XENSIV™ magnetic position sensors

Features

- Analog ratiometric linear Hall sensor
- 3.3 V and 5 V nominal supply
- Magnetic sensitivity options (Table 1) to cover different field ranges (V_{DD} = 5 V)
  - TLE49901-1M: ±45 mT
  - TLE49901-2M: ±72 mT
  - TLE49901-3M: ±90 mT
  - TLE49901-4M: ±180 mT
- High 20 kHz sensing bandwidth
- Best-in-class magnetic accuracy
- Low noise output
- Compensation for temperature and stress
- Robust ratiometric analog output interface
- Wide temperature range: -40°C to 150°C
- Small SOT-23 SMD package (see Chapter 6)

Potential applications

- Precise linear and angular position sensing
- Gear position
- Height leveling
- Motor commutation

Product validation

Product validation according to AEC-Q100, grade 0. Qualified for automotive applications.

Description

The TLE49901 is an absolute magnetic field Hall effect sensor in BiCMOS technology with a ratiometric analog output. Thereby the output voltage is proportional to the supply voltage and the applied magnetic field. The Hall element of the sensor is sensitive to magnetic fields perpendicular to the top side. In case of no magnetic field the output is set to V_{DD}/2. With a temperature and stress compensation of the signal, the sensor provides highest accuracy over temperature and lifetime. The sensor incorporates a low noise performance with a large signal bandwidth up to 20 kHz. The power supply voltage range enables the usage in a wide range of different applications including battery supplied devices.

For perfect application fit, different options for the sensitivity of the device are available via ordering option.

Table 1 Ordering information

Product name	Variant	Marking	Ordering code	Package
TLE49901-1M	S = 50 mV/mT (V_{DD} = 5 V) S = 33 mV/mT (V_{DD} = 3.3 V)	E1M	SP006041489	PG-SOT23-3
TLE49901-2M	S = 31.25 mV/mT (V_{DD} = 5 V) S = 20.6 mV/mT (V_{DD} = 3.3 V)	E2M	SP006041498	PG-SOT23-3
TLE49901-3M	S = 25 mV/mT (V_{DD} = 5 V) S = 16.5 mV/mT (V_{DD} = 3.3 V)	E3M	SP006041506	PG-SOT23-3
TLE49901-4M	S = 12.5 mV/mT (V_{DD} = 5 V) S = 8.25 mV/mT (V_{DD} = 3.3 V)	E4M	SP006041510	PG-SOT23-3

