XENSIV™ Amplified Linear Position Sensor

RoHS

Features

- Linear position sensor in universal SOT23-6 package
- 5 V and 3.3 V supply voltage
- ±41/25 and ±25/16 mT magnet range with full scale output amplitude
- Up to 85.5 mV/mT sensitivity
- Ultra low noise, up to 8.1 µTRMS until 1 MHz bandwidth

Potential applications

- Power tool trigger detection
- Service robots and drones angle sensing
- High precision dual encoder setup
- Low power applications

Product validation

Product validation according to JEDEC JESD47.

Description

The TLI55950 is a TMR (Tunnel Magneto Resistance) based magnetic linear sensor with integrated operational amplifier enabling a single ended full range voltage output, suitable for low cost high sensitivity sensing applications.

Product type	Description and feature	Package	Marking Type	Ordering code
TLI55950-A6E-E0001	Industrial variant. FS = 41 mT at V_{DD} = 5 V FS = 25 mT at V_{DD} = 3.3 V	PG-SOT23-6-4	50A	SP006153153
TLI55950-A6E-E0002	Industrial variant. FS = 25 mT at V_{DD} = 5 V FS = 16 mT at V_{DD} = 3.3 V	PG-SOT23-6-4	50B	SP006206460

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1 Functional block diagram

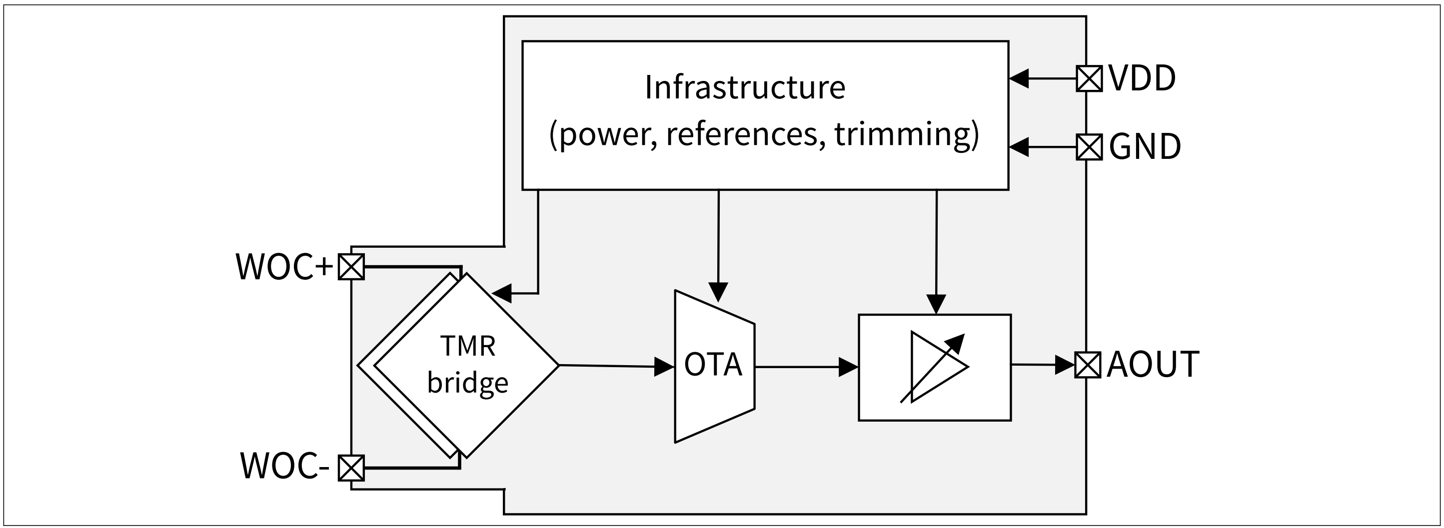

Figure 1 **Device functional block diagram**

The device measures a magnetic field via a Tunnel Magneto Resistance (TMR) bridge. The output signal from the TMR bridge is fed into a first stage of amplification via an Operational Transconductance Amplifier (OTA). The output of the OTA runs through a differential amplifier, which provides a signal on the AOUT pin. The sensor is temperature compensated, pre-calibrated and trimmed.

