

## XtremeSense™ TMR Contactless Current Sensor with 1 MHz Bandwidth and Programmable Gain

### FEATURES AND BENEFITS

- User-programmable field range:
  - 6 to 24 mT
- Preset magnetic field ranges:
  - 0 to 6 mT
  - ±6 mT
  - 0 to 12 mT
  - ±12 mT
  - 0 to 24 mT
  - ±24 mT
- Linear analog output voltage
- 1 MHz bandwidth
- Response time: <300 ns
- Reference voltage output for unipolar/bipolar field measurements
- Supply voltage: 4.75 to 5.50 V
- Low noise performance
- Filter pin to reduce noise on output
- Package options:
  - 8-lead SOIC
  - 8-lead TSSOP

### APPLICATIONS

- Solar/power inverters
- Battery management systems
- Industrial equipment
- Power utility meters
- Power conditioner
- DC/DC converters

### DESCRIPTION

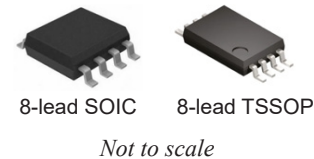
The CT450 is a high-bandwidth and low-noise integrated contactless current sensor that uses Allegro patented XtremeSense™ TMR technology to enable high-accuracy current measurements for many consumer, enterprise, and industrial applications. The device supports six standard field ranges where the CT450 senses and translates the magnetic field into a linear analog output voltage. The device achieves a total error output of less than ±1.0% over voltage and temperature after calibration.

The CT450 is also available in a user-programmable variant which enables end-of-line calibration of gain, while the sensor is preprogrammed to adjust offset and compensate temperature drift. The ability to adjust gain relaxes mechanical tolerances during sensor mounting.

The device has less than 300 ns output response time while the current consumption is about 6.0 mA. The CT450 is equipped with a filter function to reduce noise on the output pin.

The CT450 is housed in an 8-lead SOIC package and a low-profile, industry-standard 8-lead TSSOP package that are both green and RoHS compliant.

### PACKAGES:



### FUNCTIONAL BLOCK DIAGRAMS

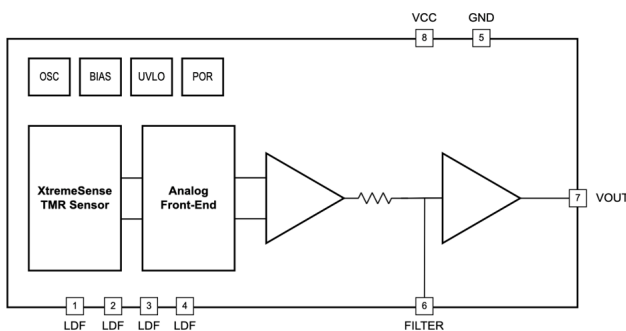


Figure 1: CT450 Functional Block Diagram for SOIC-8

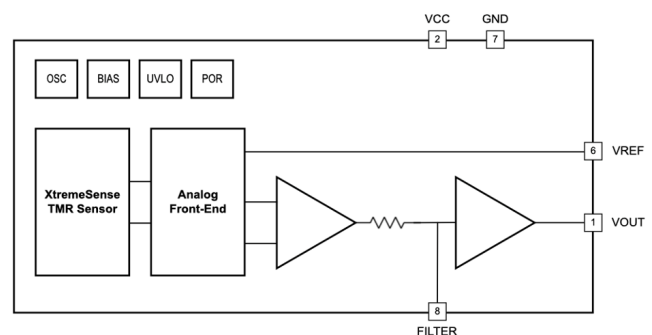


Figure 2: CT450 Functional Block Diagram for TSSOP-8

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## SELECTION GUIDE

Part Number	Automotive Grade	Range (mT)	Operating Temperature Range (°C)	Package	Packing
<b>BIPOLAR SENSITIVITY</b>					
CT450-H06MRSN08	–	±6	–40 to 125	8-lead SOIC 4.89 mm × 6.00 mm × 1.62 mm	Tape and Reel
CT450-H12MRSN08	–	±12			
CT450-H24MRSN08	–	±24			
CT450-H06MRTS08	–	±6	–40 to 125	8-lead TSSOP 3.00 mm × 6.40 mm × 1.10 mm	Tape and Reel
CT450-H12MRTS08	–	±12			
CT450-H24MRTS08	–	±24			
<b>UNIPOLAR SENSITIVITY</b>					
CT450-H06DRSN08	–	6	–40 to 125	8-lead SOIC 4.89 mm × 6.00 mm × 1.62 mm	Tape and Reel
CT450-H12DRSN08	–	12			
CT450-H24DRSN08	–	24			
CT450-H06DRTS08	–	6	–40 to 125	8-lead TSSOP 3.00 mm × 6.40 mm × 1.10 mm	Tape and Reel
CT450-H12DRTS08	–	12			
CT450-H24DRTS08	–	24			
<b>PROGRAMMABLE SENSITIVITY</b>					
CT450-H00MRSN08	–	±6 to ±24	–40 to 125	8-lead SOIC 4.89 mm × 6.00 mm × 1.62 mm	Tape and Reel
CT450-H00DRSN08	–	6 to 24			
CT450-H00MRTS08	–	±6 to ±24	–40 to 125	8-lead TSSOP 3.00 mm × 6.40 mm × 1.10 mm	Tape and Reel
CT450-H00DRTS08	–	6 to 24			

## EVALUATION BOARD SELECTION GUIDE

Part Number	Magnetic Field Range (mT)	Operating Temperature Range (°C)	Package
CTD450-06U	0 to 6	-40 to 125	8-lead SOIC 4.89 mm × 6.00 mm × 1.62 mm
CTD450-06B	±6		
CTD450-12U	0 to 12		
CTD450-12B	±12		
CTD450-24U	0 to 24		
CTD450-24B	±24		

## ABSOLUTE MAXIMUM RATINGS [1]

Characteristic	Symbol	Notes	Rating	Unit
Supply Voltage Strength	$V_{CC}$		-0.3 to 6.0	V
Analog Input/Output Pins Maximum Voltage	$V_{I/O}$		-0.3 to $V_{CC} + 0.3$ [2]	V
Electrostatic Discharge Protection Level	ESD	Human Body Model (HBM) per JESD22-A114	±2.0 (min)	kV
		Charged Device Model (CDM) per JESD22-C101	±0.5 (min)	kV
Junction Temperature	$T_J$		-40 to 150	°C
Storage Temperature	$T_{STG}$		-65 to 155	°C
Lead Soldering Temperature	$T_L$	10 seconds	260	°C

[1] Stresses exceeding the absolute maximum ratings may damage the CT450 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.

[2] The lower of  $V_{CC} + 0.3$  V or 6.0 V.

## RECOMMENDED OPERATING CONDITIONS [1]

Characteristic	Symbol	Notes	Min.	Typ.	Max.	Unit
Supply Voltage Range	$V_{CC}$		4.75	5.00	5.50	V
Output Voltage Range	$V_{OUT}$		0	-	$V_{CC}$	V
Output Current	$I_{OUT}$		-	-	±1.0	mA
Operating Ambient Temperature	$T_A$	Industrial	-40	25	85	°C
		Extended Industrial	-40	25	125	°C

[1] The Recommended Operating Conditions table defines the conditions for actual operation of the CT450. Recommended operating conditions are specified to ensure optimal performance to the specifications. Allegro does not recommend exceeding them or designing to absolute maximum ratings.

## APPLICATION DIAGRAMS

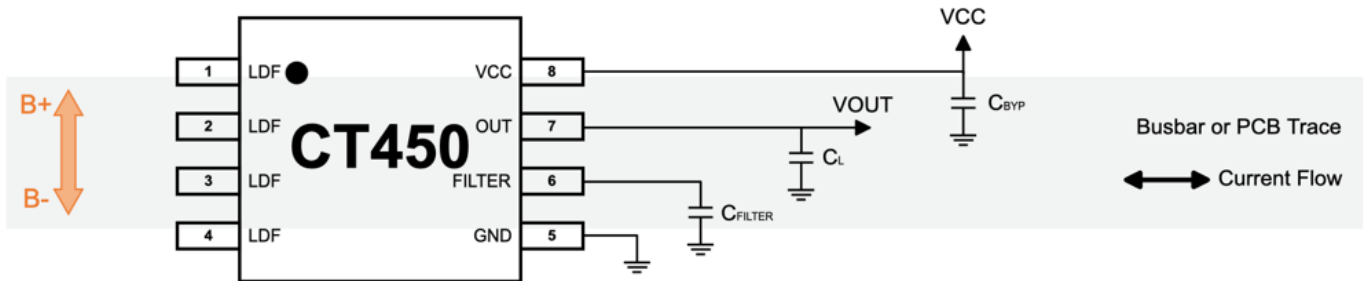


Figure 3: CT450 Application Diagram for SOIC-8

Table 1: Recommended External Components

Component	Description	Vendor and Part Number	Min.	Typ.	Max.	Unit
$C_{BYP}$	1.0 $\mu$ F, X5R or better	Murata GRM155C81A105KA12	–	1.0	–	$\mu$ F
$C_{FILTER}$	Various, X5R or better	Murata	–	Figure 27	–	pF