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1 Block diagram

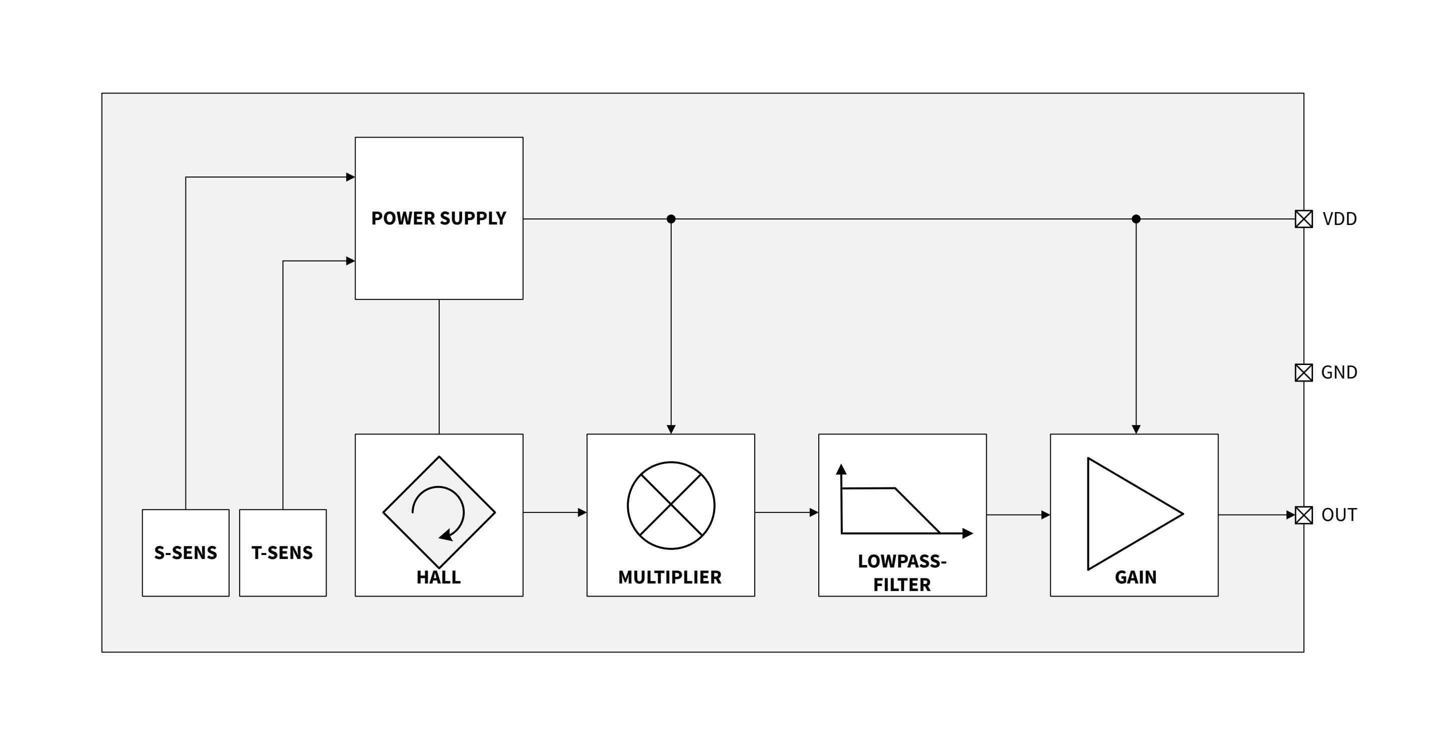


Figure 1 TLE49901 block diagram

The TLE49901 linear analog sensor uses a chopped and spinned Hall element to measure the magnetic flux density. The biasing of the Hall elements is used to compensate for temperature and stress effects offering superior drift performance. The Hall signal is then multiplied with the supply voltage and amplified to provide a fully ratiometric signal output. This also scales the nominal sensitivity of the sensor to the supply voltage accuracy to interface with low-cost analog-to-digital converters. A low-pass filter reduces high frequency noise improving the signal to noise ratio of the signal. The output buffer is able to drive capacitive loads up to a certain extent.

2 Pin configuration

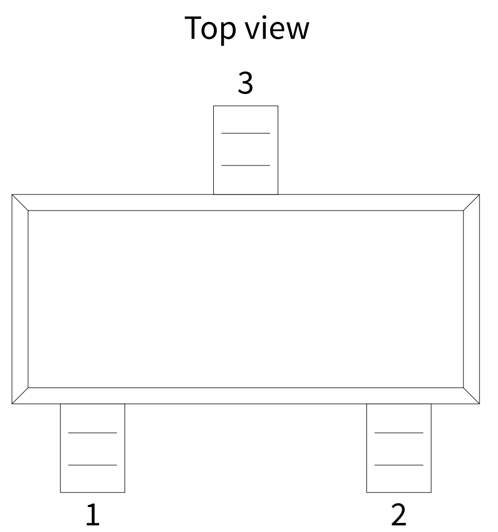


Figure 2 **Pin configuration**

Table 2 **Pin definitions and function**

Pin No.	Symbol	Function
1	VDD	Supply voltage
2	OUT	Analog output
3	GND	Ground

3 General product characteristics

3.1 Absolute maximum ratings

Table 3 Absolute maximum ratings

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	-0.5	–	8.0	V	
Output pin voltage	V_{OUT}	-0.5	–	8.0	V	
Supply current	I_{DD}	–	–	12	mA	
Output current	I_{OUT}	-2	–	2	mA	
Junction temperature	T_J	-40	–	165	°C	
ESD robustness (HBM)	$V_{ESD\ HBM}$	-2	–	2	kV	Human body model (HBM) robustness according to AEC - Q100-002
ESD robustness (CDM)	V_{ESD_CDM}	-750	–	750	V	Charged device model (CDM) robustness according to AEC - Q100-011 Rev-D; voltage refers to test condition (TC) mentioned in the standard

Attention: ***Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the section "functional range" of this data sheet is not implied. Furthermore, only single error cases are assumed. More than one stress/error case may also damage the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. During absolute maximum rating overload conditions the voltage on VDD pins with respect to ground (VSS) must not exceed the values defined by the absolute maximum ratings. Lifetime statements are an anticipation based on an extrapolation of Infineon's qualification test results. The actual lifetime of a component depends on its form of application and type of use etc. and may deviate from such statement. Lifetime statements shall in no event extend the agreed warranty period.***

3.2 Functional range

The following functional range must not be exceeded in order to ensure correct operation of the device. All parameters specified in the following sections refer to these operating conditions unless otherwise indicated.

Table 4 Functional range

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	3	–	5.5	V	
Supply current	I_{DD}	–	5.5	7	mA	I_{out} sourced to GND has to be added
Output current	I_{OUT}	-1	–	1	mA	

(table continues...)

Table 4 (continued) Functional range

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Power-on reset voltage	V_{POR}	2.55	2.75	2.95	V	For $V_{DD} < V_{POR}$ the output is set to high impedance
Load resistance	R_L	4.2	4.7	–	kΩ	
Load capacitance	C_L	1	4.7	6.8	nF	
Ambient temperature	T_A	-40	–	150	°C	

3.3 Thermal resistance

Table 5 Thermal resistance

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Thermal Resistance Junction-to-Ambient	R_{thJA}	–	–	180	K/W	Measured on 2s2p PCB board

4 Product features

4.1 Functional description

4.1.1 Signal processing

The TLE49901 is a linear Hall sensor with an analog output interface. It measures the magnetic flux density *B* perpendicular to the package (see Figure 3). The Hall elements are spinned and chopped for minimal initial offset and high linearity of the sensor. For stable accuracy the signal is temperature and stress compensated. The magnetic range of the sensor can be selected via ordering option. It offers a large signal bandwidth and low noise for fast applications. The output buffer is a fully ratiometric output buffer with low offset from the quiescent voltage and high linearity to interface seamlessly with general purpose ADC architectures.