2 Pin configuration

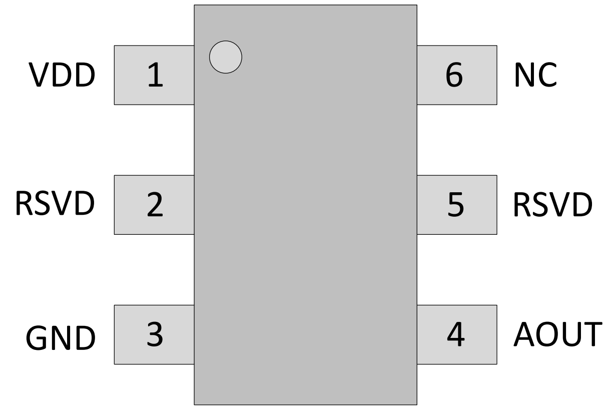

Figure 2 **Package pinout**

Table 1 **Pin definitions and function**

Pin No.	Symbol	Function	Comment
1	VDD	Supply voltage	–
2	RSVD	Pin shorted with sensor lead frame	1)
3	GND	Ground	–
4	AOUT	Analog output	–
5	RSVD	Pin shorted with sensor lead frame	1)
6	NC	Not connected	–

1) Lead frame shall be connected to GND. Only one of the pins connected to the lead frame shall be connected to GND to avoid GND loops through the lead frame. The other RSVD pins shall be left open.

3 General product characteristics

3.1 Absolute maximum ratings

Table 2 Absolute maximum ratings

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Electrical						
Supply voltage	V_{DD_ABS}	-0.3	–	6.5	V	Maximum 10 hours between 5.5 V to 6.5 V
Voltage on AOUT pin	V_{AOUT}	-0.3	–	V_{DD}	V	
ESD voltage	V_{ESD_HBM}	-2	–	2	kV	Human Body Model, according to JEDEC JESD47.
	V_{ESD_CDM}	-1	–	1	kV	Charged Device Model, according to JEDEC JESD47.
Temperature						
Storage temperature	T_S	-40	–	150	°C	
Junction Temperature	T_J	-40	–	175	°C	
Magnetic						
Magnetic field at TMR sensing element	B_{TMR_ABS}	-75	–	75	mT	$B_{TMR\_ABS} = \pm\sqrt{(B_X^2 + B_Y^2)}$

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" 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 shall 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 shall 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 3 Functional range

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Electrical						
Operating supply voltage	V_{DD}	3	–	5.5	V	
Analog output linear range	V_{AOUT_LR}	0.3	–	V_{DD} - 0.3	V	
Temperature						
Operating ambient temperature	T_A	-40	–	150	°C	
Operating junction temperature	T_{J_OP}	-40	–	160	°C	
Magnetic						
Operating magnetic field at TMR sensing element	B_{TMR}	-35	–	35	mT	$B_{TMR} = \pm\sqrt{(B_X^2+B_Y^2)}$
Magnetic input field (BFS1)	B_{FS1}	-41	–	41	mT	V_{DD} = 5 V. Valid for TLI55950-A6E-E0001 1) 2)
		-25	–	25	mT	V_{DD} = 3.3 V. Valid for TLI55950-A6E-E0001 2)
Magnetic input field (BFS2)	B_{FS2}	-25	–	25	mT	V_{DD} = 5 V. Valid for TLI55950-A6E-E0002 1) 2)
		-16	–	16	mT	V_{DD} = 3.3 V. Valid for TLI55950-A6E-E0002 1) 2)
Circuit						
Capacitance on VDD pin	C_{VDD}	–	100	–	nF	External capacitance connected to VDD pin. Typical value is a condition valid for all performance parameters unless otherwise specified
Capacitance on AOUT pin	C_{AOUT}	80	220	250	pF	External capacitance connected to AOUT, including parasitic capacitance on the PCB. Typical value is a condition valid for all performance parameters unless otherwise specified
Pull-up resistor on AOUT pin	R_{PU_AOUT}	24.3	33	–	kΩ	Pull-up resistor to V_{DD} connected to AOUT pin. Typical value is a condition valid for all performance parameters unless otherwise specified