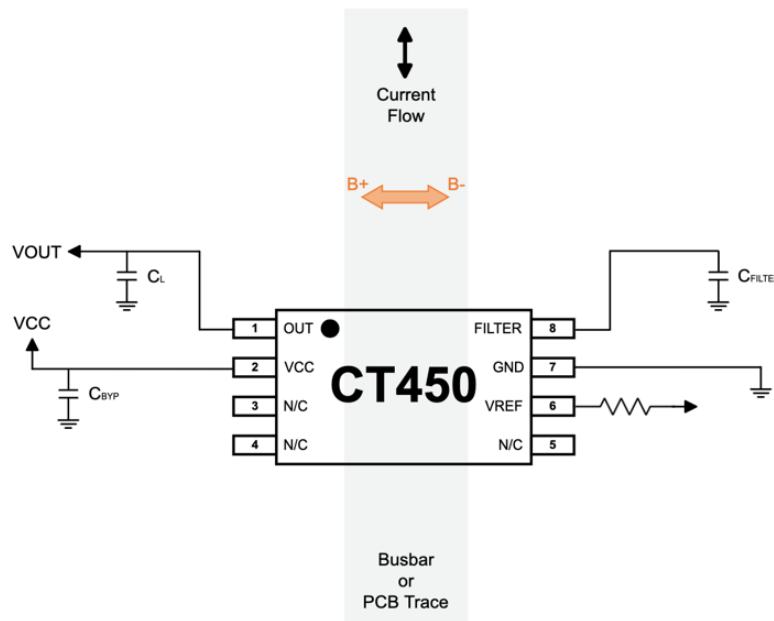


Figure 4: CT450 Application Diagram for TSSOP-8

Table 2: Recommended External Components

Component	Description	Vendor and Part Number	Min.	Typ.	Max.	Unit
$C_{BYP}$	1.0 $\mu$ F, X5R or better	Murata GRM155C81A105KA12	–	1.0	–	$\mu$ F
$C_{FILTER}$	Various, X5R or better	Murata	–	Figure 27	–	pF
$R_{VREF}$	10 k $\Omega$ resistor	Various	–	10	–	k $\Omega$

## PINOUT DIAGRAMS AND TERMINAL LISTS

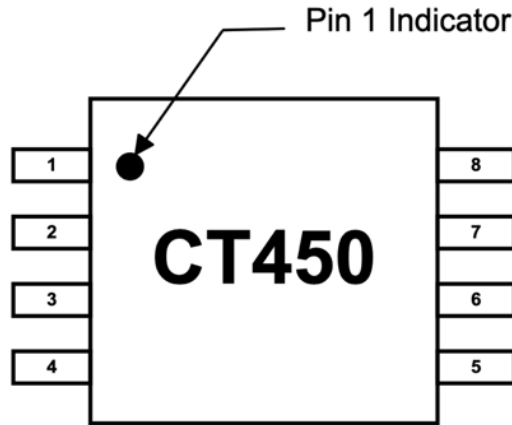
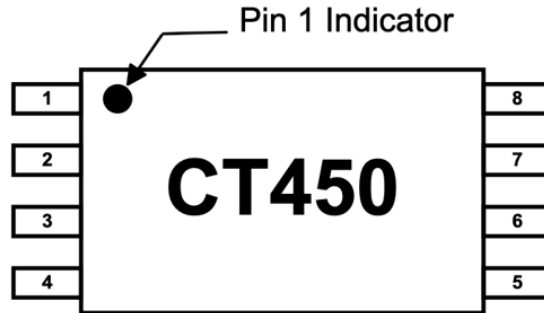


Figure 5: CT450 Pinout Diagram for 8-lead SOIC Package (Top-Down View)

### Terminal List

Number	Name	Function
1, 2, 3, 4	LDF	Lead frame Pin – A single (1) LDF pin should be connected to GND. The other three (3) LDF pins should be left unconnected to avoid ground loops through the lead frame.
5	GND	Ground.
6	FILTER	Filter pin to improve noise performance by connecting an external capacitor to set the cutoff frequency. No connect if the FILTER pin is not used.
7	OUT	Analog output voltage that represents the measured current/field.
8	VCC	Supply voltage.



**Figure 6: CT450 Pinout Diagram for 8-lead TSSOP Package (Top-Down View)**

### Terminal List

Number	Name	Function
1	OUT	Analog output voltage that represents the measured current/field.
2	VCC	Supply voltage.
3, 4, 5	NC	No connect (do not use).
6	VREF	Reference voltage output. If not used, then do not connect.
7	GND	Ground.
8	FILTER	Filter pin to improve noise performance by connecting an external capacitor to set the cutoff frequency. No connect if the FILTER pin is not used.

**ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>POWER SUPPLIES</b>						
Supply Current	$I_{CC}$	$f_{BW} = 1$ MHz, no load, $B_{OP} = 0$ mT	–	6.0	9.0	mA
OUT Maximum Drive Capability	$I_{OUT}$	OUT covers 10% to 90% of $V_{CC}$ span	–1.0	–	+1.0	mA
OUT Capacitive Load	$C_{L\_OUT}$		–	–	100	pF
OUT Resistive Load	$R_{L\_OUT}$		–	100	–	k $\Omega$
Internal Filter Resistance [1]	$R_{FILTER}$		–	15	–	k $\Omega$
Power Supply Rejection Ratio [1]	PSRR		–	35	–	dB
Sensitivity Power Supply Rejection Ratio [1]	SPSRR		–	35	–	dB
Offset Power Supply Rejection Ratio [1]	OPSRR		–	40	–	dB
<b>ANALOG OUTPUT (OUT)</b>						
OUT Voltage Linear Range	$V_{OUT}$	$V_{SIG\_AC} = \pm 2.00$ V, $V_{SIG\_DC} = +4.00$ V	0.50	–	4.50	V
Output High Saturation Voltage	$V_{OUT\_SAT}$	$T_A = 25^\circ\text{C}$	$V_{CC} - 0.30$	$V_{CC} - 0.25$	–	V
<b>REFERENCE VOLTAGE (VREF) FOR TSSOP-8 ONLY</b>						
Reference Voltage	$V_{REF}$	Unipolar variant	–	0.50	–	V
		Bipolar variant	–	2.50	–	V
VREF Maximum Drive Capability	$I_{VREF}$	TSSOP-8 variant only	–50	–	50	$\mu$ A
VREF Capacitive Load	$C_{L\_VREF}$	TSSOP-8 variant only	–	–	10	pF
VREF Resistive Load	$R_{L\_VREF}$	TSSOP-8 variant only	–	10	–	k $\Omega$
<b>TIMINGS</b>						
Power-On Time	$t_{ON}$	$V_{CC} \geq 4.0$ V	–	100	200	$\mu$ s
Rise Time [1]	$t_{RISE}$	$B_{OP} = B_{OP(MAX)}$ , $T_A = 25^\circ\text{C}$ , $C_L = 100$ pF	–	200	–	ns
Response Time [1]	$t_{RESPONSE}$	$B_{OP} = B_{OP(MAX)}$ , $T_A = 25^\circ\text{C}$ , $C_L = 100$ pF	–	300	–	ns
Propagation Delay [1]	$t_{DELAY}$	$B_{OP} = B_{OP(MAX)}$ , $T_A = 25^\circ\text{C}$ , $C_L = 100$ pF	–	250	–	ns
<b>PROTECTION</b>						
Undervoltage Lockout	$V_{UVLO}$	Rising $V_{CC}$	–	2.50	–	V
		Falling $V_{CC}$	–	2.45	–	V
UVLO Hysteresis	$V_{UV\_HYS}$		–	50	–	mV

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

## ELECTRICAL CHARACTERISTICS

$V_{CC} = 5.00\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0\ \mu\text{F}$  (unless otherwise specified)

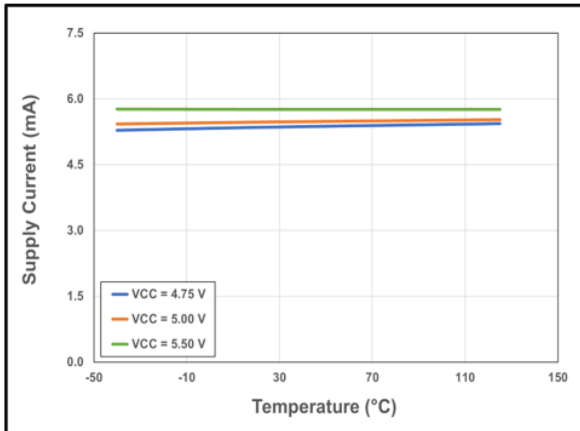


Figure 7: CT450 Supply Current vs. Temperature vs. Supply Voltage

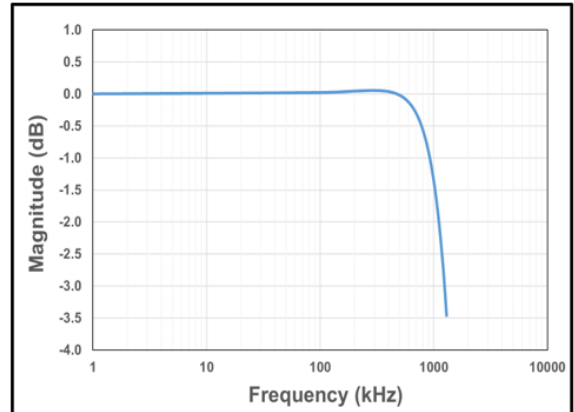


Figure 8: CT450 Bandwidth with  $C_{FILTER} = 1.0\ \text{pF}$

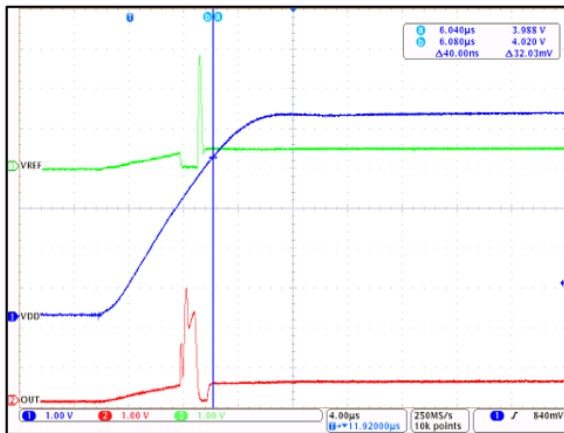


Figure 9: CT450 Startup Waveforms for  $V_{OQ} = 0.50\text{ V}$  (Unipolar Sensor Variant)

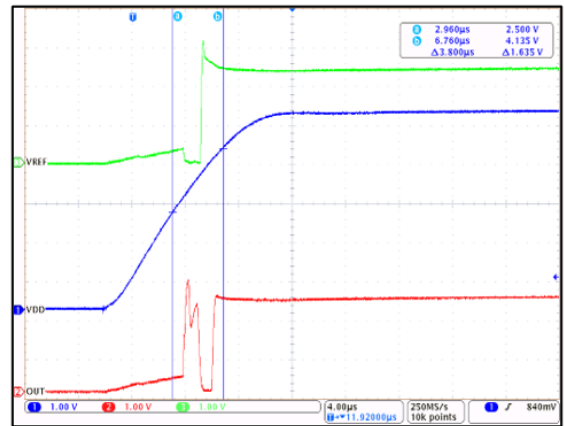


Figure 10: CT450 Startup Waveforms for  $V_{OQ} = 2.50\text{ V}$  (Bipolar Sensor Variant)



