

# ZMT32

## Magnetic Field Angle Sensor

### Description

The ZMT32 is a thin film permalloy magnetic field sensor, which contains two galvanic isolated Wheatstone Bridges for high precision angle measurement applications under low field conditions. This angle sensor is based on the anisotropic magnetoresistive effect (AMR). The two internal ( $V_{CC1}$ ,  $V_{CC2}$ ) bridges enclose a relative sensitive angle of 45 degrees. The input field is a rotating magnetic field in the chip plane (parallel to the surface of package). This rotating field will make available two independent sinusoidal output signals with the following relationship

$$\frac{V_{O2}}{V_{O1}} = \frac{\sin(2\alpha)}{\cos(2\alpha)} = \tan(2\alpha)$$

where  $\alpha$  = angle between sensor axis and field direction

### Features

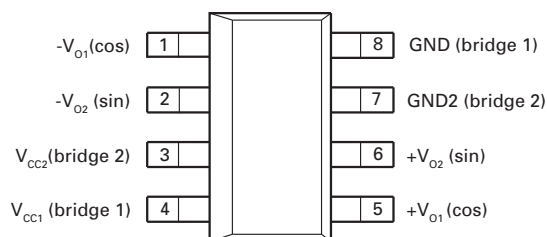
- contactless angle measurement up to 180°
- flexible measuring solutions for moved systems
- stable operation over long time
- high temperature range up to +160°C

The precise ZMT32 works with low field applications ( $H_{rot} = 8$  to 25kA/m), much lower than similar devices. The ultimate output signal quality depends on the external magnetic material and on the mechanical realization.

The ZMT32 is a passive part and the Arc-Tangent interpolation needs external signal processing. Typical areas of application are angle and speed measurement.

### Applications

- angle and angular velocity measuring systems
- absolute angle and angle change
- automotive electronic (steering, throttle control, pedal positioning, etc)
- contactless rotary switches and potentiometer
- automatic adjustment



### Ordering Information

Device	Reel size (Inches)	Tape width (mm)	Quantity per reel	Device marking
ZMT32TA	7	12	1,000	ZETEX ZMT32

## Absolute maximum ratings

Parameter	Symbol	Limit	Unit
Supply Voltages	$V_{cc1}$ and $V_{cc2}$	10	V
Single Bridge Current	$I_{cc1}$ or $I_{cc2}$	4	mA
Operating Temperature Range	$T_A$	-40 to +160	°C
Storage Temperature Range	$T_{stg}$	-55 to +175	°C

## Recommended operating conditions

Symbol	Parameter	Min	Typ	Max	Unit
$V_{cc1}, V_{cc2}$	Supply Voltages		5	8.5	V
$H_{rot}$	Applied Magnetic Field Strength	8	25		kA/m

## Electrical characteristics

General test conditions (unless otherwise noted)

$T_A = +23 \pm 5^\circ\text{C}$ ,  $V_{CC1} = V_{CC2} = +5\text{V}$ ,  $H_{ROT} = 25\text{kA/m}^{(†)}$ ,  $k = 100 \cdot (V_{PO1}/V_{PO2})$  with  $V_{CC1} = V_{CC2}$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (*)	MAX	UNIT
$S_{\alpha 1}$ or $S_{\alpha 2}$	Sensitivities (zero crossing)	$\alpha 1 = 135^\circ$ , $\alpha 2 = 0^\circ$		0.35		mV/V/deg
$V_{PO1}$ or $V_{PO2}$	Peak Output Voltages (sinusoidal signals)		40	50	60	mV
k	Amplitude bridge matching		99.77	100	100.23	%
TCk	Temperature coefficient of amplitude bridge matching	$T_A = -40$ to $+160^\circ\text{C}$	-0.008		+0.008	%/K
$R_{B1}$ or $R_{B2}$	Bridge resistances	no $H_{ROT}$	$T_A = -40^\circ\text{C}$ $T_A = 23^\circ\text{C}$ $T_A = +160^\circ\text{C}$	2017 3000 3345	3040 3600 5114	$\Omega$
$TCR_B^B$	TC of Bridge Resistances		+0.28	+0.32	+0.36	%/K
$\Delta V_{O1}/V_{CC1}^A$ or $\Delta V_{O2}/V_{CC2}^A$	Peak to peak output swing	$H_{ROT} = 8\text{ kA/m}^{(†)}$	$T_A = -40^\circ\text{C}$ $T_A = 23^\circ\text{C}$ $T_A = +160^\circ\text{C}$ $T_A = 23^\circ\text{C}$	19.2 16 6.7 16	30.4 20 13.4 24	mV/V
$TCV_O^B$	TC of peak to peak output swing		-0.35	-0.32	-0.28	%/K
$V_{OFF1}/V_{CC1}^A$ or $V_{OFF2}/V_{CC2}^A$	Output offset voltage	$H_{ROT} = 8\text{ kA/m}^{(†)}$ no $H_{ROT}$	$T_A = -40^\circ\text{C}$ $T_A = +160^\circ\text{C}$ $T_A = 23^\circ\text{C}$	-1.25 -1.55 -1 -2	+1.25 +1.55 0 0	mV/V
$TCV_{OFF}^B$	TC of output offset voltage		-4	0	+4	$\mu\text{V/V/K}$
$\Delta\alpha^A$	Angular Inaccuracy			0.05	0.2	deg
$\Delta\alpha^A$	Angular hysteresis	$H_{ROT} = 8\text{ kA/m}^{(†)}$			0.1 0.5 (‡)	deg
$I_{iso1-2}$	Isolation Bridge Current	no $H_{ROT}$	0		0.1	$\mu\text{A}$