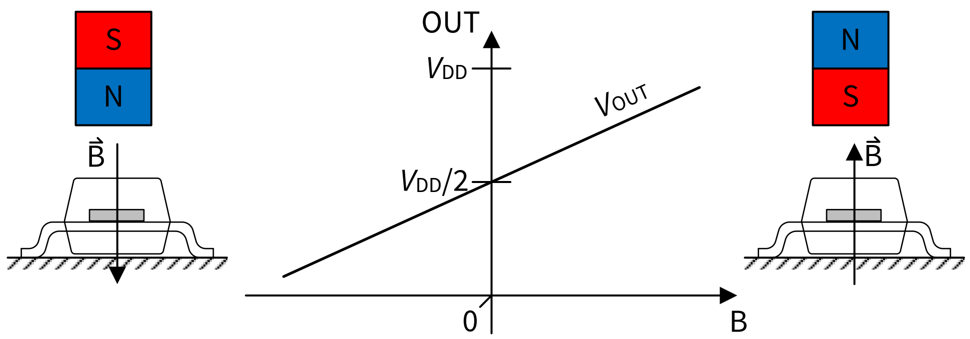


Figure 3 Magnetic field direction with corresponding sensor out signal

4.1.2 Ratiometric output

The sensor has a ratiometric output signal. This means that the sensitivity and output quiescent voltage is dependent on the supply voltage. In case the supply voltage changes also the sensitivity and quiescent voltage are simultaneously adapted. For example as shown in Figure 4 if the supply voltage increases 10% also V_Q increases with the same percentage. The sensitivity also changes with V_{DD} therefore the ratio between V_{DD} and the output signal is constant for a static magnetic field. An ADC which uses V_{DD} as reference voltage therefore converts consistent values independent from power supply variation.

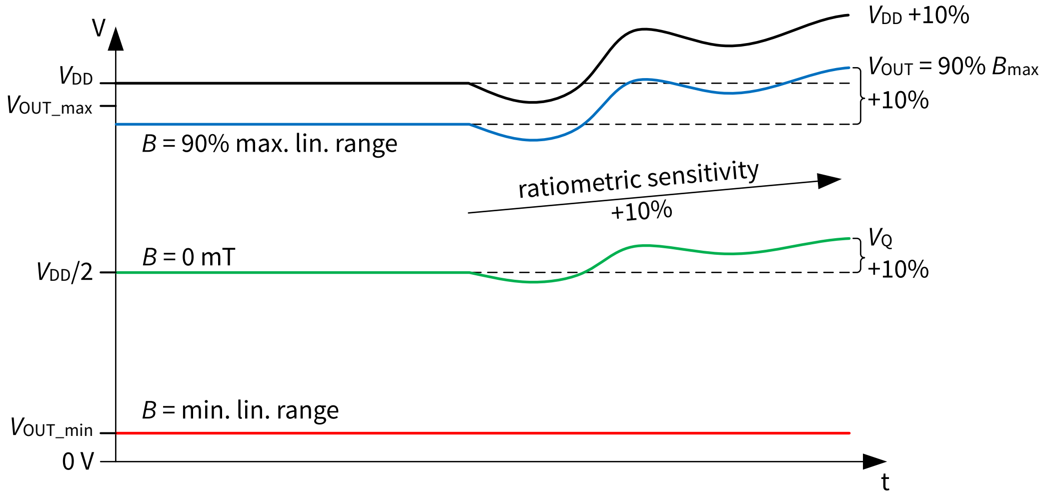


Figure 4 Ratiometric output behavior

4.2 Electrical characteristics

For functional range, V_{DD} = $V_{DD\_nominal}$ = 3.3 V or 5 V unless otherwise specified.

Table 6 Electrical characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Linear output voltage range	V_{OUT}	250	–	V_{DD} -250	mV	Valid for I_{OUT} = 1 mA
Power-on time	t_{Pon}	–	80	100	µs	For definition of t_{Pon} see Figure 6
Signal bandwidth	f_{BW}	–	20	–	kHz	
Output quiescent voltage	V_Q	2.48	2.50	2.52	V	T_A = 25°C, B = 0 mT, V_{DD} = 5 V
		1.63	1.65	1.67	V	T_A = 25°C, B = 0 mT, V_{DD} = 3.3 V
Output quiescent voltage drift	ΔV_Q	-25	–	25	mV	B = 0 mT, including temperature and lifetime drift
Ratiometry offset error	ΔV_{R0}	-0.3	±0.06	0.3	% of V_{DD}/2	B = 0 mT, additional offset error due to V_{DD} variation
Out RMS noise	$V_{N\_RMS\_1M}$	–	1.20	–	mV	S = 50 mV/mT, V_{DD} = 5 V
		–	1.07	–	mV	S = 33 mV/mT, V_{DD} = 3.3 V
	$V_{N\_RMS\_2M}$	–	0.75	–	mV	S = 31.25 mV/mT, V_{DD} = 5 V
		–	0.70	–	mV	S = 20.6 mV/mT, V_{DD} = 3.3 V
	$V_{N\_RMS\_3M}$	–	0.65	–	mV	S = 25 mV/mT, V_{DD} = 5 V
		–	0.63	–	mV	S = 16.5 mV/mT, V_{DD} = 3.3 V
	$V_{N\_RMS\_4M}$	–	0.40	–	mV	S = 12.5 mV/mT, V_{DD} = 5 V
		–	0.35	–	mV	S = 8.3 mV/mT, V_{DD} = 3.3 V

4.3 Sensing characteristics

For functional range, V_{DD} = $V_{DD\_nominal}$ = 3.3 V or 5 V unless otherwise specified.

