CT310

XtremeSense™ 2D TMR Angle Sensor

FEATURES AND BENEFITS

- Angle error less than 0.60° (after one-time compensation) over full temperature range
- Dual full-bridge resistor network
- Operating magnetic field: 250 to 900 G
- Differential outputs for SIN and COS axes
- Supply voltage: 1.0 to 5.5 V
- AEC-Q100 Grade 1
- Package options:
  - □ 8-lead TSSOP
  - □ 8-lead DFN, 2.00 mm × 2.00 mm × 0.45 mm

APPLICATIONS

- Angular measurements
- Rotary and angular sensors
- BLDC motors

DESCRIPTION

The CT310 is a 2D angle sensor in a dual full-bridge configuration from Allegro developed on its patented XtremeSense™ 2D tunnel magnetoresistance (TMR) technology. The operating magnetic field for this 2D sensor is 250 to 900 G and has an angle error less than 0.60° over temperature following a one-time offset and gain compensation. The sensitive axes of the TMR elements are orthogonal to each other, providing a 90° phase separation between the sine and cosine outputs when measured differentially. This phase separation is inherently independent of magnet pole spacing and air gap.

The CT310 is available in a 8-lead TSSOP package, and for space-critical applications, a low-profile and small form factor 8-lead DFN package that is 2.00 mm × 2.00 mm × 0.45 mm in size. The packages are RoHS compliant and lead (Pb) free with a 100% matte-tin-plated leadframe.

FUNCTIONAL BLOCK DIAGRAM

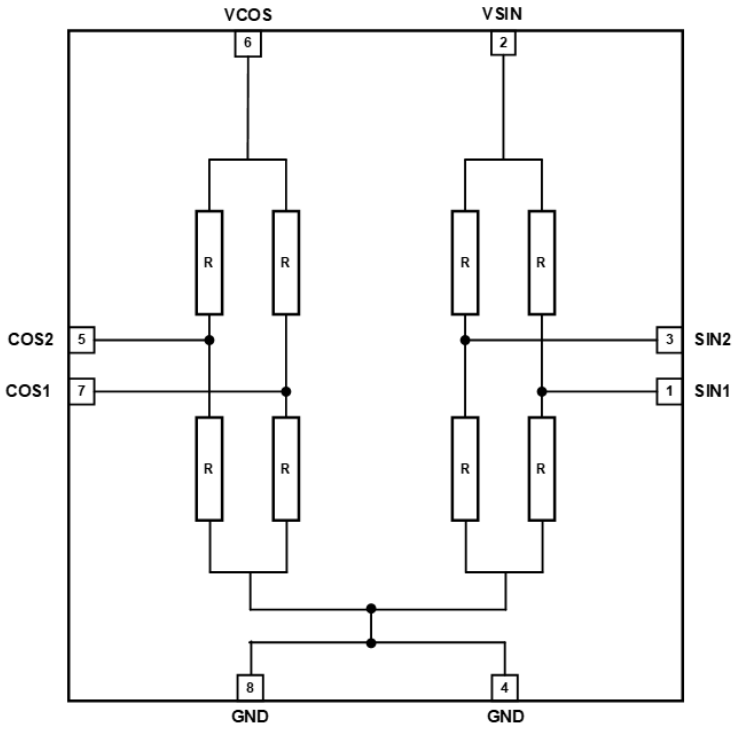


Figure 1: CT310 Functional Block Diagram

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Table of Contents

Features and Benefits 1
Description 1
Applications 1
Functional Block Diagram 1
Selection Guide 2
Absolute Maximum Ratings 2
Recommended Operating Conditions 2
Pinout Diagrams and Terminal Lists 4
Electrical Characteristics 7
Recommended Application Circuit 9
Applications Information 10
Package Outline Drawings 11
Tape and Reel Pocket Drawings and Dimensions 13
Package Information 15
Revision History 16

SELECTION GUIDE

Part Number	Operating Temp. Range (°C)	Automotive Grade	Output Type	Package	Packing
CT310LS-AT8	40 to 125	Grade 1	Differential	8-lead TSSOP 6.40 mm × 3.05 mm × 1.10 mm	Tape and Reel
CT310LS-FT8	40 to 150	–	Differential		
CT310LS-FD8	40 to 150	–	Differential	8-lead DFN 2.00 mm × 2.00 mm × 0.45 mm	Tape and Reel

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ABSOLUTE MAXIMUM RATINGS [1]

Characteristic	Symbol	Notes	Rating	Unit
Forward Voltage	V_{COS}, V_{SIN}		6.0	V
Reverse Voltage	V_{RCOS}, V_{RSIN}		–0.3	V
Electrostatic Discharge Protection Level	ESD	Human Body Model (HBM) per JESD22-A114	±4.0 (min)	kV
		Charged Device Model (CDM) per JESD22-C101	±1.0 (min)	kV
Maximum Magnetic Field	B_{MAX}	≤5 minutes at T_A = 25°C	±2000	G
Operating Ambient Temperature	T_A	Automotive	–40 to 125	°C
		Full Range	–40 to 150	°C
Storage Temperature	T_{STG}		–65 to 165	°C
Lead Soldering Temperature	T_L	10 seconds	260	°C

