

## XtremeSense™ TMR Current Sensor with High dV/dt Immunity, 5 kV Isolation, and Common-Mode Field Rejection

### FEATURES AND BENEFITS

- Integrated contact current sensing for low to medium current ranges:
  - 0 to 20 A
  - ±20 A
  - 0 to 30 A
  - ±30 A
  - ±40 A
  - 0 to 50 A
  - ±50 A
  - 0 to 65 A
  - ±65 A
  - ±70 A
- Optimized for high dV/dt applications
- Integrated current carrying conductor (CCC)
- Linear analog output voltage
- Total error output  $\leq \pm 1.0\%$  FS,  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- 1 MHz bandwidth
- Response time:  $\sim 300$  ns
- UL/IEC 62368-1 and UL1577 certification
  - Rated isolation voltage:  $5\text{ kV}_{\text{RMS}}$
  - Working voltage for basic isolation:  $1100\text{ V}_{\text{RMS}}$
  - Working voltage for reinforced isolation:  $550\text{ V}_{\text{RMS}}$
- Low noise:  $9.5$  to  $19.0\text{ mA}_{\text{RMS}}$  @  $f_{\text{BW}} = 100\text{ kHz}$
- Immunity to common mode fields:  $-54\text{ dB}$
- Supply voltage:  $3.0$  to  $3.6\text{ V}$
- AEC-Q100 grade 1
- 16-lead SOICW package

### DESCRIPTION

The CT433 is a high bandwidth and ultra-low noise integrated contact current sensor that uses Allegro patented XtremeSense™ TMR technology to enable high accuracy current measurements for many industrial, consumer and automotive applications. The device supports multiple current ranges where the integrated current carrying conductor (CCC) will handle up to 70 A of current and generates a current measurement as a linear analog output voltage. The device achieves a total output error of less than  $\pm 1.0\%$  full-scale (FS) over voltage and the full temperature range.

The device has a  $\sim 300$  ns output response time while the current consumption is  $\sim 6.0$  mA and is immune to common mode fields. The CT433 is optimized for high dV/dt applications which minimizes capacitive coupling to  $V_{\text{OUT}}$ , allowing the CT433 to be used in switching applications.

The CT433 is offered in an industry-standard 16-lead SOIC wide package that is green and RoHS compliant.

### APPLICATIONS

- Power inverters
- UPS, SMPS, and telecom power supplies
- Motor control
- Overcurrent fault protection

