XENSIV™ magnetic position sensors

RoHS

Features

- Two discrete linearized TMR bridges
- Differential sine and cosine output
- Ratiometric output signals
- High precision length measurement with multipole stripe magnet
- Wide temperature range from -40°C to 125°C
- Extreme small 6-ball wafer level package, 1.27 * 0.93 * 0.4mm (see Chapter 6)

Potential applications

- Linear and angular incremental position sensing in industrial and consumer applications with highest accuracy requirements
- Lens positioning for zoom and focus adjusting in cameras

Product validation

Qualified for industrial applications according to JEDEC JESD47K.

Description

The TLI5590 is a two channel ratiometric gradiometer for high precise length measurement.

Table 1

Product Name	Marking	Ordering Code	Package
TLI5590-A6W	90A0	SP005631773	SG-WFWLB-6-3

Table of contents

1 Block diagram

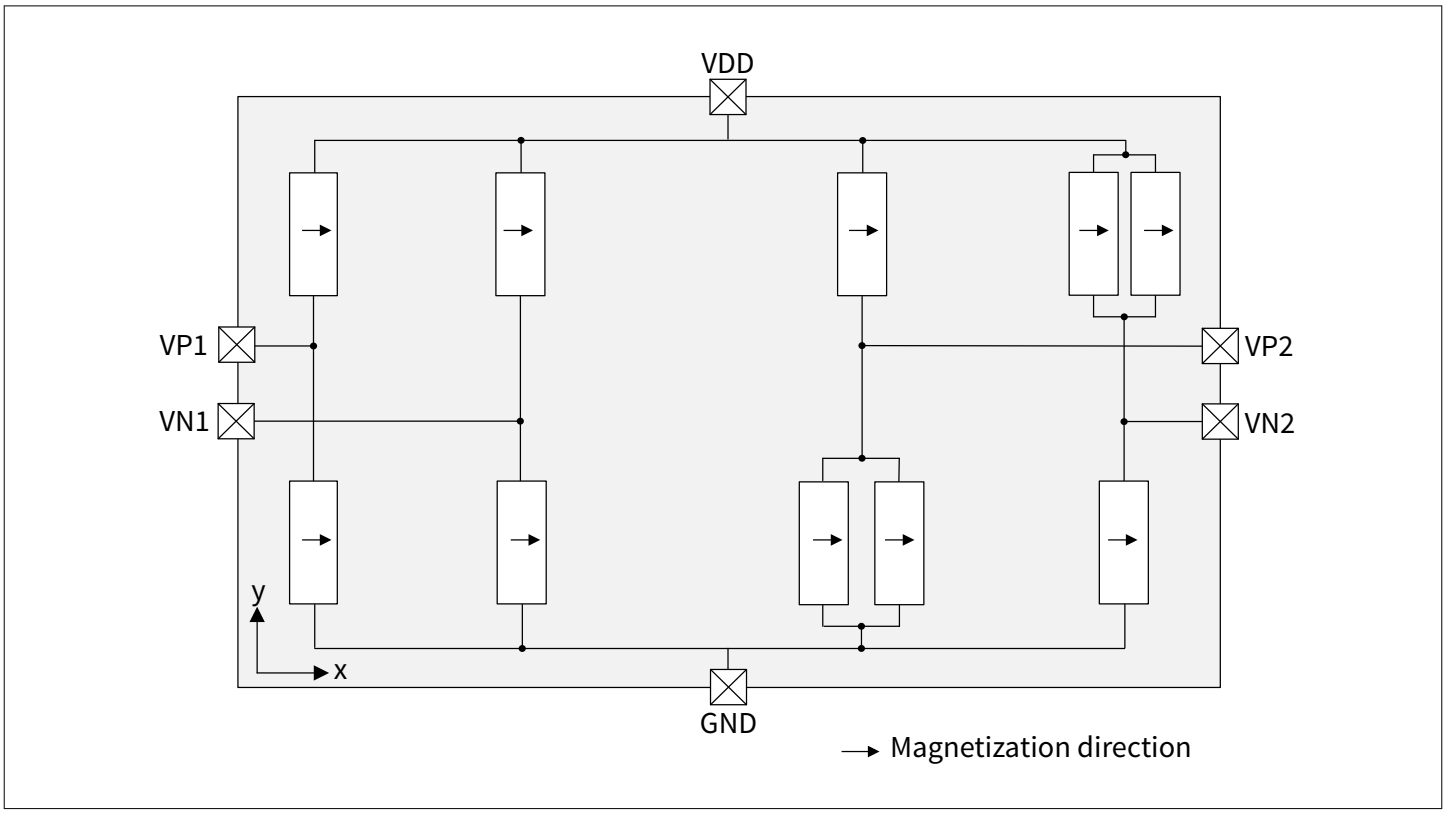

Figure 1 Block diagram

The TLI5590 consists of two TMR -Wheatstone bridges. The TMR resistance depends on the direction and strength of the external magnetic field. In combination with a multipole magnet each bridge provides a differential output signal, i.e. sine and cosine signals. These signals can further be processed for relative position measurement.

