

# TLE4946-2L

## High Precision Hall Effect Latch

### About this document

#### Overview

The TLE4946-2L is a high precision Hall effect latch with highly accurate switching thresholds for operating temperatures up to 150°C.



#### Features

- 2.7 V to 18 V supply voltage operation.
- Operation from unregulated power supply.
- High sensitivity and high stability of the magnetic switching points.
- High resistance to mechanical stress by active error compensation
- Reverse battery protection ( $V_S = -18\text{ V}$ )
- Superior temperature stability
- Low jitter (typically 1  $\mu\text{s}$ )
- High ESD performance ( $\pm 4\text{ kV HBM}$ )
- Digital output signal

#### Target applications

The TLE4946-2L is an integrated circuit Hall-effect sensor with low switching thresholds and low hysteresis. It is specially designed for high sensitivity applications and is ideally suited to detect the rotor position in a BLDC motor. Also for index counting with small pole wheels and large air gaps the sensor provides a reliable switching information.

Product name	Product type	Ordering code	Package
Hall Effect Latch	TLE4946-2L	SP000398352	PG-SSO-3-2

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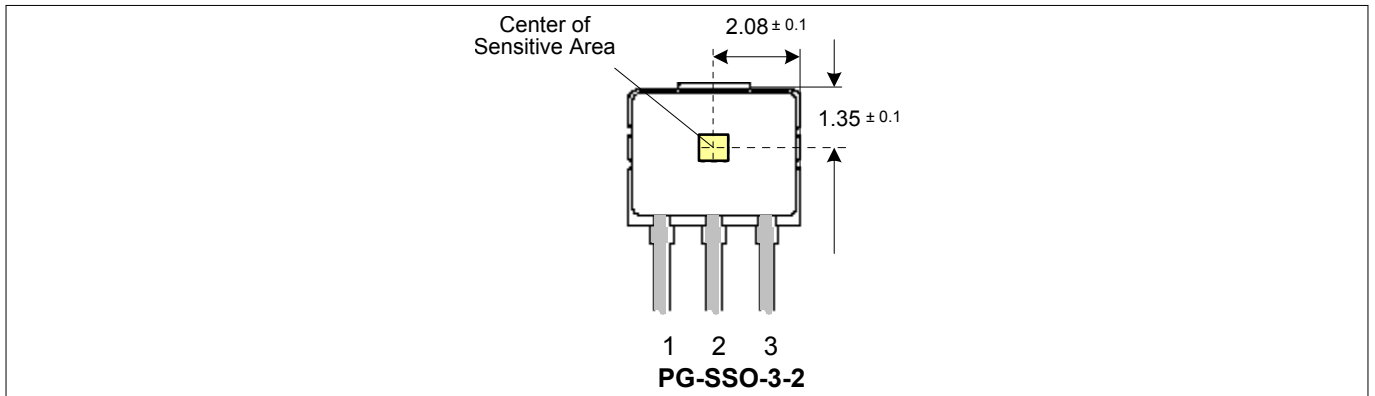
**1 Functional description**

**1 Functional description**

**1.1 General**

Precise magnetic switching thresholds and high temperature stability are achieved by active compensation circuits and chopper techniques on chip. Offset voltages, generated by temperature induced stress or overmolding are canceled and high accuracy is achieved. The IC has an open collector output stage with 20 mA current sink capability. A wide operating voltage range from 2.7 V to 18 V with reverse polarity protection up to -18V makes the device suitable for a wide range of applications. A magnetic south pole with field strength above  $B_{op}$  turns the output on and a magnetic north pole exceeding  $B_{rp}$  turns it off.

