



# CT310

## XtremeSense™ 2D TMR Angular Sensor

### Features

- Angular Error less than 0.25° (After Compensation) Over Full Temperature Range
- Dual Full-Bridge Resistor Network
- Operating Magnetic Field: 25 mT to 90 mT
- Differential Outputs for SIN and COS Axes
- Supply Voltage: 1.0 V to 5.5 V
- Package Options:
  - 8-lead TSSOP
  - 8-lead DFN, 2.00 × 2.00 × 0.45 mm

### Applications

- Angular Measurements
- Rotary and Angular Sensors
- BLDC Motors

### Product Description

The CT310 is a 2D angular sensor in a dual full-bridge configuration from Crocus Technology developed on its patented XtremeSense™ 2D TMR technology. The operating magnetic field for this 2D sensor is 25 mT to 90 mT and has an angular error less than 0.25° after compensation over the full operating temperature range. It has differential outputs for both sine (SIN) and cosine (COS) axes and operates with a supply voltage range from 1.0 V to 5.5 V.

It is packaged in an 8-lead TSSOP package and for applications where space is critical, a low profile, small form factor 8-lead DFN package that is 2.00 × 2.00 × 0.45 mm in size.

### Ordering Information

| Part Number   | Operating Temperature Range | Angular Error <sup>(1)</sup> | Output Type  | Package                               | Packing Method |
|---------------|-----------------------------|------------------------------|--------------|---------------------------------------|----------------|
| CT310LS-IT8-M | -40°C to +85°C              | 0.25°                        | Differential | 8-lead TSSOP<br>6.40 x 3.05 x 1.10 mm | Tape & Reel    |
| CT310LS-HT8-M | -40°C to +125°C             |                              |              |                                       |                |
| CT310LS-ID8-M | -40°C to +85°C              | 0.25°                        | Differential | 8-lead DFN<br>2.00 x 2.00 x 0.45 mm   | Tape & Reel    |
| CT310LS-HD8-M | -40°C to +125°C             |                              |              |                                       |                |