Table 7 Sensing characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Magnetic Field Range						
Magnetic field range	B_{1M}	–	±45	–	mT	S = 50 mV/mT, T_A = 25°C, V_{DD} = 5 V
		–	±42	–	mT	S = 33 mV/mT, T_A = 25°C, V_{DD} = 3.3 V

(table continues...)

Table 7 **(continued) Sensing characteristics**

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Magnetic field range	B_{2M}	–	±72	–	mT	S = 31.25 mV/mT, T_A = 25°C, V_{DD} = 5 V
		–	±68	–	mT	S = 20.6 mV/mT, T_A = 25°C, V_{DD} = 3.3 V
	B_{3M}	–	±90	–	mT	S = 25 mV/mT, T_A = 25°C, V_{DD} = 5 V
		–	±85	–	mT	S = 16.5 mV/mT, T_A = 25°C, V_{DD} = 3.3 V
	B_{4M}	–	±180	–	mT	S = 12.5 mV/mT, T_A = 25°C, V_{DD} = 5 V
		–	±169	–	mT	S = 8.3 mV/mT, T_A = 25°C, V_{DD} = 3.3 V
Sensing characteristics						
Sensitivity	S_{1M}	48.75	50	51.25	mV/mT	T_A = 25°C, V_{DD} = 5 V
		32.18	33	33.83	mV/mT	T_A = 25°C, V_{DD} = 3.3 V
	S_{2M}	30.47	31.25	32.03	mV/mT	T_A = 25°C, V_{DD} = 5 V
		20.01	20.6	21.12	mV/mT	T_A = 25°C, V_{DD} = 3.3 V
	S_{3M}	24.38	25	25.63	mV/mT	T_A = 25°C, V_{DD} = 5 V
		16.09	16.5	16.91	mV/mT	T_A = 25°C, V_{DD} = 3.3 V
	S_{4M}	12.19	12.5	12.81	mV/mT	T_A = 25°C, V_{DD} = 5 V
		8.04	8.25	8.46	mV/mT	T_A = 25°C, V_{DD} = 3.3 V
Sensitivity temperature coefficient	S_{TC}	–	1200	–	ppm/K	Temperature compensation for magnets. See Chapter 5.4
Sensitivity linearity error	S_{LE}	-0.5	–	0.5	%	T_A = 25°C
Sensitivity drift over temperature	ΔS_T	-3	±1.5	3	%	
Sensitivity drift over lifetime	ΔS	-2	–	2	%	
Ratiometry sensitivity error	ΔS_{RE}	-1	–	1	%	additional sensitivity error due to V_{DD} variation

5 Application information

***Note**: The following information is given as a hint for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.*

5.1 Application circuit

The application circuit recommends a supply capacitance C_S of 47nF to suppress any supply voltage disturbances. Furthermore, the output can drive an output load which is specified either by a capacitive load up to C_L or a resistive load of R_L (see Table 4).