[1] Stresses exceeding the absolute maximum ratings may damage the CT310 and may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	Value	Unit
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	TSSOP-8 package	TBD	°C/W
		DFN-8 package	TBD	°C/W

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PINOUT DIAGRAMS AND TERMINAL LISTS

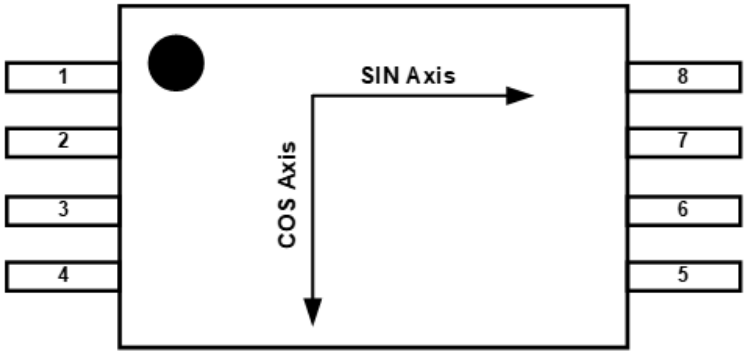


Figure 2: TSSOP-8 – Top-Down View

Terminal List

Number	Name	Function
1	SIN1 [1]	Differential output #1 for sine.
2	VSIN	Supply voltage for sine
3	SIN2 [1]	Differential output #2 for sine.
4	GND	Ground for sine.
5	COS2 [2]	Differential output #2 for cosine.
6	VCOS	Supply voltage for cosine
7	COS1 [2]	Differential output #1 for cosine.
8	GND	Ground for cosine.

[1] SIN2 – SIN1 = SIN.
[2] COS2 – COS1 = COS.

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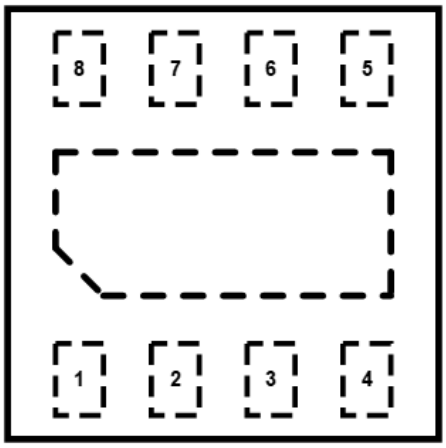


Figure 3: DFN-8,Top-Down View

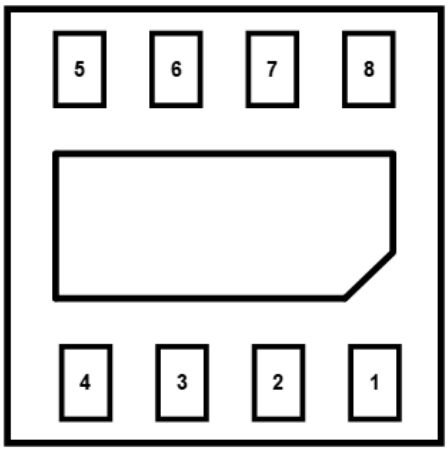


Figure 4: DFN-8, Bottom-Up View

Terminal List

Number	Name	Function
1	SIN1 [1]	Differential output #1 for sine.
2	VSIN	Supply voltage for sine
3	SIN2 [1]	Differential output #2 for sine.
4	GND	Ground for sine.
5	COS2 [2]	Differential output #2 for cosine.
6	VCOS	Supply voltage for cosine
7	COS1 [2]	Differential output #1 for cosine.
8	GND	Ground for cosine.

[1] SIN2 – SIN1 = SIN.
[2] COS2 – COS1 = COS.