(1) After Compensation

### Block Diagram

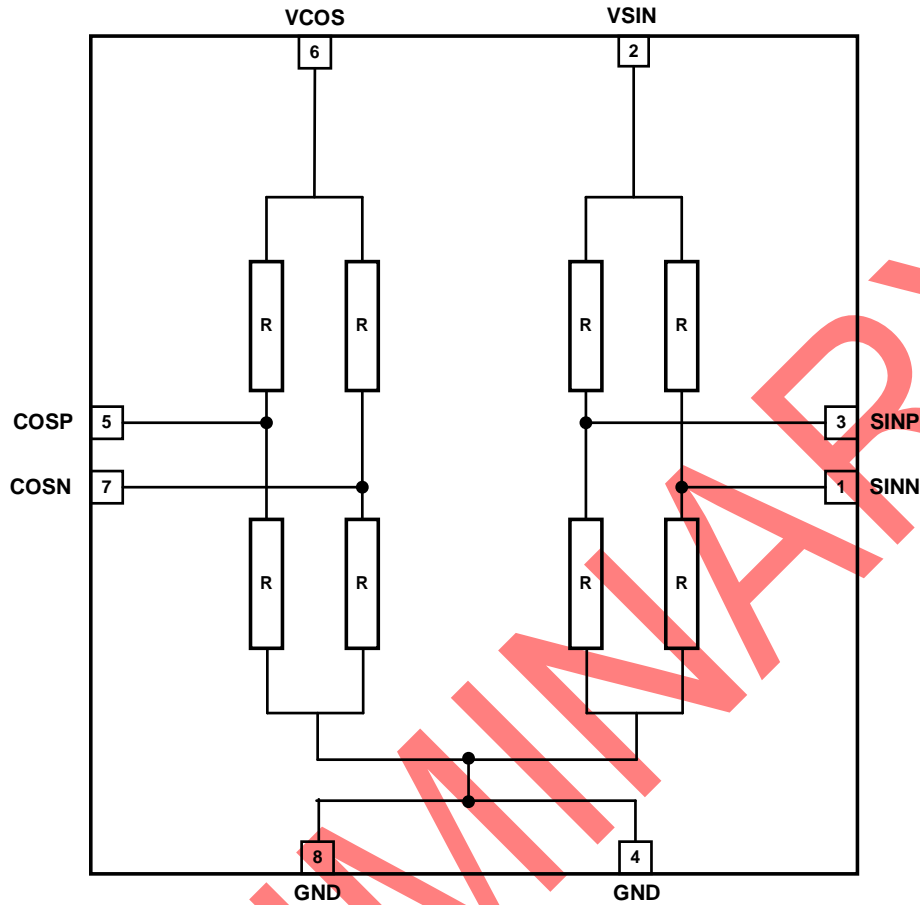


Figure 1. CT310 Functional Block Diagram

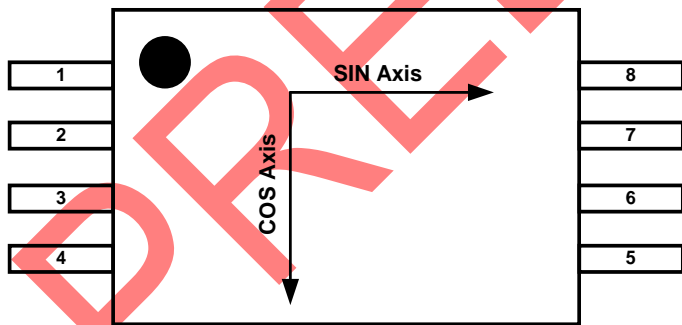


Figure 2. CT310 Axes of Sensitivity for TSSOP-8

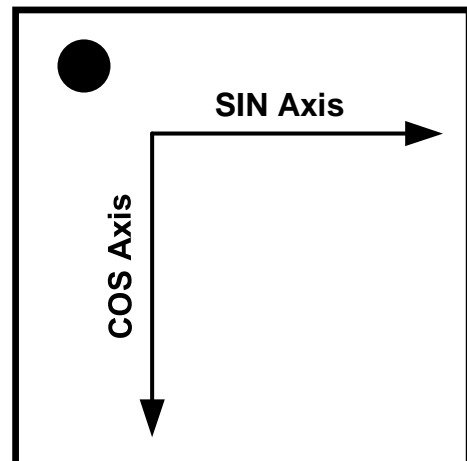
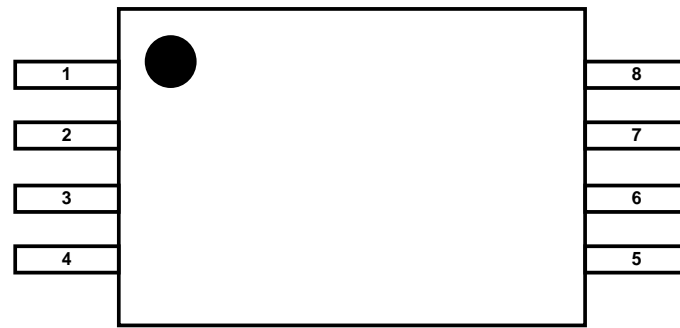
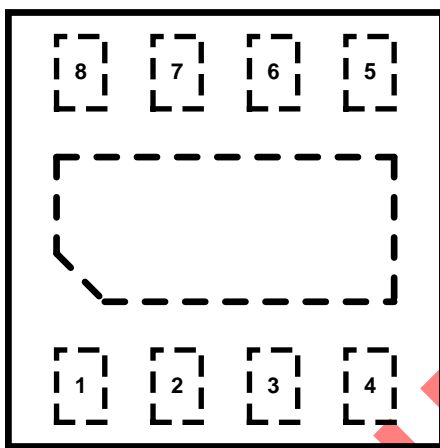