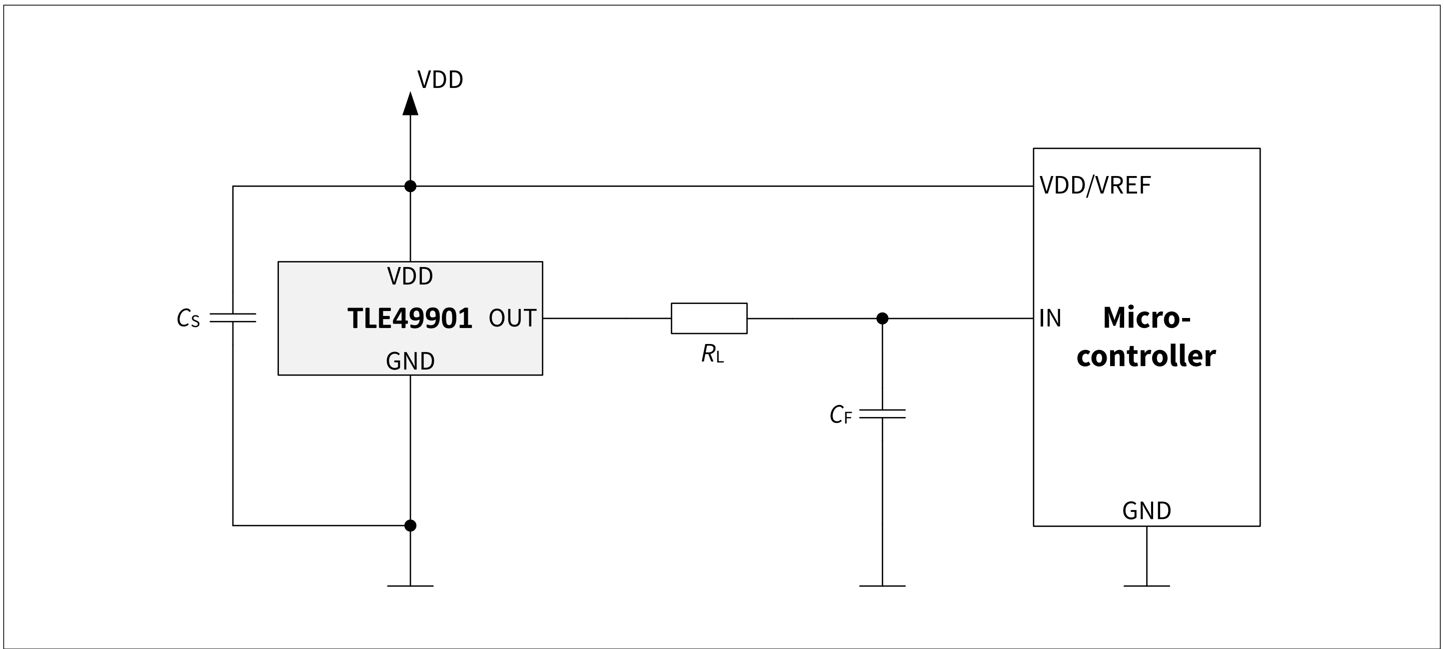


Figure 5 Recommended application circuit

***Note**: This is a very simplified example. The function must be verified in the real application.*

5.2 Adding a low-pass filter

For applications which do not need the full bandwidth, a low-pass filter can be added at the output line of the sensor. This filter reduces noise and improves the signal quality. With the resistor R_L and the capacitance C_F an RC low-pass filter can be added at the sensor output to improve the signal to noise ratio (see Figure 5). Important for the filter design is, that the overall capacitive load on the sensor output is below the limit C_L (Table 4).

5.3 Power on time

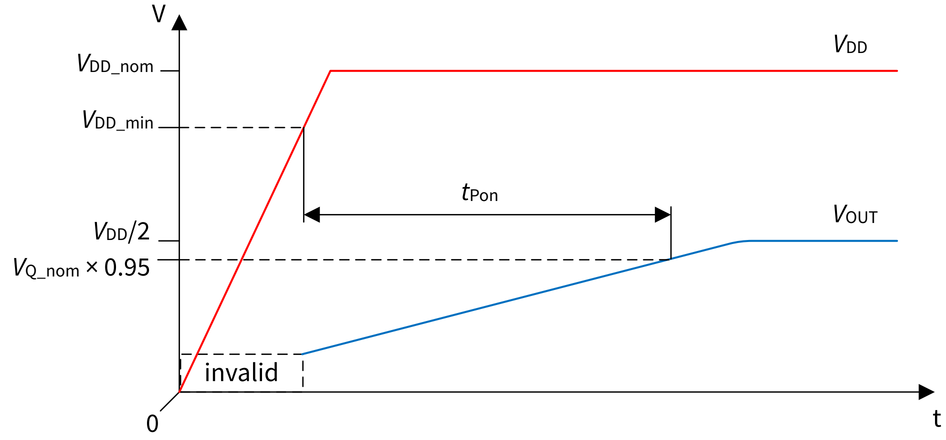


Figure 6 **Definition of power on time**

5.4 Temperature compensation for magnets

The magnetic field strength of a permanent magnet decreases in case of temperature increase. To counterbalance this behavior the sensor has implemented a compensation for the magnet temperature drift. The compensation is designed to work best with sintered NdFeB magnets which decreases at 0.12 %/°C. For magnets with other material, for example ferrite which decreases 0.2 %/°C, the compensation works with reduced performance.

5.5 Select optimal magnetic range option

The TLE49901 is available with different sensitivities (see Table 7). This enables the users to adapt the measuring range of the sensor to the application needs. The range shall be selected that the minimum and maximum magnetic field are close to the limits of the magnetic field range of the sensor. This maximizes the output voltage swing and results in high measurement accuracy. A magnetic simulation online tool to help design the magnetic circuit and select the correct sensitivity is available at https://www.infineon.com.

5.6 Application examples

This linear Hall sensor is capable to sense a magnetic field perpendicular to its surface. With a correct setup of magnet and sensor it is possible to measure linear as well as angular movement. The following figures are examples of how to implement the sensor setup for the different measurement requirements and show possible output behavior. Therefore the sensor can be used in wide range of different position sensing applications.

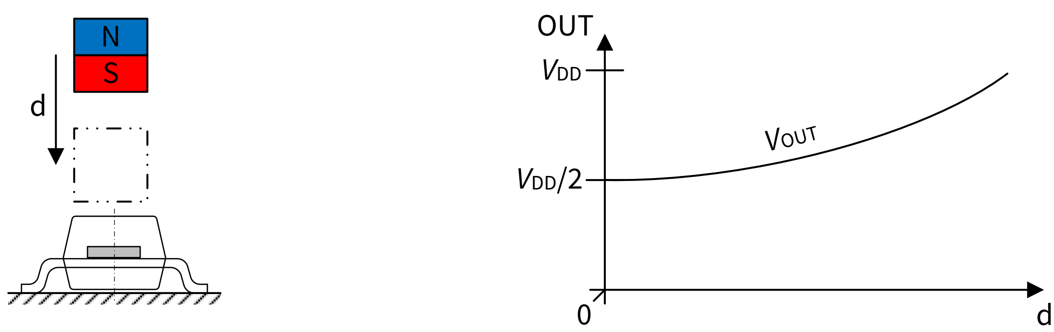


Figure 7 **Example for linear movement application with magnet approaching the sensor**