### PACKAGE:



Not to scale

16-lead SOICW



TÜV Certificate No.:  
R 72226133 0001



UL Certificate No.:  
UL-CA-2201235-0

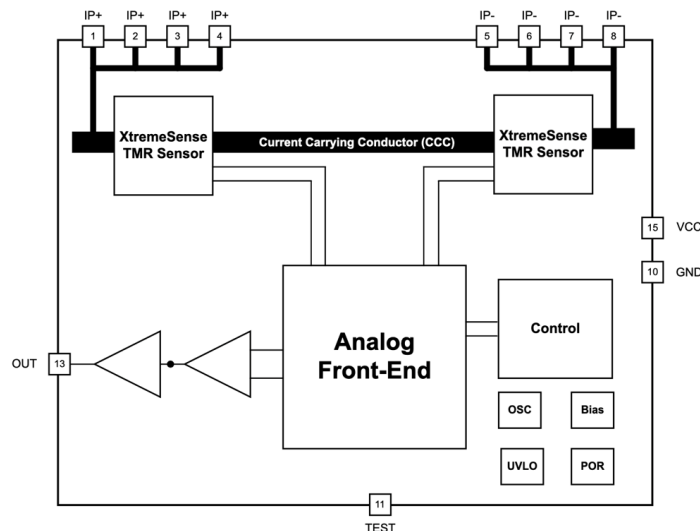


Figure 1: CT433 Functional Block Diagram for 16-lead SOICW Package

### SELECTION GUIDE

Part Number	Current Range (I <sub>PMAX</sub> ) (A)	Sensitivity (mV/A)	Operating Temperature Range (°C)	Package	Packing
CT433-HSWF20MR	±20	50	-40 to 125	16-lead SOICW 10.21 mm × 10.31 mm × 2.54 mm	Tape and Reel
CT433-HSWF30MR	±30	33.3			
CT433-HSWF40MR	±40	25			
CT433-HSWF50MR	±50	20			
CT433-HSWF65MR	±65	15.4			
CT433-HSWF70MR	±70	14.3			
CT433-HSWF20DR	20	100			
CT433-HSWF30DR	30	66.7			
CT433-HSWF50DR	50	40			
CT433-HSWF65DR	65	30.8			
<b>AEC-Q100 GRADE 1</b>					
CT433-ASWF20MR	±20	50	Grade 1 -40 to 125	16-lead SOICW 10.21 mm × 10.31 mm × 2.54 mm	Tape and Reel
CT433-ASWF30MR	±30	33.3			
CT433-ASWF50MR	±50	20			
CT433-ASWF65MR	±65	15.4			
CT433-ASWF20DR	20	100			
CT433-ASWF30DR	30	66.7			
CT433-ASWF50DR	50	40			
CT433-ASWF65DR	65	30.8			

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## 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
Current Carrying Conductor Maximum Current	$I_{CCC(MAX)}$	$T_A = 25^\circ\text{C}$	70	A
Dielectric Surge Strength Test Voltage	$V_{SURGE}$	IEC 61000-4-5: Tested $\pm 5$ Pulses at 2/60 seconds, 1.2 $\mu\text{s}$ (rise) and 50 $\mu\text{s}$ (width)	6.0 (min)	kV
Surge Strength Test Current	$I_{SURGE}$	Tested $\pm 5$ Pulses at 3/60 seconds, 8.0 $\mu\text{s}$ (rise) and 20 $\mu\text{s}$ (width)	3.0 (min)	kA
Electrostatic Discharge Protection Level	ESD	Human Body Model (HBM) per JESD22-A114	$\pm 2.0$	kV
		Charged Device Model (CDM) per JESD22-C101	$\pm 0.5$	kV
Junction Temperature	$T_J$		-40 to 150	$^\circ\text{C}$
Storage Temperature	$T_{STG}$		-65 to 155	$^\circ\text{C}$
Lead Soldering Temperature	$T_L$	10 seconds	260	$^\circ\text{C}$

[1] Stresses exceeding the absolute maximum ratings may damage the CT433 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	$V_{CC}$		3.0	3.3	3.6	V
Output Voltage Range	$V_{OUT}$		0	-	$V_{CC}$	V
Output Current	$I_{OUT}$		-	-	$\pm 1.0$	mA
Operating Ambient Temperature	$T_A$	Extended Industrial	-40	25	125	$^\circ\text{C}$
		Automotive	-40	25	125	$^\circ\text{C}$

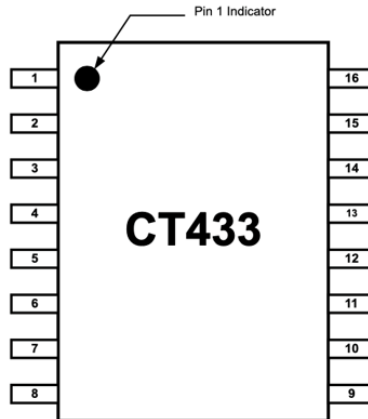
[1] The Recommended Operating Conditions table defines the conditions for actual operation of the CT433. Recommended operating conditions are specified to ensure optimal performance to the specifications. Allegro does not recommend exceeding them or designing to absolute maximum ratings.