Figure 3. CT310 Axes of Sensitivity for DFN-8

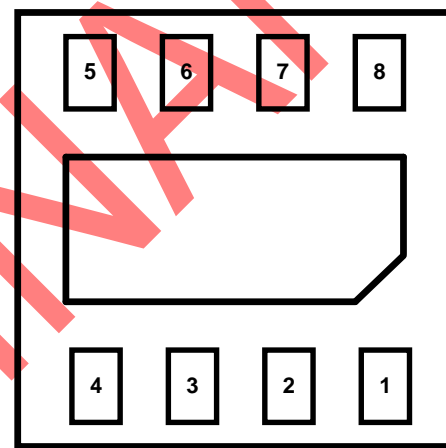
## Pin Configurations



TSSOP-8 – Top Down View



DFN-8 – Top Down View



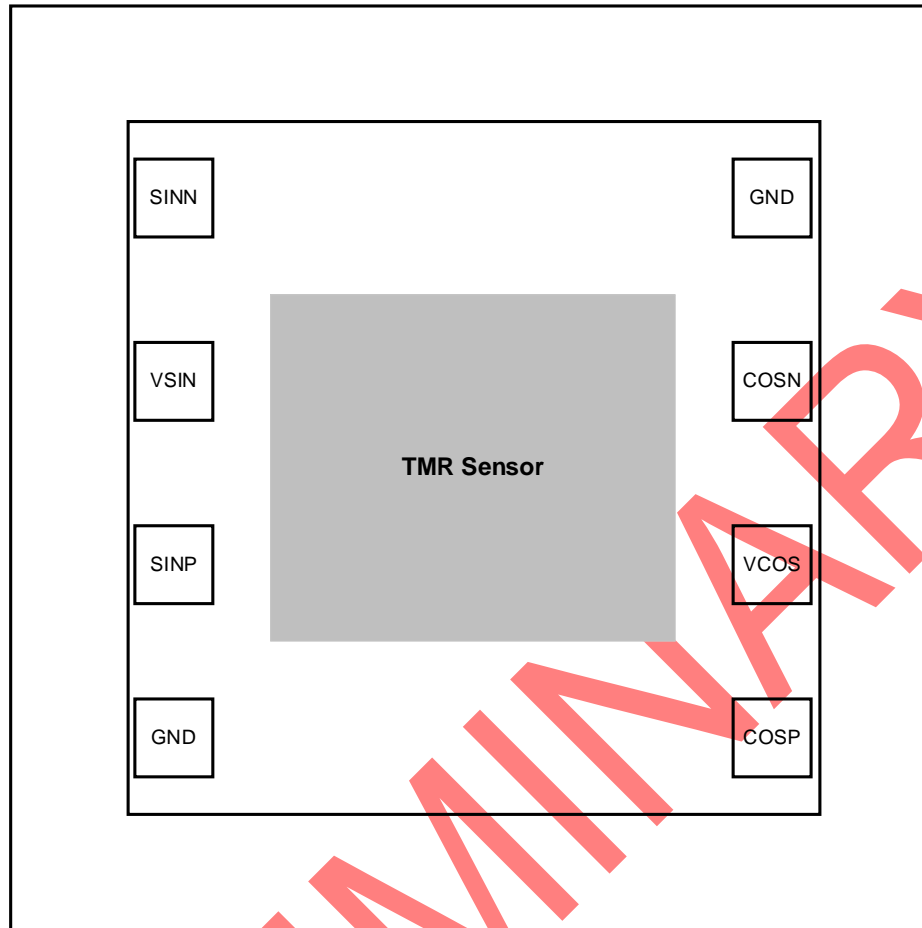
DFN-8 – Bottoms Up View

Figure 4. CT310 Pin-out Diagrams

## Pin Definitions

| TSSOP-8 Pin # | DFN-8 Pin # | Pin Name | Pin Description                          |
|---------------|-------------|----------|--|
| 1             | 1           | SINN     | Differential negative output for sine.   |
| 2             | 2           | VSIN     | Supply voltage for sine                  |
| 3             | 3           | SINP     | Differential positive output for sine.   |
| 4             | 4           | GND      | Ground for sine.                         |
| 5             | 5           | COSP     | Differential positive output for cosine. |
| 6             | 6           | VCOS     | Supply voltage for cosine                |
| 7             | 7           | COSN     | Differential negative output for cosine. |
| 8             | 8           | GND      | Ground for cosine.                       |

## Pad Configuration



CT310 Die Layout  
Top Down View

Figure 5. CT310 Pad Diagram

## Pad Definitions

| Pad # | Pad Name | Pad Description                          |
|-------|----------|--|
| 1     | SINN     | Differential negative output for sine.   |
| 2     | VSIN     | Supply voltage for sine                  |
| 3     | SINP     | Differential positive output for sine.   |
| 4     | GND      | Ground for sine.                         |
| 5     | COSP     | Differential positive output for cosine. |
| 6     | VCOS     | Supply voltage for cosine                |
| 7     | COSN     | Differential negative output for cosine. |
| 8     | GND      | Ground for cosine.                       |

## Absolute Maximum Ratings

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.

| Symbol             | Parameter   | Min.                                       | Max.      | Unit |
|--------------------|---|--|-----------|------|
| $V_{COS}, V_{SIN}$ | Supply Voltage  | -0.3                                       | 6.0       | V    |
| $V_{OUT}$          | Analog Output Pins Maximum Differential Voltage                       |  | $\pm 1.5$ | V    |
| ESD                | Electrostatic Discharge Protection Level                              | Human Body Model (HBM) per JESD22-A114     | $\pm 4.0$ | kV   |
|                    |   | Charged Device Model (CDM) per JESD22-C101 | $\pm 1.0$ |      |
| $B_{MAX}$          | Maximum Magnetic Field, $\leq 5$ minutes at $T_A = +25^\circ\text{C}$ |  | $\pm 200$ | mT   |
| $B_{SHIFT}$        | Life-time Shift   |  | TBD       | °    |
| $T_{STG}$          | Storage Temperature   | -65  | +165      | °C   |
| $T_L$              | Lead Soldering Temperature, 10 Seconds                                |  | +260      | °C   |

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual operation of the CT310. Recommended operating conditions are specified to ensure optimal performance to the specifications. Crocus Technology does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol                   | Parameter                                     | Min.                | Typ. | Max.  | Unit |
|--------------------------|---|---------------------|------|-------|------|
| $V_{COS}, V_{SIN}$       | Supply Voltage Range                          | 1.0                 |      | 5.5   | V    |
| $V_{COS\_D}, V_{SIN\_D}$ | COS and SIN Differential Output Voltage Range | -1.37               |      | +1.37 | V    |