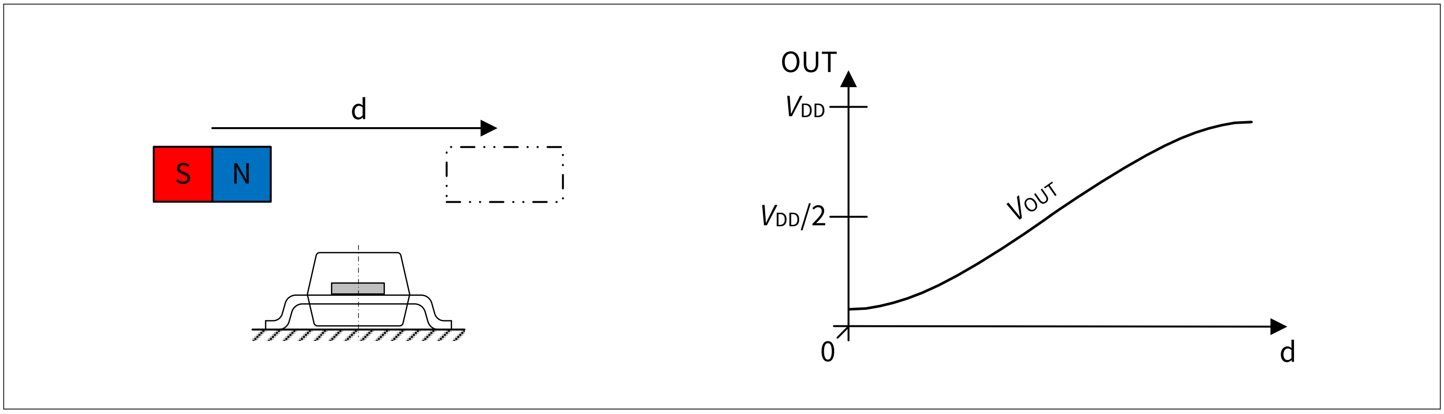


Figure 8 **Example for linear movement applications with magnet passing-by the sensor**

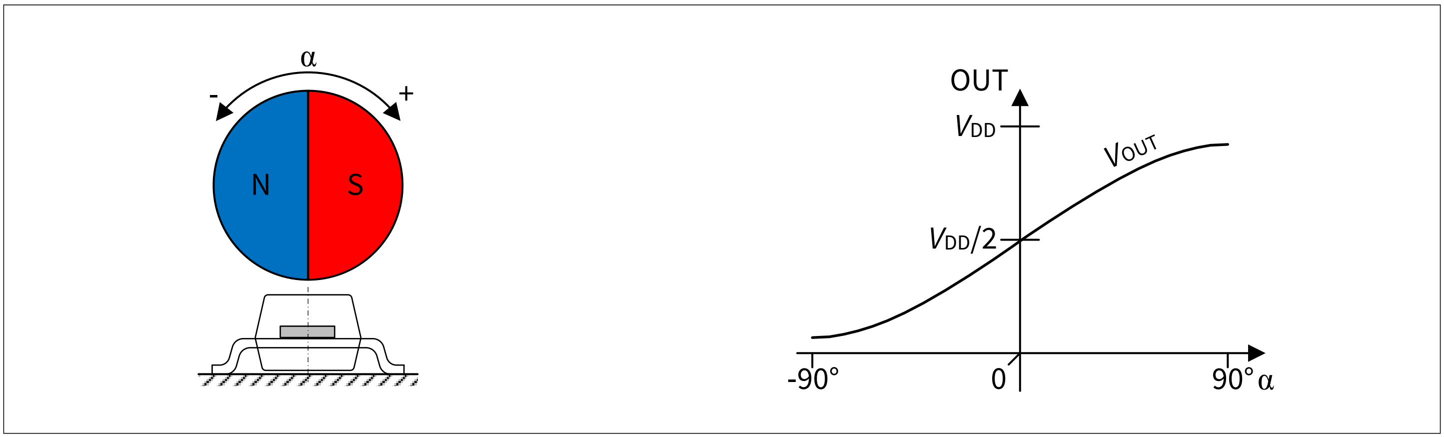


Figure 9 **Example for angle measurement smaller 180° with diametral disc magnet**

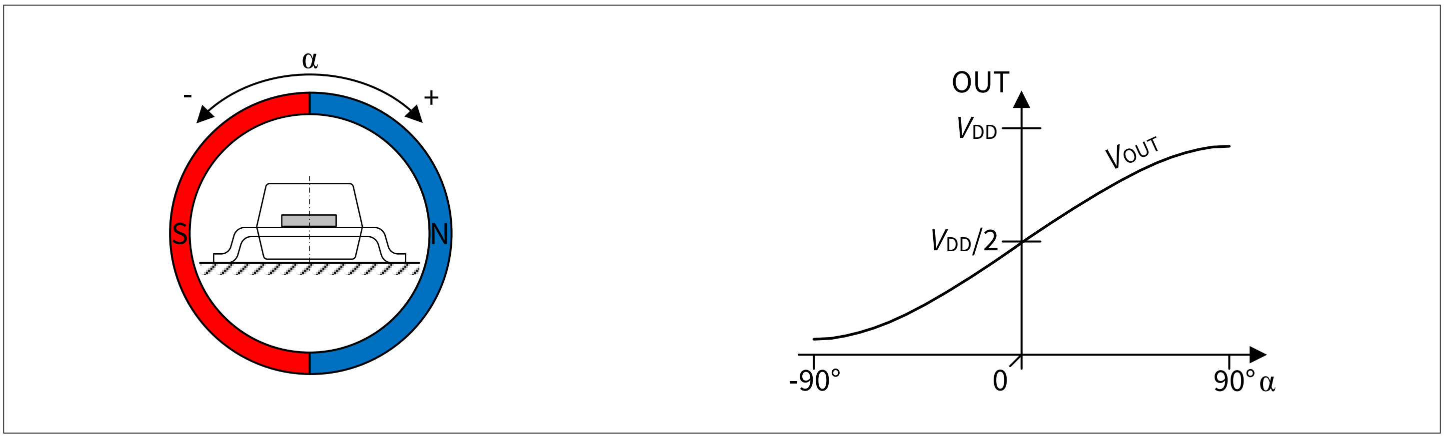


Figure 10 **Examples for angle measurement smaller 180° with diametral ring magnet**

