

## XtremeSense™ 2D TMR Angle Sensor

### FEATURES AND BENEFITS

- Angle error less than  $0.60^\circ$  (after one-time compensation) over full temperature range
- Dual full-bridge TMR 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 0

### APPLICATIONS

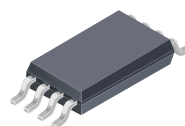
- Angular measurements
- Rotary and angular sensors
- BLDC motors

### DESCRIPTION

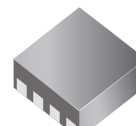
The CT310 is a 2D angle sensor in a dual full-bridge configuration using XtremeSense™ 2D tunnel magneto-resistance (TMR) technology. The operating magnetic field for this 2D sensor is 250 to 900 G and has an angle error less than  $0.60^\circ$  over temperature following a one-time offset, gain, and phase compensation. The sensitive axes of the TMR elements are orthogonal to each other, providing a  $90^\circ$  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 an 8-lead TSSOP package, and for space-critical applications, a low-profile and small form factor 8-lead DFN package that is  $2.00\text{ mm} \times 2.00\text{ mm} \times 0.45\text{ mm}$  in size. The packages are RoHS compliant and lead (Pb) free with a 100% matte-tin-plated leadframe.

### PACKAGES



8-Lead TSSOP



8-Lead DFN

*Not to scale*

### FUNCTIONAL BLOCK DIAGRAM

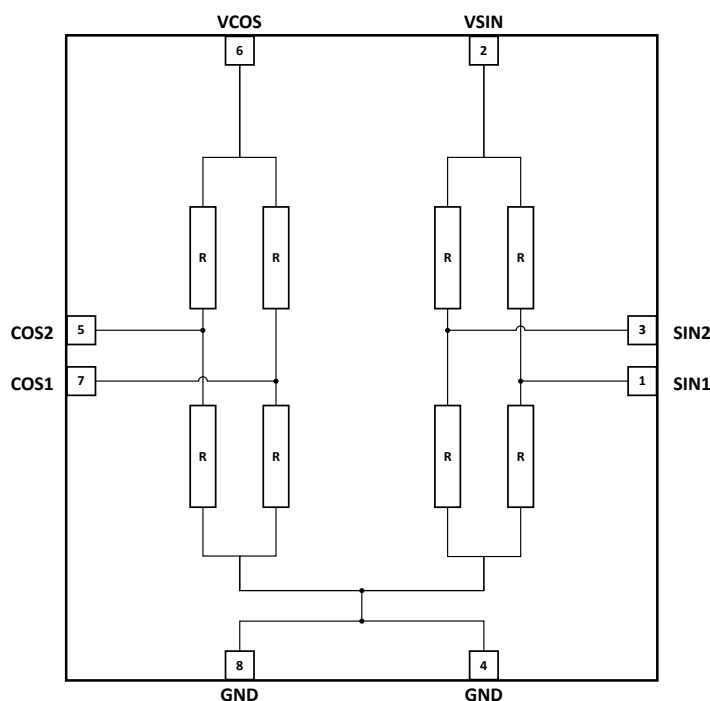


Figure 1: CT310 Functional Block Diagram

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## SELECTION GUIDE

Part Number [1]	Operating Temp. Range (°C)	Automotive Grade	Output Type	Package	Packing
CT310LS-IT8	–40 to 85	–	Differential	8-lead TSSOP 6.40 mm × 3.05 mm × 1.10 mm	Tape and Reel
CT310LS-HT8	–40 to 125	–	Differential	8-lead TSSOP 6.40 mm × 3.05 mm × 1.10 mm	Tape and Reel
CT310LS-HD8	–40 to 125	–	Differential	8-lead DFN 2.00 mm × 2.00 mm × 0.45 mm	Tape and Reel
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	Grade 0	Differential	8-lead TSSOP 6.40 mm × 3.05 mm × 1.10 mm	Tape and Reel



[1] Contact Allegro Microsystems for different temperature rated TSSOP-8 or DFN-8 package offerings or direct wafer sales.

## 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 $T_A = 25^{\circ}C$	±2000	G
Operating Ambient Temperature	$T_A$	Industrial	-40 to 85	°C
		Automotive (A), Extended Industrial (H)	-40 to 125	°C
		Full (F)	-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. 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	234	°C/W