| $B_{OPERATING}$          | Operating Magnetic Field                      | 25                  |      | 90    | mT   |
| $T_A$                    | Operating Ambient Temperature                 | Industrial          | +25  | +85   | °C   |
|                          |   | Extended Industrial | +25  | +125  |      |

## Electrical & Magnetic Specifications

Unless otherwise specified:  $V_{DD} = 1.0\text{ V to }5.5\text{ V}$ ,  $C_{BYP} = 0.1\ \mu\text{F}$ ,  $B_{OPERATING} = 25\text{ mT to }90\text{ mT}$  and  $T_A = -40^\circ\text{C to }+150^\circ\text{C}$ . Typical values are  $V_{DD} = 3.0\text{ V}$  and  $T_A = +25^\circ\text{C}$ .

| Symbol                             | Parameter   | Conditions   | Min.          | Typ.    | Max.    | Units                        |
|------------------------------------|---|--|---------------|---------|---------|------------------------------|
| <b>Magnetic</b>                    |   |  |               |         |         |                              |
| $B_{OPERATING}$                    | Operating Magnetic Field  |  | 25            | 60      | 90      | mT                           |
| <b>Electrical</b>                  |   |  |               |         |         |                              |
| $R_{BRIDGE}$                       | Bridge Resistance   | $T_A = +25^\circ\text{C}$  | 3.0           | 4.5     | 6.0     | k $\Omega$                   |
| TCR                                | Temperature Coefficient of Resistance <sup>(1)</sup>            |  |               | 500     |         | ppm/ $^\circ\text{C}$        |
| <b>Differential Outputs</b>        |   |  |               |         |         |                              |
| $\theta_{ERR}$                     | Angular Error <sup>(2)</sup>                                    | After Compensation   |               | 0.25    | 0.60    | $^\circ$                     |
| $\theta_{ERR\_HYST}$               | Angle Error due to Hysteresis                                   |  | No Hysteresis |         |         | $^\circ$                     |
| $V_{SIN\_D}$ ,<br>$V_{COS\_D}$     | SIN, COS Differential Output Voltage Peak-to-Peak               |  | 0.35          | 0.45    | 0.50    | V/V                          |
| TCV <sub>OUT</sub>                 | Temperature Coefficient of Differential Output <sup>(1)</sup>   |  |               | -1200   |         | ppm/ $^\circ\text{C}$        |
| $V_{OFF\_SIN}$ ,<br>$V_{OFF\_COS}$ | SIN, COS Voltage Offset   |  |               | $\pm 1$ | $\pm 5$ | mV/V                         |
| k                                  | SIN, COS Amplitude Synchronism Ratio                            |  | 97            | 100     | 103     | %                            |
| Tck                                | Temperature Coefficient of Amplitude Synchronism <sup>(1)</sup> |  |               | 3.0     |         | ppm/ $^\circ\text{C}$        |
| $OE_{SIN}$ ,<br>$OE_{COS}$         | SIN, COS Orthogonality Error                                    |  | 88            | 90      | 92      | $^\circ$                     |
| t <sub>RESPONSE</sub>              | SIN, COS Response Time <sup>(1)</sup>                           | $C_L = 22\text{ pF}$   |               | 1.0     |         | $\mu\text{s}$                |
| e <sub>N</sub>                     | Noise <sup>(1)</sup>  | $f_{BW} = 1\text{ Hz to }10\text{ kHz}$ ,<br>$V_{DD} = 3.0\text{ V}$ |               | 2.4     |         | $\mu\text{V}_{RMS}/\text{V}$ |