### NOTES:

(\*) Typical values apply to an ambient temperature of  $23^\circ\text{C}$

(†) See point "Magnetic Field Tests" below

(‡) The accurate control of this parameter ( $\text{Lim}_{\text{max}} = 0.1\text{deg}$ ,  $H_{ROT} = 25\text{kA/m}$ ) takes place by means of sample tests

### A: Output characteristic definitions

$$\Delta V_{O1}/V_{CC1} = (V_{OMAX1} - V_{OMIN1})/V_{CC1} \quad \text{or} \quad \Delta V_{O2}/V_{CC2} = (V_{OMAX2} - V_{OMIN2})/V_{CC2}$$

$$V_{OFF1}/V_{CC1} = \frac{1}{2}(V_{OMAX1} + V_{OMIN1})/V_{CC1} \quad \text{or} \quad V_{OFF2}/V_{CC2} = \frac{1}{2}(V_{OMAX2} + V_{OMIN2})/V_{CC2}$$

$$\Delta\alpha^H = \text{MAX} | \alpha_{\text{LEFT TURN}} - \alpha_{\text{RIGHT TURN}} | \quad (\text{max. angular difference between left and right turn})$$

$$\Delta\alpha = \text{MAX} | \alpha_0 - \alpha | \quad (\text{max. angular difference between actual value } \alpha_0 \text{ and measured angle, without offset error})$$

### B: Temperature coefficient (TC) equations

$$T_1 = -25^\circ\text{C}, \quad T_0 = +25^\circ\text{C}, \quad T_2 = +125^\circ\text{C}$$

$$TCV_O = \frac{1}{T_2 - T_1} \times \frac{\frac{\Delta V_O}{V_{CC}}(T_2) - \frac{\Delta V_O}{V_{CC}}(T_1)}{\frac{\Delta V_O}{V_{CC}}(T_0)} \times 100\%$$

where  $\frac{\Delta V_O}{V_{CC}}(T_n)$  is the peak-peak output voltage at temperature  $T_n$

$$TCR_B = \frac{1}{T_2 - T_1} \times \frac{R_B(T_2) - R_B(T_1)}{R_B(T_0)} \times 100\%$$

where  $R_B(T_n)$  is the bridge resistance at temperature  $T_n$

$$TCV_{OFF} = \frac{V_{OFF(T_2)} - V_{OFF(T_1)}}{(T_2 - T_1)}$$

where  $V_{OFF(T_n)}$  is the output offset voltage at temperature  $T_n$

## Magnetic field tests

For these tests a rotating magnetic field is generated and the output signals of both bridges are measured at four different field angles for right rotation as well as for left rotation. Using these measured output signals the diameter and the center coordinates of the best circle are calculated. They correspond to the output voltage range and the offset voltage. Furthermore the field angles for both rotation directions and angular hysteresis are calculated

$$[\text{measured angle}] = \alpha = \arctan\left(\frac{V_{O2}}{V_{O1}}\right)$$

## Method

The data pairs are transformed onto a unit circle starting from their position in the data collection for determining direction information or angle information.