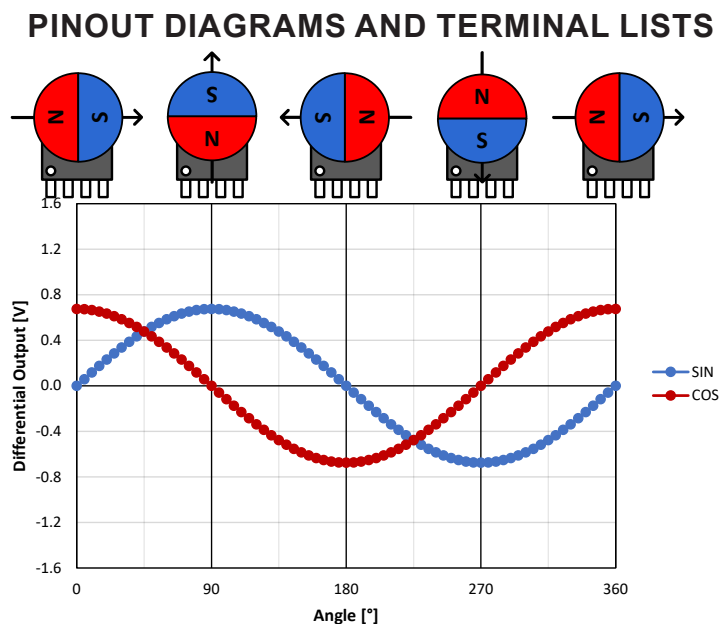


Figure 2: Nominal Differential Output,  $V_{COS} = V_{SIN} = 3.0\text{ V}$

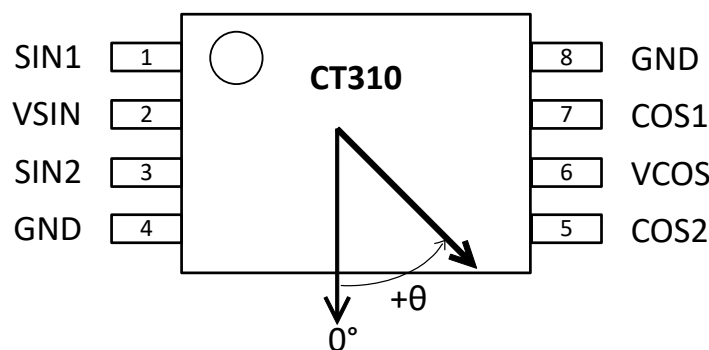


Figure 3: TSSOP-8 – Top-Down View

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]  $COS2 - COS1 = COS$ .

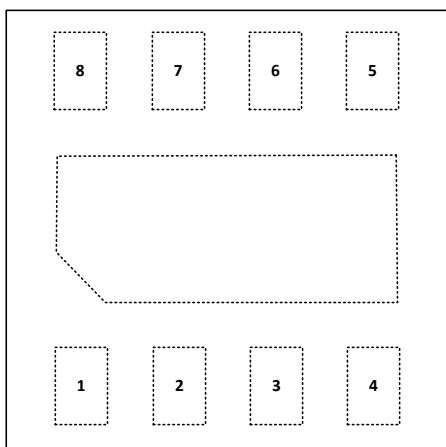


Figure 4: DFN-8, Top-Down View

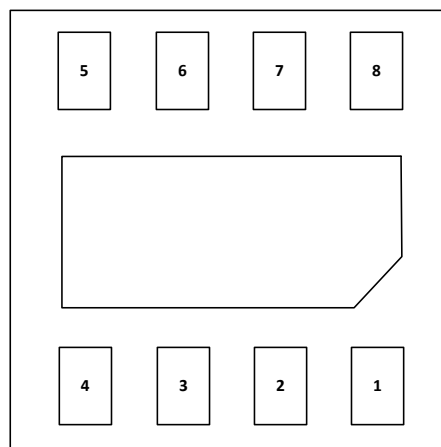


Figure 5: DFN-8, Bottom-Up View

## Terminal List

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

<sup>[1]</sup> SIN2 – SIN1 = SIN.

<sup>[2]</sup> COS2 – COS1 = COS.