**ELECTRICAL CHARACTERISTICS (continued)**

$V_{CC} = 5.00\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0\ \mu\text{F}$  (unless otherwise specified)

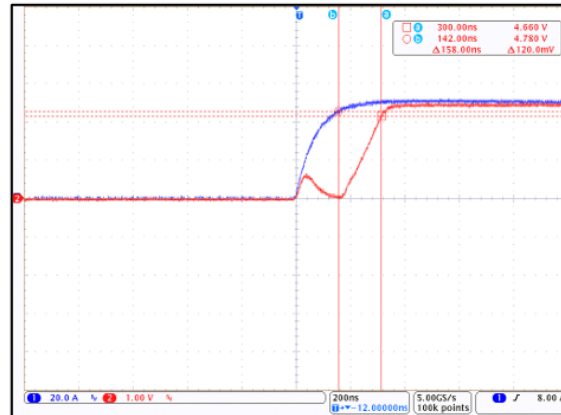


Figure 11: CT450 Response Time;  $B_{OP} = 12\text{ mT}$  and  $C_L = 100\text{ pF}$  (Blue = B Field, Red =  $V_{OUT}$ )

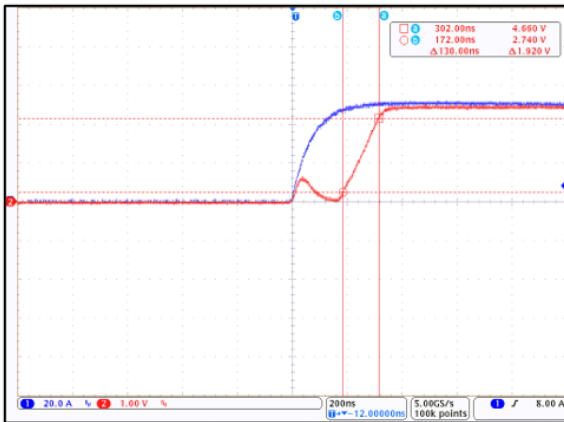


Figure 12: CT450 Rise Time;  $B_{OP} = 12\text{ mT}$  and  $C_L = 100\text{ pF}$  (Blue = B Field, Red =  $V_{OUT}$ )

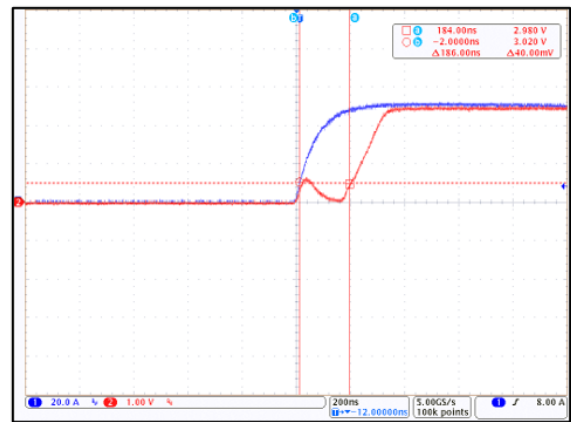


Figure 13: CT450 Propagation Delay;  $B_{OP} = 12\text{ mT}$  and  $C_L = 100\text{ pF}$  (Blue = B Field, Red =  $V_{OUT}$ )

**CT450-x06DR: 0 to 6 mT – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Magnetic Field Range	$B_{RNG}$		0	–	6	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $B_{OP} = 0$ mT	0.495	0.500	0.505	V
Sensitivity	S	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	666.7	–	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = $-3$ dB	–	1.0	–	MHz
Noise [1]	$e_N$	$T_A = 25^\circ\text{C}$ , $f_{BW} = 100$ kHz	–	1.63	–	mV <sub>RMS</sub>
			–	2.45	–	$\mu$ T <sub>RMS</sub>
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$		–	$\pm 0.3$	–	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	–	$\pm 0.3$	–	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		–	$\pm 1.0$	–	% FS

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

## ELECTRICAL CHARACTERISTICS FOR CT450-x06DR

$V_{CC} = 5.0$  V,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0$   $\mu$ F (unless otherwise specified)

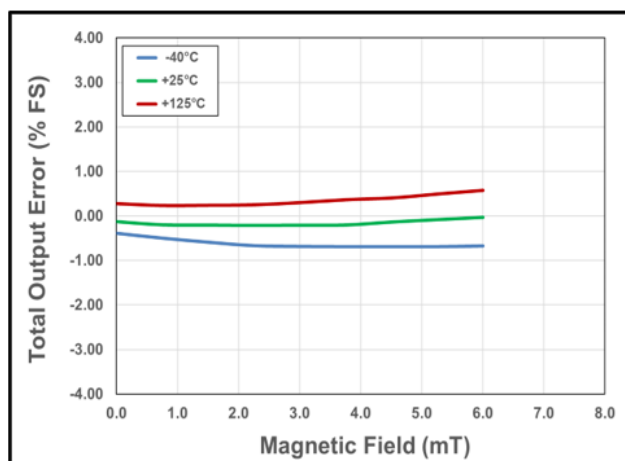


Figure 14: Total Output Error vs. B Field vs. Temperature

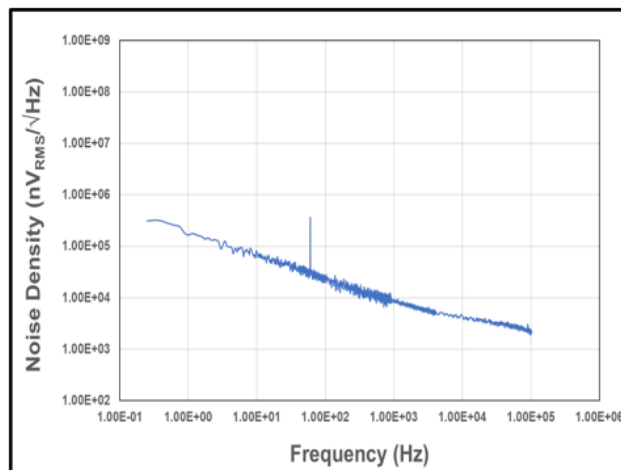


Figure 15: Noise Density vs. Frequency

**CT450-x06MR: ±6 mT – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ$ C to  $125^\circ$ C, typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ$ C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Magnetic Field Range	$B_{RNG}$		-6	-	6	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ$ C, $B_{OP} = 0$ mT	2.490	2.500	2.510	V
Sensitivity	S	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	-	333.3	-	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = -3 dB	-	1.0	-	MHz
Noise [1]	$e_N$	$T_A = 25^\circ$ C, $f_{BW} = 100$ kHz	-	0.92	-	mV <sub>RMS</sub>
			-	2.77	-	$\mu$ T <sub>RMS</sub>
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		-	±0.1	-	% FS
Sensitivity Error	$E_{SENS}$		-	±0.3	-	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	-	±0.2	-	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		-	±1.0	-	% FS

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

## ELECTRICAL CHARACTERISTICS FOR CT450-x06MR

$V_{CC} = 5.0$  V,  $T_A = 25^\circ$ C, and  $C_{BYP} = 1.0$   $\mu$ F (unless otherwise specified)

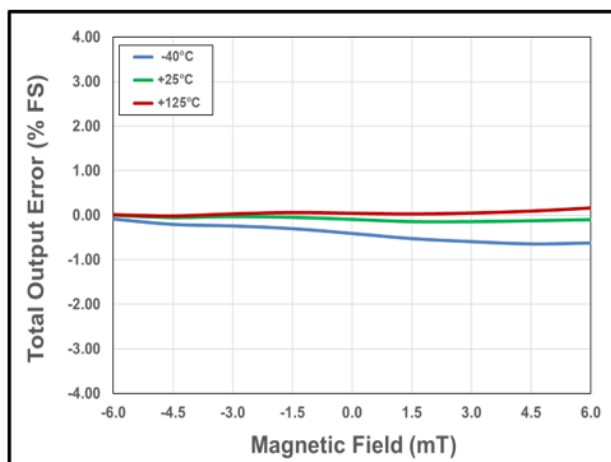


Figure 16: Total Output Error vs. B Field vs. Temperature

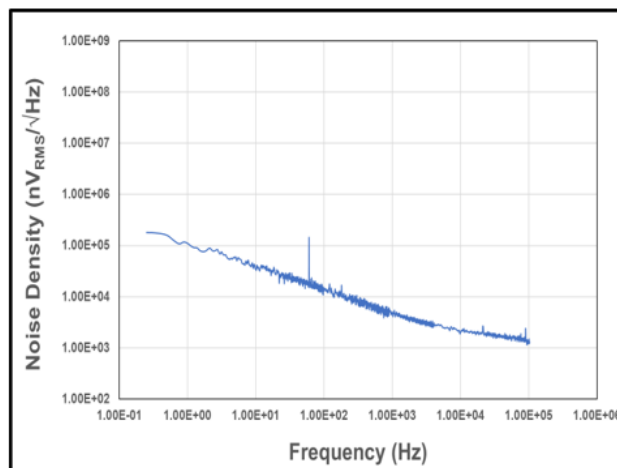


Figure 17: Noise Density vs. Frequency

**CT450-x12DR: 0 to 12 mT – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Magnetic Field Range	$B_{RNG}$		0	–	12	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $B_{OP} = 0$ mT	0.495	0.500	0.505	V
Sensitivity	S	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	333.3	–	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = $-3$ dB	–	1.0	–	MHz
Noise [1]	$e_N$	$T_A = 25^\circ\text{C}$ , $f_{BW} = 100$ kHz	–	1.30	–	mV <sub>RMS</sub>
			–	3.90	–	$\mu$ T <sub>RMS</sub>
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$		–	$\pm 0.3$	–	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	–	$\pm 0.2$	–	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		–	$\pm 1.0$	–	% FS

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

## ELECTRICAL CHARACTERISTICS FOR CT450-x12DR

$V_{CC} = 5.0$  V,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0$   $\mu$ F (unless otherwise specified)