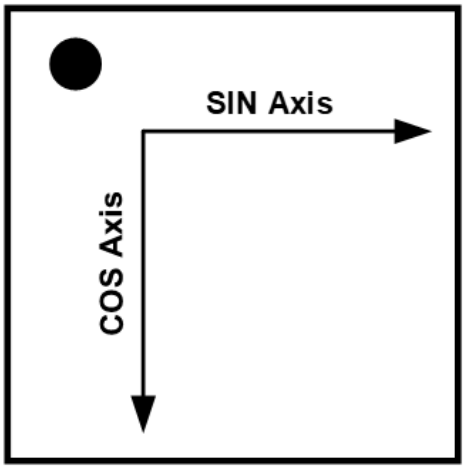


Figure 5: CT310 Axes of Sensitivity for DFN-8

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ELECTRICAL CHARACTERISTICS: Valid over all operating voltage and temperature conditions, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. [3]	Max.	Unit
ELECTRICAL						
Supply Voltage Range	V_{COS}, V_{SIN}		1.0	–	5.5	V
COS and SIN Differential Output Voltage Range	V_{COS_D}, V_{SIN_D}		–1.37	–	+1.37	V
Bridge Resistance	R_{BRIDGE}	T_A = 25°C	3.0	4.5	6.0	kΩ
Temperature Coefficient Resistance [1]	TCR		–	0.05	–	%/°C
MAGNETIC						
Operating Magnetic Field	B		250	600	900	G
DIFFERENTIAL OUTPUTS						
Angle Error [2]	θ_{ERR}	After compensation	–	0.30	0.60	°
Angle Error @ 20 mT [1][2]	θ_{ERR_20mT}	After compensation, B_{OP} = 20 mT	–	–	0.90	°
Angle Error Due to Hysteresis [1]	θ_{ERR_HYST}		–	–	TBD	°
Lifetime Shift	B_{SHIFT}		–	–	TBD	°
SIN, COS Differential Output Voltage Peak-to-Peak	V_{SIN_D}, V_{COS_D}	T_A = 25°C	0.35	0.45	0.50	V/V
Temperature Coefficient of Differential Output [1]	TCV_{OUT}		–	–0.16	–	%/°C
SIN, COS Voltage Offset	V_{OFF_SIN}, V_{OFF_COS}		–	±1	±5	mV/V
SIN, COS Amplitude Synchronism Ratio	k		97	100	103	%
Temperature Coefficient of Amplitude Synchronism [1]	TC_k		–	0.005	–	%/°C
SIN, COS Orthogonality Error	OE_{SIN}, OE_{COS}	Deviation from ideal phase separation between SIN and COS	–2	0	2	°
SIN, COS Response Time [1]	$t_{RESPONSE}$	C_L = 22 pF	–	1.0	–	µs
Noise [1]	e_N	f_{BW} = 1 Hz to 10 kHz, V_{DD} = 3.0 V	–	2.4	–	$\mu V_{RMS}/V$

[1] Guaranteed by design and characterization; not tested in production.
[2] Hysteresis error and output noise are included in the Angular Error specification.
[3] Typical values correspond to performance at V_{DD} = 3.0 V and T_A = 25°C, unless otherwise specified.

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ELECTRICAL CHARACTERISTICS

V_{DD} = 3.0 V and T_A = 25°C (unless otherwise specified)