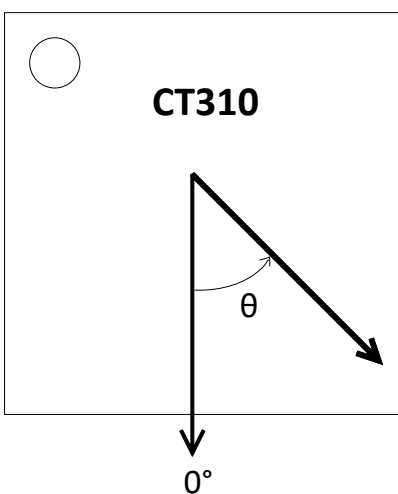


Figure 6: CT310 Axes of Sensitivity for DFN-8

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

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>ELECTRICAL</b>						
Supply Voltage Range	$V_{COS}, V_{SIN}$		1.0	–	5.5	V
Bridge Resistance [3]	$R_{BRIDGE}$	$T_A = 25^{\circ}C$	3.0	4.5	6.0	k $\Omega$
Temperature Coefficient Resistance [1][3]	TCR		–	–0.05	–	%/ $^{\circ}C$
<b>MAGNETIC</b>						
Operating Magnetic Field	B		250	600	900	G
Extended Magnetic Field [1]	$B_{EXT}$		200	–	–	G
<b>OUTPUT CHARACTERISTICS</b>						
SIN, COS Voltage Offset [3]	$V_{OFF\_SIN}, V_{OFF\_COS}$		–	$\pm 1$	$\pm 5$	mV/V
SIN, COS Differential Output Voltage Peak-to-Peak [3]	$V_{SIN\_D}, V_{COS\_D}$	$T_A = 25^{\circ}C$	0.35	0.45	0.50	V/V
Temperature Coefficient of Differential Output [1][3]	$TCV_{OUT}$		–	–0.16	–	%/ $^{\circ}C$
SIN, COS Amplitude Synchronism Ratio	k		97	100	103	%
Temperature Coefficient of Amplitude Synchronism [1][3]	$TC_k$		–	$\pm 0.005$	–	%/ $^{\circ}C$
SIN, COS Orthogonality Error	$OE_{SIN}, OE_{COS}$	Deviation from ideal phase separation between SIN and COS	–2	0	2	degrees
Noise [1][3]	$e_N$	$f_{BW} = 1 \text{ Hz to } 10 \text{ kHz}, V_{COS}, V_{SIN} = 3.0 \text{ V}$	–	2.4	–	$\mu V_{RMS}/V$
<b>ANGLE PERFORMANCE</b>						
Angle Error [2][3]	$\theta_{ERR}$	After one-time offset, amplitude, and orthogonality correction at $25^{\circ}C$ , 0 hour over B	–	0.30	0.60	degrees
Angle Error, Extended Range [1][2]	$\theta_{ERR\_EXT}$	After one-time offset, amplitude, and orthogonality correction at $25^{\circ}C$ , 0 hour over $B_{EXT}$	–	–	0.90	degrees
Angle Error, Lifetime [2][4]	$\theta_{ERR\_LIFE}$	Over lifetime, after one-time offset, amplitude, and orthogonality correction at $25^{\circ}C$ , 0 hour, over B	–	–	1.0	degrees
Angle Error, Extended Range and Lifetime [2][5]	$\theta_{ERR\_Ext\_Life}$	Over lifetime, after one-time offset, amplitude, and orthogonality correction at $25^{\circ}C$ , 0 hour, over $B_{EXT}$	–	–	1.3	degrees
Angle Error Due to Hysteresis [1][3]	$\theta_{ERR\_HYST}$		–	0.03	–	degrees

[1] Determined by design and characterization; not tested in production.

[2] Hysteresis error and output noise are included in the Angular Error specification.

[3] Typical values represent  $3\sigma$  performance unless otherwise specified.

[4] Maximum angle error observed following AEC-Q100 Grade 0 or Grade 1 stress with corrections performed according to zero hour performance.

[5] Angle Error, Extended Range and Lifetime values are estimated based on characterized performance over  $B_{EXT}$  and worst-case lifetime stresses observed during the AEC-Q100 Grade 0 qualification. This parameter is not directly measured.

**ELECTRICAL CHARACTERISTICS**
 $V_{\text{COS}} = V_{\text{SIN}} = 3.0 \text{ V}$  and  $T_A = 25^\circ\text{C}$  (unless otherwise specified)

Figures 8-13 show typical (mean,  $\mu$ ) performance over temperature and field to convey general performance trends for the identified specifications. A sample population of 20 devices was used for the below nominal performance plots.