1) Product specifications are valid only within the functional range of B_{TMR}.
2) Magnetic field component in the sensing direction at TMR sensing element location.

3.3 Thermal resistance

Table 4 Thermal resistance

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Thermal resistance	$R_{th,JA}$	–	152	200	K/W	Junction to air, according to JEDEC JESD51-7

4 Product features

4.1 Electrical characteristics

Table 5 Electrical characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Current consumption	I_{DD}	–	5.5	8	mA	I(AOUT) = 0 A
Power-on time	t_{PON}	–	–	100	µs	1)
Analog output nominal quiescent voltage	V_{OQ}	–	$V_{DD}/2$	–	V	Nominal value in case of input magnetic field $B_X = 0$
Analog output slew rate	SL_{AOUT_MAX}	10	–	–	V/µs	V_{DD} = 5 V. 10% to 90% of B_{FSX}
		6	–	–	V/µs	V_{DD} = 3.3 V. 10% to 90% of B_{FSX}
Analog output maximum drive capability	I_{AOUT_MAX}	1	–	–	mA	DC
Analog output impedance	Z_{AOUT}	–	4	20	Ω	B_X = 0. I(AOUT) = I_{AOUT_MAX}

1) V_{DD} rising from 0V to the nominal value of V_{DD}. Device functions according to specification after power-on time, which starts when the V_{DD} reaches the minimum value specified in the functional range and stops when the device is fully operational.

4.2 Full scale definition

The magnetic input full scale and analog output full scale are defined in the following figure.