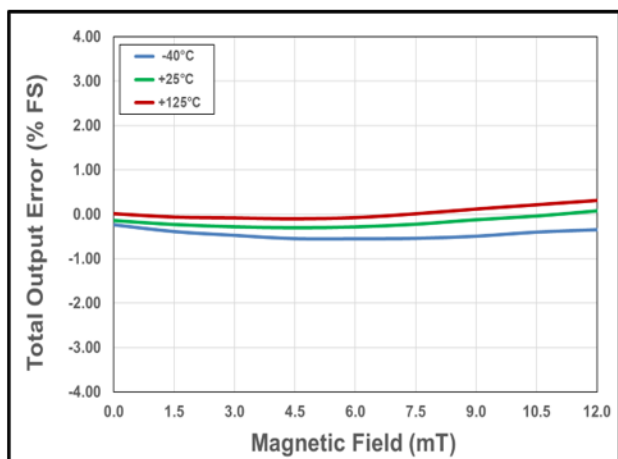


Figure 18: Total Output Error vs. B Field vs. Temperature

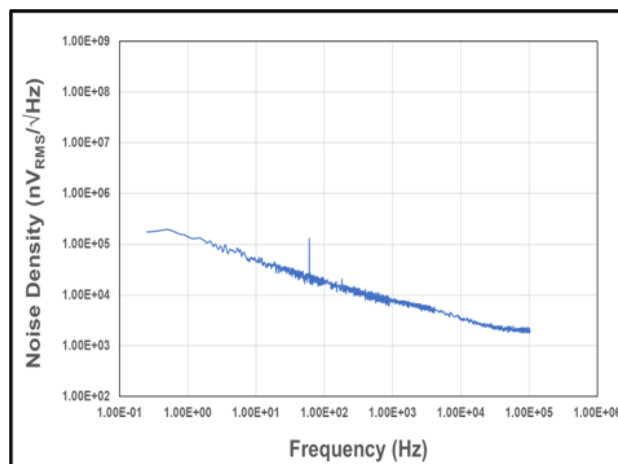


Figure 19: Noise Density vs. Frequency

**CT450-x12MR: ±12 mT – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ$ C to  $125^\circ$ C, typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ$ C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Magnetic Field Range	$B_{RNG}$		-12	-	12	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ$ C, $B_{OP} = 0$ mT	2.490	2.500	2.510	V
Sensitivity	S	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	-	166.7	-	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = -3 dB	-	1.0	-	MHz
Noise [1]	$e_N$	$T_A = 25^\circ$ C, $f_{BW} = 100$ kHz	-	0.75	-	mV <sub>RMS</sub>
			-	4.50	-	$\mu$ T <sub>RMS</sub>
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		-	±0.1	-	% FS
Sensitivity Error	$E_{SENS}$		-	±0.3	-	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	-	±0.2	-	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		-	±1.0	-	% FS

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

## ELECTRICAL CHARACTERISTICS FOR CT450-x12MR

$V_{CC} = 5.0$  V,  $T_A = 25^\circ$ C, and  $C_{BYP} = 1.0$   $\mu$ F (unless otherwise specified)

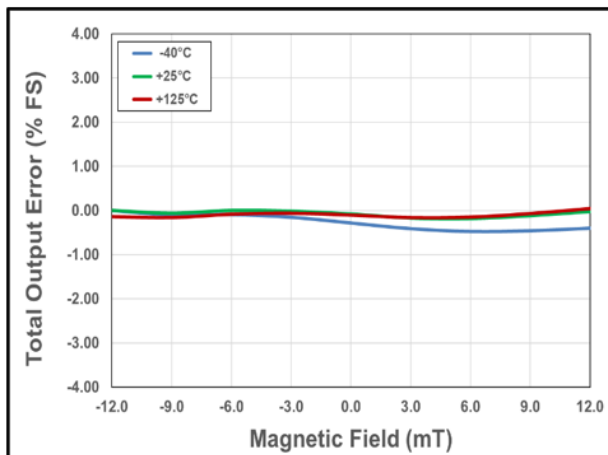


Figure 20: Total Output Error vs. B Field vs. Temperature

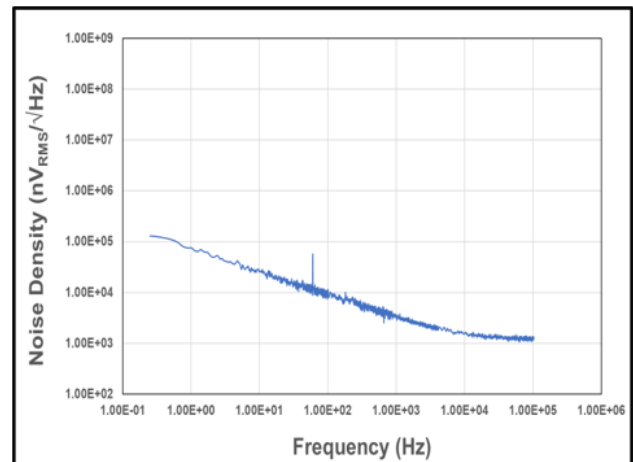


Figure 21: Noise Density vs. Frequency

**CT450-x24DR: 0 to 24 mT – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Magnetic Field Range	$B_{RNG}$		0	–	24	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $B_{OP} = 0$ mT	0.495	0.500	0.505	V
Sensitivity	S	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	166.7	–	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = $-3$ dB	–	1.0	–	MHz
Noise [1]	$e_N$	$T_A = 25^\circ\text{C}$ , $f_{BW} = 100$ kHz	–	0.46	–	mV <sub>RMS</sub>
			–	2.77	–	$\mu$ T <sub>RMS</sub>
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		–	$\pm 0.3$	–	% FS
Sensitivity Error	$E_{SENS}$		–	$\pm 0.3$	–	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	–	$\pm 0.2$	–	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		–	$\pm 1.0$	–	% FS

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

## ELECTRICAL CHARACTERISTICS FOR CT450-x24DR

$V_{CC} = 5.0$  V,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0$   $\mu$ F (unless otherwise specified)

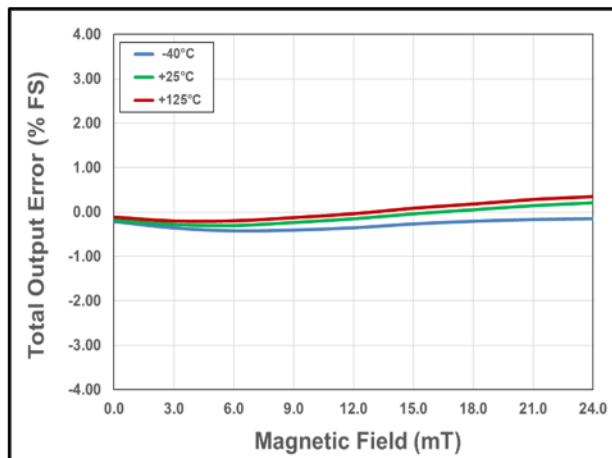


Figure 22: Total Output Error vs. B Field vs. Temperature

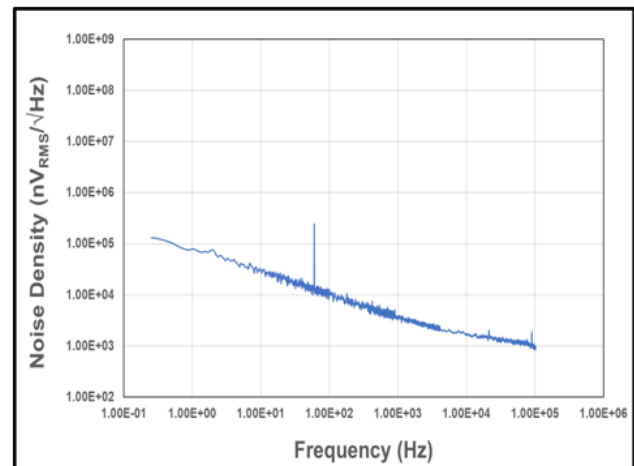


Figure 23: Noise Density vs. Frequency

**CT450-x24MR: ±24 mT – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ$ C to  $125^\circ$ C, typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ$ C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Magnetic Field Range	$B_{RNG}$		-24	-	24	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ$ C, $B_{OP} = 0$ mT	2.490	2.500	2.510	V
Sensitivity	S	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	-	83.3	-	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = -3 dB	-	1.0	-	MHz
Noise [1]	$e_N$	$T_A = 25^\circ$ C, $f_{BW} = 100$ kHz	-	0.38	-	mV <sub>RMS</sub>
			-	4.56	-	$\mu$ T <sub>RMS</sub>
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		-	±0.1	-	% FS
Sensitivity Error	$E_{SENS}$		-	±0.3	-	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	-	±0.3	-	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		-	±1.0	-	% FS

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

## ELECTRICAL CHARACTERISTICS FOR CT450-x24MR

$V_{CC} = 5.0$  V,  $T_A = 25^\circ$ C, and  $C_{BYP} = 1.0$   $\mu$ F (unless otherwise specified)

