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 α = angle between sensor axis and field direction

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.

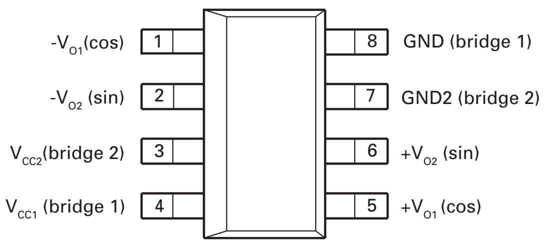
The ZMT32 is a passive part and the Arc-Tangent interpolation needs external signal processing. Typical areas of application are angle and speed measurement.

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

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±5°C, V_{CC1}=V_{CC2} = +5V, H_{ROT}=25kA/m(†), k=100•(V_{PO1}/V_{PO2}) with V_{CC1}=V_{CC2}

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP (*)	MAX	UNIT
$S_{\alpha1}$ or $S_{\alpha2}$	Sensitivities (zero crossing)	α1=135°, α2=0°			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°C		-0.008		+0.008	%/K
R_{B1} or R_{B2}	Bridge resistances	no H_{ROT}	T_A = -40°C	2017		3040	Ω
			T_A = 23°C	2500	3000	3600	
			T_A = +160°C	3345		5114	
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		T_A = -40°C	19.2		30.4	mV/V
			T_A = 23°C	16	20	24	
			T_A = +160°C	6.7		13.4	
		H_{ROT} = 8 kA/m(†)	T_A = 23°C	16	20	24	
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		T_A = -40°C	-1.25		+1.25	mV/V
			T_A = +160°C	-1.55		+1.55	
		H_{ROT} = 8 kA/m (†)	T_A = 23°C	-1	0	+1	
		no H_{ROT}	T_A = 23°C	-2	0	+2	
TCV_{OFF}[B]	TC of output offset voltage			-4	0	+4	μV/V/K
Δα[A]	Angular Inaccuracy				0.05	0.2	deg
ΔαH[A]	Angular hysteresis					0.1	deg
		H_{ROT} = 8 kA/m(†)				0.5 (‡)	deg
I_{iso1-2}	Isolation Bridge Current	no H_{ROT}		0		0.1	μA

NOTES:

(*) Typical values apply to an ambient temperature of 23°C

(†) See point "Magnetic Field Tests" below

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

A: Output characteristic definitions

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

$V_{OFF1}/V_{CC1} = ½(V_{OMAX1} + V_{OMIN1})/V_{CC1}$ or/ $V_{OFF2}/V_{CC2} = ½(V_{OMAX2} + V_{OMIN2})/V_{CC2}$

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

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

B: Temperature coefficient (TC) equations

T_1 = -25°C, T_0 = +25°C, T_2 = +125°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

$$TCV_{OFF} = \frac{V_{OFF(T2)} - V_{OFF(T1)}}{(T_2 - T_1)}$$

where $V_{OFF(Tn)}$ 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).

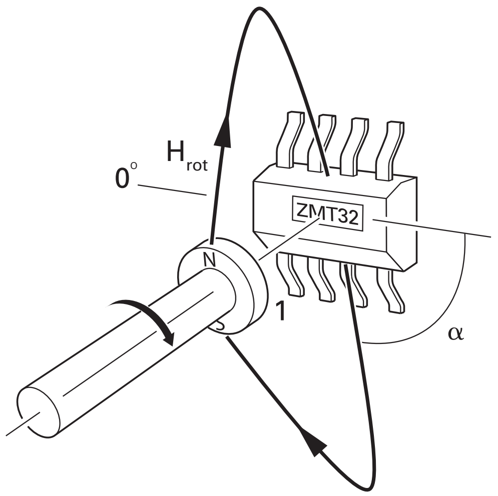
The field rotation steps are:

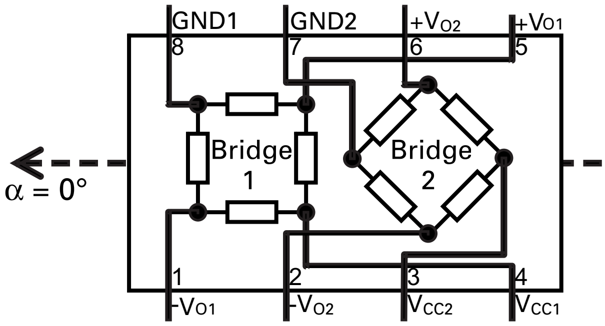
→ start in 180° position

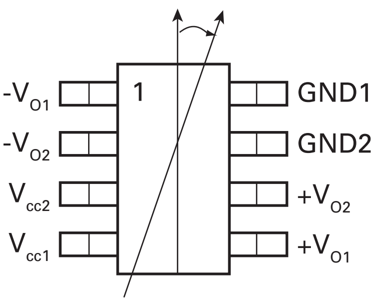
- § right rotation to 22.5° with measurement of sensor outputs
- § right rotation to 67.5° with measurement of sensor outputs
- § right rotation to 112.5° with measurement of sensor outputs
- § right rotation to 157.5° with measurement of sensor outputs
- § right rotation to 0° (360°) , stop , reversal
- § 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







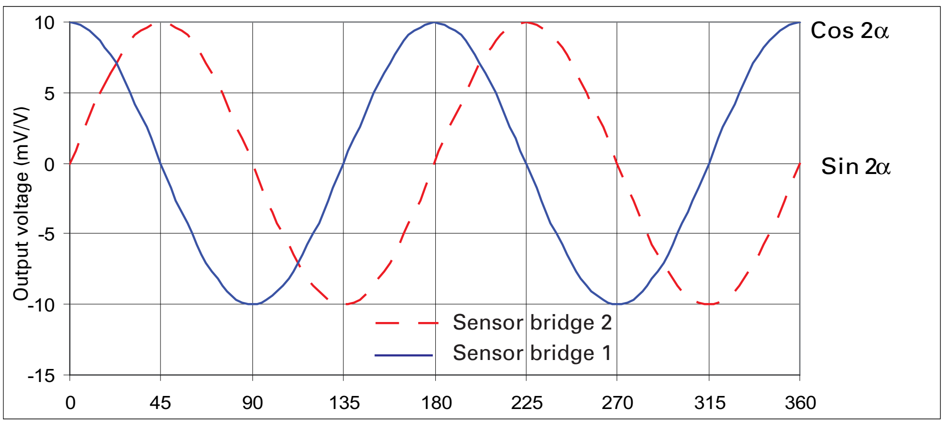
When a common-magnetic field is applied through the ZMT32 the 2 internal magneto-resistive bridges are affected slightly differently due to their 45° rotation to one another. This 45° rotation enables the ZMT32 to determine angular position, of a rotating magnetic field.

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

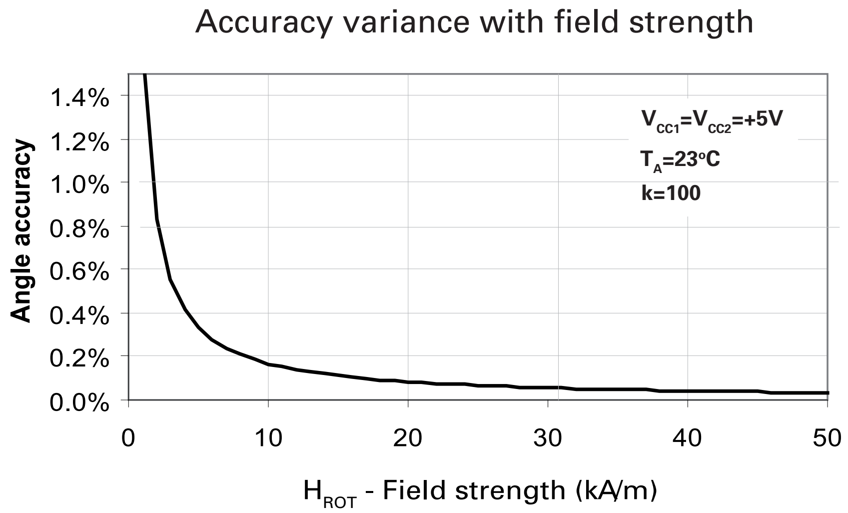
- proportional to the field strength applied
- proportional to the supply voltage applied,
- rotating at twice the angular position
- 90° apart (as seen below).