(1) Guaranteed by design and characterization.

(2) Hysteresis error and output noise are included in the Angular Error specification.

## Electrical Characteristics

$V_{DD} = 3.0\text{ V}$  and  $T_A = +25^\circ\text{C}$

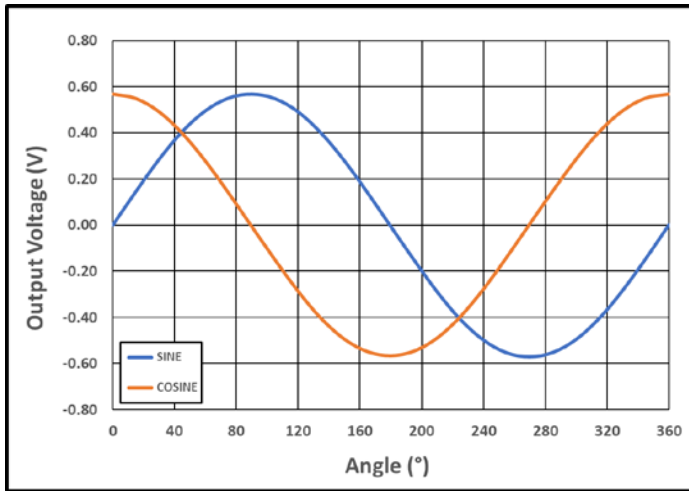


Figure 6. Output Voltage vs. Angle at  $B_{OP} = 25\text{ mT}$

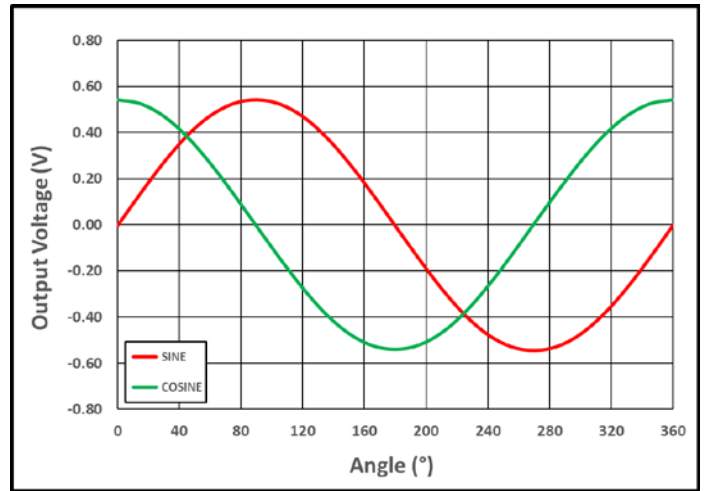


Figure 7. Output Voltage vs. Angle at  $B_{OP} = 90\text{ mT}$

PRELIMINARY

Recommended Application Circuit

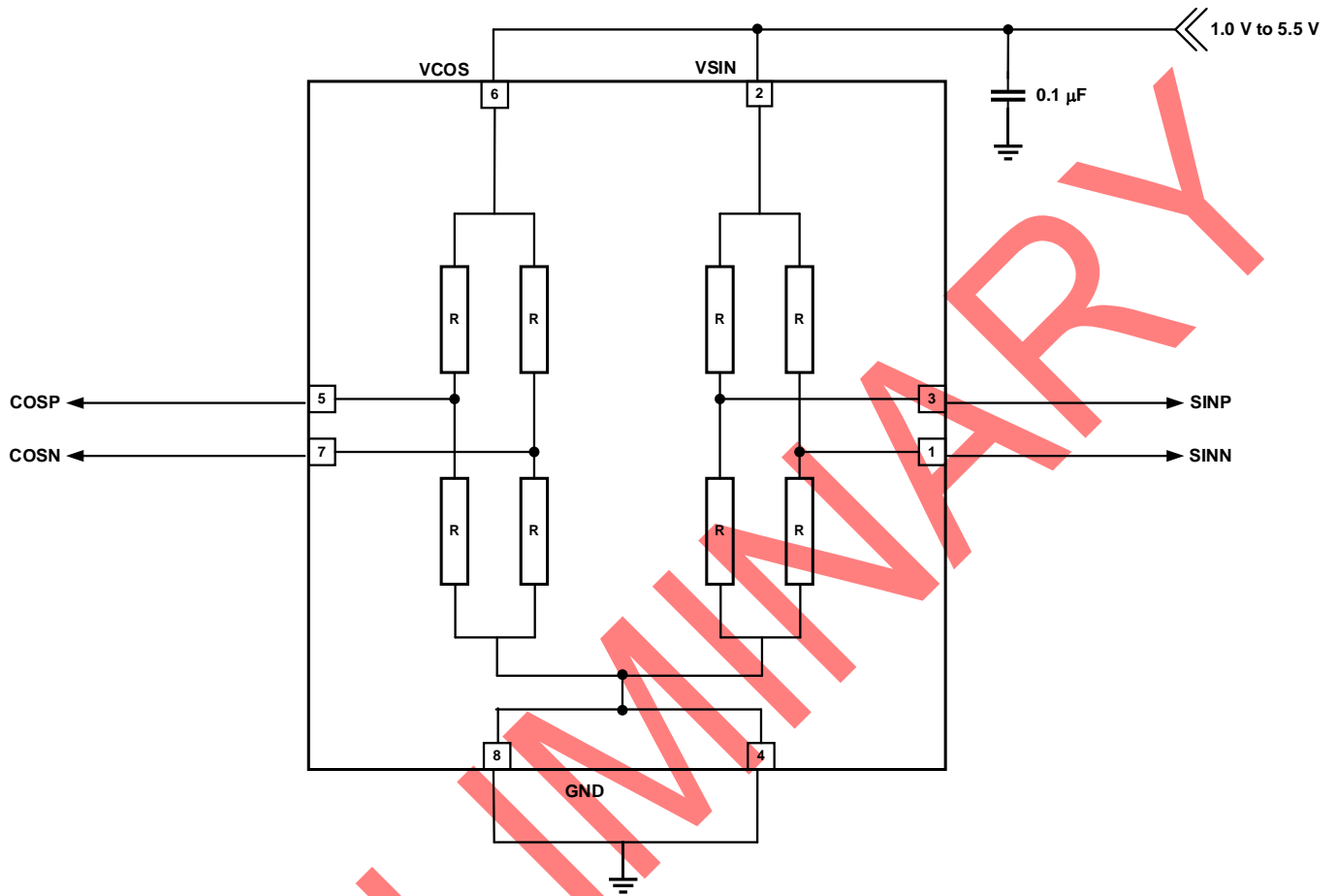


Figure 8. CT310 Application Diagram

Table 1. Recommended External Components

| Component        | Description | Vendor & Part Number        | Parameter | Min. | Typ. | Max. | Unit |
|------------------|-------------|-----------------------------|-----------|------|------|------|------|
| C <sub>BYP</sub> | 0.1 μF, X7R | Murata<br>GRM033Z71A104KE14 | C         |      | 0.1  |      | μF   |
|                  |             | Others                      |           |      |      |      |      |



## Applications Information

The MLU sensor location for the CT310 for the x, y dimensions are shown in Figure 9 and Figure 10 for the TSSOP-8 and DFN-8 packages respectively. Figure 11 and Figure 12 illustrates the location of the CT310's MLU sensor from the z dimension. All dimensions in the figures below are nominal.