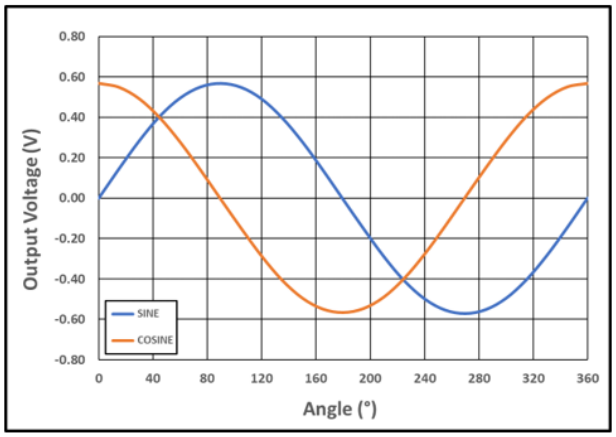


Figure 7: Output Voltage vs. Angle at B = 250 G

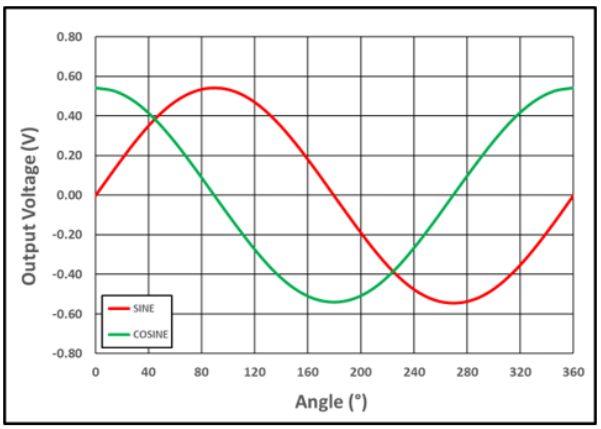


Figure 8: Output Voltage vs. Angle at B = 900 G

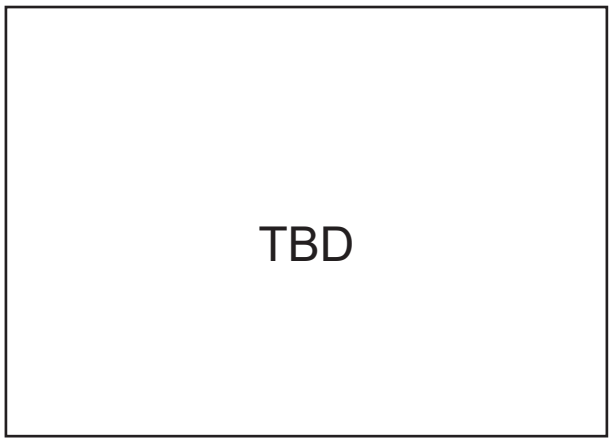


Figure 9: Differential Output Voltage (V/V) over Temperature, B = TBD G

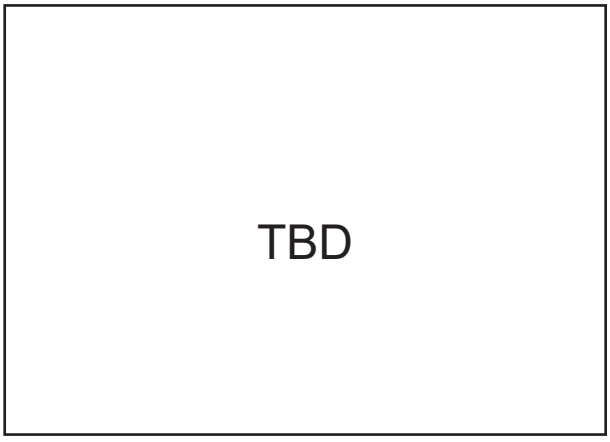


Figure 10: Differential Output Voltage (mV/V) over Temperature, B = TBD G

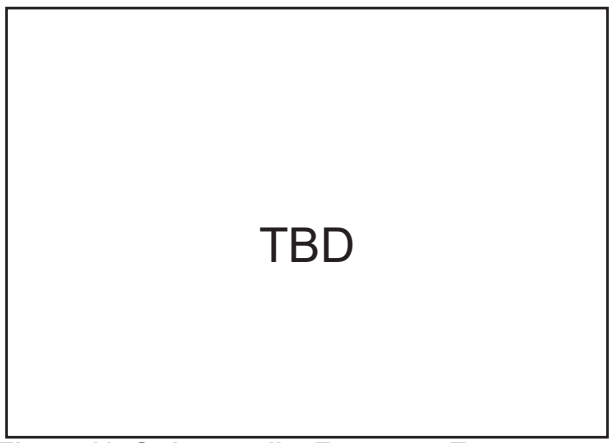


Figure 11: Orthogonality Error over Temperature, B = TBD G

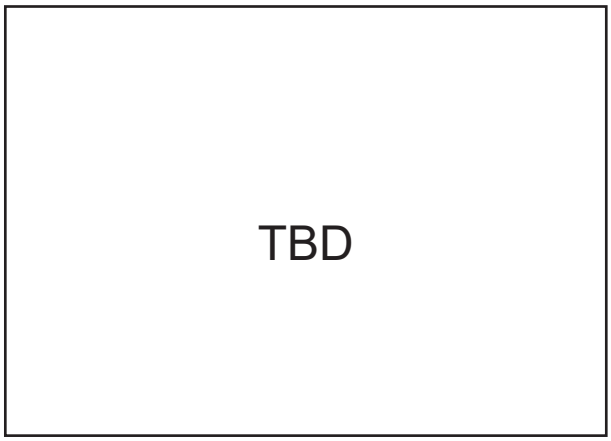


Figure 12: Angle Error After Compensation (25°C, TBD G) over Field

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RECOMMENDED APPLICATION CIRCUIT