2 Pin configuration

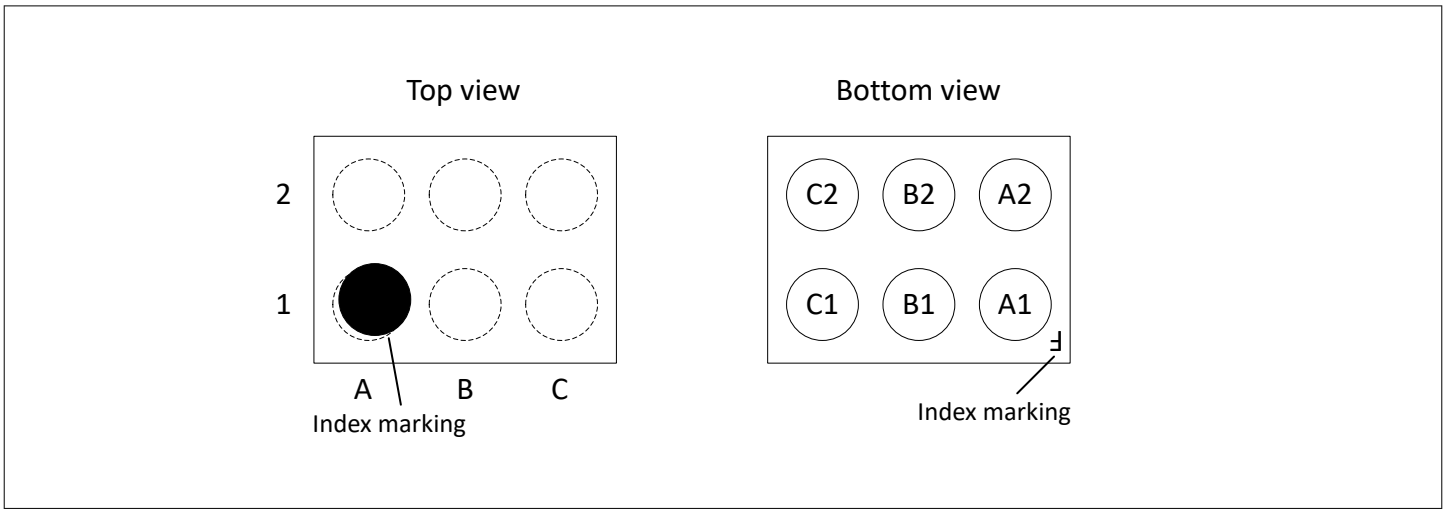

Figure 2 TLI5590 - A6W pinout

Table 2 SG-WFWLB-6-3 pin description and configuraiton

Pin no.	Name	Description
A1	VP2	Positive out of bridge #2
A2	VN2	Negative out of bridge #2
B1	GND	Ground
B2	VDD	Supply voltage
C1	VP1	Positive out of bridge #1
C2	VN1	Negative out of bridge #1

3 General product characteristics

3.1 Absolute maximum ratings

All specifications are valid over the full temperature range and over lifetime.

Stresses above the maximum 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 device.

Table 3 Absolute maximum ratings

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	-3.6	–	6.5	V	limited to 40 h over lifetime
Maximum ambient temperature	$T_{A\,max}$	-40	–	125	°C	Temperature cycle 850x -40°C to 125°C acc. JEDEC JESD47K
Storage temperature	$T_{storage}$	-40	–	150	°C	1000h HTSL at 150°C acc. JEDEC JESD47K
Magnetic field	B_{max}	-350	–	350	mT	max. 5 min. at 125°C

Table 4 ESD voltage

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
ESD HBM	V_{HBM}	-2	–	2	kV	HBM contact discharge for all pins, according to ANSI/ESDA/JEDEC JS-001-2010
ESD CDM	$V_{CDM(all)}$	-0.5	–	0.5	kV	valid for all pins, according to JS-002-2018
ESD CDM	$V_{CDM(corner)}$	-0.75	–	0.75	kV	valid for corner pins, according to JS-002-2018