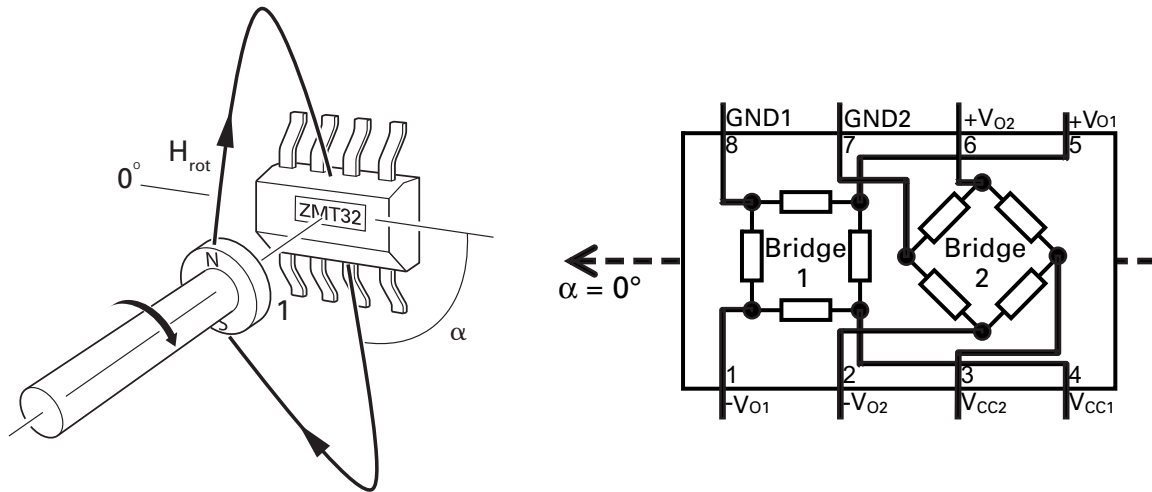
It must be evaluated with four pair values (cos, sin) on a right rotation (magnetic field rotation) and four pair values (cos, sin) on a left rotation (magnetic field rotation).

## The field rotation steps are:

- start in 180° position
  - § right rotation to 22.5° with measurement of sensor outputs
  - § right rotation to 67.5° with measurement of sensor outputs
  - § right rotation to 112.5° with measurement of sensor outputs
  - § right rotation to 157.5° with measurement of sensor outputs
  - § right rotation to 0° (360°) , stop , reversal
  - § left rotation to 157.5° with measurement of sensor outputs
  - § left rotation to 112.5° with measurement of sensor outputs
  - § left rotation to 67.5° with measurement of sensor outputs
  - § left rotation to 22.5° with measurement of sensor outputs , end position

General description of tests with external magnetic field.

## Operating principle

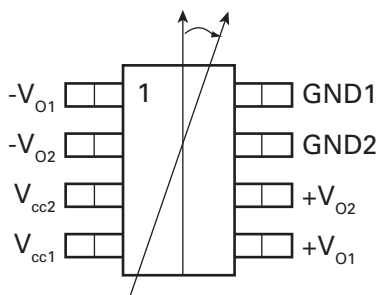


When a common-magnetic field is applied through the ZMT32 the 2 internal magneto-resistive bridges are affected slightly differently due to their 45° rotation to one another. This 45° rotation enables the ZMT32 to determine angular position, of a rotating magnetic field.

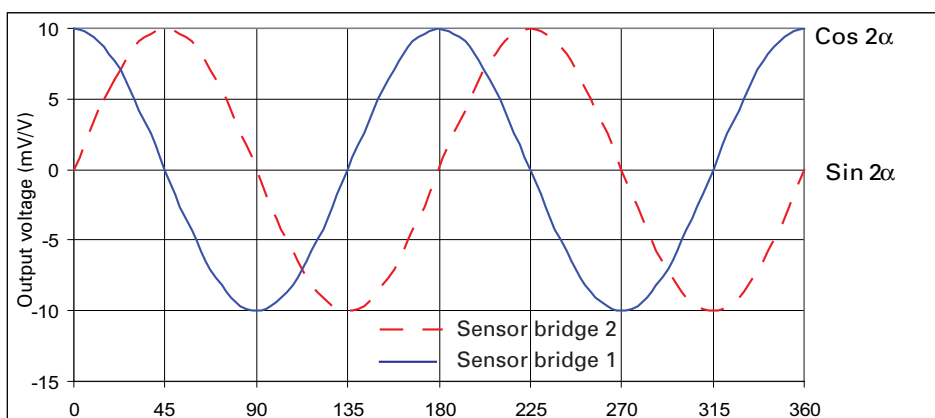
When a rotating magnetic field is applied to the ZMT32 it will output 2 sinusoidal voltages that are:

- proportional to the field strength applied
- proportional to the supply voltage applied,
- rotating at twice the angular position
- 90° apart (as seen below).