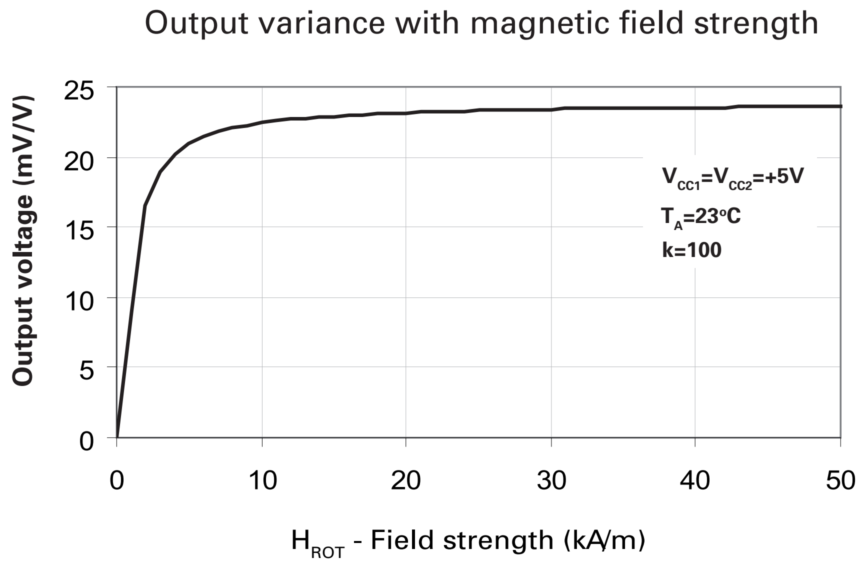
By taking the arcTan of the ratio of V_{O2} to V_{O1} the angular position of the magnetic field can be determined.