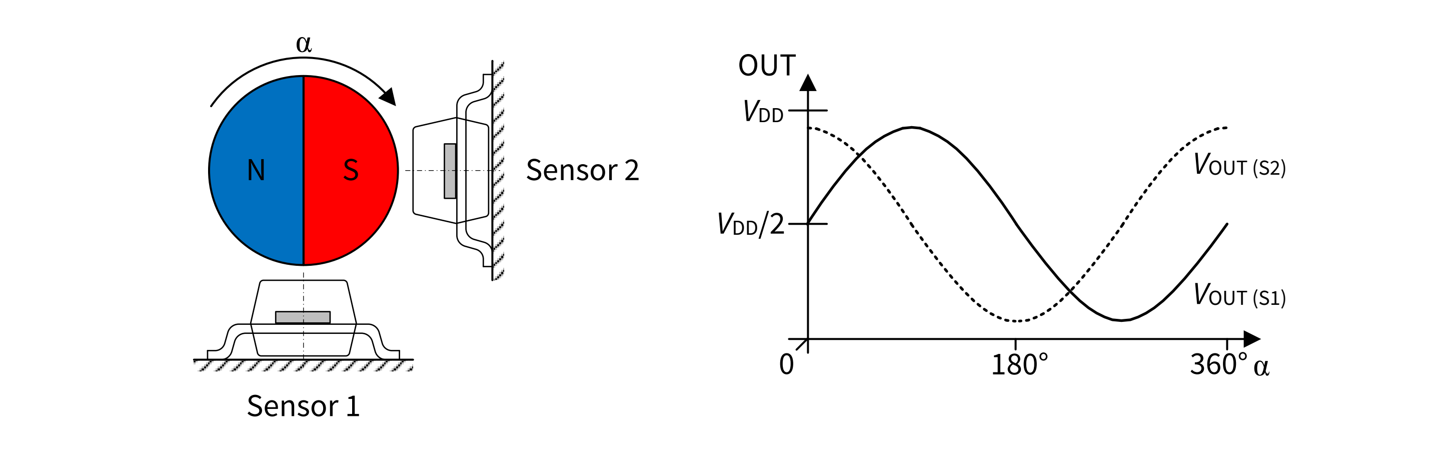
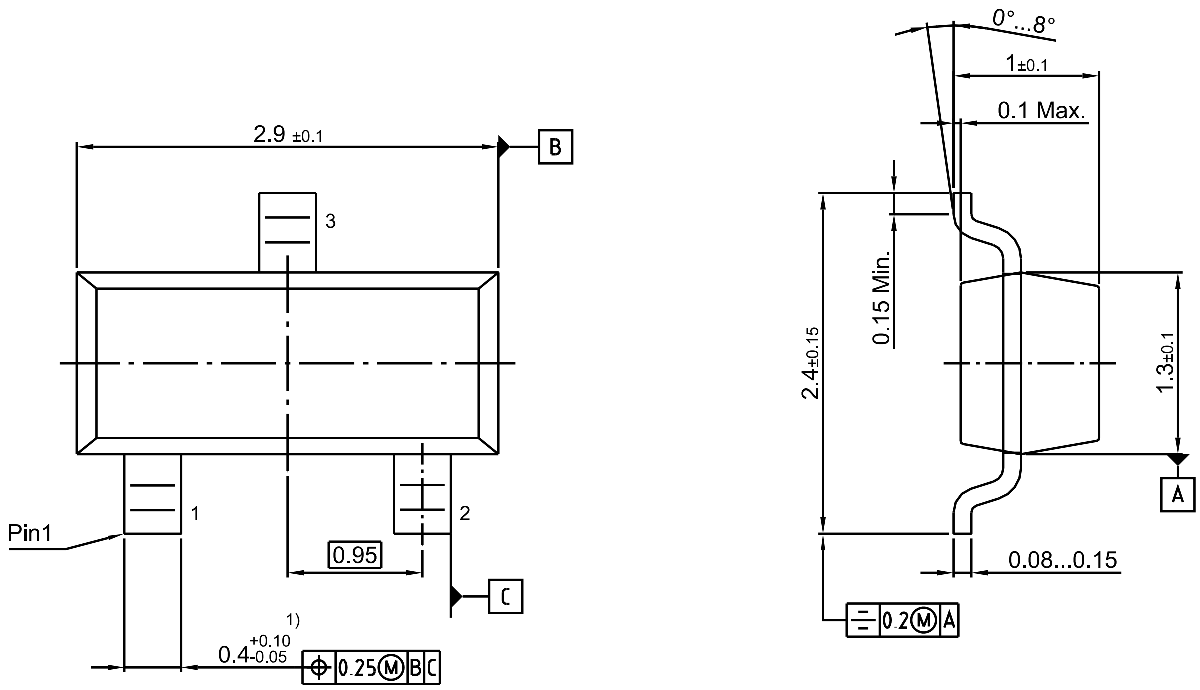


Figure 11 **Example of angle measurement up to 360° with diametral disc magnet and two sensors**

6 Package information

The device is mounted in the PG-SOT23-3-15 package.