### ISOLATION RATINGS

Characteristic	Symbol	Notes	Rating	Unit
Impulse Withstand Voltage	V <sub>IMPULSE</sub>	Tested ±5 pulses at 2/minute in compliance to IEC 61000-4-5 1.2 μs (rise) / 50 μs (width)	8000	V <sub>PK</sub>
Dielectric Withstand Voltage	V <sub>ISO</sub>	Agency rated for 60 seconds per UL 62368-1:2014 (edition 2) and per UL 1577 <sup>[1]</sup>	5000	V <sub>RMS</sub>
Working Voltage for Basic Isolation	V <sub>WVBI</sub>	Maximum approved working voltage for basic insulation according to UL 62368-1:2014 (edition 2)	1556	V <sub>PK</sub>
			1100	V <sub>RMS</sub>
Working Voltage for Reinforced Isolation	V <sub>WBRI</sub>	Maximum approved working voltage for reinforced insulation according to UL 62368-1:2014 (edition 2)	778	V <sub>PK</sub>
			550	V <sub>RMS</sub>
Creepage Distance	D <sub>CR</sub>	Minimum distance along package body from IP leads to signal leads.	7.8	mm
Clearance Distance	D <sub>CL</sub>	Minimum distance through air from IP leads to signal leads	7.8	mm
Distance Through Isolation	DTI	Minimum internal distance through isolation	110	μm
Comparative Tracking Index	CTI	Material Group II	400 to 599	V

[1] 100% Production-tested for 1 second in accordance with UL 62368-1 (edition 2) and UL 1577.

### PINOUT DIAGRAM AND TERMINAL LIST



**Figure 2: CT433 Pinout Diagram for 16-lead SOICW Package (Top-Down View)**

#### Terminal List

Number	Name	Function
1, 2, 3, 4	IP+	Terminal for primary conductor (positive).
5, 6, 7, 8	IP-	Terminal for primary conductor (negative).
9	NC	No connect.
10	GND	Ground.
11	TEST	Pin used for factory calibration. Connect to Ground.
12	NC	No connect.
13	OUT	Analog output voltage that represents the measured current.
14	NC	No connect.
15	VCC	Supply voltage.
16	NC	No connect.

**ELECTRICAL CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ$ C to  $125^\circ$ C, typical values are  $V_{CC} = 3.3$  V and  $T_A = 25^\circ$ 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, $I_P = 0$ A	–	6.0	9.0	mA
OUT Maximum Drive Capability [1]	$I_{OUT}$	OUT covers 10% to 90% of $V_{CC}$ span	–1.0	–	+1.0	mA
OUT Capacitive Load [1]	$C_{L\_OUT}$		–	–	100	pF
OUT Resistive Load [1]	$R_{L\_OUT}$		–	100	–	k $\Omega$
Primary Conductor Resistance [1]	$R_{IP}$		–	1	–	m $\Omega$
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, Typical	$V_{OUT}$	$V_{SIG\_AC} = \pm 2.00$ V, $V_{SIG\_DC} = +4.00$ V	0.65	–	2.65	V
Output High Saturation Voltage	$V_{OUT\_SAT}$	$V_{OUT}$ , $T_A = 25^\circ$ C	$V_{CC} - 0.30$	$V_{CC} - 0.25$	–	V
Common Mode Field Rejection Ratio [1]	CMFRR		–	–54	–	dB
			–	0.5	–	mA/G
<b>TIMINGS</b>						
Power-On Time [1]	$t_{ON}$	$V_{CC} \geq 2.50$ V	–	100	200	$\mu$ s
Rise Time [1]	$t_{RISE}$	$I_P = I_{RANGE(MAX)}$ , $T_A = 25^\circ$ C, $C_L = 100$ pF	–	200	–	ns
Response Time [1]	$t_{RESPONSE}$	$I_P = I_{RANGE(MAX)}$ , $T_A = 25^\circ$ C, $C_L = 100$ pF	–	300	–	ns
Propagation Delay [1]	$t_{DELAY}$	$I_P = I_{RANGE(MAX)}$ , $T_A = 25^\circ$ C, $C_L = 100$ pF	–	250	–	ns
<b>PROTECTION</b>						
Undervoltage Lockout	$V_{UVLO}$	Rising $V_{DD}$	–	2.50	–	V
		Falling $V_{DD}$	–	2.45	–	V
UVLO Hysteresis	$V_{UV\_HYS}$		–	50	–	mV