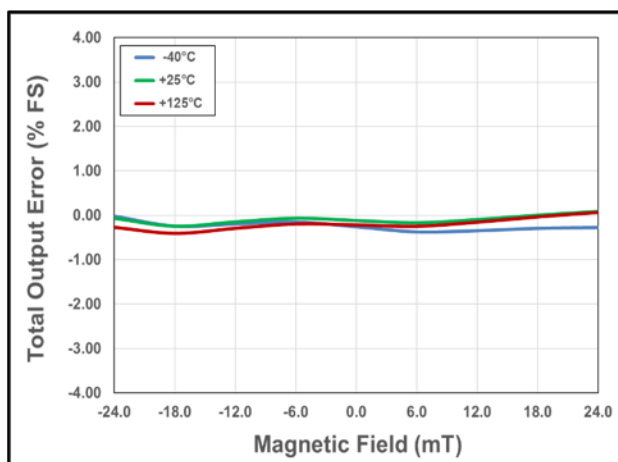


Figure 24: Total Output Error vs. B Field vs. Temperature

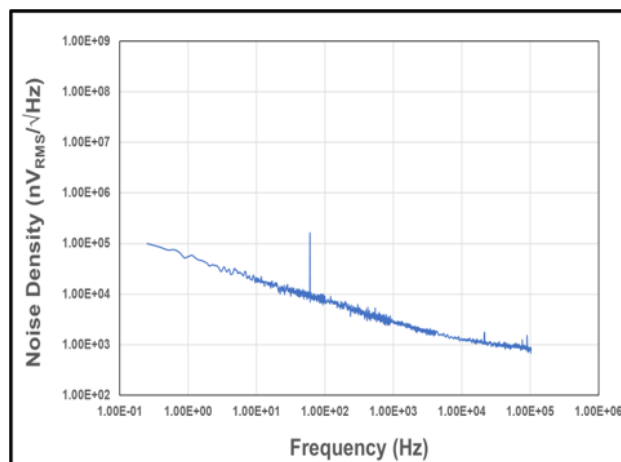


Figure 25: Noise Density vs. Frequency

**CT450-x00MR: Programmable Gain – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Programmable Magnetic Field Range	$B_{PRNG}$		$\pm 6$	–	$\pm 24$	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $B_{OP} = 0$ mT	2.490	2.500	2.510	V
Maximum Programmable Sensitivity	$S_{PMAX}$	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	333.3	–	mV/mT
Minimum Programmable Sensitivity	$S_{PMIN}$	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	83.4	–	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = $-3$ dB	–	1.0	–	MHz
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$		–	$\pm 0.3$	–	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	–	$\pm 0.3$	–	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		–	$\pm 1.0$	–	% FS

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

## Calibration Description

The CT450-x00MR is factory-trimmed for sensitivity and offset temperature drift. The sensor provides the ability to adjust gain to allow for all the mechanical tolerances during manufacturing. Gain calibration is recommended to be performed at room temperature ( $25^\circ\text{C}$ ) using the Allegro CTC4000 Calibration Box.



**CT450-x00DR: Programmable Gain – ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 4.75$  to  $5.50$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , typical values are  $V_{CC} = 5.00$  V and  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Programmable Magnetic Field Range	$B_{PRNG}$		6	–	24	mT
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $B_{OP} = 0$ mT	0.495	0.500	0.505	V
Maximum Programmable Sensitivity	$S_{PMAX}$	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	666.7	–	mV/mT
Minimum Programmable Sensitivity	$S_{PMIN}$	$B_{RNG(MIN)} < B_{OP} < B_{RNG(MAX)}$	–	166.7	–	mV/mT
Bandwidth [1]	$f_{BW}$	Small Signal = $-3$ dB	–	1.0	–	MHz
<b>OUT ACCURACY PERFORMANCE</b>						
Non-Linearity Error	$E_{LIN}$		–	$\pm 0.3$	–	% FS
Sensitivity Error	$E_{SENS}$		–	$\pm 0.3$	–	% FS
Offset Voltage	$V_{OFFSET}$	$B_{OP} = 0$ mT	–	$\pm 0.3$	–	% FS
<b>LIFETIME DRIFT</b>						
Total Output Error Lifetime Drift	$E_{TOT\_DRIFT}$		–	$\pm 1.0$	–	% FS

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

## Calibration Description

The CT450-x00DR is factory-trimmed for sensitivity and offset temperature drift. The sensor provides the ability to adjust gain to allow for all the mechanical tolerances during manufacturing. Gain calibration is recommended to be performed at room temperature ( $25^\circ\text{C}$ ) using the Allegro CTC4000 Calibration Box.

## FUNCTIONAL DESCRIPTION

### Overview

The CT450 is a very high accuracy contactless current sensor that can sense magnetic fields from 6 to 24 mT. The device has high sensitivity and a wide dynamic range with excellent accuracy (low total output error) across temperature. This current sensor supports six field ranges as standard and can also be user-programmable:

- 0 to 6 mT
- 0 to 12 mT
- 0 to 24 mT
- ±6 mT
- ±12 mT
- ±24 mT

The CT450 is also available in a user-programmable variant which enables end-of-line calibration of gain. While the sensor is pre-programmed to adjust sensitivity and offset temperature drift, the ability to adjust gain relaxes mechanical tolerances during sensor mounting.

When current is flowing through a busbar above or below the CT450, the XtremeSense TMR sensor inside the chip senses the field which in turn generates a differential voltage signals that then goes through the Analog Front-End (AFE) to output a current measurement as low as ±1.0% full-scale total output error ( $E_{OUT}$ ).

The chip is designed to enable a fast response time of 300 ns for the current measurement from the OUT pin as the bandwidth for the CT450 is 1.0 MHz. Even with a high bandwidth, the chip consumes a minimal amount of power.

### Linear Output Current Measurement

The CT450 provides a continuous linear analog output voltage which represents the current measurement. The output voltage range of OUT is from 0.50 to 4.50 V with a  $V_{OQ}$  of 0.50 V and 2.50 V for unidirectional and bidirectional currents, respectively. Figure 26 illustrates the output voltage range of the OUT pin as a function of the measured current.

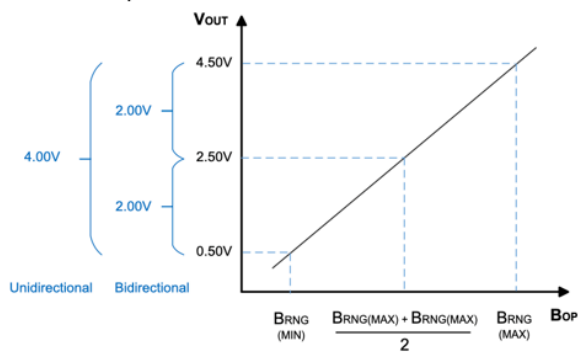


Figure 26: Linear Output Voltage Range (OUT) vs. Measured Magnetic Field ( $B_{OP}$ )

### Voltage Reference Function (VREF)

The CT450 in TSSOP-8 package has a reference voltage (VREF) pin that may be used as an output voltage reference for AC or DC field/current measurements. The VREF pin should be connected to a buffer circuit.

If VREF is not used, then it should be left unconnected.

### Filter Function (FILTER)

The CT450 has a pin for the FILTER function which will enable it to improve the noise performance by changing the cutoff frequency. The bandwidth of the CT450 is 1.0 MHz; however, adding a capacitor to the FILTER pin—which will be in-series with an internal resistance of approximately 15 k $\Omega$ —will set the cutoff frequency to reduce noise. Figure 27 shows the capacitor values required to achieve different cutoff frequencies.

Experimentally measured bandwidth does not necessarily match the calculated bandwidth value obtained by using the equation  $f_{BW} = 1/2\pi RC$  because of the parasitic capacitances due to PCB manufacturing and layout. This is further impacted by the small, picofarad level  $C_{FILTER}$  recommendations.

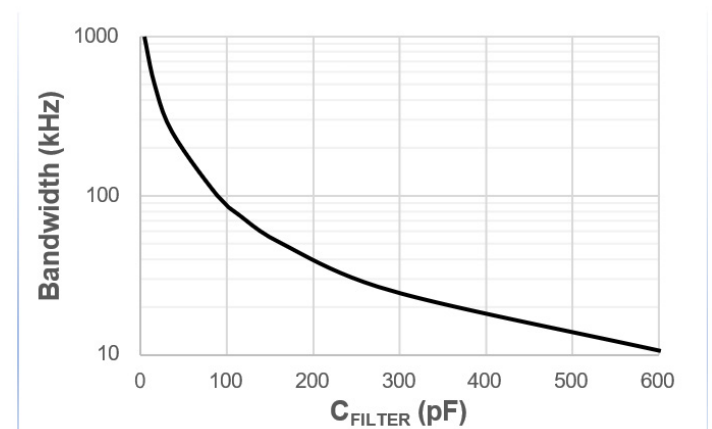


Figure 27: Bandwidth vs.  $C_{FILTER}$

### Total Output Error

The Total Output Error ( $E_{OUT}$ ) is the maximum deviation of the sensor output from the ideal sensor transfer curve over the full temperature range relative to the sensor full scale.

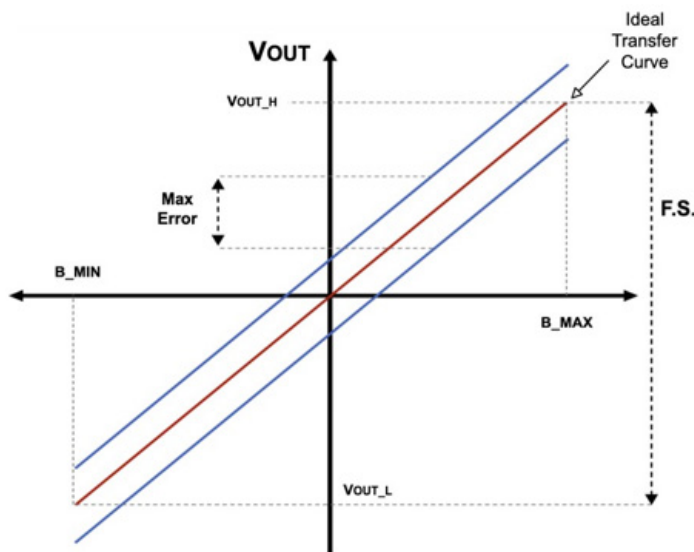
The Total Output Error is measured by performing a full-scale primary current (IP) sweep and measuring  $V_{OUT}$  at multiple points.

$$E_{OUT} = 100 * \frac{\max(V_{OUT_{IDEAL}}(I) - V_{OUT}(I))}{F.S.}$$

The Ideal Transfer Curve is calculated based on datasheet parameters as described below.

$$V_{OUT_{IDEAL}}(I_P) = V_{OQ} + S * I_P$$

$E_{OUT}$  incorporates all sources of error and is a function of the sensed current ( $I_P$ ) from the current sensor.



**Figure 28: Total Output Error ( $E_{OUT}$ ) vs. Field ( $B_{OP}$ )**

The CT450 achieves a total output error ( $E_{OUT}$ ) that is less than  $\pm 1.0\%$  of Full-Scale (FS) over supply voltage and temperature. It is designed with innovative and proprietary TMR sensors and circuit blocks to provide very accurate magnetic field measurements regardless of the operating conditions.