**1.2 Pin configuration**



**Figure 1 Pin configuration and sensitive area (Top View, Figure not to Scale)**

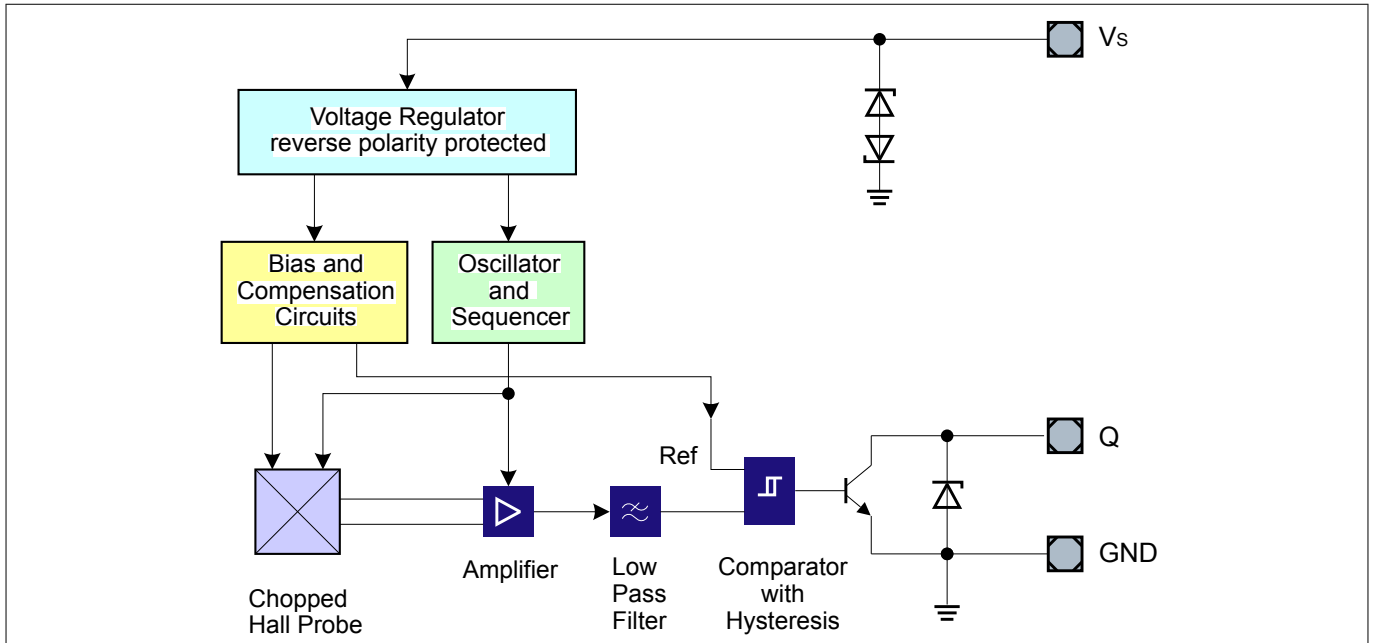
**1.3 Pin description**

**Table 1 Pin description**

Pin or Ball No.	Name	Pin Type	Function	Comments
1	Vs	I	Supply voltage	
2	GND	O	Ground	
3	Q	O	Output	