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

**ELECTRICAL CHARACTERISTICS**

$V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0\ \mu\text{F}$  (unless otherwise specified)

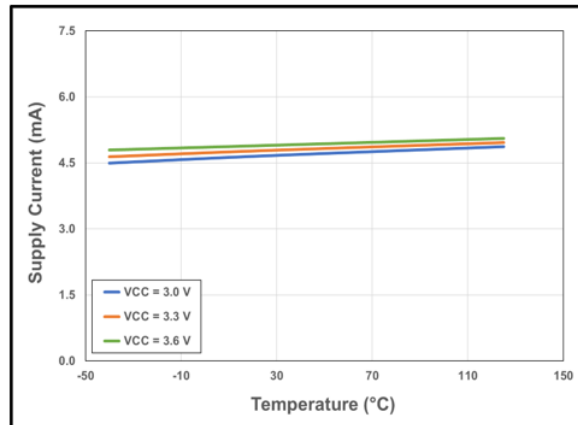


Figure 3: CT433 Supply Current vs. Temperature vs. Supply Voltage

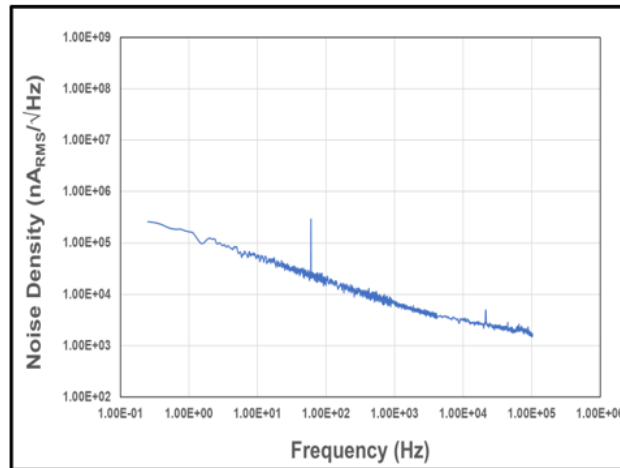


Figure 4: Noise Density vs. Frequency

### ELECTRICAL CHARACTERISTICS (continued)

$V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , and  $C_{BYP} = 1.0\ \mu\text{F}$  (unless otherwise specified)

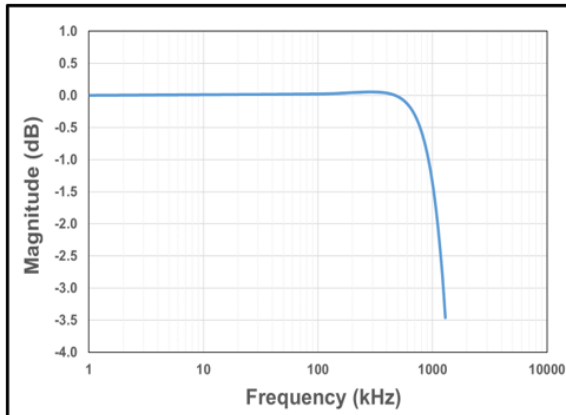


Figure 5: CT433 Bandwidth

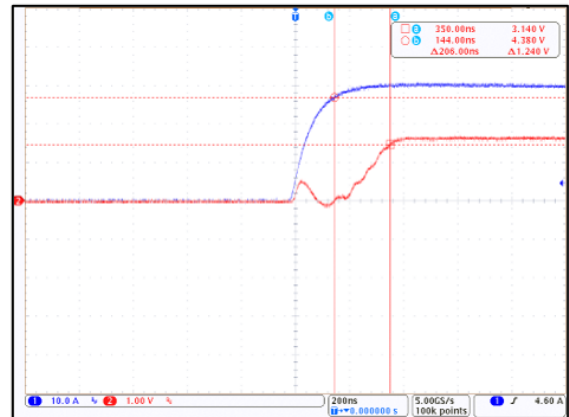


Figure 6: CT433 Response Time;  $I_P = 30\text{ A}_{PK}$  and  $C_L = 100\text{ pF}$  (Blue =  $I_{CC}$ , Red =  $V_{OUT}$ )