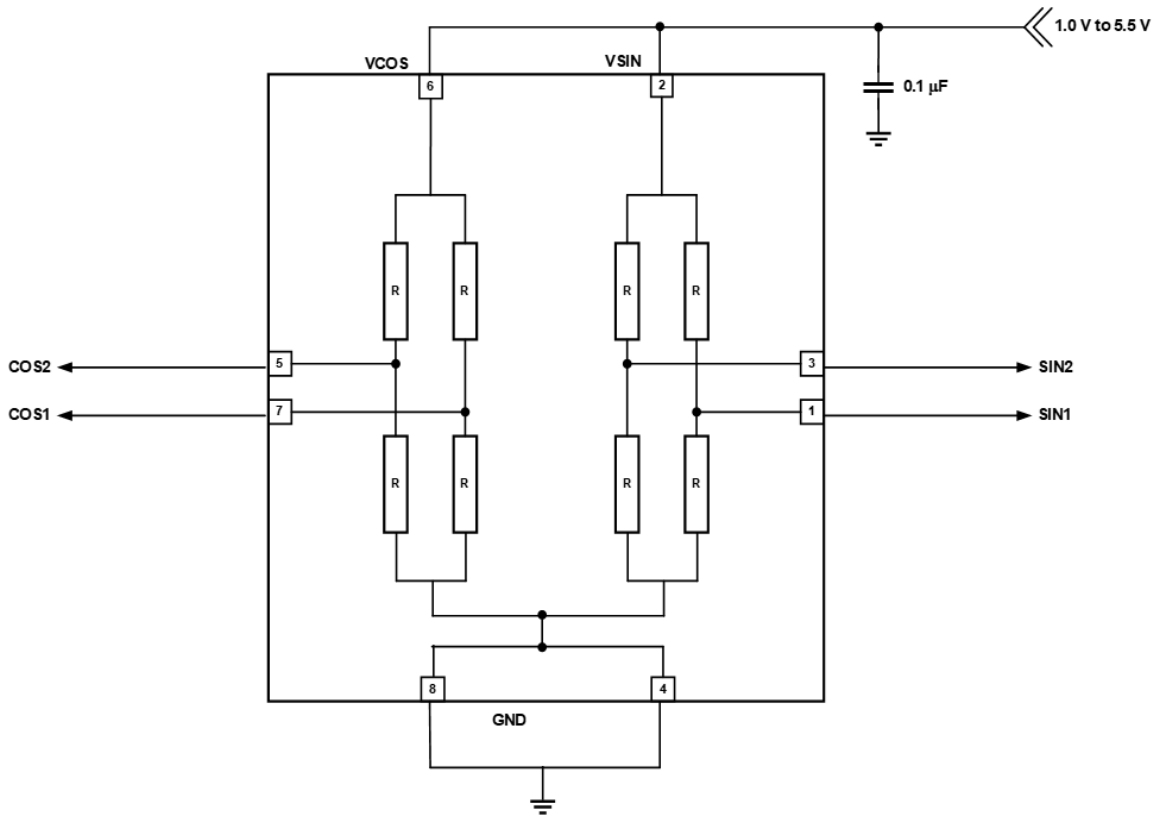


Figure 13: CT310 Application Diagram

Table 1: Recommended External Components

Component	Description	Vendor and Part Number	Parameter	Min.	Typ.	Max.	Unit
C_{BYP}	0.1 µF, X7R	Murata GRM033Z71A104KE14	C	–	0.1	–	µF

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Applications Information

The XtremeSense TMR sensor location for the CT310 for the x, y dimensions are shown in Figure 11 and Figure 12 for the TSSOP-8 and DFN-8 packages respectively. Figure 13 and Figure 14 illustrates the location of the CT310 XtremeSense TMR sensor from the z dimension. All dimensions in the figures below are nominal.

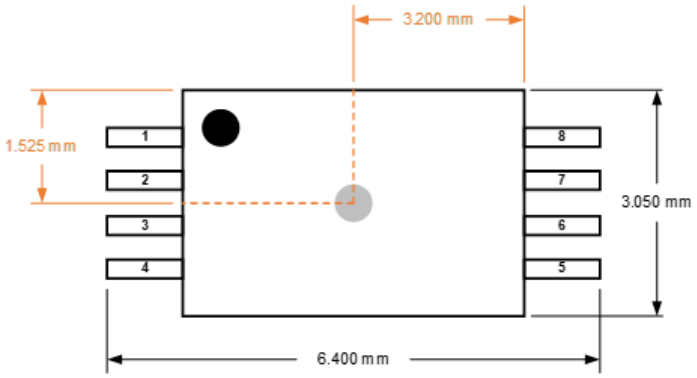


Figure 14: XtremeSense TMR Sensor Location in x-y Plane for CT310 in TSSOP-8 Package

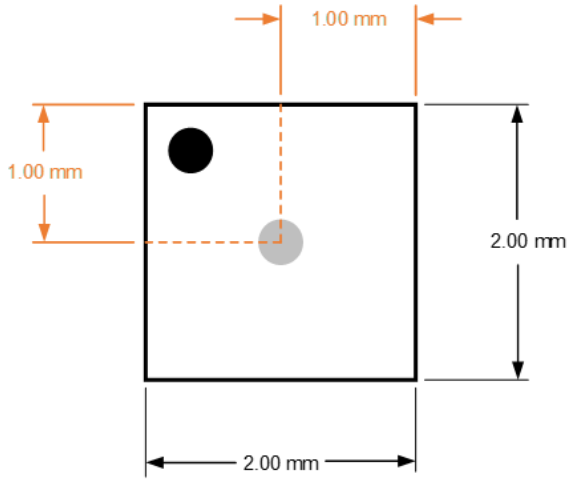


Figure 15: XtremeSense TMR Sensor Location in x-y Plane for CT310 in DFN-8 Package

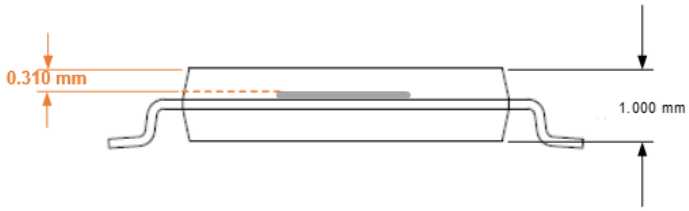


Figure 16: XtremeSense TMR Sensor Location in z Dimension for CT310 in TSSOP-8 Package



Figure 17: XtremeSense TMR Sensor Location in z Dimension for CT310 in DFN-8 Package