By taking the arcTan of the ratio of  $V_{O2}$  to  $V_{O1}$  the angular position of the magnetic field can be determined.

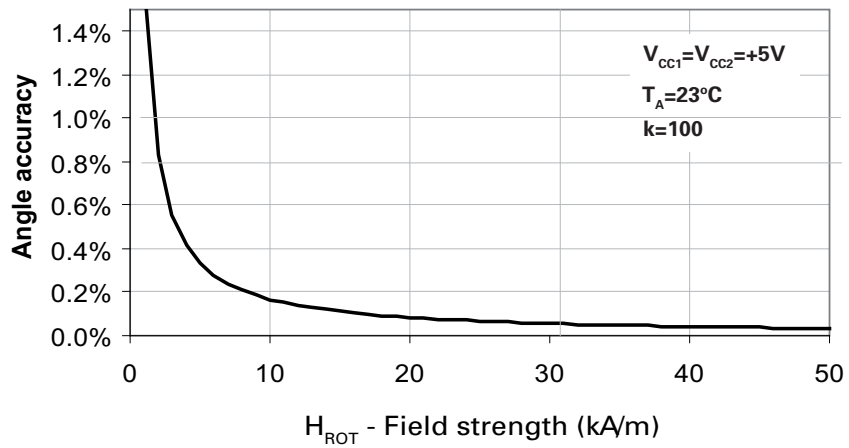


## Characteristic output curves $V_{O1}$ , $V_{O2}$

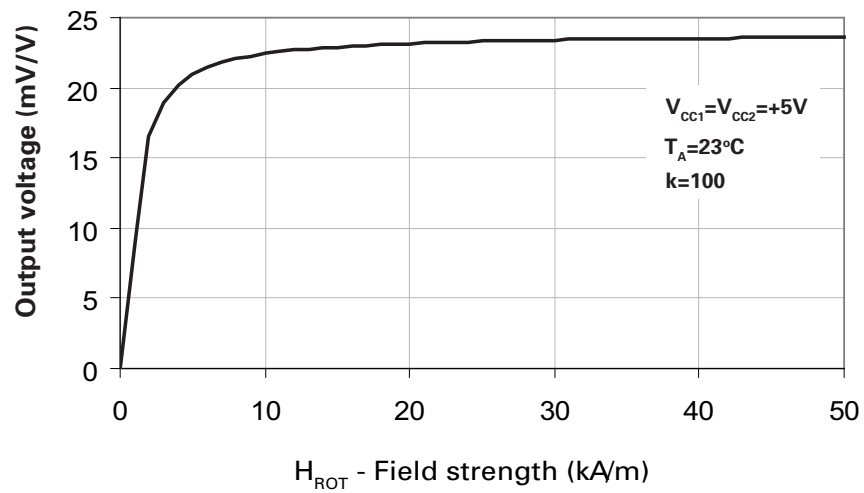


## Typical characteristics

### Accuracy variance with field strength

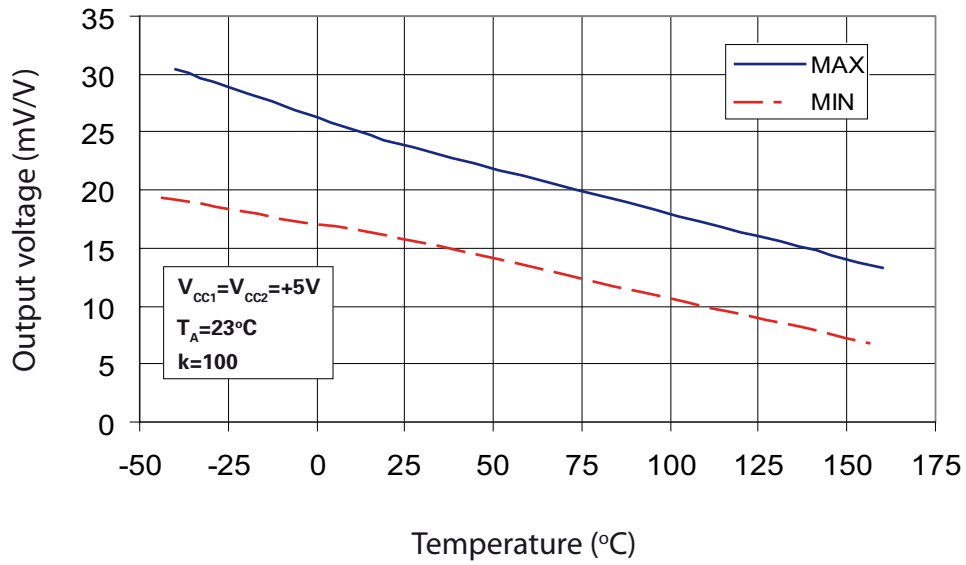


### Output variance with magnetic field strength

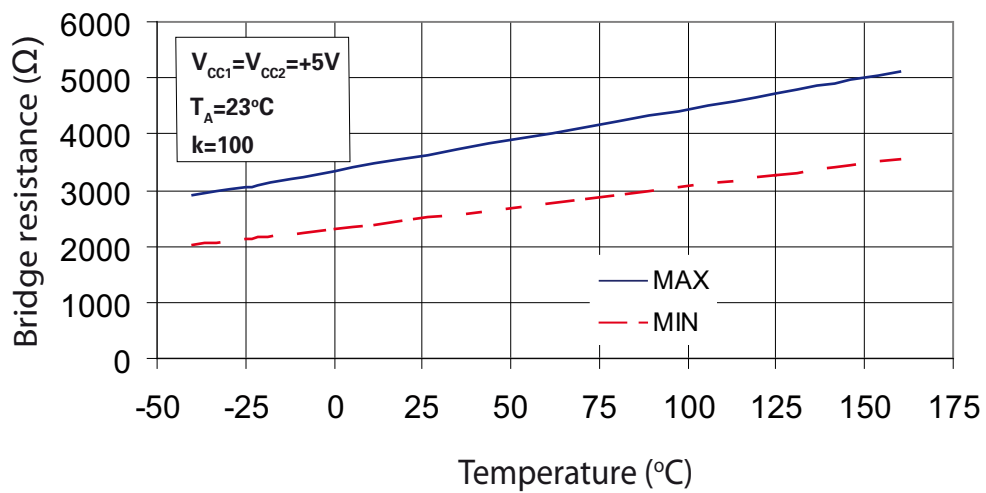


