_{OPmax} down to B_{RPmin} until the output is switched off.

13 Application Information

13.1 Typical Three-Wire Application Circuit



13.2 Two-Wire Circuit



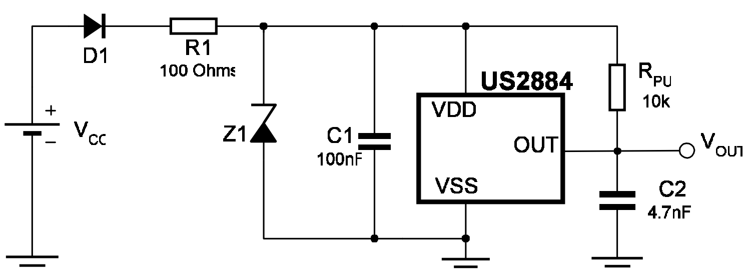
Note:

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

13.3 Automotive and Harsh, Noisy Environments Three-Wire Circuit



14 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 $\leq$ 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.

15 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.

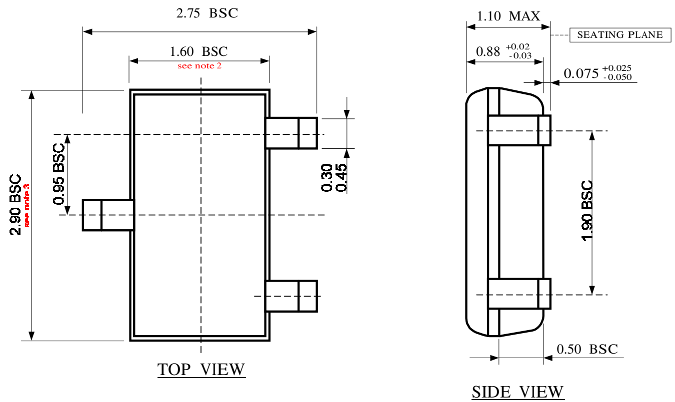
The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

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

16 ESD Precautions

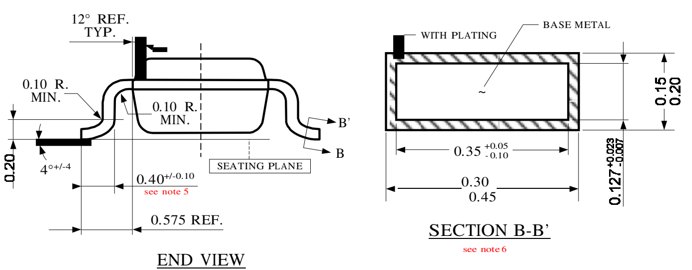
Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

17 SE Package Information (TSOT23-3L)



Notes:

1. All dimensions are in millimeters
2. Outermost plastic extreme width does not include mold flash or protrusions. Mold flash and protrusions shall not exceed 0.15mm per side.
3. Outermost plastic extreme length does not include mold flash or protrusions. Mold flash and protrusions shall not exceed 0.25mm per side.
4. The lead width dimension does not include dambar protrusion. Allowable dambar protrusion shall be 0.07mm total in excess of the lead width dimension at maximum material condition.
5. Dimension is the length of terminal for soldering to a substrate.
6. Dimension on SECTION B-B' are apply to the flat section of the lead between 0.08mm and 0.15mm from the lead tip.
7. Formed lead shall be planar with respect to one another with 0.076mm at seating plane.

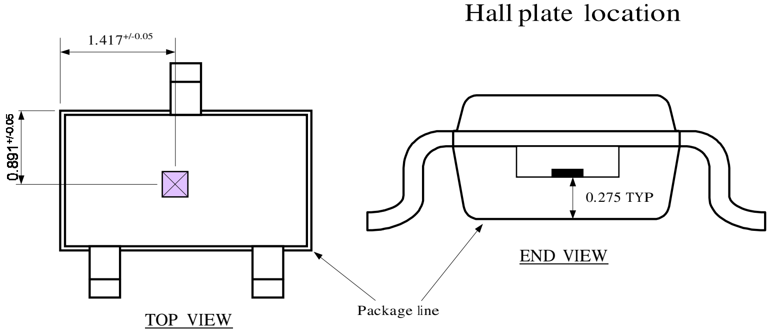


Marking:

Top side : 2884 - Name of the Device

Bottom side : xyww
x = last digit of lot number
y = last digit of year
ww = week

Hall plate location



Notes:

1. All dimensions are in millimeters

18 Disclaimer

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