**1 Functional description**

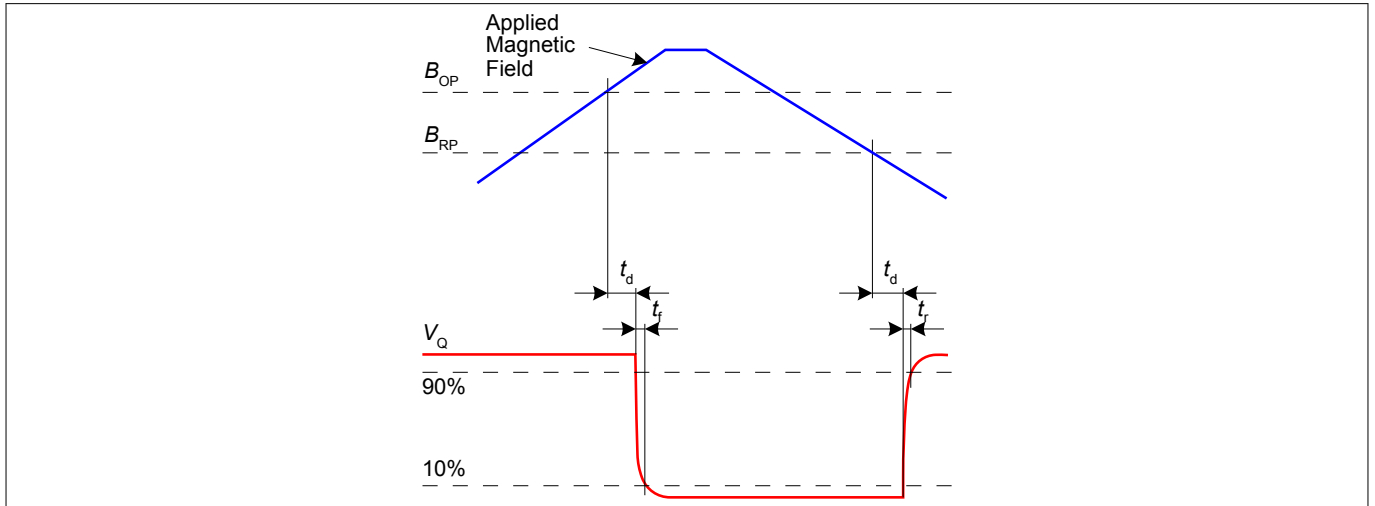
**1.4 Block diagram**



**Figure 2 TLE4946-2L Block diagram**

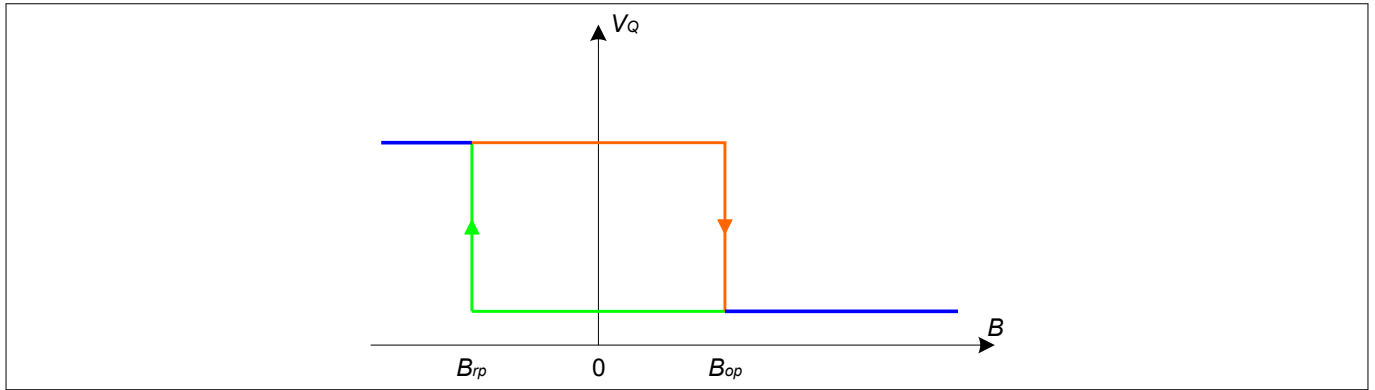
**1.5 Operating modes and states**

Field Direction Definition: Positive magnetic fields are related with the south pole of the magnet to the branded side of package.