3.2 Functional range

Table 5 Functional range

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	1	3.3	5.5	V	
Supply current	I_{CC}	–	1	–	mA	This corresponds to a typical voltage of V_{Br}=3.3V and a resistance of R_{Br}=6.6kOhm
Operating ambient temperature	T_A	-40	–	125	°C	1000h HTOL at 125°C, temperature budget acc. JEDEC JESD47K

Table 6 Magnetic parameters

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Magnetic field range	B	-5	–	5	mT	
Bandwidth	f_{BW}	–	5	–	kHz	Assumption: 6.6kOhm TMR resistance and max. 5nF capacitance C_{out}, $f_{characteristic}$=4.8kHz

4 Product features

4.1 Functional description

The measurement principle of the sensor is based on the TMR (tunneling magneto-resistance) effect. The sensor measures the strength of the magnetic field parallel to the package surface. The sensor provides two differential analog output signals for external calculation. The provided output signal is ratiometric to the supply voltage.

A magnetic flux B parallel to the package plane influences the TMR cells of the sensor. The strength of the flux controls the resistance of the sensor.

For correct operation the pole length l_{pole} of the magnet needs to fit the TMR bridge distance. Please see Table 9 for details.

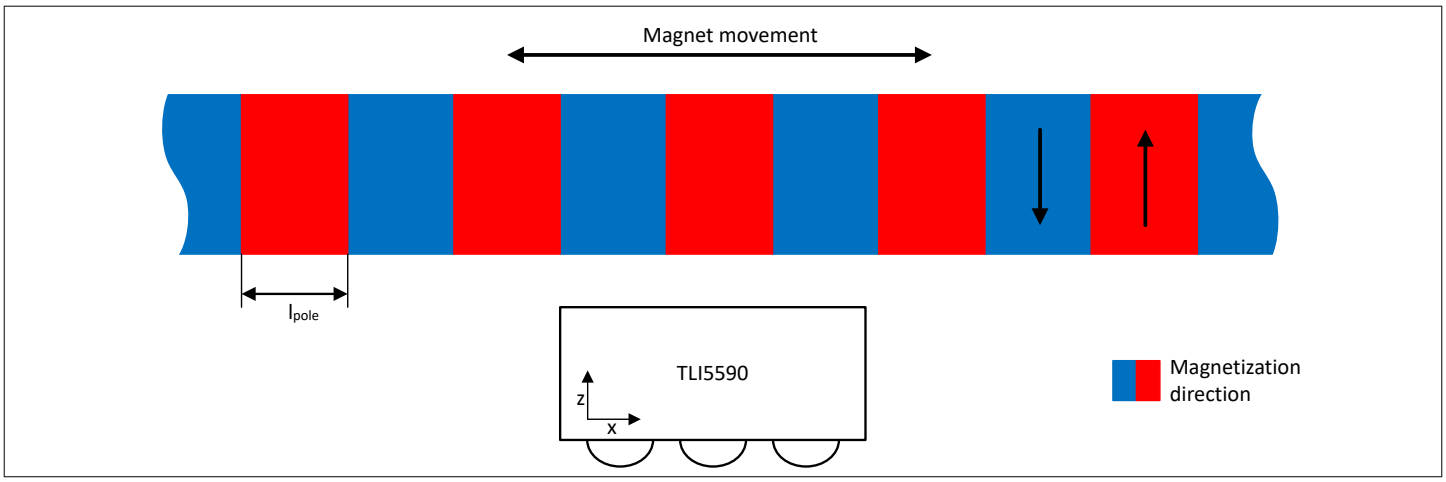

Figure 3 TLI5590 with multipol magnet system setup

Due to the special architecture of the Wheatstone bridges the output signals of the sensor have different amplitudes (see Figure 1 and Table 7). Regarding normalized out signals, the differential signal of bridge 2 has half the amplitude of the out signal from bridge 1 (see Figure 4). For position calculation it is necessary to multiply the output 2 with the factor of two.