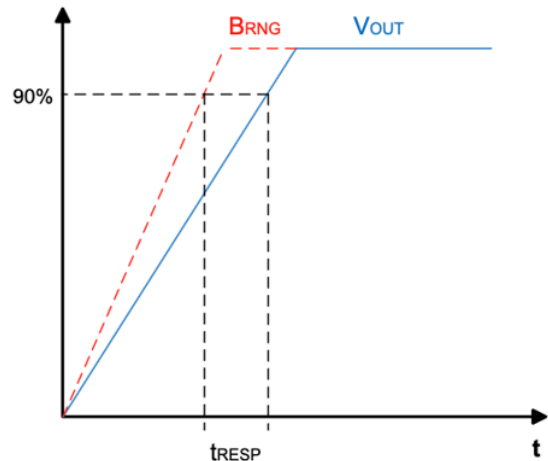
## Power-On Time ( $t_{ON}$ )

Power-On Time ( $t_{ON}$ ) of 100  $\mu s$  is the amount of time required by CT450 to start up, fully power the chip, and becoming fully operational from the moment the supply voltage is greater than the UVLO voltage. This time includes the ramp-up time and the settling time (within 10% of steady-state voltage under an applied magnetic field) after the power supply has reached the minimum  $V_{CC}$ .

## Response Time ( $t_{RESPONSE}$ )

Response Time ( $t_{RESPONSE}$ ) of 300 ns for the CT450 is the time interval between the following terms:

1. When the primary current signal reaches 90% of its final value,
2. When the chip reaches 90% of its output corresponding to the applied current.



**Figure 29: CT450 Response Time Curve**

## Rise Time ( $t_{RISE}$ )

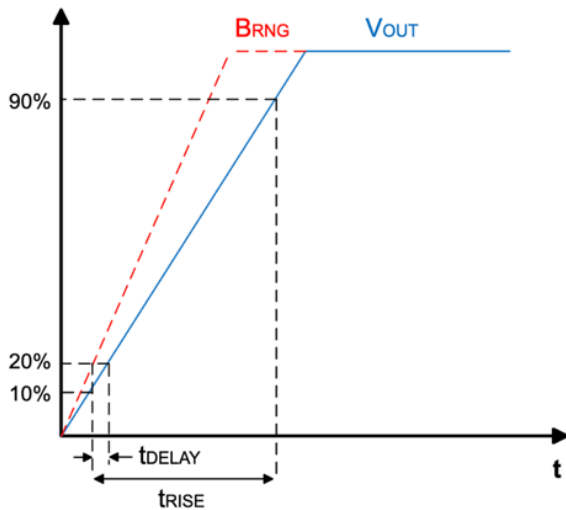
Rise Time ( $t_{RISE}$ ) is the time interval of when it reaches 10% and 90% of the full-scale output voltage. The  $t_{RISE}$  of the CT450 is 200 ns.

## Propagation Delay ( $t_{DELAY}$ )

Propagation Delay ( $t_{DELAY}$ ) is the time difference between these two events:

1. When the primary current reaches 20% of its final value
2. When the chip reaches 20% of its output corresponding to the applied current.

The CT450 has a propagation delay of 250 ns.



**Figure 30: CT450 Propagation Delay and Rise Time Curve**

## Undervoltage Lockout (UVLO)

The Undervoltage Lockout protection circuitry of the CT450 is activated when the supply voltage ( $V_{CC}$ ) falls below 2.45 V. The CT450 remains in a low quiescent state until  $V_{CC}$  rises above the UVLO threshold (2.50 V). In this condition where  $V_{CC}$  is less than 2.45 V and UVLO is triggered, the output from the CT450 is not valid. Once  $V_{CC}$  rises above 4.0 V, then the UVLO is cleared.

## Current Sensing

The CT450 can sense and therefore measure the current by either placing a current-carrying busbar above or under the device. The busbar should be placed crosswise or over the pins of the package for the CT450 (in SOIC-8) to measure the current. The chip is also sensitive enough to measure the current from a PCB trace that is routed beneath it.

## Bypass Capacitor

A single 1.0  $\mu\text{F}$  capacitor is needed for the VCC pin to reduce the noise from the power supply and other circuits. This capacitor

should be placed as close as possible to the CT450 to minimize inductance and resistance between the two devices.

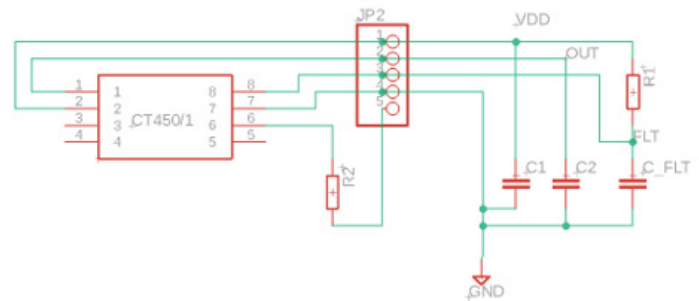
## VREF Resistors (TSSOP-8)

In designs where the VREF pin of the CT450 in TSSOP-8 is used, a 10 k $\Omega$  resistor must be connected as close to the pin as possible in series with a load.

If the VREF pin is not needed in the application, then this pin should not be connected and be left floating.

## Recommended PCB Layout

The CT450 is able to sense the field generated by the current flowing through a Printed Circuit Board (PCB) trace or busbar. Figure 31 shows the schematic for the CTD450 which is the evaluation board for the CT450.



**Figure 31: CTD450 Evaluation Board Schematic**

The PCB layout of the CTD450 is shown in Figure 32 where the CT450 can sense the current through the PCB trace on the bottom layer of a 4-layer PCB. The width of the PCB trace and the thickness of the copper used will dictate the amount of current that it can carry. Use the Allegro Contactless Current Sensor Calculator to set the parameters to determine the amount of current the PCB trace (or busbar) can support.

For the implementation of the current trace on the bottom layer, a distance of 1.60 mm between the IC pads on the top side of the PCB to the bottom layer of the trace will yield an isolation voltage that is greater than 5.0 kV.

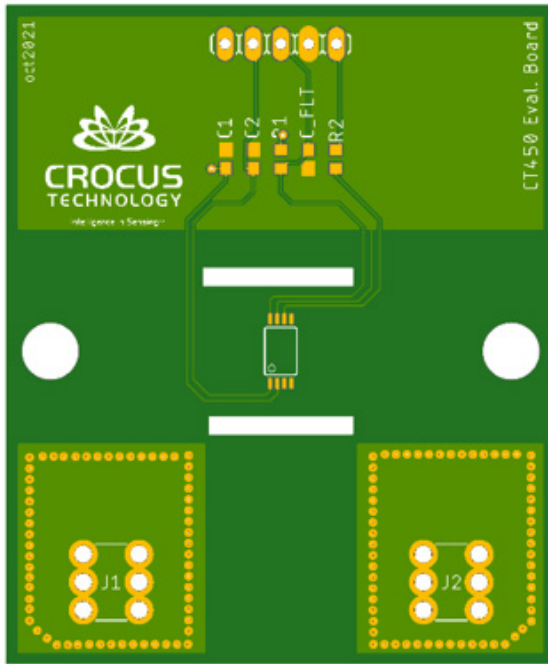


Figure 32: CTD450 Evaluation Board PCB Layout

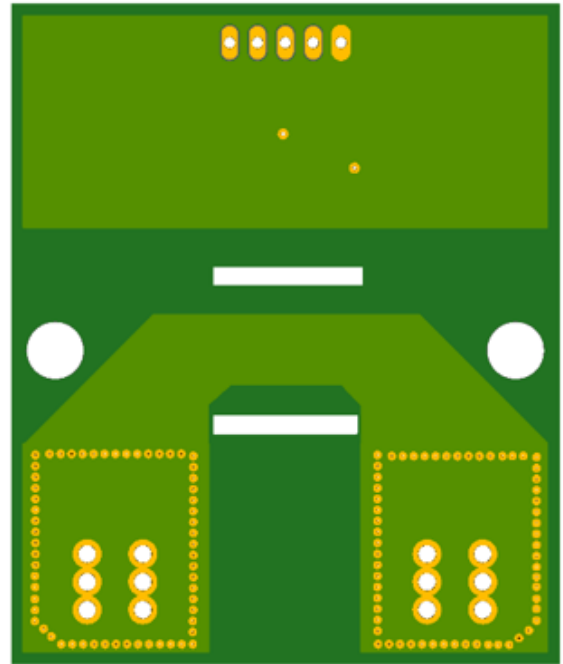


Figure 33: CTD450 Evaluation Board PCB Layout

## XtremeSense TMR Current Sensor Location

The XtremeSense TMR current sensor location of the CT450 is shown below. All dimensions in the figures are nominal.