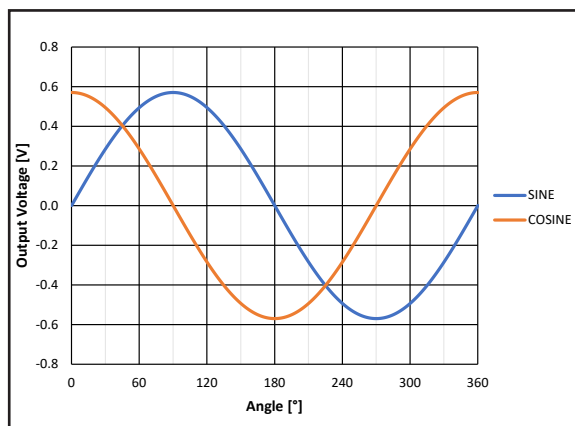


Figure 8: Output Voltage vs. Angle at B = 250 G

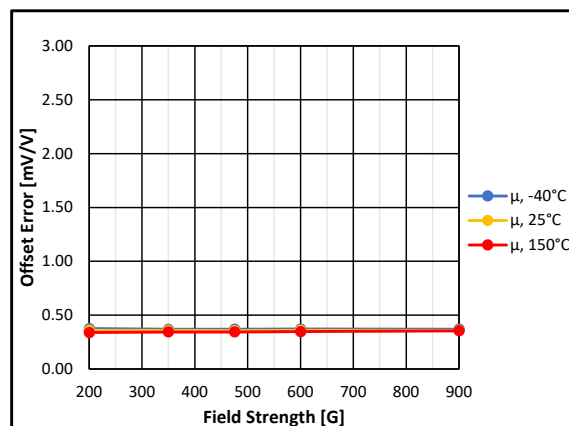


Figure 9: Voltage Offset (mV/V) over Field and Temp

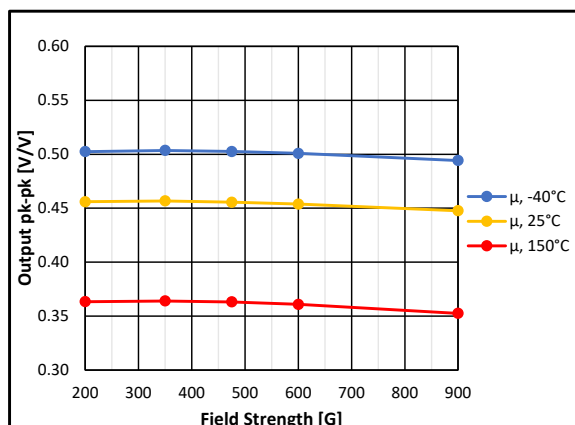


Figure 10: Differential Output Voltage (V/V) over Field and Temp

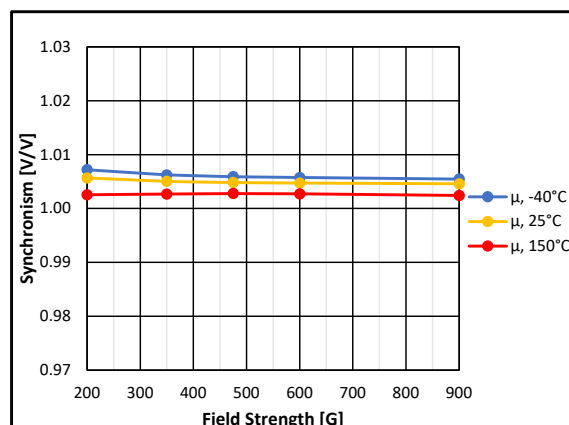


Figure 11: Amplitude Synchronism (V/V) over Field and Temperature

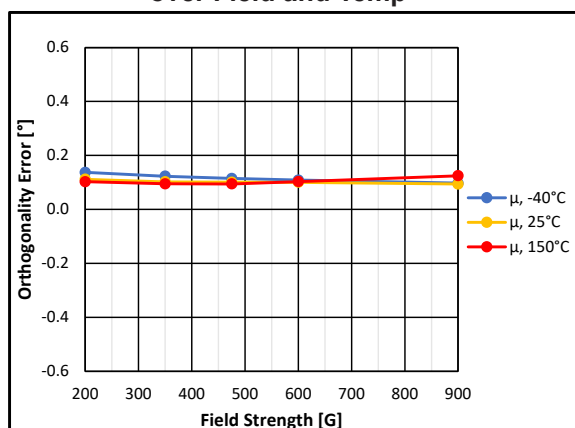


Figure 12: Orthogonality Error over Field and Temp

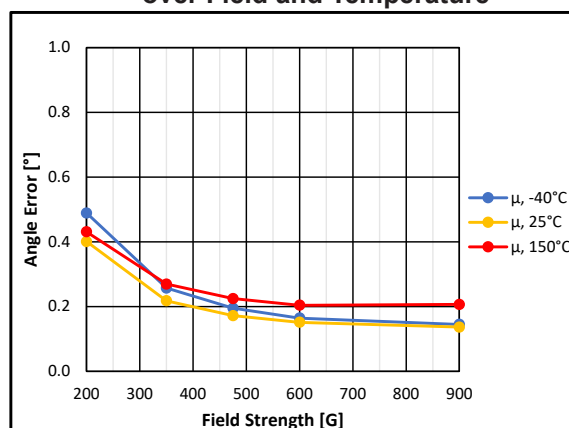


Figure 13: Angle Error After Compensation (25°C) over Field and Temp

## RECOMMENDED APPLICATION CIRCUIT

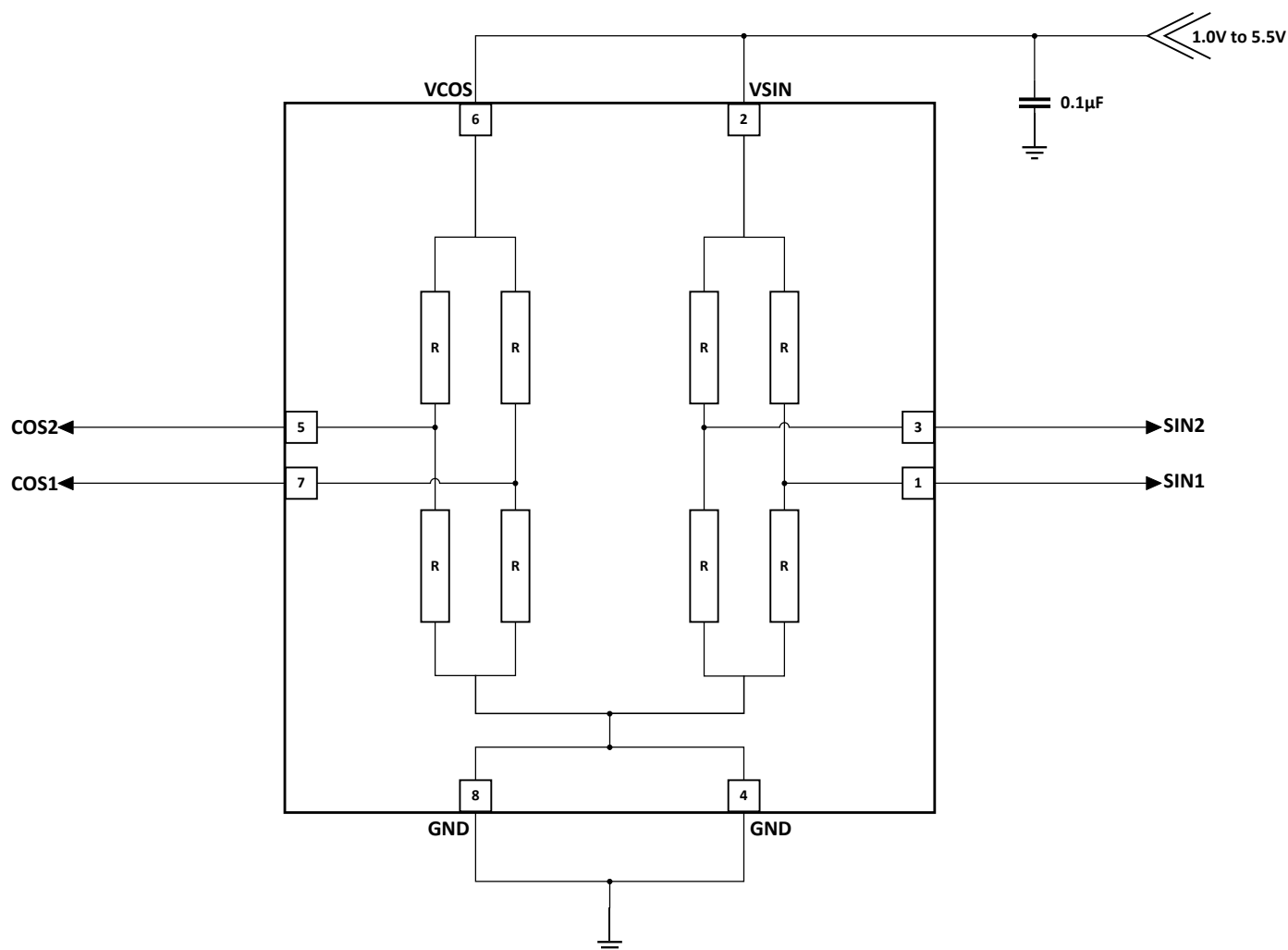


Figure 14: CT310 Application Diagram