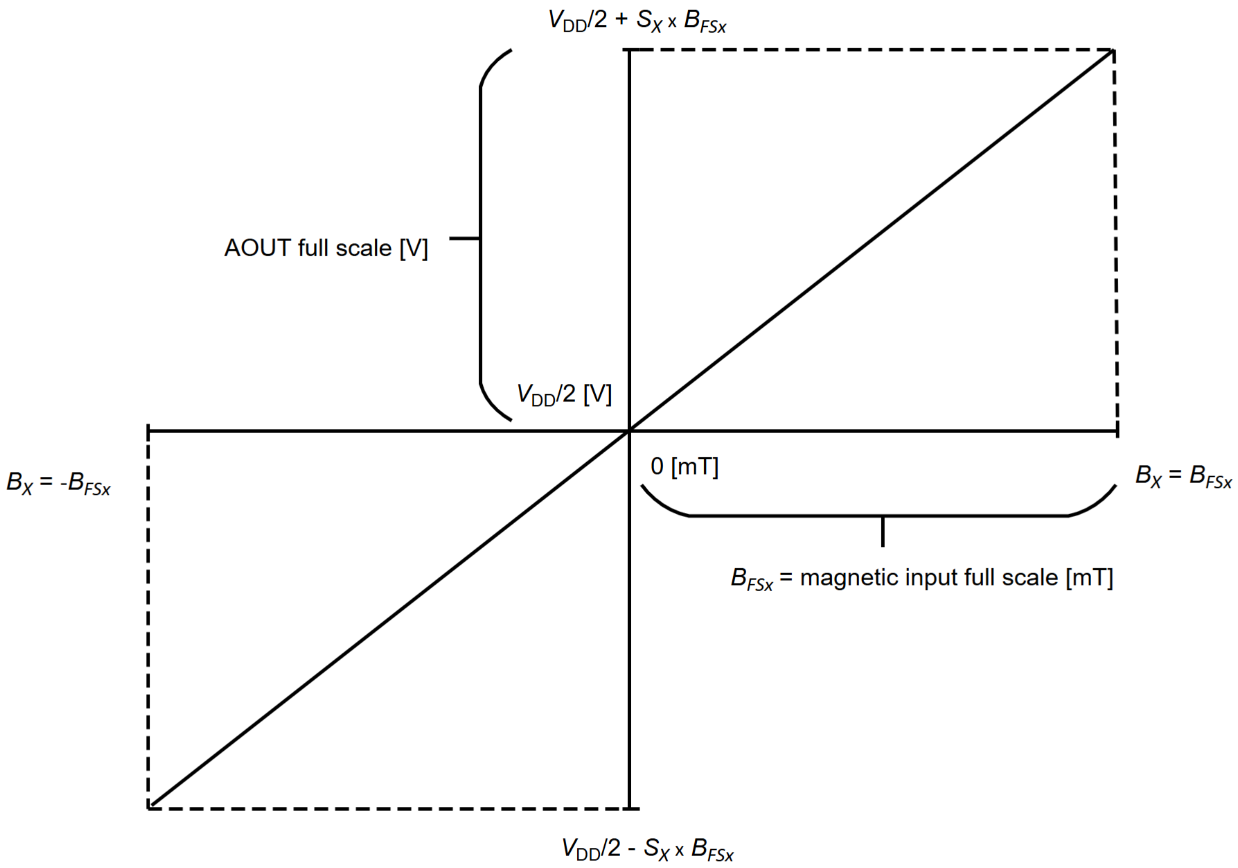

Figure 3 Full scale (B_{FSx}) definition

The errors specified in Chapter 4.4 are referred to the magnetic input full scale (B_{FSx}). Referring the errors to the whole [-B_{FSx}... B_{FSx}] range would reduce the errors by a factor of two.

4.3 Output noise

Output noise referenced to magnetic input field can be expressed according to the following formula:

$$B_{NOISE} = V_{NOISE} \times \frac{1}{S} \times 10^3 \quad (1)$$

Where:

- B_{NOISE} is the output noise referenced to magnetic input field [μT_{RMS}];
- V_{NOISE} is the output noise voltage in [mV_{RMS}];
- S is the sensitivity in [mV/mT].

4.4 Sensing characteristics

Table 6 Sensing characteristics valid for all variants

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Analog output propagation delay	t_{PD}	–	–	100	ns	From 20% of the magnetic input field to 20% of the output voltage. Input rise time from 10% to 90% equal to 10 ns
Analog output response time	$t_{RESPONSE}$	–	–	300	ns	From 90% of the magnetic input field to 90% of the output voltage. Input rise time from 10% to 90% equal to 10 ns
Transfer function cutoff frequency	BW	1	–	–	MHz	-3 dB criterion
Hysteresis	B_{HYS}	-0.5	-	0.5	%	$\pm B_{FSX}$ applied

Table 7 Sensing characteristics TLI55950-A6E-E0001

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Sensitivity (S1)	$S1$	–	53.5	–	mV/mT	T_A = 25°C, 0 h.
Output noise	B_{NOISE}	–	4.1	8.1	μT_{RMS}	BW = 1 MHz. Referenced to magnetic input field
Initial offset	E_{OFF_INIT}	-180	±120	180	µT	T_A = 25°C, 0 h; it can be compensated in the application by EOL-calibration at RT in the microcontroller 1) ; Strayfields like earth magnetic field and possible hysteresis are excluded from this parameter.
Offset drift over temperature	E_{OFF_T}	-150	±90	150	µT	-5°C ≤ T_A ≤ 85°C. Difference with respect to 25°C 1)
		-180	±120	180	µT	-20°C ≤ T_A ≤ 105°C. Difference with respect to 25°C 1)
		-230	±150	230	µT	-40°C ≤ T_A ≤ 125°C. Difference with respect to 25°C 1)
		-230	±150	230	µT	-40°C ≤ T_A ≤ 150°C. Difference with respect to 25°C 1)
Offset drift over temperature and lifetime	E_{OFF_L}	-300	±200	300	µT	-40°C ≤ T_A ≤ 150°C. Difference with respect to 25°C at 0 h 1)
Offset ratiometricity error over temperature	$E_{OFF\_RATIO\_T}$	-100	±40	100	µV/ %V_{DD}	±10% V_{DD} variation 1)

(table continues...)