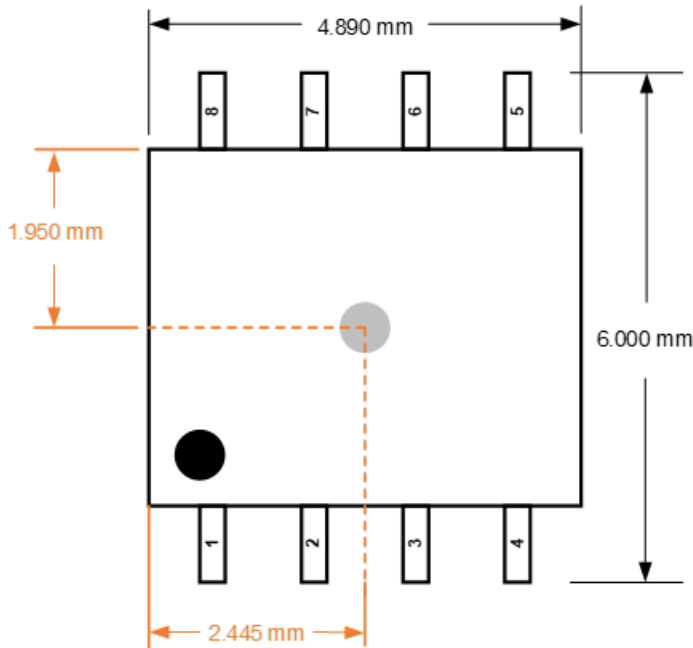


Figure 34: XtremeSense TMR Current Sensor Location in x-y Plane for CT450 in SOIC-8 Package

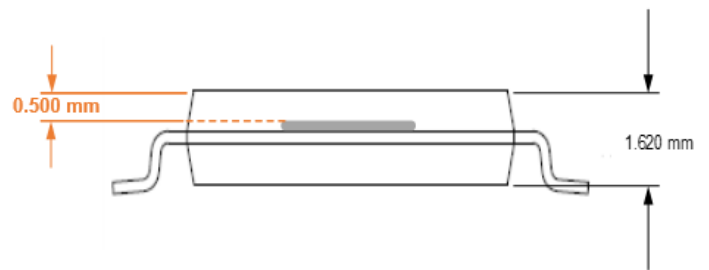


Figure 35: XtremeSense TMR Current Sensor Location in z Dimension for CT450 in SOIC-8 Package

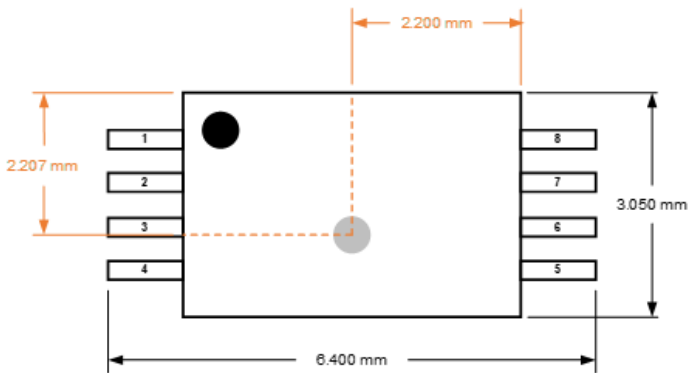


Figure 36: XtremeSense TMR Current Sensor Location in x-y Plane for CT450 in TSSOP-8 Package

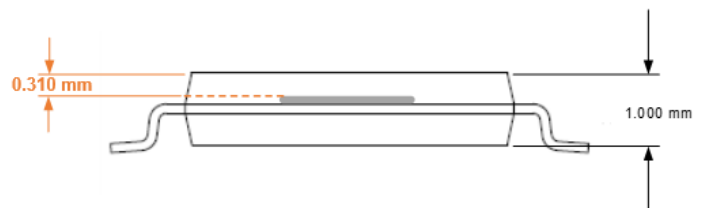


Figure 37: XtremeSense TMR Current Sensor Location in z Dimension for CT450 in TSSOP-8 Package

## PACKAGE OUTLINE DRAWINGS

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

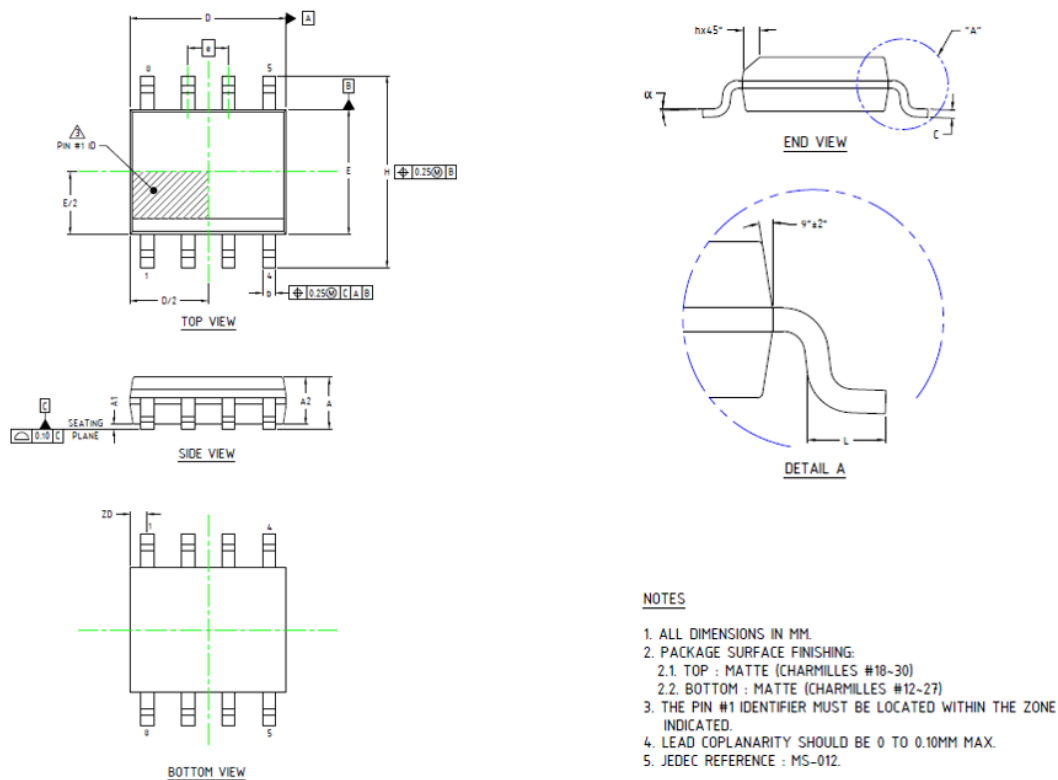


Figure 38: SOIC-8 Package Drawing and Dimensions

Table 3: CT450 SOIC-8 Package Dimensions

Symbol	Dimensions in Millimeters (mm)		
	Min.	Typ.	Max.
A1	0.10	0.18	0.25
b	0.36	0.41	0.46
C	0.19	0.22	0.25
D	4.80	4.89	4.98
E	3.81	3.90	3.99
e	1.27 BSC		
H	5.80	6.00	6.20
h	0.25	0.37	0.50
L	0.41	–	1.27
A	1.52	1.62	1.72
α	0°	–	8°
ZD	0.53 REF		
A2	1.37	1.47	1.57