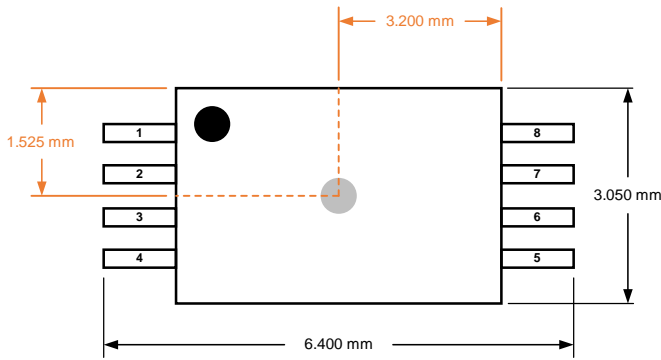


Figure 9. MLU Sensor Location in x-y Plane for CT310 in TSSOP-8 Package

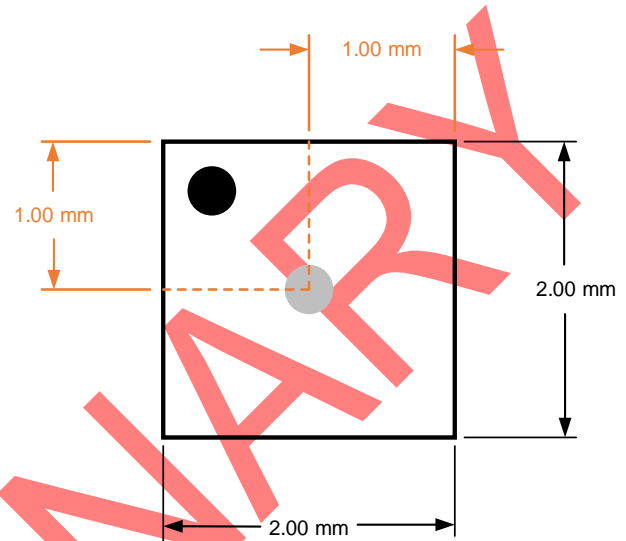


Figure 10. MLU Sensor Location in x-y Plane for CT310 in DFN-8 Package

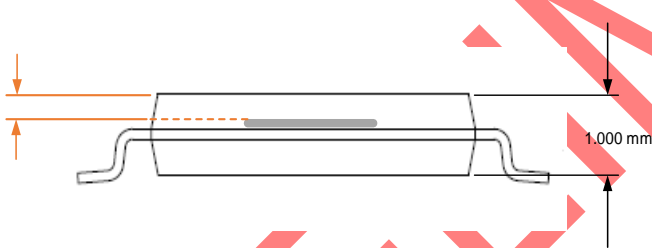


Figure 11. MLU Sensor Location in z Dimension for CT310 in TSSOP-8 Package

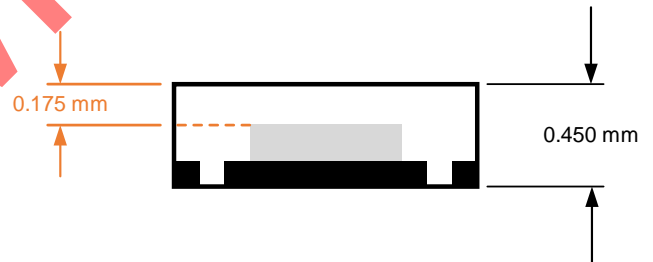


Figure 12. MLU Sensor Location in z Dimension for CT310 in DFN-8 Package

TSSOP-8 Package Drawing and Dimensions

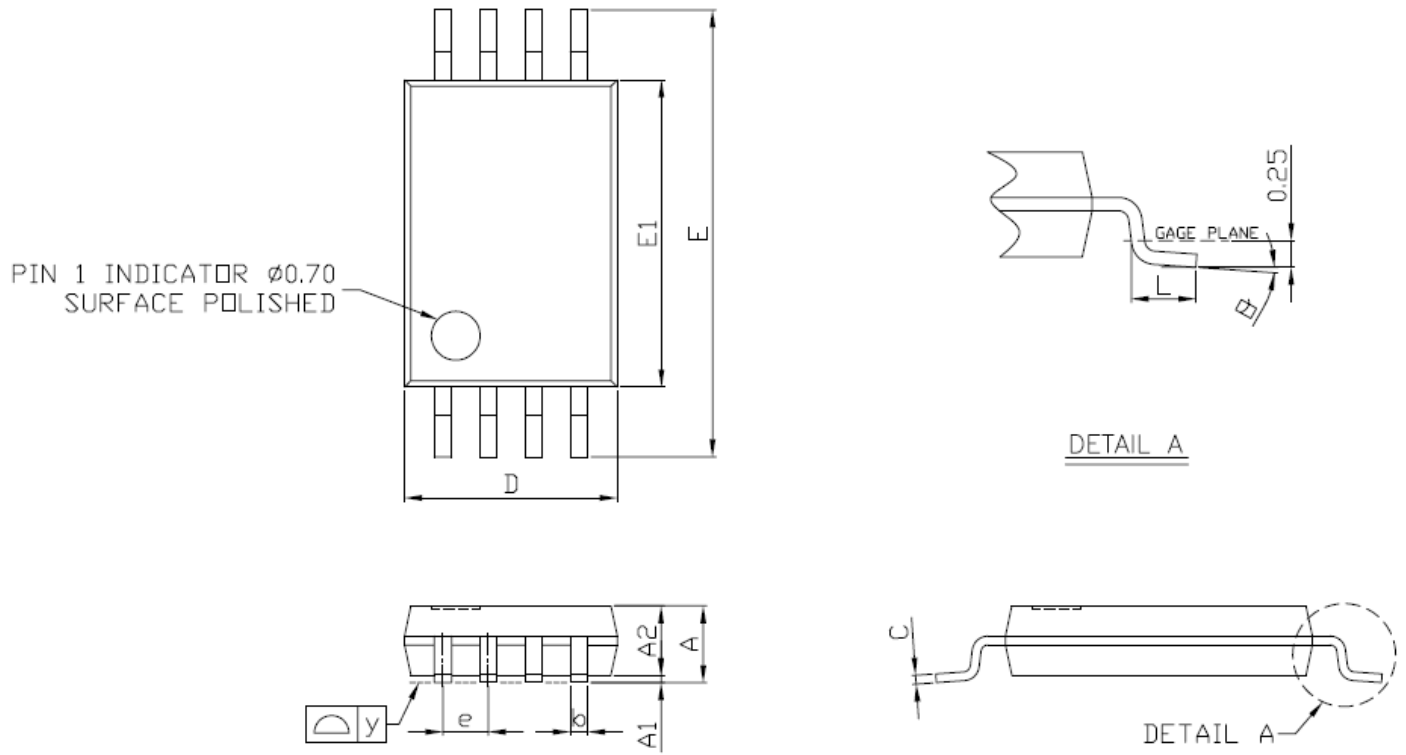


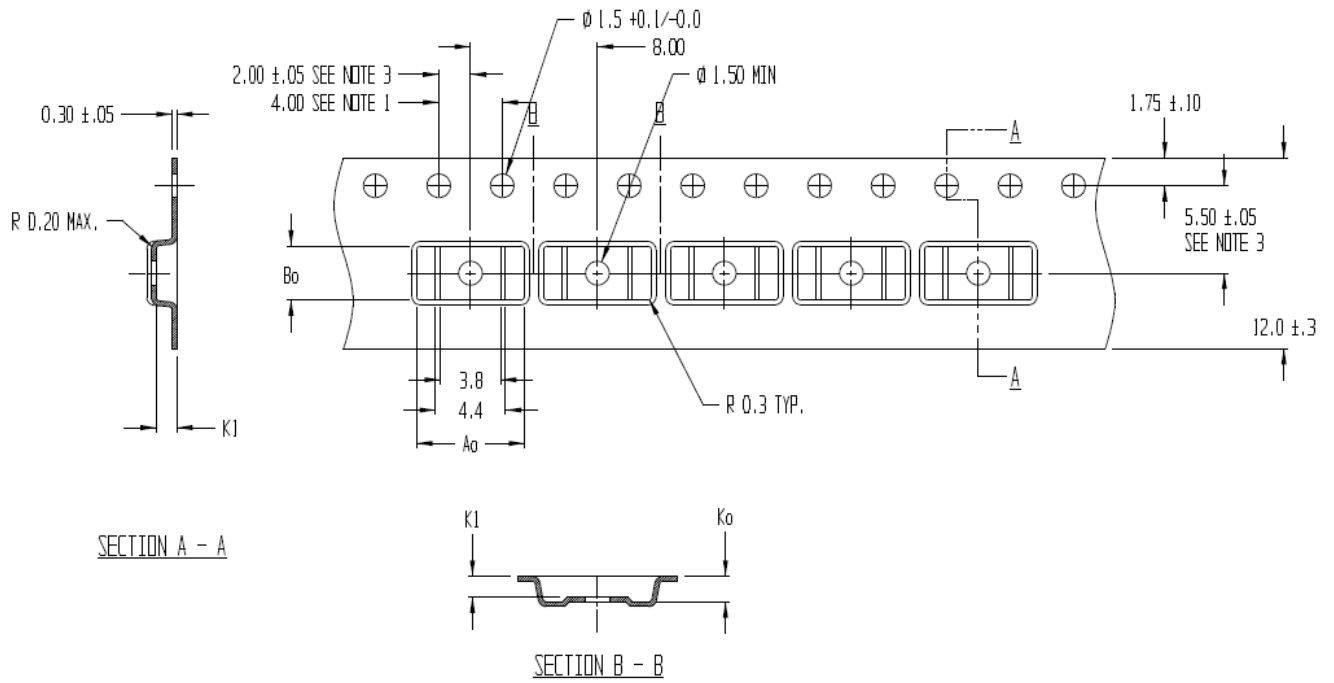
Figure 13. TSSOP-8 Package Drawing

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°    |