Table 7 (continued) Sensing characteristics TLI55950-A6E-E0001

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Offset ratiometricity error over temperature and lifetime	$E_{OFF\_RATIO\_L}$	-100	±40	100	µV/ %V_{DD}	±10% V_{DD} variation [1)]
Initial sensitivity error	E_{SENS}	-4	±2.4	4	%	T_A = 25°C, 0 h; it can be compensated in the application by EOL-calibration at RT in the microcontroller [1)]
Sensitivity drift over temperature	E_{SENS_T}	-4	±2.5	4	%	-40°C ≤ T_A < 25°C. Difference with respect to 25°C [1)]
	E_{SENS_T}	-4	±2.5	4	%	25°C ≤ T_A ≤ 150°C. Difference with respect to 25°C [1)]
		-3	±1.5	3	%	-5°C ≤ T_A ≤ 85°C. Difference with respect to 25°C [1)]
Sensitivity drift over temperature and lifetime	E_{SENS_L}	-4.75	±3	4.75	%	-40°C ≤ T_A < 25°C. Difference with respect to 25°C at 0 h [1)]
		-4.75	±3	4.75	%	25°C ≤ T_A ≤ 150°C. Difference with respect to 25°C at 0 h [1)]
		-3.75	±2	3.75	%	-5°C ≤ T_A ≤ 85°C. Difference with respect to 25°C at 0 h [1)]
Non-linearity error over temperature and lifetime	E_{NL}	-1.82	±1	1.82	%	% of B_{FSX} [1)]

1) Typical values are ±3σ.

Table 8 Sensing characteristics TLI55950-A6E-E0002

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Sensitivity (S2)	*S2*	–	85.5	–	mV/mT	T_A = 25°C, 0 h.
Output noise	B_{NOISE}	–	4.1	8.1	µT_{RMS}	*BW* = 1 MHz. Referenced to magnetic input field
Initial offset	E_{OFF_INIT}	-180	±120	180	µT	T_A = 25°C, 0 h; it can be compensated in the application by EOL-calibration at RT in the microcontroller [1)]; Strayfields like earth magnetic field and possible hysteresis are excluded from this parameter.

(table continues...)

Table 8 (continued) Sensing characteristics TLI55950-A6E-E0002

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Offset drift over temperature	E_{OFF_T}	-150	±90	150	µT	-5°C ≤ T_A ≤ 85°C. Difference with respect to 25°C [1]
		-180	±120	180	µT	-20°C ≤ T_A ≤ 105°C. Difference with respect to 25°C [1]
		-230	±150	230	µT	-40°C ≤ T_A ≤ 125°C. Difference with respect to 25°C [1]
		-230	±150	230	µT	-40°C ≤ T_A ≤ 150°C. Difference with respect to 25°C [1]
Offset drift over temperature and lifetime	E_{OFF_L}	-300	±200	300	µT	-40°C ≤ T_A ≤ 150°C. Difference with respect to 25°C at 0 h [1]
Offset ratiometricity error over temperature	$E_{OFF\_RATIO\_T}$	-100	±40	100	µV/ %V_{DD}	±10% V_{DD} variation [1]
Offset ratiometricity error over temperature and lifetime	$E_{OFF\_RATIO\_L}$	-100	±40	100	µV/ %V_{DD}	±10% V_{DD} variation [1]
Initial sensitivity error	E_{SENS}	-4	±2.4	4	%	T_A = 25°C, 0 h; it can be compensated in the application by EOL-calibration at RT in the microcontroller [1]
Sensitivity drift over temperature	E_{SENS_T}	-4	±2.5	4	%	-40°C ≤ T_A < 25°C. Difference with respect to 25°C [1]
	E_{SENS_T}	-4	±2.5	4	%	25°C ≤ T_A ≤ 150°C. Difference with respect to 25°C [1]
		-3	±1.5	3	%	-5°C ≤ T_A ≤ 85°C. Difference with respect to 25°C [1]
Sensitivity drift over temperature and lifetime	E_{SENS_L}	-4.75	±3	4.75	%	-40°C ≤ T_A < 25°C. Difference with respect to 25°C at 0 h [1]
		-4.75	±3	4.75	%	25°C ≤ T_A ≤ 150°C. Difference with respect to 25°C at 0 h [1]
		-3.75	±2	3.75	%	-5°C ≤ T_A ≤ 85°C. Difference with respect to 25°C at 0 h [1]
Non-linearity error over temperature and lifetime	E_{NL}	-1	±0.5	1	%	% of B_{FSX} [1]