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



Typical characteristics





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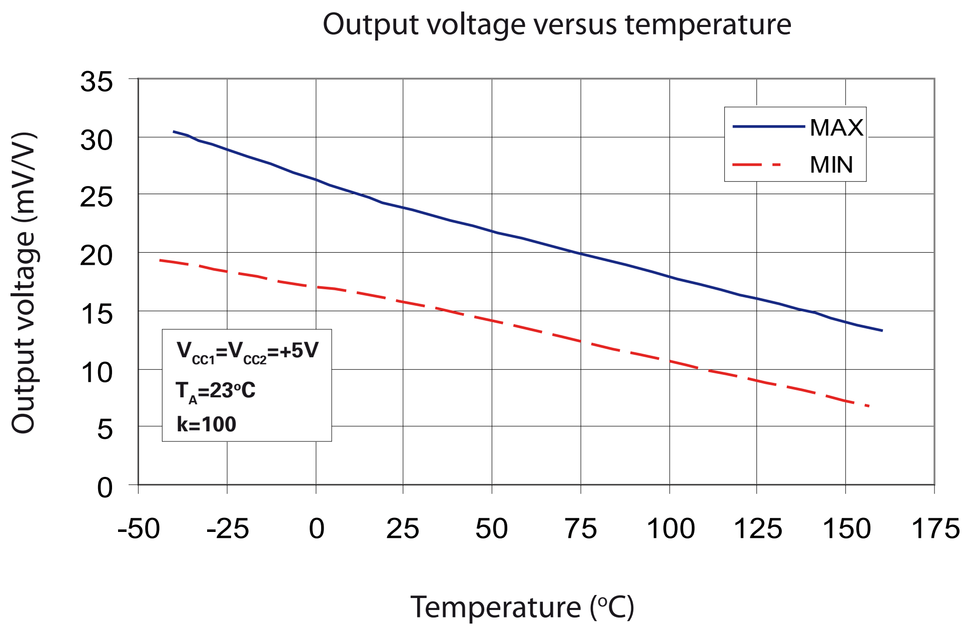
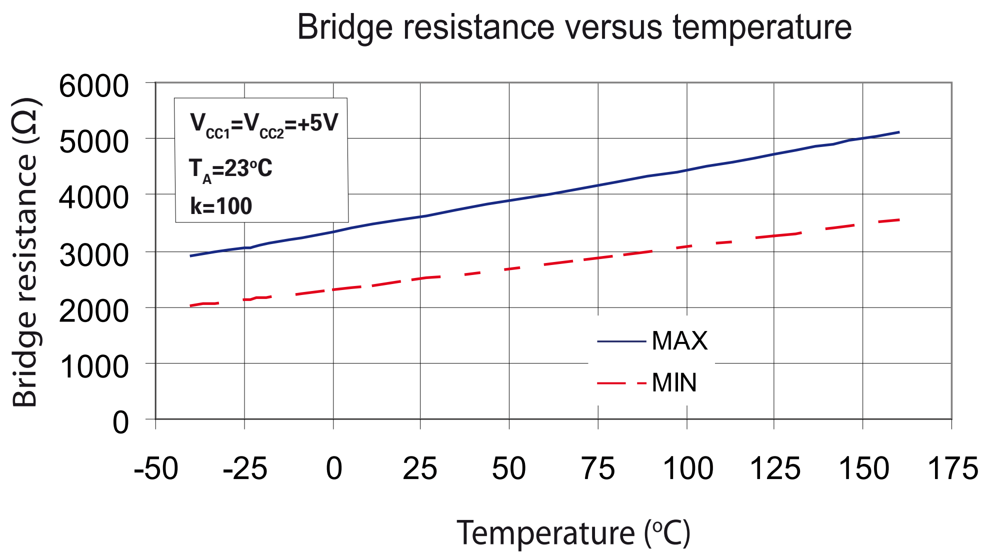
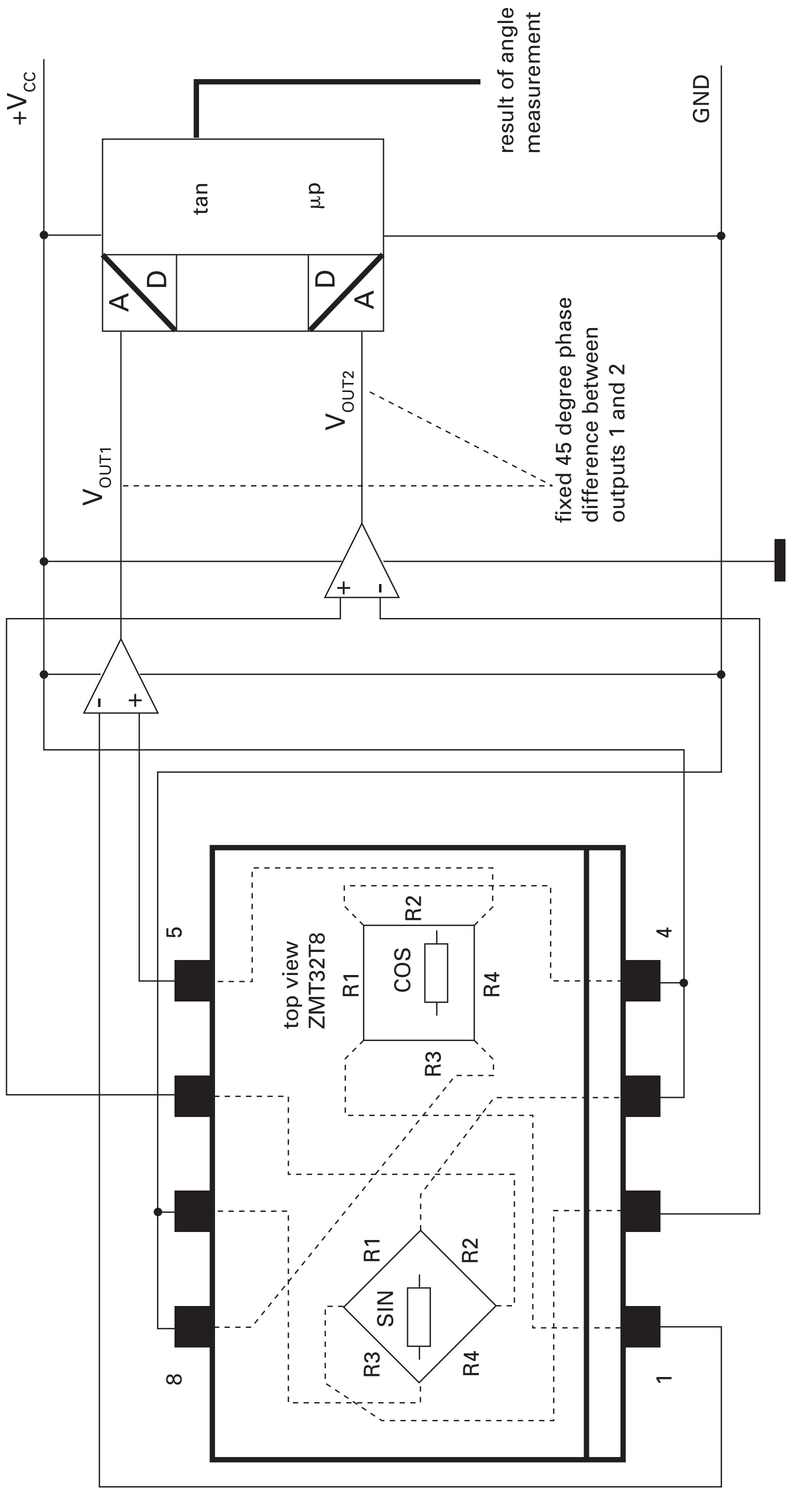
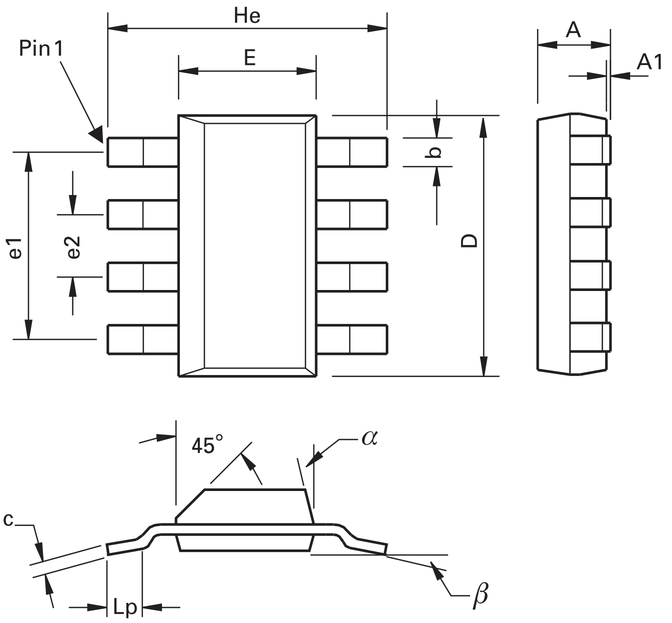




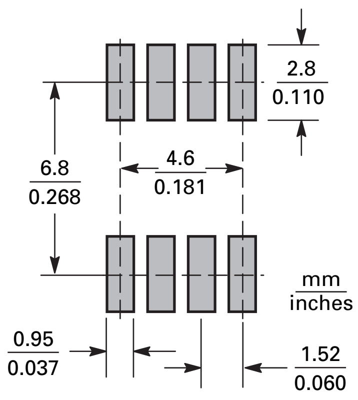
Typical application



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	-	α	-	15°	-	-	15°	-
E	3.3	3.7	-	0.130	0.145	-	β	-	-	10°	-	-	10°

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

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