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PACKAGE OUTLINE DRAWINGS

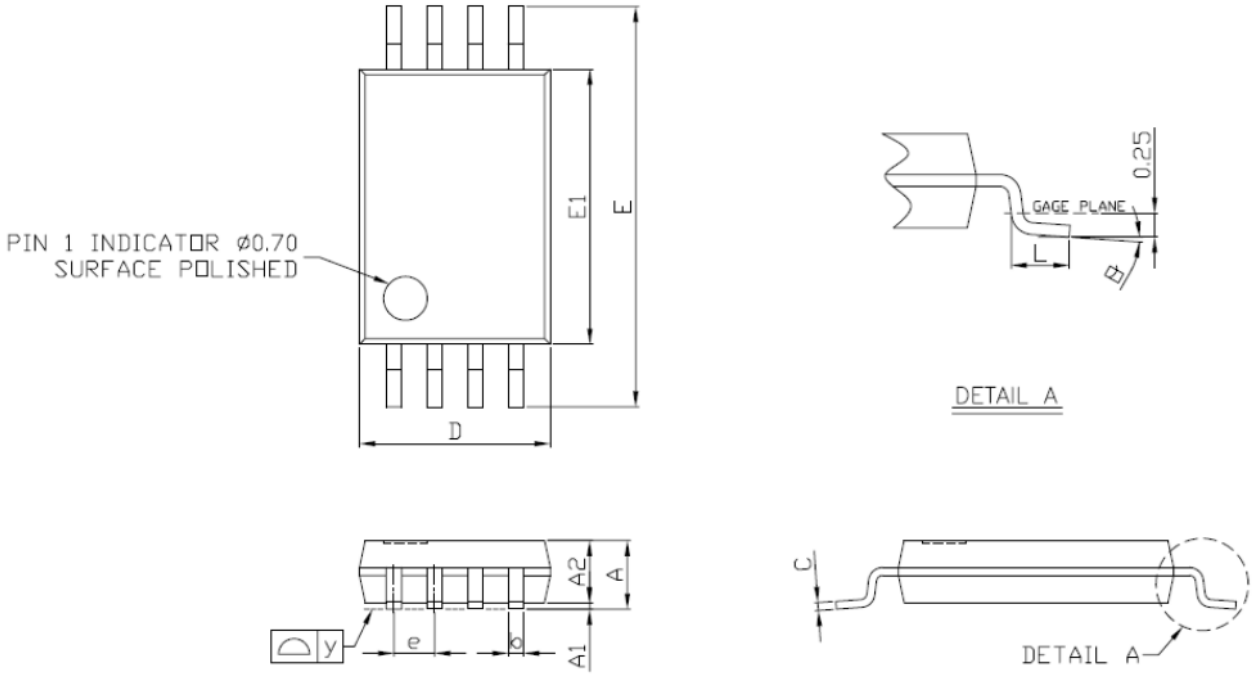
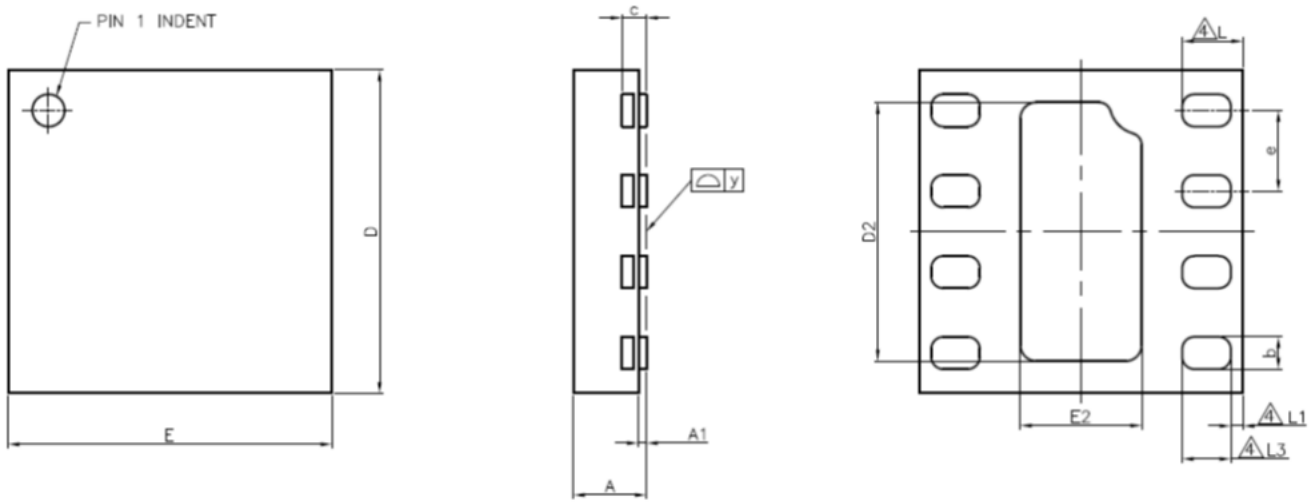


Figure 18: TSSOP-8 Package Drawing

Table 2: CT310 TSSOP-8 Package Dimensions

Symbol	Dimensions in Millimeters (mm)		
	Min.	Typ.	Max.
A	1.05	1.10	1.20
A1	0.05	0.10	0.15
A2	–	1.00	1.05
b	0.25	–	0.30
C	–	0.127	–
D	2.90	3.05	3.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	–	0.65	–
L	0.50	0.60	0.70
y	–	–	0.076
θ	0°	4°	8°

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NOTES:

1. The terminal #1 identifier is a laser marked feature.

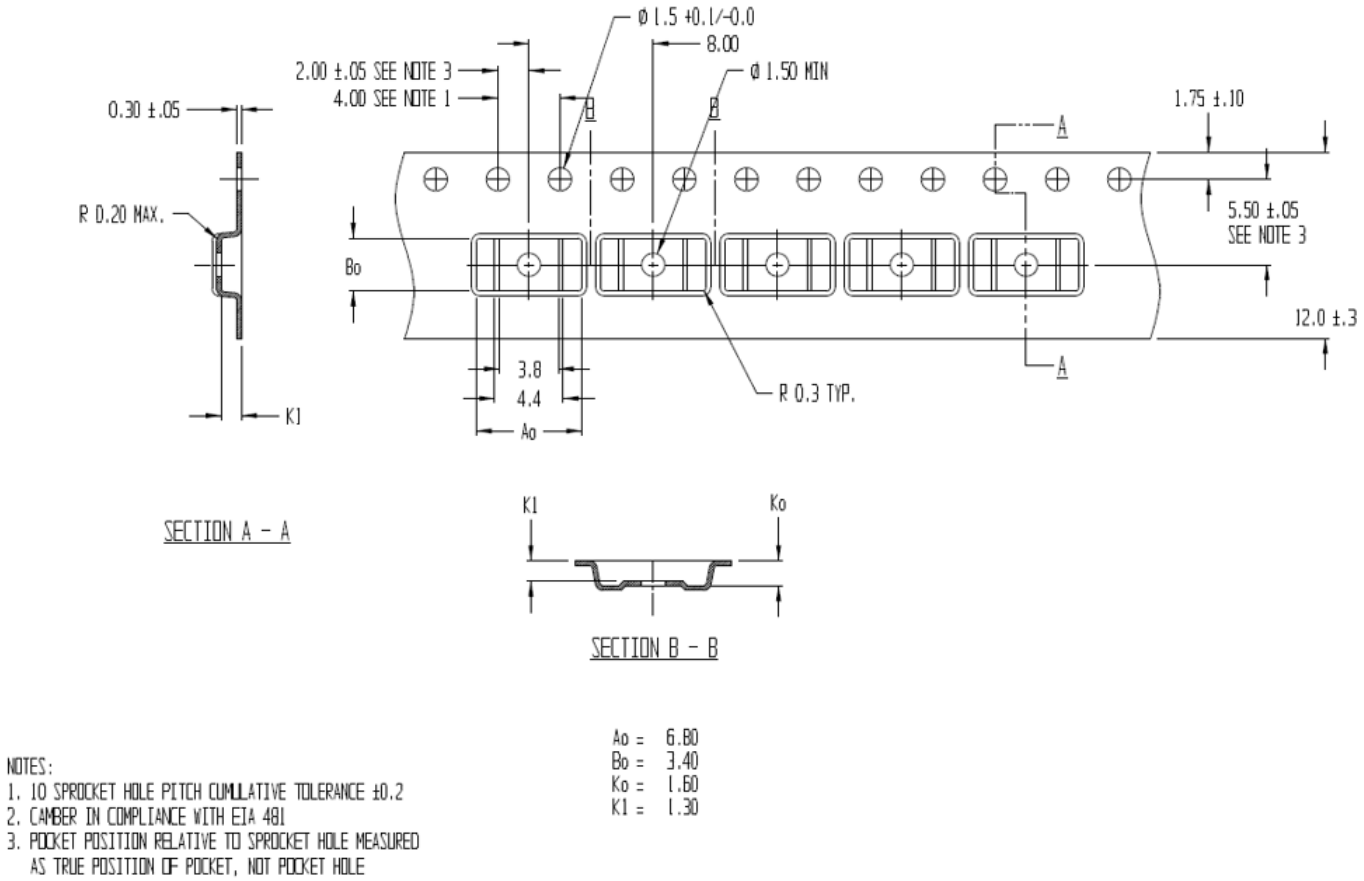
Figure 19: DFN-8 Package Drawing

Table 3: CT310 DFN-6 Package Dimensions

Symbol	Dimensions in Millimeters (mm)		
	Min.	Typ.	Max.
A	0.40	0.45	0.50
A1	0.00	0.02	0.05
b	0.15	0.20	0.25
c	–	0.150 REF	–
D	1.925	2.000	2.075
D2	1.550	1.600	1.650
E	1.925	2.000	2.075
E2	0.700	0.750	0.800
e	–	0.500	–
L ④	0.325	0.375	0.425
L1 ④	–	0.075	–
L3 ④	0.250	0.300	0.350
y	0.000	–	0.075