**Figure 3 Timing diagram**

## 1 Functional description



**Figure 4** Output signal

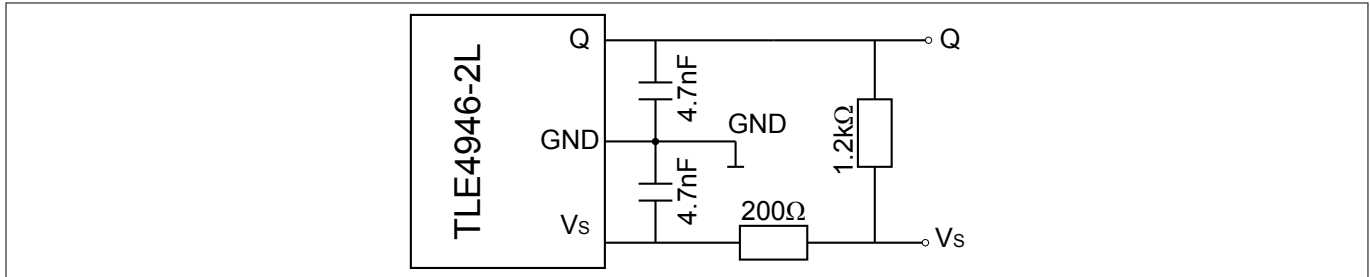
### 1.6 Functional block description

The chopped Hall IC switch comprises a Hall probe, bias generator, compensation circuits, oscillator and output transistor. The bias generator provides currents for the Hall probe and the active circuits. Compensation circuits stabilize the temperature behavior and reduce technology variations. The Active Error Compensation rejects offsets in signal stages and the influence of mechanical stress to the Hall probe caused by molding and soldering processes and other thermal stresses in the package. This chopper technique together with the threshold generator and the comparator ensure high accurate magnetic switching points.

**2 Specification**

**2 Specification**

**2.1 Application circuit**



**Figure 5 Application circuit**

It is recommended to use a serial resistor of 200 Ω in the supply line for current limitation in the case of an overvoltage pulse. Two capacitors of 4.7 nF enhance the EMC performance. The pull-up resistor of 1.2 kΩ limits the current through the output transistor.

**2.2 Absolute maximum ratings**

**Table 2 Absolute maximum ratings**

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Max. junction temperature	$T_J$	-40	-	150	°C	
		-	-	155		for 2000 h (not additive)
		-	-	165		for 1000 h (not additive)
		-	-	175		for 168 h (not additive)
		-	-	195		for 3 x 1 h (additive)
Supply voltage	$V_{DD}$	-18	-	18	V	
		-18	-	24		for 1h, $R_S \geq 200 \Omega$
		-18	-	26		for 5min, $R_S \geq 200 \Omega$
Supply current through protection device	$I_S$	-50	-	50	mA	
Output voltage	$V_Q$	-0.7	-	18	V	
		-0.7	-	26		for 5min @ 1.2 kΩ pull up
Storage temperature	$T_S$	-40	-	150	°C	
Magnetic flux density	B		-	unlimited	mT	
ESD robustness HBM: 1.5 kΩ, 100 pF	$V_{ESD,HBM}$	4			kV	According to EIA/JESD22-A114-B

**Attention:** Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

## 2 Specification

### 2.3 Operating range

The following operating conditions must not be exceeded in order to ensure correct operation of the TLE4946-2L. All parameters specified in the following sections refer to these operating conditions unless otherwise mentioned.

**Table 3** Operating range

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply voltage	$V_S$	2.7	–	18	V	
Output voltage	$V_Q$	-0.7	–	18	V	
Junction temperature	$T_j$	-40	–	150	°C	
Output current	$I_Q$	0	–	20	mA	

### 2.4 Characteristics

Product characteristics involve the spread of values guaranteed within the specified voltage and ambient temperature range. Typical characteristics are the median of the production (at  $V_S = 12\text{ V}$  and  $T_A = 25^\circ\text{C}$ ).

**Table 4** Electrical Characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply current	$I_S$	2	4	6	mA	$V_S = 2.7\text{ V} \dots 18\text{ V}$
Reverse current	$I_{SR}$	0	0.2	1	mA	$V_S = -18\text{ V}$
Output saturation voltage	$V_{QSAT}$	–	0.3	0.6	V	$I_Q = 20\text{ mA}$
Output leakage current	$I_{QLEAK}$	–	0.05	10	$\mu\text{A}$	for $V_Q = 18\text{ V}$
Output fall time	$t_f$	–	0.02	1	$\mu\text{s}$	$R_L = 1.2\text{ k}\Omega$ ; $C_L = 50\text{ pF}$
Output rise time	$t_r$	–	0.4	1	$\mu\text{s}$	
Chopper frequency	$f_{OSC}$	–	320	–	kHz	
Switching frequency	$f_{SW}$	0	–	15 <sup>(1)</sup>	kHz	
Delay time <sup>(2)</sup>	$t_d$	–	13	–	$\mu\text{s}$	
Output jitter <sup>(3)</sup>	$t_{QJ}$	–	1	–	$\mu\text{s}_{RMS}$	Typ. value for square wave signal 1 kHz
Power-on time <sup>(4)</sup>	$t_{PON}$	–	13	–	$\mu\text{s}$	$V_S \geq 2.7\text{ V}$
Thermal resistance <sup>(5)</sup>	$R_{thJA}$	–		190	K/W	PG-SSO-3-2