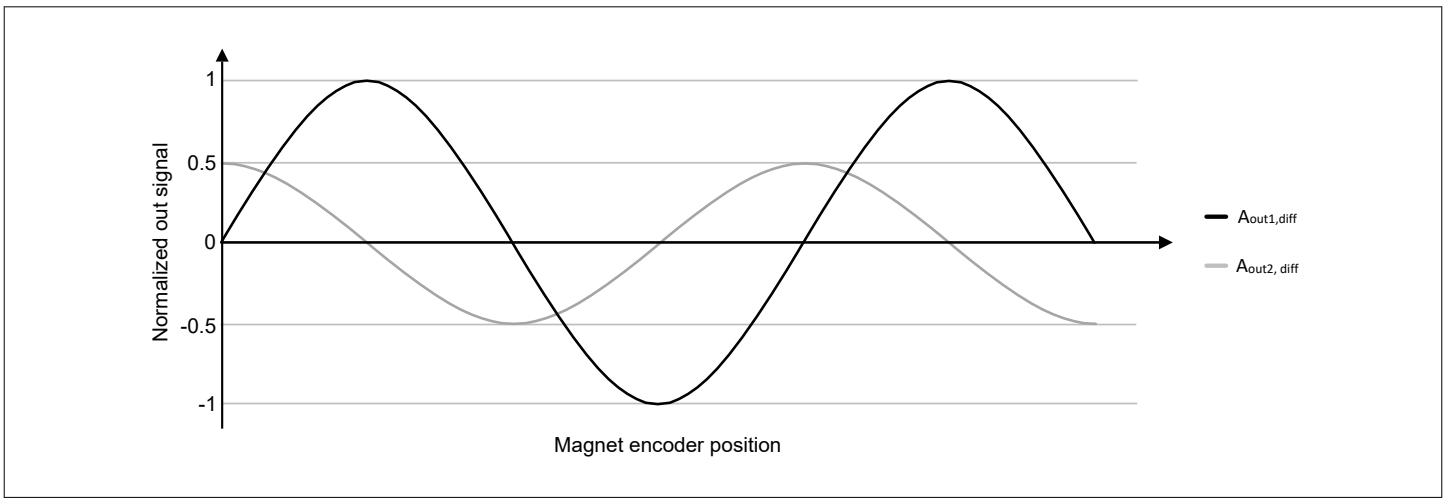

Figure 4 TLI5590 normalized sensor out amplitudes when a multi pole magnet is passed by

4.2 Electrical characteristics

The indicated parameters apply to the full operating range, unless otherwise specified.
Typical values correspond to a supply voltage V_{DD} = 3.3 V and T_A = 25°C, unless individually specified.
All specifications are valid over the full temperature range and over lifetime.

Table 7 Electrical characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Bridge resistance	R_{bridge}	4.62	6.6	8.58	kOhm	for T_A = 25°C, B=0mT, [1]
Temperature coefficient of bridge resistance	TC_{bridge}	-0.1	-0.07	-0.03	%/K	
Differential output voltage amplitude (bridge 1)	$A_{out1, diff}$	12	18.5	25	mV/V/mT	$A_{out1, diff}$ = VP1 - VN1
Differential output voltage amplitude (bridge 2)	$A_{out2, diff}$	6	9	12.5	mV/V/mT	$A_{out2, diff}$ = VP2 - VN2
Temperature coefficient of differential output voltage amplitude	TC_{Amp}	-0.1	-0.01	0.05	%/K	
Differential offset voltage	$V_{off, diff}$	-10	–	10	mV/V	
Temperature coefficient of offset voltage (differential ended)	$TC_{off, diff}$	-10	0	10	µV/V/K	

1) Resistance of each single Wheatstone bridge

4.3 Residual measurement errors

Table 8 Residual measurement errors

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Residual angle error, B ≤ 1.5mT	$A_{err, res, 1.5mT}$	-	±0.8	±2.5	°	B ≤ 1.5mT; with ideal compensation of offset and amplitude synchronicity, [1]
Residual angle error	$A_{err, res}$	-	±2.0	±4.1	°	1.5 < B ≤ 5mT; with ideal compensation of offset and amplitude synchronicity, , [1]
Amplitude synchronism	Amp_{sync}	95	100	105	%	

1) Angle error if 360° corresponds to a travel of 1000µm (= dipole length).

4.3.1 Typical performance

Figure 5 shows the typical angle error with ideal compensation of offset and amplitude synchronicity.