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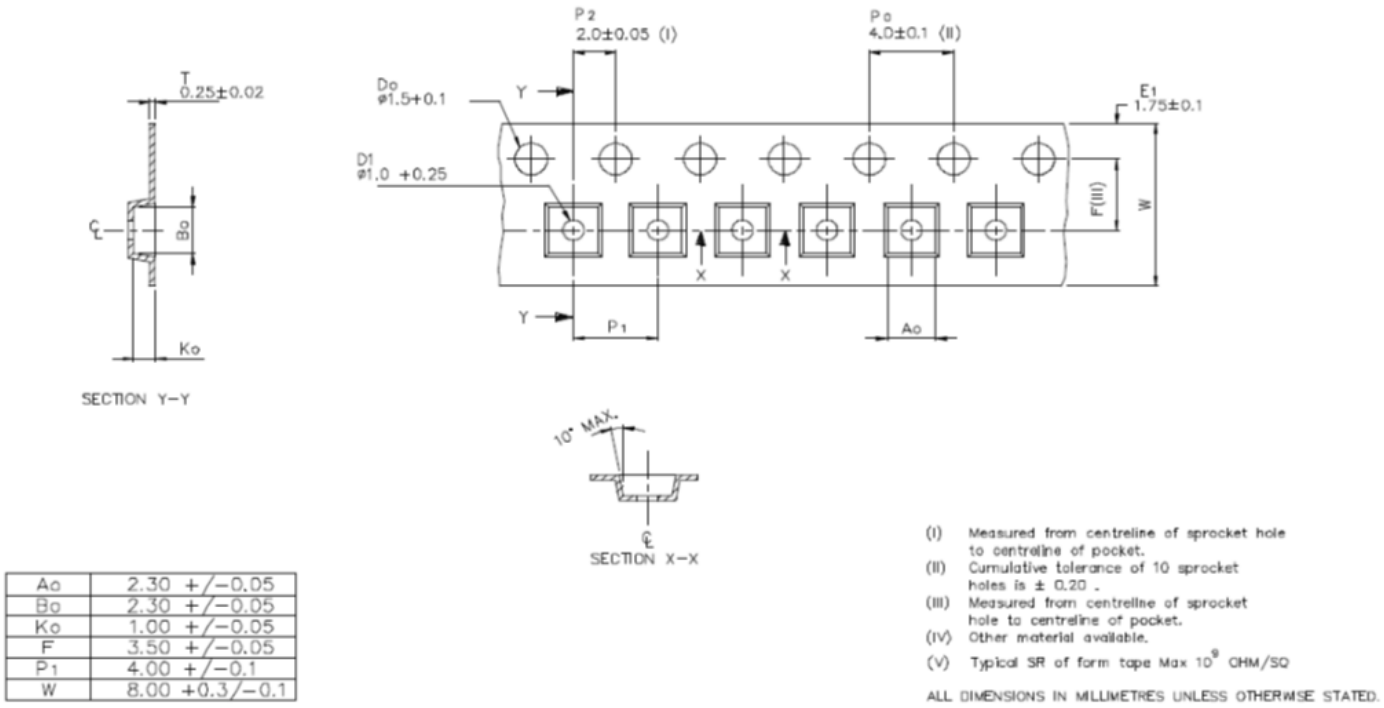
TAPE AND REEL POCKET DRAWINGS AND DIMENSIONS



NOTES:
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2. CAMBER IN COMPLIANCE WITH EIA 481
3. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

Figure 20: TSSOP-8 Tape and Pocket Drawings

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Ao	2.30 +/−0.05
Bo	2.30 +/−0.05
Ko	1.00 +/−0.05
F	3.50 +/−0.05
P1	4.00 +/−0.1
W	8.00 +0.3/−0.1

Figure 21: DFN-8 Tape and Pocket Drawings

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PACKAGE INFORMATION

Table 4: CT310 Package Information

Part Number	Package Type	# of Leads	Package Quantity	Lead Finish	Eco Plan [1]	MSL Rating [2]	Operating Temperature [3]	Device Marking [4]
CT310LS-AT8	TSSOP	8	3000	Sn	Green & RoHS	1	–40°C to 125°C	CT310LS-AT8 YYWWSS
CT310LS-FT8	TSSOP	8	3000	Sn	Green & RoHS	1	–40°C to 150°C	CT310LS-FT8 YYWWSS
CT310LS-FD8	DFN	8	3000	Sn	Green & RoHS	1	–40°C to 150°C	310F YWWS

[1] RoHS is defined as semiconductor products that are compliant to the current EU RoHS requirements. It also will meet the requirement that RoHS substances do not exceed 0.1% by weight in homogeneous materials. Green is defined as the content of chlorine (Cl), bromine (Br), and antimony trioxide based flame retardants satisfy JS709B low halogen requirements of ≤ 1,000 ppm.
[2] MSL Rating = Moisture Sensitivity Level Rating as defined by JEDEC standard classifications.
[3] Package will withstand ambient temperature range of –40°C to 150°C and storage temperature range of –65°C to 165°C.
[4] Device Marking for TSSOP is defined as CT310LS-XT8 YYWWSS where CT310LS = base part number, X = temperature code, T8 = TSSOP-8 package, YY = year, WW = work week, and SS = sequential number. DFN is defined as 300X where X = temperature code and Y = year, WW = work week, and S = sequential number.

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Revision History

Number	Date	Description
1	December 8, 2023	Document rebranded and minor editorial updates

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