(1) To operate the sensor at the max. switching frequency, the value of the magnetic signal amplitude must be 1.4 times higher than for static fields. This is due to the -3 dB corner frequency of the low pass filter in the signal path.

(2) Systematic delay between magnetic threshold reached and output switching

(3) Jitter is the unpredictable deviation of the output switching delay

(4) Time from applying  $V_S \geq 2.7\text{ V}$  to the sensor until the output state is valid

(5) Thermal resistance from junction to ambient

**2 Specification**

**Table 5**                    **Magnetic characteristics**

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Operate point	$B_{OP}$	0.5	2.0	3.5	mT	
Release point	$B_{RP}$	-3.5	-2.0	-0.5	mT	
Hysteresis	$B_{HYS}$	1.0	4	6.0	mT	
Magnetic Offset <sup>(1)</sup>	$B_{OFF}$	-1.5	0	1.5	mT	
Temperature compensation of magn. thresholds	$TC$		-350		ppm/°C	
Repeatability of magnetic thresholds <sup>(2)</sup>	$B_{REP}$		20		$\mu T_{RMS}$	

(1)  $B_{off} = (B_{op} + B_{rp}) / 2$

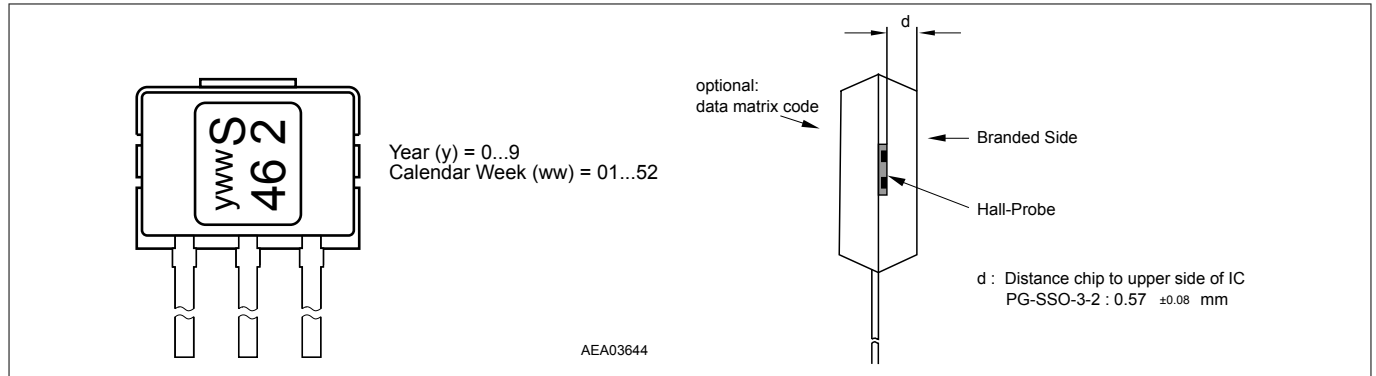
(2)  $B_{REP}$  is equivalent to the noise constant