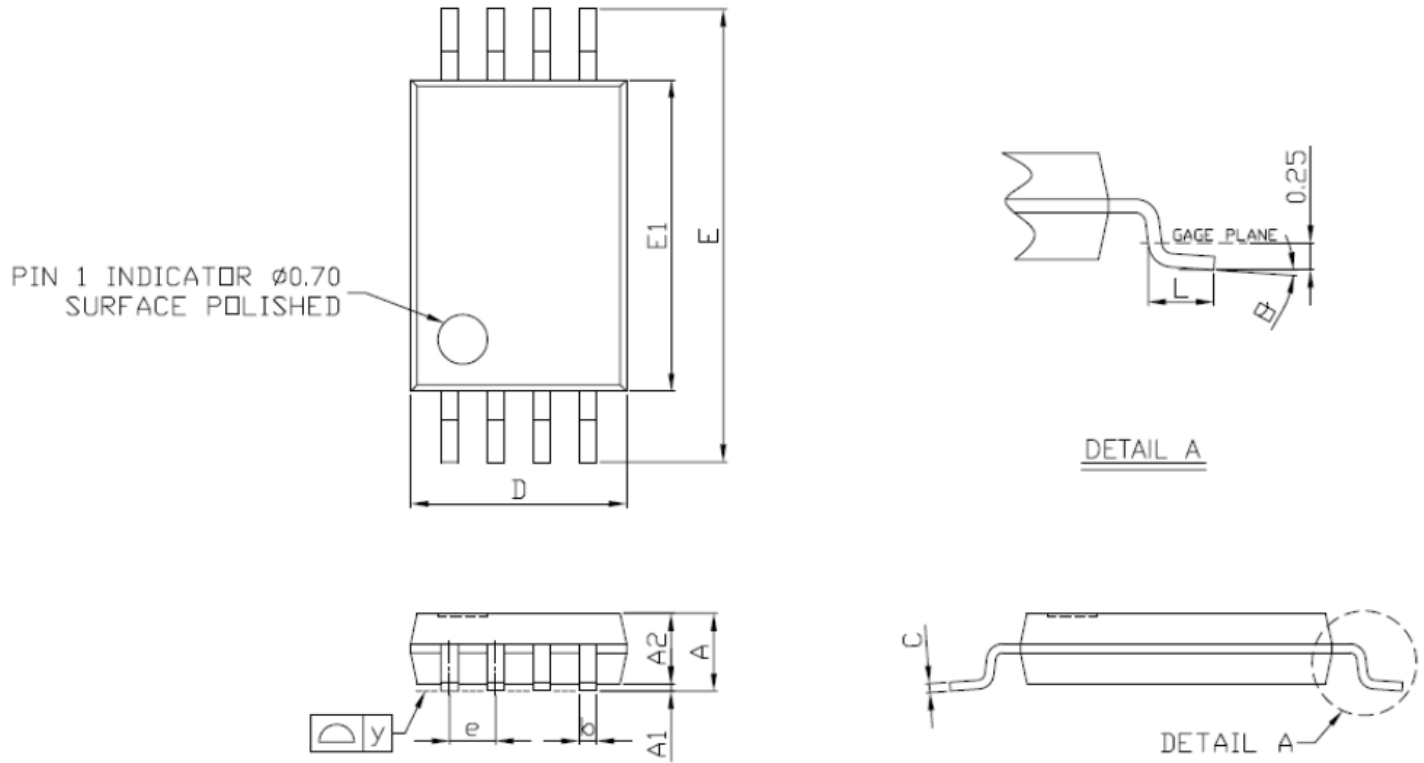


Figure 39: TSSOP-8 Package Drawing and Dimensions

Table 4: CT450 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°



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

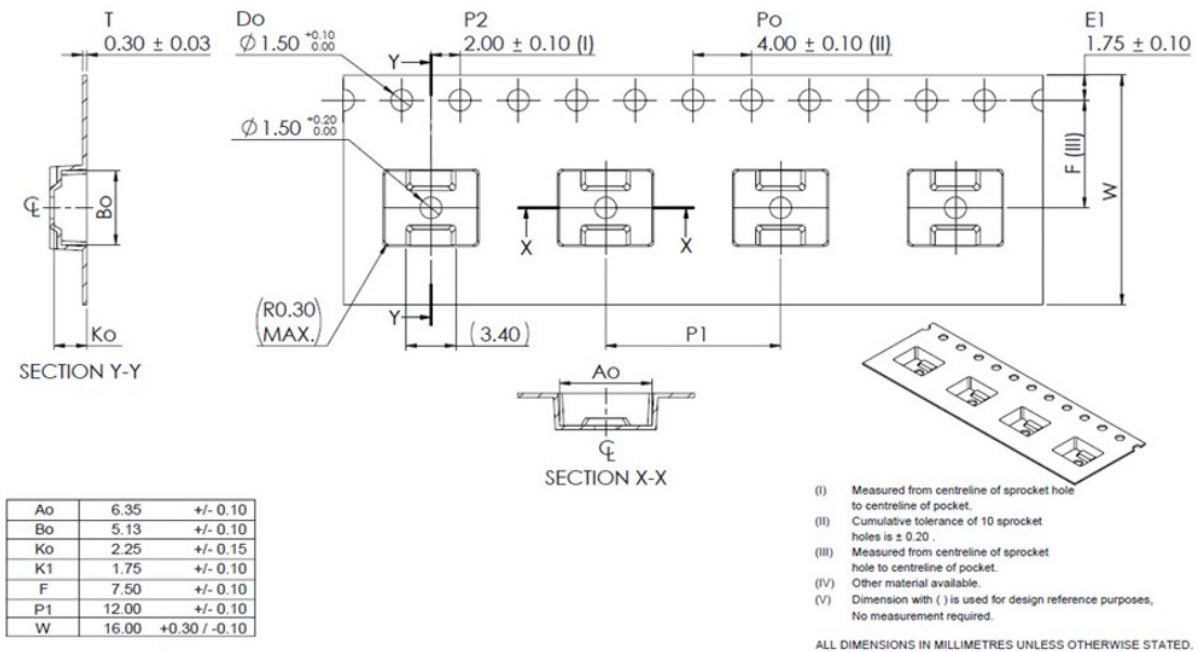


Figure 40: Tape and Pocket Drawing for SOIC-8 Package

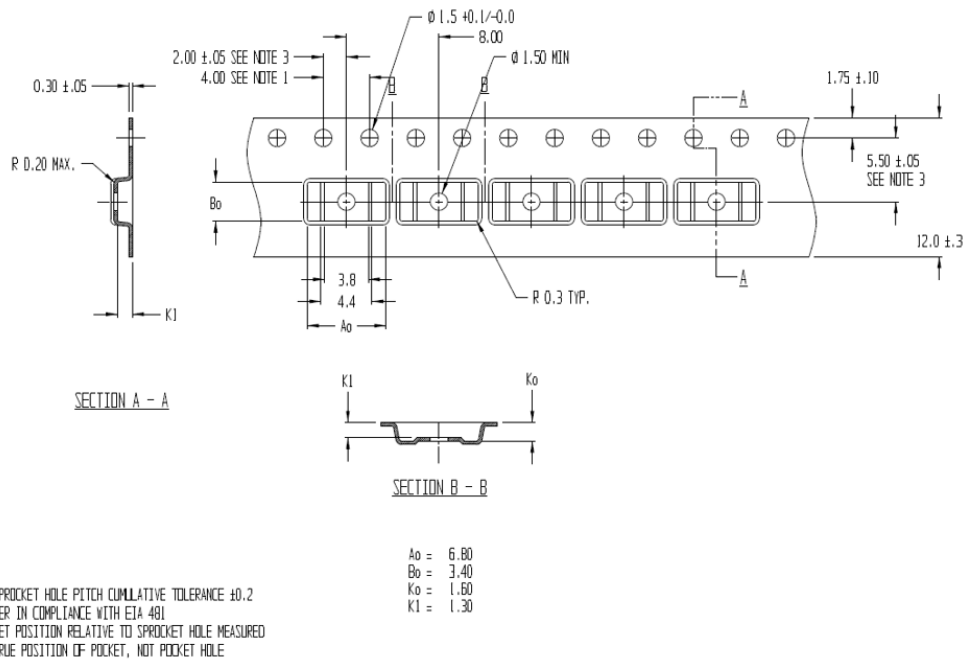


Figure 41: Tape and Pocket Drawing for TSSOP-8 Package

## PACKAGE INFORMATION

Table 5: CT450 Package Information

Part Number	Package Type	# of Leads	Package Quantity	Lead Finish	MSL Rating [2]	Operating Temperature (°C) [3]	Device Marking [4]
CT450-H06DRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 06DR YYWWLL
CT450-H06MRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 06MR YYWWLL
CT450-H06DRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-06DR YYWWLL
CT450-H06MRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-06MR YYWWLL
CT450-H12DRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 12DR YYWWLL
CT450-H12MRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 12MR YYWWLL
CT450-H12DRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-12DR YYWWLL
CT450-H12MRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-12MR YYWWLL
CT450-H24DRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 24DR YYWWLL
CT450-H24MRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 24MR YYWWLL
CT450-H24DRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-24DR YYWWLL
CT450-H24MRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-24MR YYWWLL
CT450-H00DRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 24MR YYWWLL
CT450-H00MRSN08	SOIC	8	2000	Sn	3	-40 to 125	CT450 24DR YYWWLL
CT450-H00DRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-24MR YYWWLL
CT450-H00MRTS08	TSSOP	8	3000	Sn	1	-40 to 125	CT450-00DR YYWWLL

[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  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  and storage temperature range of  $-65^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ .

[4] For the CT450, device marking for the SOIC-8 is defined as CT450 xxZR YYWWLL where the first 2 lines = part number, and third line is YY = year, WW = work week and LL = lot code. Device marking for the TSSOP-8 is defined as CT450 xxZR YYWWLL where the first line = part number, and second line is YY = year, WW = work week and LL = lot code.

## DEVICE MARKINGS

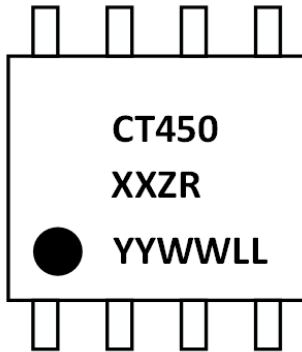


Figure 42: CT450 Device Marking for 8-Lead SOIC Package

Table 6: CT450 Device Marking Definition for 8-lead SOIC Package

Row No.	Code	Definition
3	•	Pin 1 Indicator
1	CT450	Allegro Part Number
2	XX	Maximum Field Rating
2	ZR	Polarity
3	YY	Calendar Year
3	WW	Work Week
3	LL	Lot Code

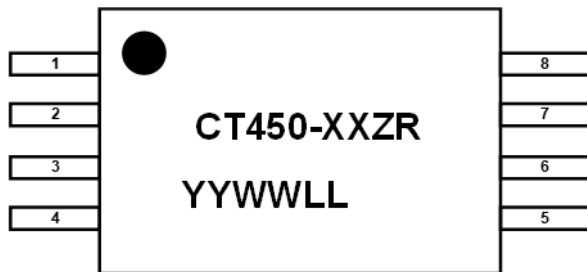
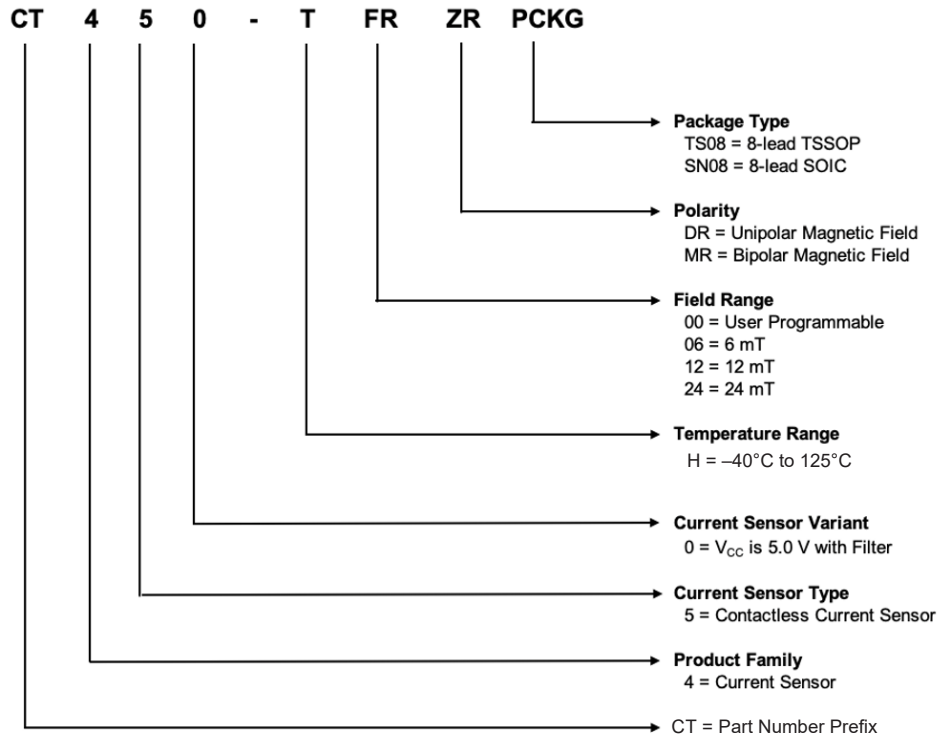


Figure 43: CT450 Device Marking for 8-Lead TSSOP Package

Table 7: CT450 Device Marking Definition for 8-lead TSSOP Package

Row No.	Code	Definition
1	•	Pin 1 Indicator
2	CT450	Allegro Part Number
2	XX	Maximum Magnetic Field Rating
2	ZR	Polarity
3	YY	Calendar Year
3	WW	Work Week
3	LL	Lot Code

## PART ORDERING NUMBER LEGEND



**Revision History**

Number	Date	Description
1	November 2, 2023	Document rebranded and minor editorial updates
2	February 13, 2024	Removed AEC-Q100 (pages 1, 2, 26-28) and updated MSL levels (page 26)
3	March 6, 2024	Updated Offset Voltage (pages 10-17); removed Out Accuracy Performance and Lifetime Drift footnotes (pages 10-17); updated Sensitivity and removed Noise (pages 16-17); and updated branding information (pages 26-27)
4	June 5, 2024	Added notes to package drawings (pages 23 and 25)

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