1) Typical values are ±3σ.

5 Application circuit

The figure below shows an example application circuit of the device. Please refer to Functional range for the value of passive components.

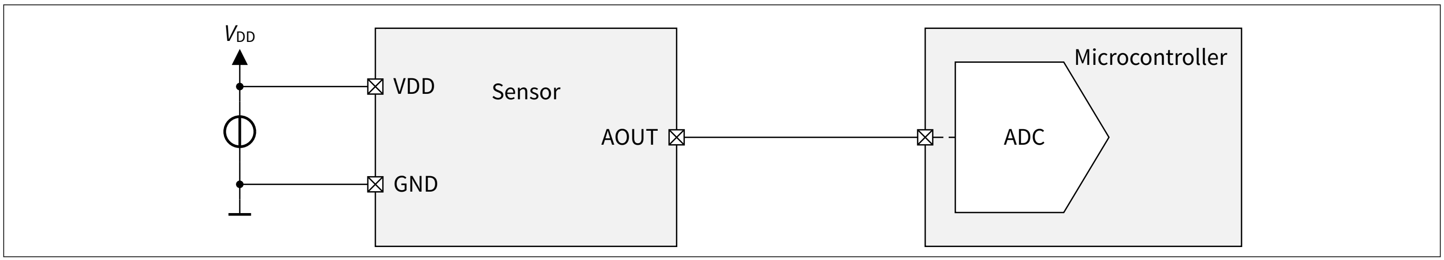

Figure 4 Application circuit example

Note: This is a simplified example of an application circuit. The function must be verified in the real application.

6 Package

The device is mounted in the PG-SOT23-6-4 package.