**3 Package information**

**3 Package information**

**3.1 Package outline**



**Figure 6 Marking of TLE4946-2L and Distance of chip to upper side of IC**

3 Package information

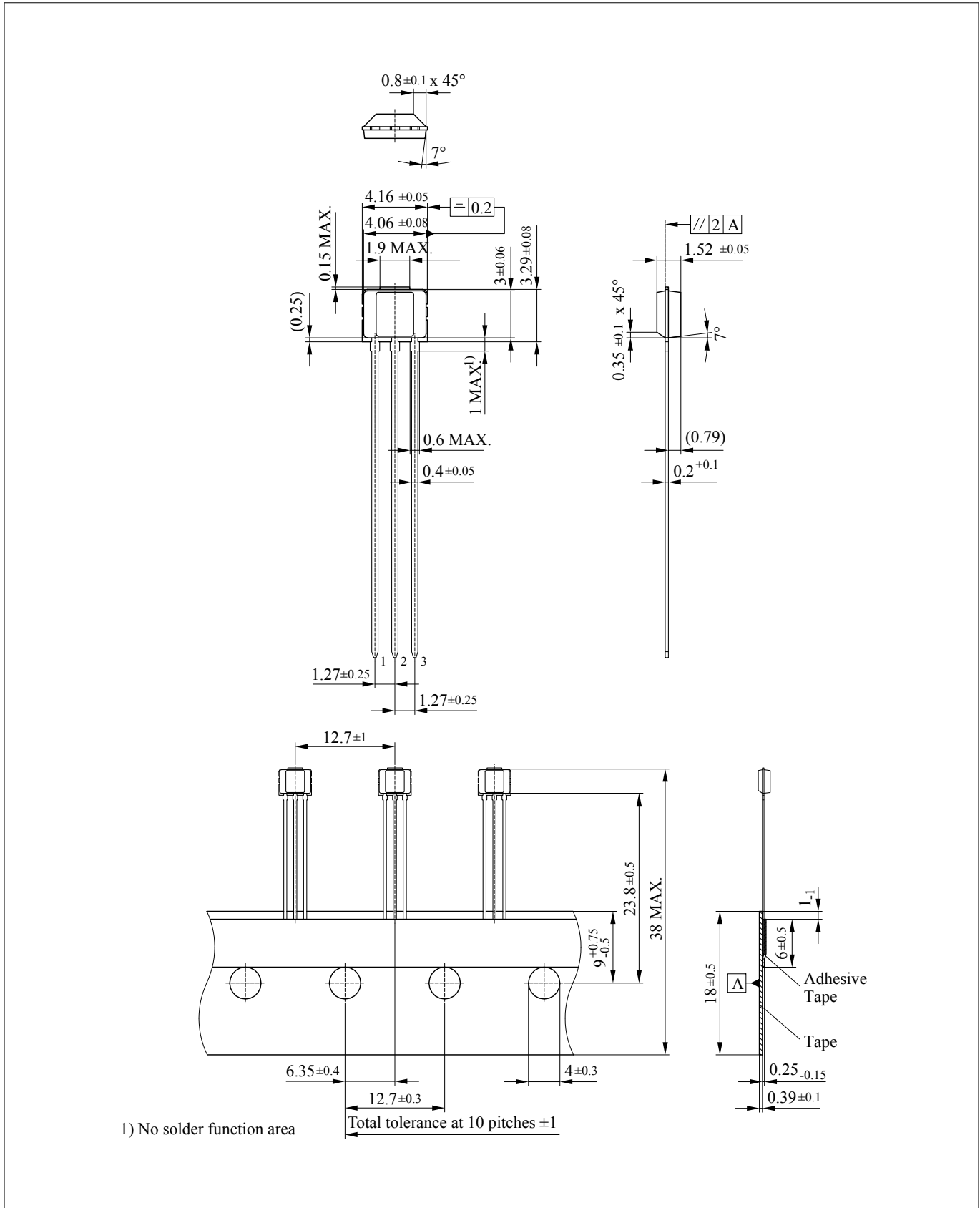


Figure 7 Package outline

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**4 Revision history**

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**Revision History**

<b>Page</b>	<b>Subjects (major changes since last revision)</b>
Revision History: 2020-08, Rev 1.1	
Previous Revisions: 1.0	
10	Edited figure 6 (optional: data matrix code)

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