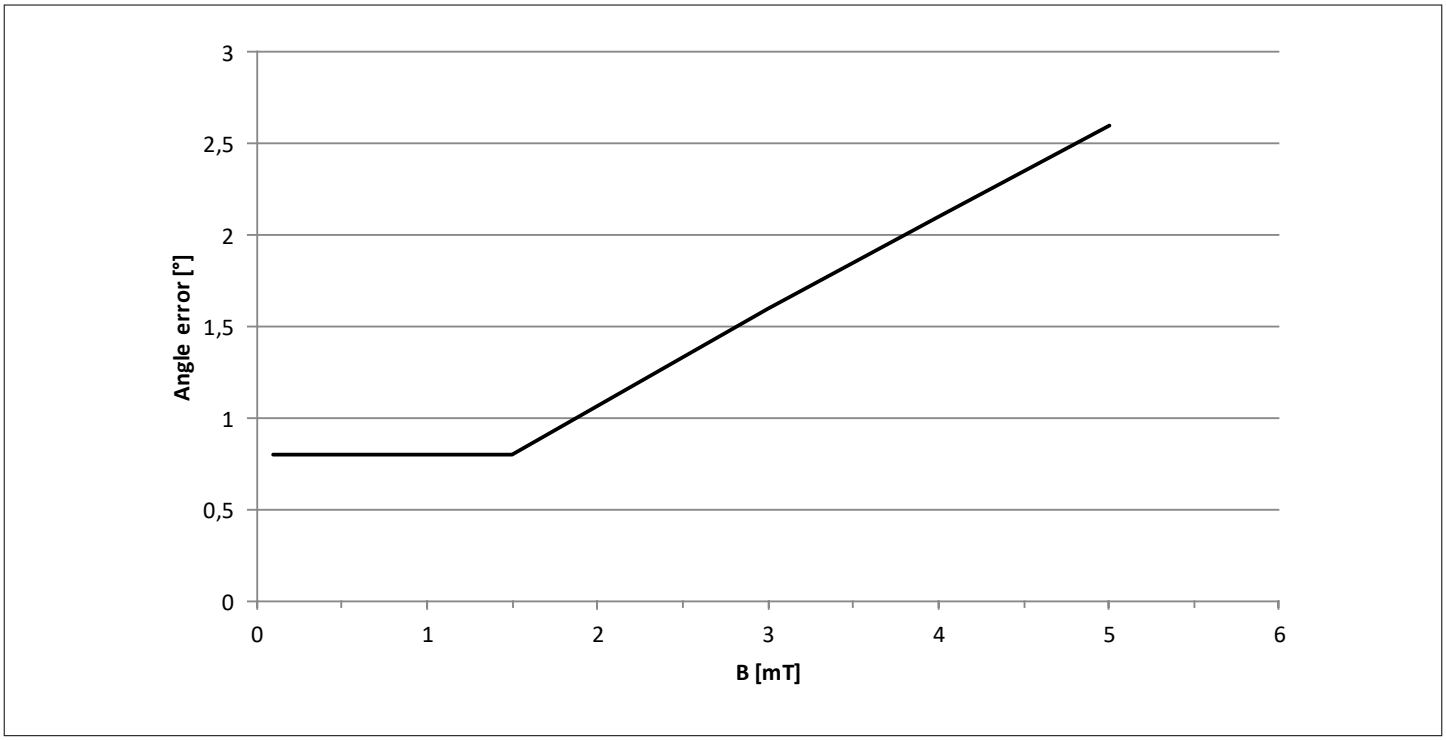

Figure 5 Typical residual angle error

5 Application information

5.1 Magnet

The parameters in this datasheet were specified for a multipole magnet strip fitting perfectly to the sensor((see Figure 3), where pole length match the distances between TMR elements inside the sensor.

However, different pole length between 500µm to 1mm can be used with this product. In case the pole length deviates from 500µm the accuracy can degrade from the values specified.

Table 9

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Magnet pole pitch	l_{pole}	–	500	–	µm	Both ends of the magnet must have the same polarity. Both end poles must be a half pole (half pitch length)