Crocus Technology provides package drawings as a service to customers considering or planning to use Crocus products in their designs. Drawings may change without notice. Please note the revision and date of the data sheet and contact a Crocus Technology representative to verify or obtain the most recent version. The package specifications do not expand the terms of Crocus Technology's worldwide terms and conditions, specifically the warranty therein, which covers Crocus Technology's products.

TSSOP-8 Tape & Pocket Drawing and Dimensions



NOTES:

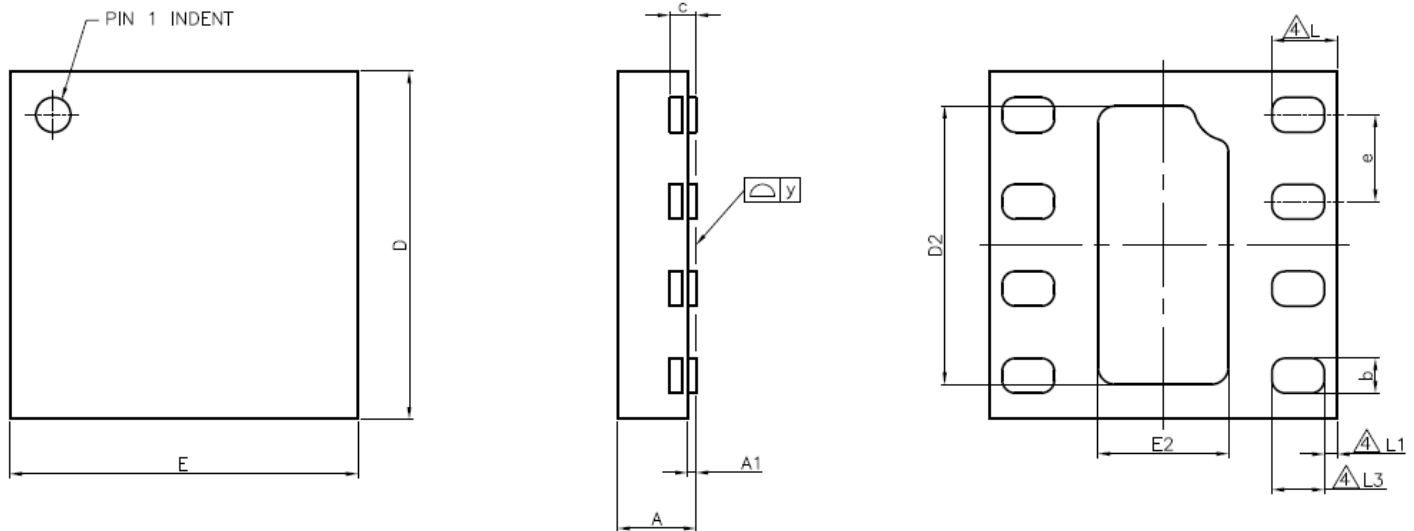
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE  $\pm 0.2$
2. CAMBER IN COMPLIANCE WITH EIA 481
3. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