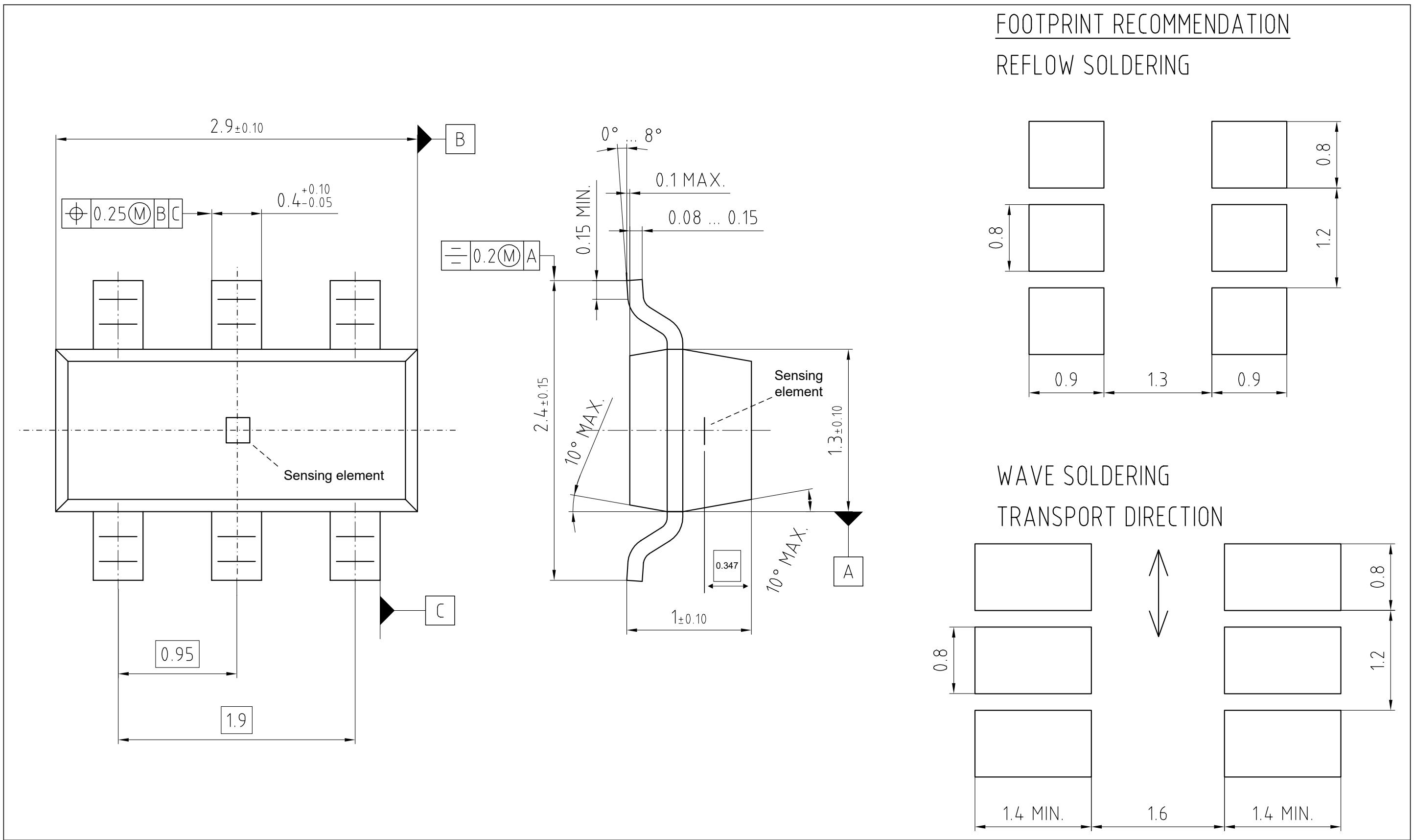

Figure 5 **PG-SOT23-6-4 package outline. Sensing element dimensions and position are not in scale**

The sensing element is placed in the center of the package. The in-plane sensing element position tolerance referenced to mold housing edge is ±100 µm. The vertical tolerance referred to top mold housing edge is ± 50 µm. The vertical tolerance referred to bottom mold housing edge is ± 100 µm (including lead bending tolerances).

The PG-SOT23-6-4 package fulfills the MSL level 1 according to IPC/JEDEC J-STD-033B.1.

The package marking of the device is as shown in the figure below.

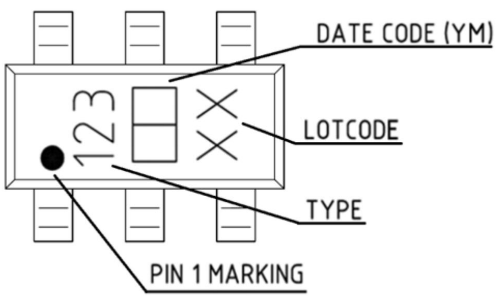

Figure 6 **Package marking - front side**

7 Revision history

Table 9 Revision history

Revision number	Date of release	Description of changes
1.00	2026-01-16	Initial release

Trademarks

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