5.2 Sensitive area

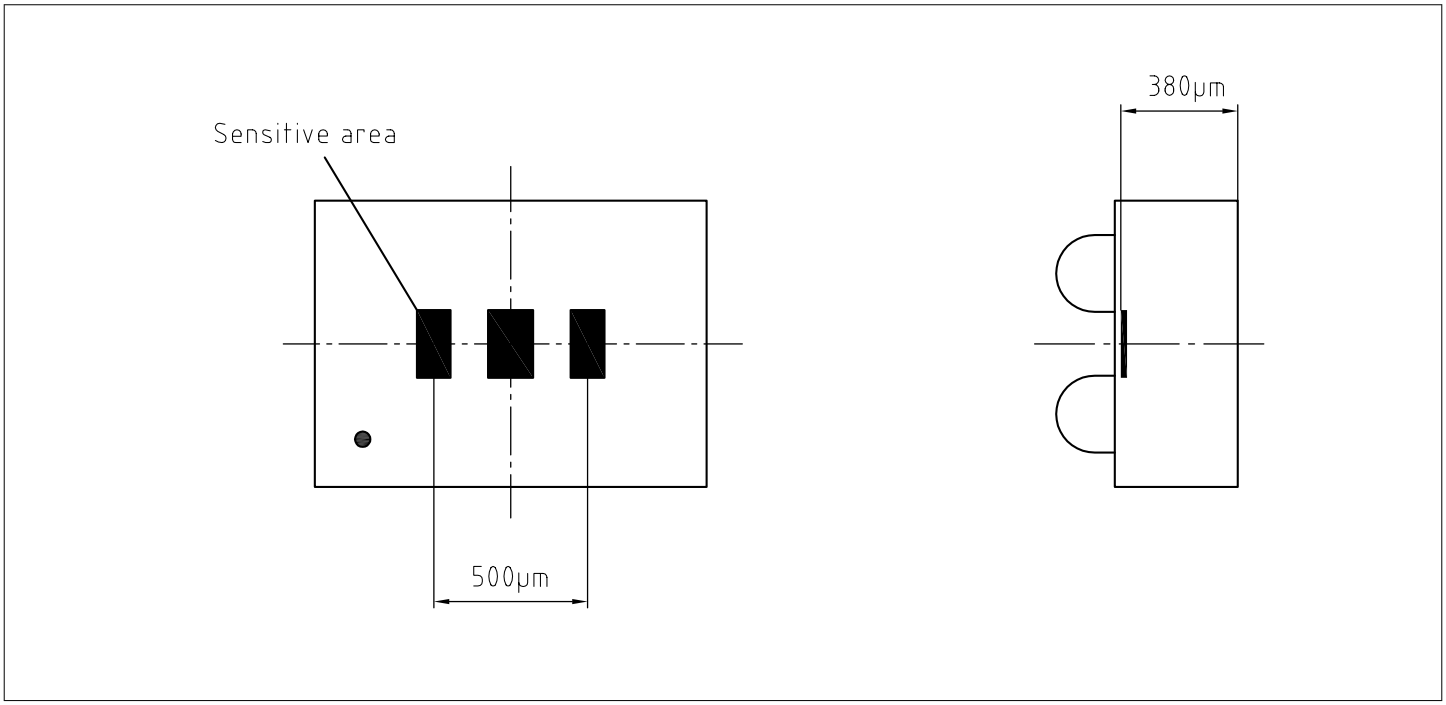

Figure 6 Placement of senstive area in the package

5.3 Application circuit

Figure 7 shows the application circuit which is proposed for TLI5590. The value for the buffer capacitor C_b has to be adjusted according to the speed of the magnetic input signal. In combination with the TMR resistor it represents a low-pass-filter. This filter limits the bandwidth of the circuit but also improves the noise performance. Without any buffer capacitor C_b, the bandwidth of the device is determined by the TMR resistor and the input capacitor of the used ADC. This has to be considered and the ADC sample and hold time adjusted accordingly.