$A_o = 6.80$   
 $B_o = 3.40$   
 $K_o = 1.60$   
 $K_1 = 1.30$

Figure 14. TSSOP-8 Tape and Pocket Drawings

PREVIEW

## DFN-8 Package Drawing and Dimensions






## NOTE:

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

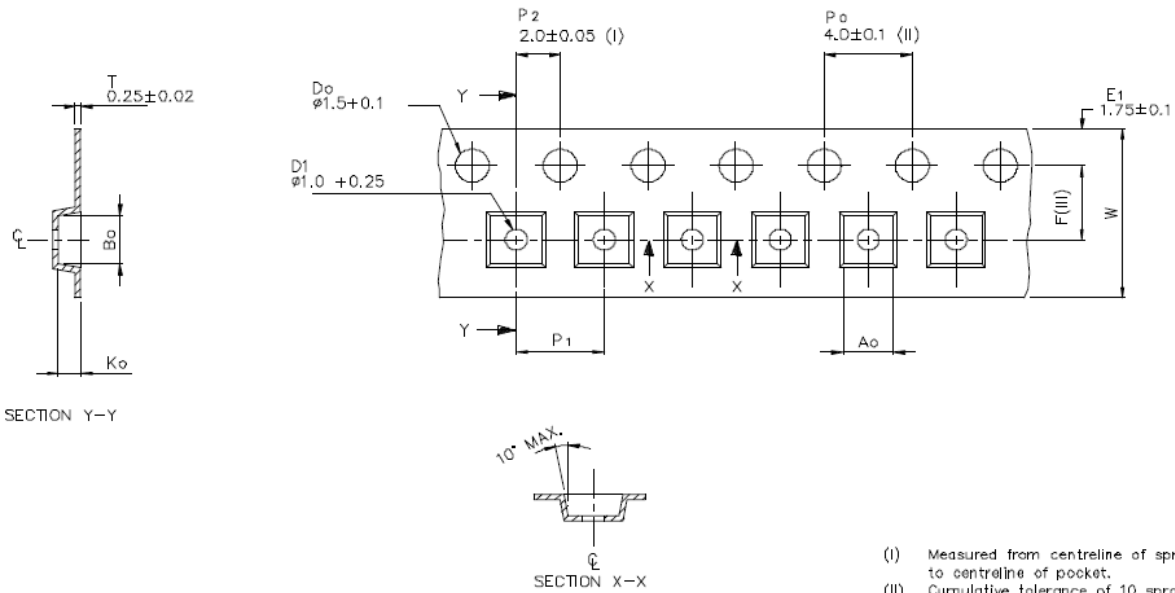
Figure 15. DFN-8 Package Drawing

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   | 0.325                          | 0.375     | 0.425 |
| L1  | -                              | 0.075     | -     |
| L3  | 0.250                          | 0.300     | 0.350 |
| y  | 0.000                          | -         | 0.075 |

Crocus Technology provides package drawings as a service to customers considering or planning to use Crocus products in their designs. Drawings may change without notice. Please note the revision and date of the data sheet and contact a Crocus Technology representative to verify or obtain the most recent version. The package specifications do not expand the terms of Crocus Technology's worldwide terms and conditions, specifically the warranty therein, which covers Crocus Technology's products.

DFN-8 Tape & Pocket Drawing and Dimensions



SECTION Y-Y

SECTION X-X

- (I) Measured from centreline of sprocket hole to centreline of pocket.
  - (II) Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$ .
  - (III) Measured from centreline of sprocket hole to centreline of pocket.
  - (IV) Other material available.
  - (V) Typical SR of form tape Max  $10^8$  OHM/SQ
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

|                |                |
|----------------|----------------|
| A <sub>0</sub> | 2.30 +/−0.05   |
| B <sub>0</sub> | 2.30 +/−0.05   |
| K <sub>0</sub> | 1.00 +/−0.05   |
| F              | 3.50 +/−0.05   |
| P <sub>1</sub> | 4.00 +/−0.1    |
| W              | 8.00 +0.3/−0.1 |

Figure 16. DFN-8 Tape and Pocket Drawings

PRELIM

## Package Information

Table 4. CT310 Package Information

| Part Number   | Package Type | # of Leads | Package Quantity | Lead Finish | Eco Plan <sup>(1)</sup> | MSL Rating <sup>(2)</sup> | Operating Temperature <sup>(3)</sup> | Device Marking        |
|---------------|--------------|------------|------------------|-------------|-------------------------|---------------------------|--------------------------------------|-----------------------|
| CT310LS-IT8-M | TSSOP        | 8          | 3,000            | Sn          | Green & RoHS            | 1                         | -40°C to +85°C                       | CT310LS-IT8<br>YYWWSS |
| CT310LS-HT8-M | TSSOP        | 8          | 3,000            | Sn          | Green & RoHS            | 1                         | -40°C to +125°C                      | CT310LS-HT8<br>YYWWSS |
| CT310LS-ID8-M | DFN          | 8          | 3,000            | Sn          | Green & RoHS            | 1                         | -40°C to +85°C                       | 310I<br>YWWS          |
| CT310LS-HD8-M | DFN          | 8          | 3,000            | Sn          | Green & RoHS            | 1                         | -40°C to +125°C                      | 310H<br>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  $\leq 1,000$  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.

**Disclaimer:** The contents of this document are provided for informational purposes only. CROCUS TECHNOLOGY, INC. AND CROCUS TECHNOLOGY SA (COLLECTIVELY "CROCUS") MAKE NO REPRESENTATIONS OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS HEREIN, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Crocus reserves the right to make changes to the specifications and product descriptions, and/or to discontinue or make changes to its products at any time without notice. Crocus's products have not been designed, tested, or manufactured for use and should not be used in applications where the failure, malfunction or inaccuracy of the Products carries a risk of death or serious bodily injury or damage to tangible property, including, but not limited to, life support systems, nuclear facilities, military, aircraft navigation or communication, emergency systems, harsh environments, or other applications with a similar degree of potential hazard.

## Product Status Definition

| Data Sheet Identification | Product Status                              | Definition   |
|---------------------------|---|--|
| Objective                 | Proposed New Product Idea or In Development | Data sheet contains design target specifications and are subject to change without notice at any time.   |
| Preliminary               | First Production                            | Data sheet contains preliminary specifications obtained by measurements of early samples. Follow-on data will be published at a later date as more test data is acquired. Crocus reserves the right to make changes to the data sheet at any time. |
| None                      | Full Production                             | Data sheet contains final specifications for all parameters. Crocus reserves the right to make changes to the data sheet at any time.  |
| Obsolete                  | Not in Production                           | Data sheet for a product that is no longer in production at Crocus. It is for reference only.  |