The PG-SOT23-3 package fulfills the MSL level 1 according to IPC/JEDEC J-STD-033B.1.



1) Lead width can be 0.6 max.in dambar area
All dimensions are in units mm
The drawing is in compliance with ISO 128-30, Projection Method 1 [ ]
Drawing according to ISO 8015, general tolerances ISO 2768-mK

Figure 12 **PG-SOT23-3 package outline**

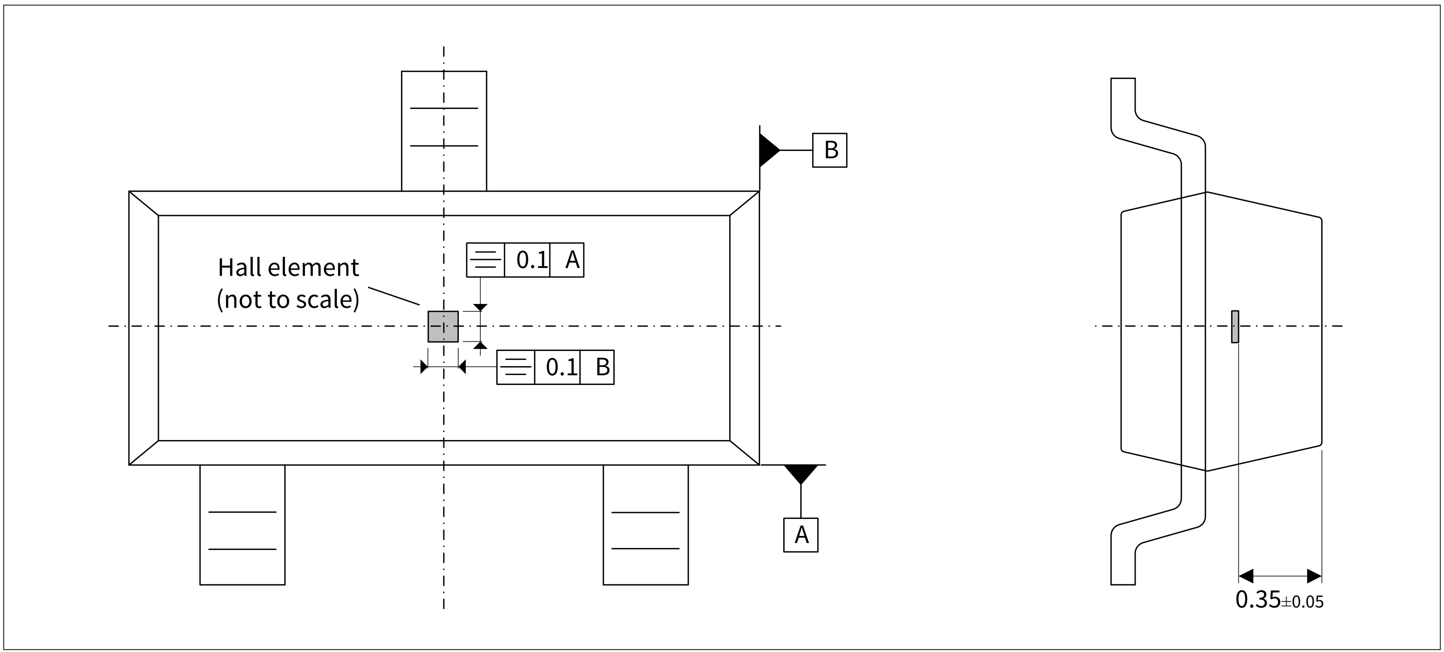


Figure 13 **Sensing element placement inside package**

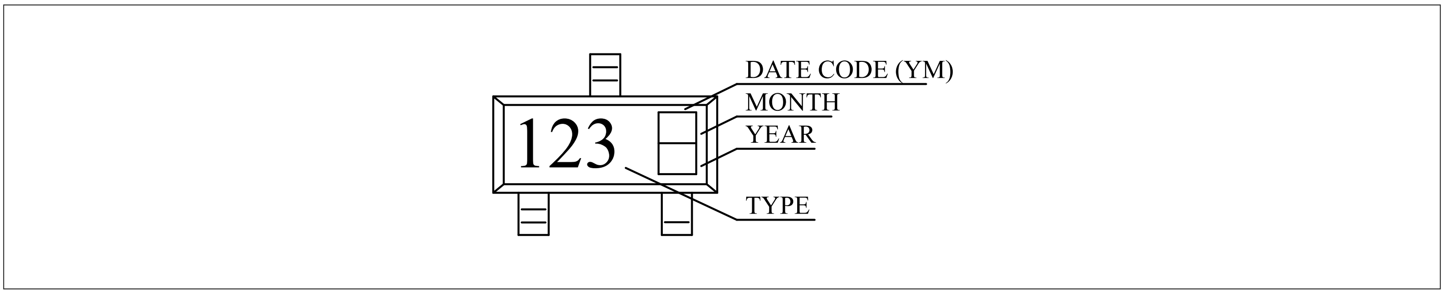


Figure 14 **Package marking**

6.1 Further information on packages

Further information like footprint or packaging drawings are available at https://www.infineon.com.

7 Revision history

Revision number	Date of release	Description of changes
1.00	2026-02-13	Initial release

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