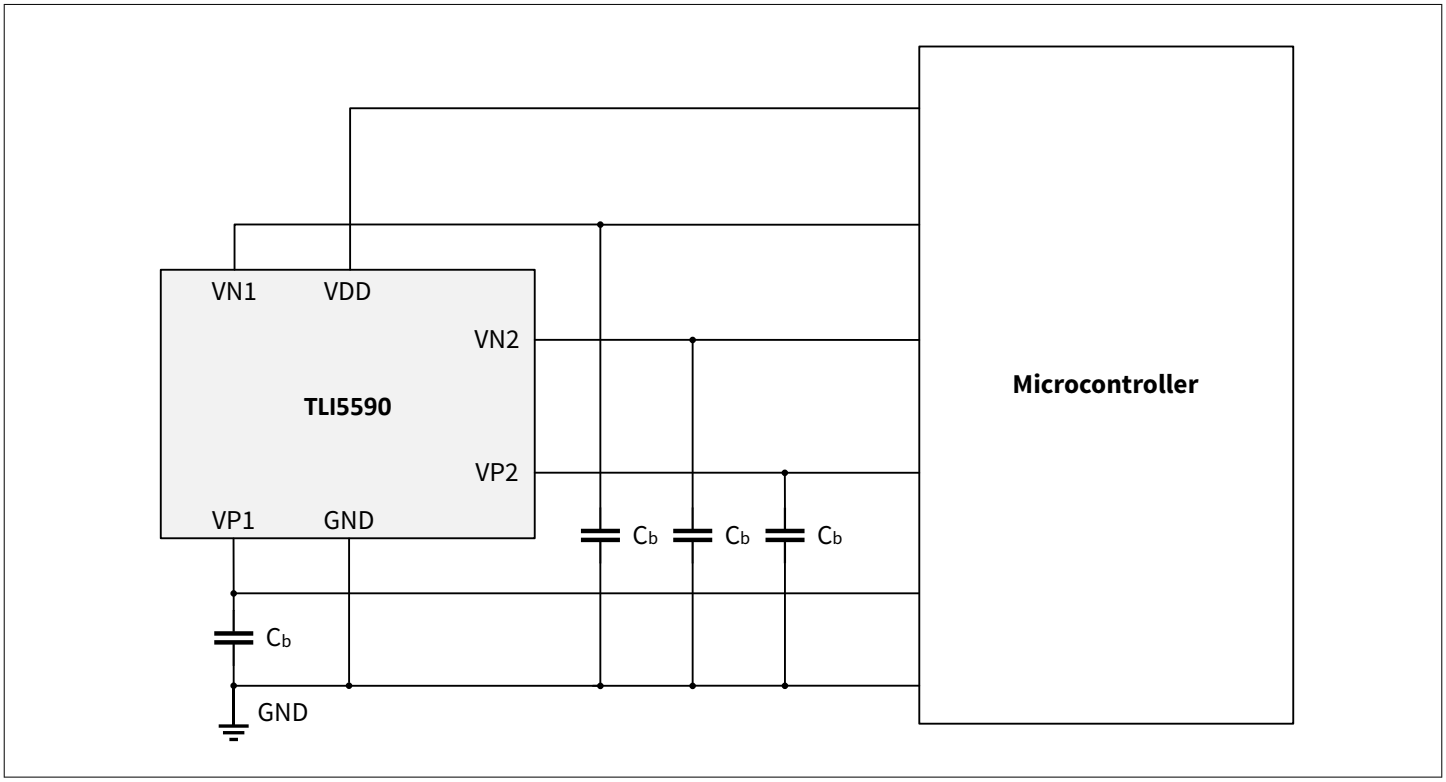

Figure 7 Application circuit

6 Package

6.1 Package information

The package of the device is a wafer level package SG-WFWLB-6-3.

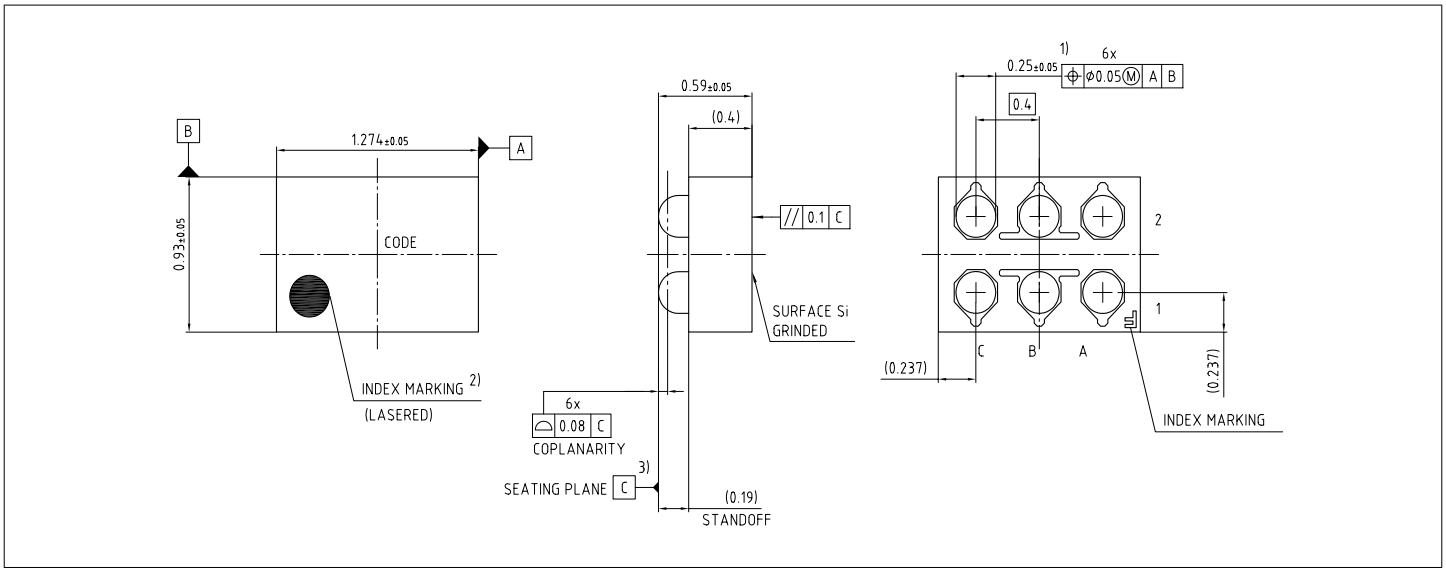

Figure 8 Package dimensions

1) Dimension is measured at the maximum solder ball diameter, parallel to primary datum C.
2) Ball A1 corner identified by marking.
3) Primary datum C and seating plane are defined by the domed crowns of the balls.