Table 1: Recommended External Components

Component	Description	Parameter	Min.	Typ.	Max.	Unit
C <sub>BYP</sub>	0.1 µF, X7R	C	–	0.1	–	µF



## Applications Information

The XtremeSense TMR sensor location for the CT310 for the x, y dimensions are shown in Figure 15 and Figure 16 for the TSSOP-8 and DFN-8 packages respectively. Figure 17 and Figure 18 illustrates the location of the CT310 XtremeSense TMR sensor from the z dimension. All dimensions in the figures below are nominal.

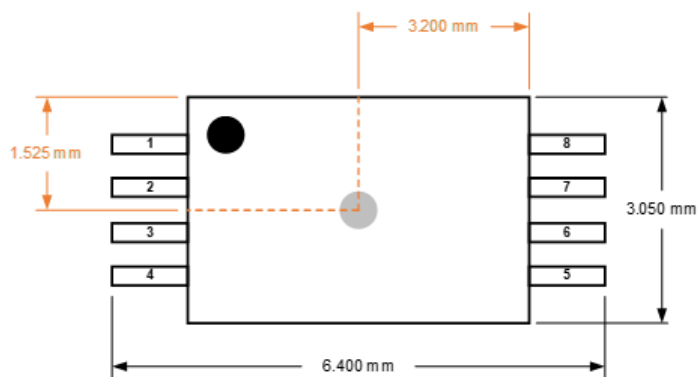


Figure 15: XtremeSense TMR Sensor Location in x-y Plane for CT310 in TSSOP-8 Package

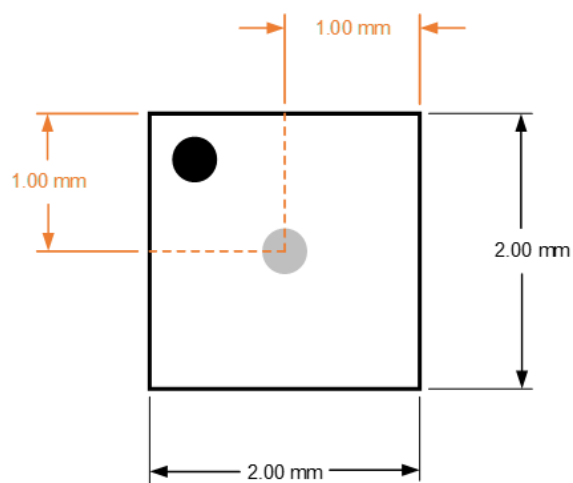


Figure 16: XtremeSense TMR Sensor Location in x-y Plane for CT310 in DFN-8 Package