## Typical characteristics

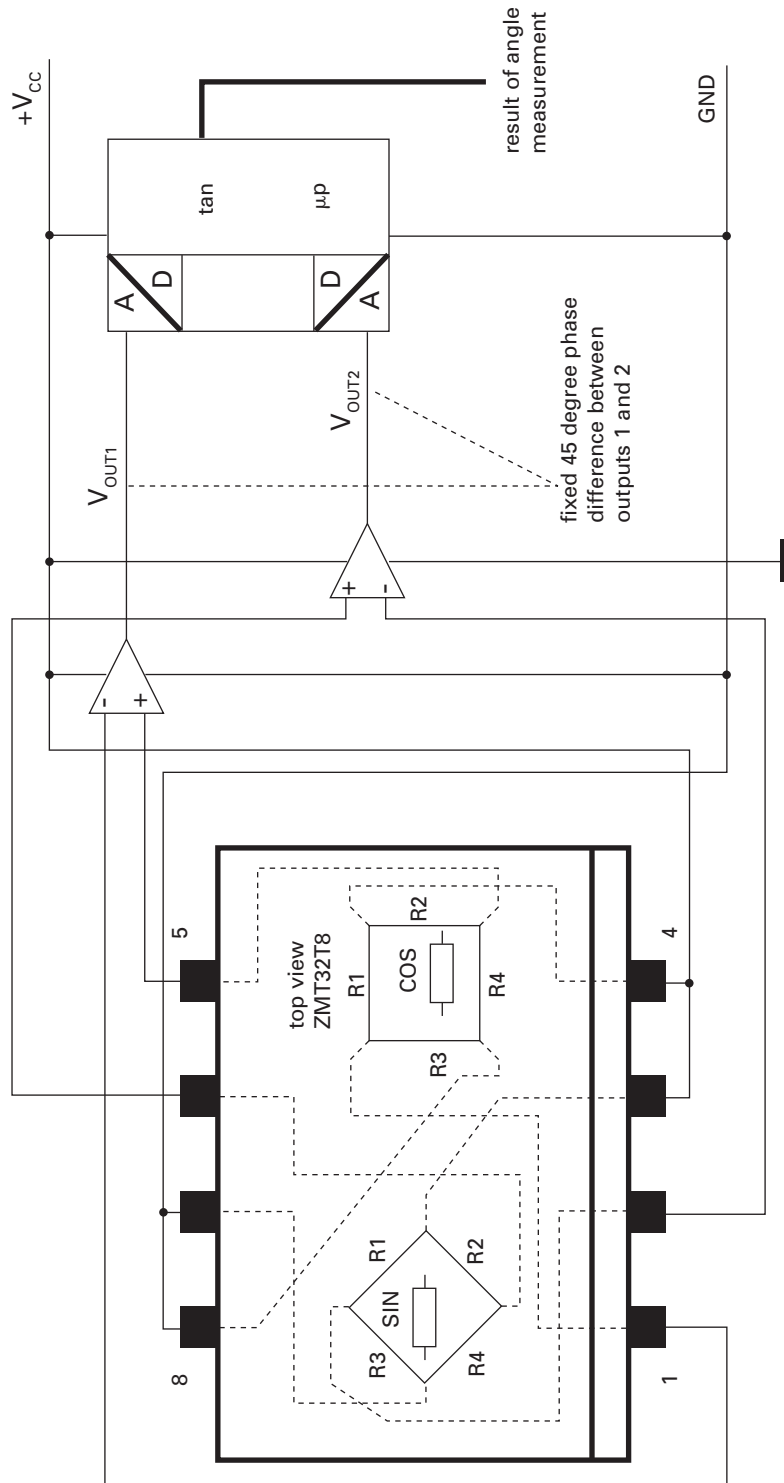
Output voltage versus temperature



Bridge resistance versus temperature

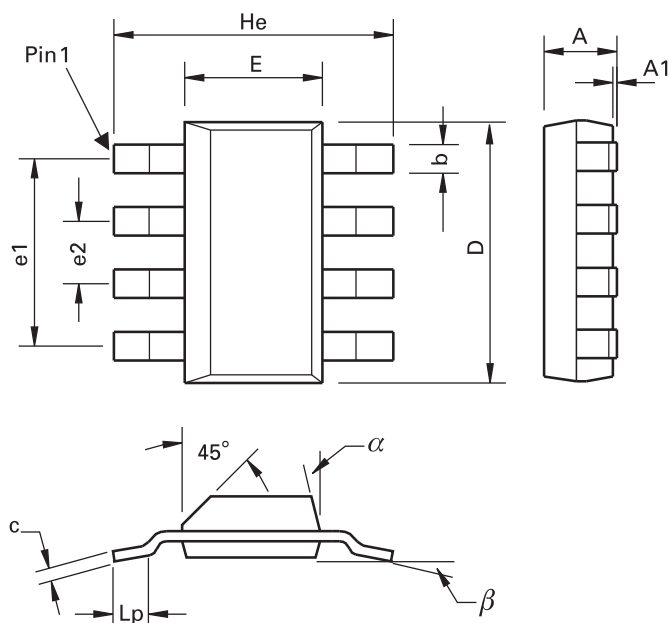


## Typical application

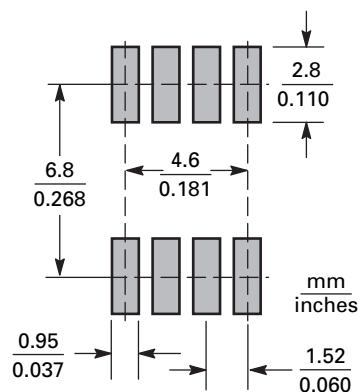




## Package outline - SM-8



## Soldering footprint



DIM	Millimeters			Inches			DIM	Millimeters			Inches		
	Min.	Max.	Typ.	Min.	Max.	Typ.		Min.	Max.	Typ.	Min.	Max.	Typ.
A	-	1.7	-	-	0.067	-	e1	-	-	4.59	-	-	0.1807
A1	0.02	0.1	-	0.0008	0.004	-	e2	-	-	1.53	-	-	0.0602
b	-	-	0.7	-	-	0.0275	He	6.7	7.3	-	0.264	0.287	-
c	0.24	0.32	-	0.009	0.013	-	Lp	0.9	-	-	0.035	-	-
D	6.3	6.7	-	0.248	0.264	-	$\alpha$	-	15°	-	-	15°	-
E	3.3	3.7	-	0.130	0.145	-	$\beta$	-	-	10°	-	-	10°

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

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