The SG-WFWLB-6-3 package fulfills the MSL level 1 according to IPC/JEDEC J-STD-033B.1.

6.2 Packing

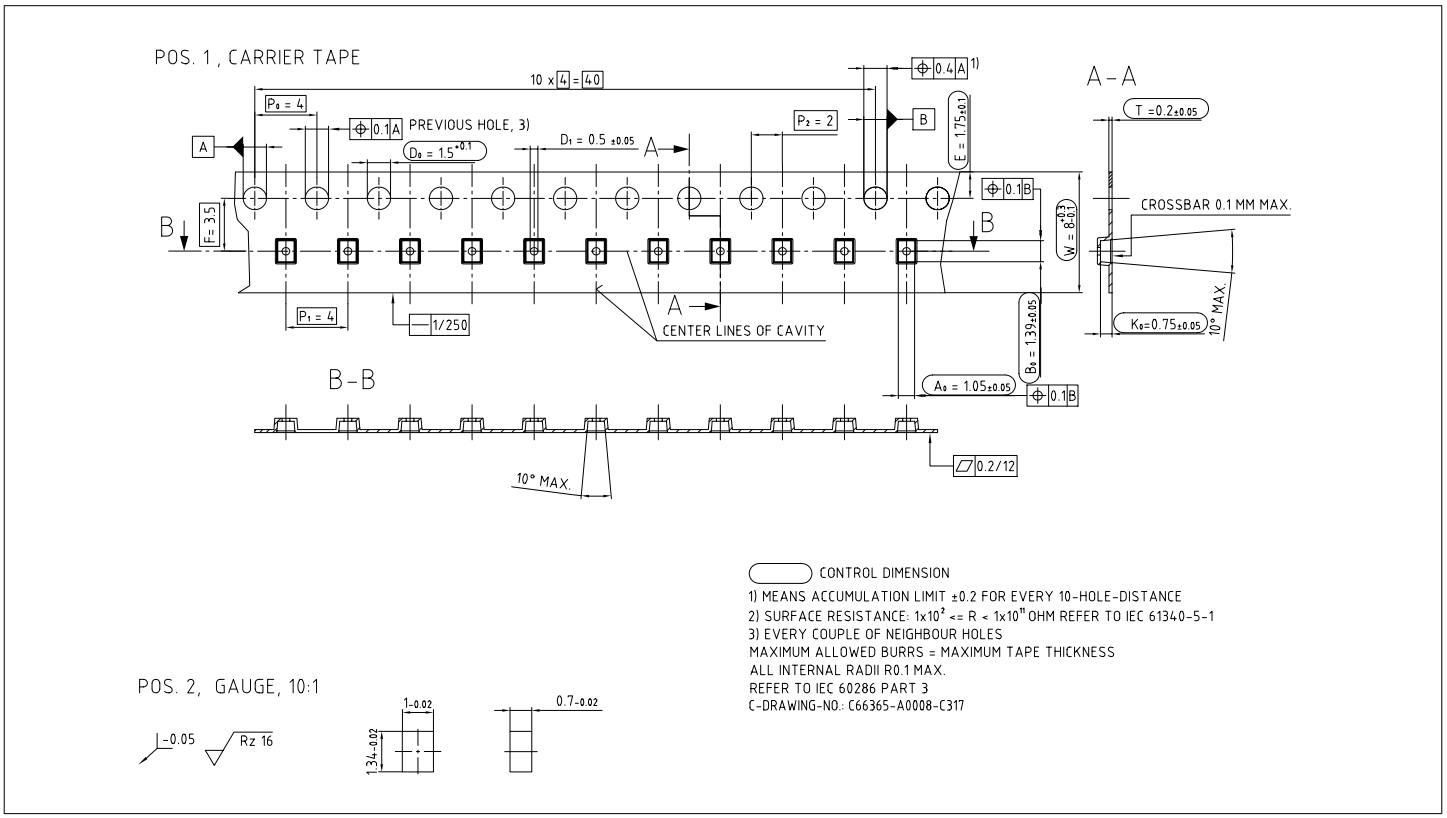

Figure 9 Packing

6.3 Additional package information

Further information about the package and processing can be found here:
https://www.infineon.com/cms/en/product/packages/SG-WFWLB/

7 Revision history

Table 10 Revision History

Document version	Date of release	Description of changes
01.00	2022-12-09	Initial release
01.10	2024-01-25	Added CDM value to ESD-Table; Magnet description updated; Formatting changes

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