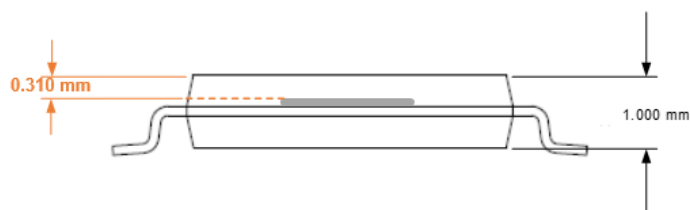


Figure 17: XtremeSense TMR Sensor Location in z Dimension for CT310 in TSSOP-8 Package



Figure 18: XtremeSense TMR Sensor Location in z Dimension for CT310 in DFN-8 Package

## PACKAGE OUTLINE DRAWINGS

## For Reference Only – Not for Tooling Use

(Reference Allegro DWG-0000986 (Preliminary) and JEDED MO-153AA)

Dimensions in millimeters - NOT TO SCALE

Dimensions exclusive of mold flash, gate burrs, and dambar protrusions

Exact case and lead configuration at supplier discretion within limits shown

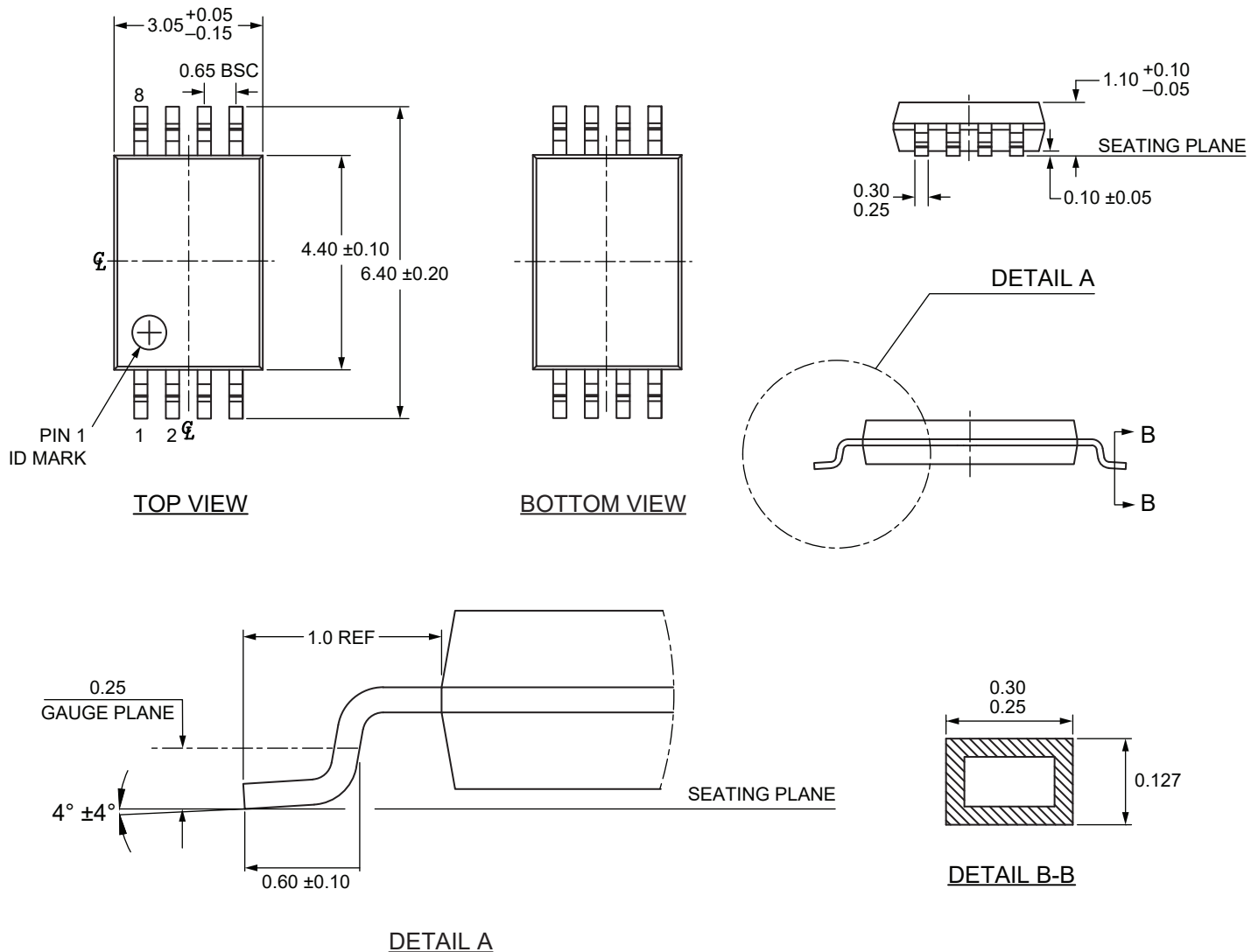
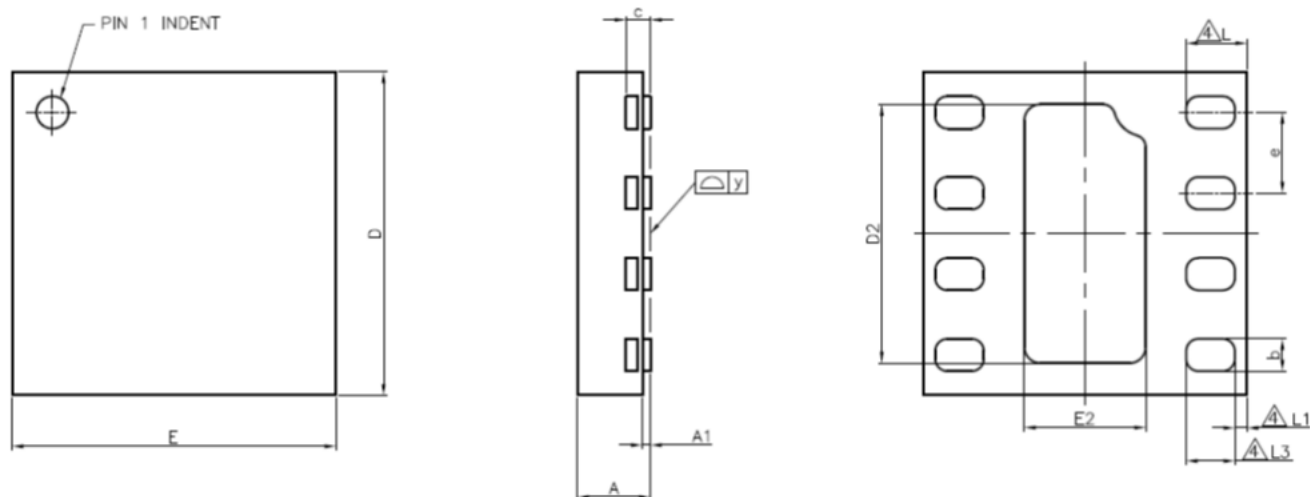


Figure 19: TSSOP-8 Package Drawing



## NOTES:

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

Figure 20: DFN-8 Package Drawing

Table 3: CT310 DFN-8 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 $\Delta$	0.325	0.375	0.425
L1 $\Delta$	—	0.075	—
L3 $\Delta$	0.250	0.300	0.350
y	0.000	—	0.075

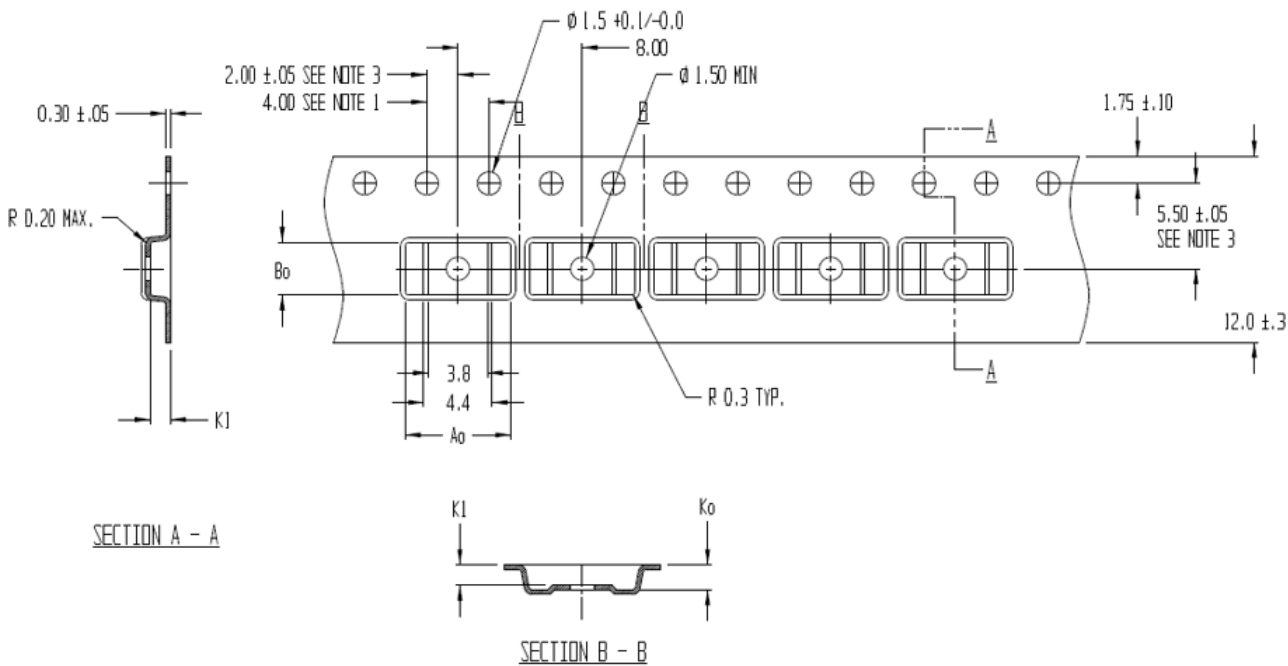
## TAPE AND REEL POCKET DRAWINGS AND DIMENSIONS

## For Reference Only – Not for Tooling Use

Dimensions in millimeters – NOT TO SCALE

Dimensions exclusive of mold flash, gate burs, and dambar protrusions

Exact case and lead configuration at supplier discretion within limits shown



## NOTES:

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

$A_0 = 6.80$   
 $B_0 = 3.40$   
 $K_0 = 1.60$   
 $K1 = 1.30$

Figure 21: TSSOP-8 Tape and Pocket Drawings

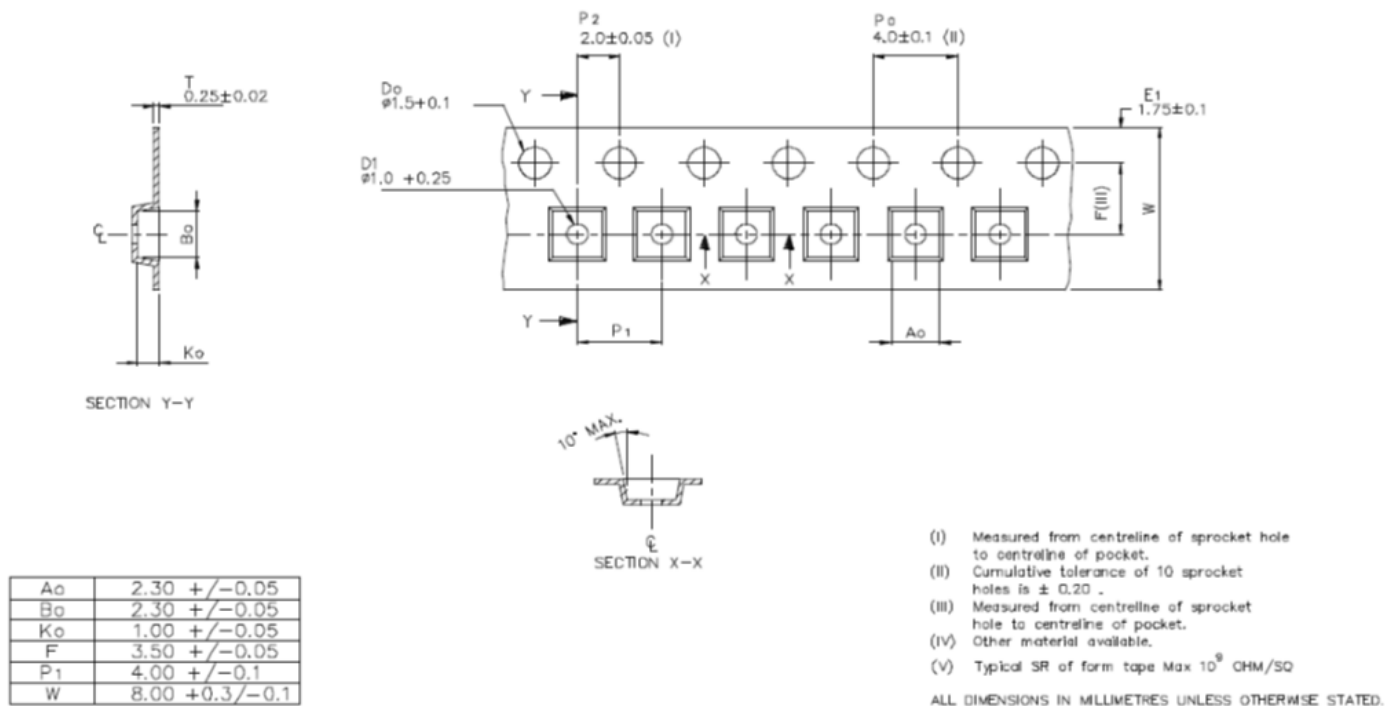


Figure 22: DFN-8 Tape and Pocket Drawings

## 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-IT8	TSSOP	8	3000	Sn	Green & RoHS	1	–40°C to 85°C	CT310LS-IT8 YYWWSS
CT310LS-HT8	TSSOP	8	3000	Sn	Green & RoHS	1	–40°C to 125°C	CT310LS-HT8 YYWWSS
CT310LS-HD8	DFN	8	3000	Sn	Green & RoHS	1	–40°C to 125°C	310H YWWSS
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

[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  $\leq 1,000$  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.

## REVISION HISTORY

Number	Date	Description
1	April 24, 2024	Document rebranded and minor editorial updates
2	June 4, 2024	Added notes to package outline drawing (pages 10 and 12)
3	March 13, 2025	Added Grade 0 Product Offering and description (pages 1, 2, and 14); modified product offerings (pages 2 and 14); reformatted the electrical characteristics, included Grade 0 Angle Error specifications (page 6); updated nominal electrical performance plots to reflect the Grade 0 temperature range (page 7); updated TSSOP-8 package outline drawing (page 10); minor image formatting and editorial updates (various pages).
4	March 17, 2025	Updated "Angle Error, Lifetime" footnotes and conditions; updated "Angle Error, Extended Range and Lifetime" value and footnote; updated footnote 4; removed footnote 5

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