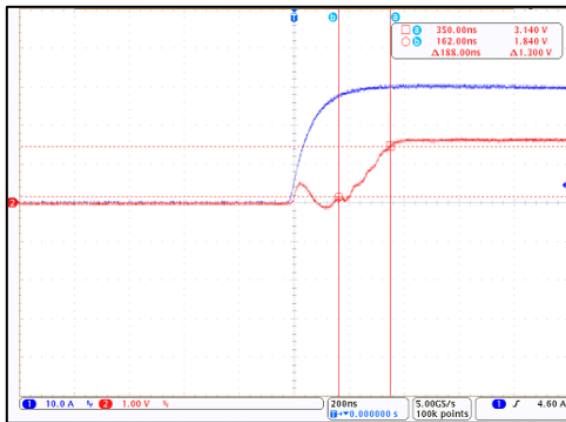


Figure 7: CT433 Rise Time;  $I_P = 30\text{ A}_{PK}$  and  $C_L = 100\text{ pF}$  (Blue =  $I_{CC}$ , Red =  $V_{OUT}$ )

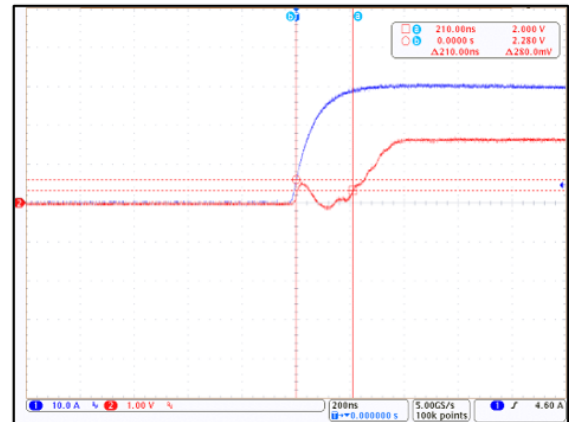


Figure 8: CT433 Propagation Delay;  $I_P = 30\text{ A}_{PK}$  and  $C_L = 100\text{ pF}$  (Blue =  $I_{CC}$ , Red =  $V_{OUT}$ )

**CT433-xSWF20DR: 0 to 20 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		0	–	20	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	0.645	0.650	0.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	–	100	–	mV/A
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	–	9.5	–	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	–	–	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	–	$\pm 0.2$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	–	$\pm 1.2$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	–	$\pm 1.2$	–	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	–	$\pm 3$	–	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	–	$\pm 17$	–	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	–	$\pm 13$	–	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 1.9$	–	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 2.0$	–	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 26$	–	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF20MR: ±20 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		-20	-	20	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	1.645	1.650	1.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	-	50	-	mV/A
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	-	11.0	-	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	-	-	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 0.1$	-	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	-	$\pm 0.1$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	-	$\pm 1.4$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	-	$\pm 1.4$	-	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	-	$\pm 2$	-	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	-	$\pm 13$	-	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	-	$\pm 15$	-	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 2.1$	-	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 28$	-	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF30DR: 0 to 30 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		0	–	30	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	0.645	0.650	0.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	–	66.7	–	mV/A
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	–	10.0	–	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	–	–	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	–	$\pm 0.2$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	–	$\pm 1.2$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	–	$\pm 1.1$	–	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	–	$\pm 2$	–	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	–	$\pm 13$	–	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	–	$\pm 13$	–	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 1.9$	–	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 2.0$	–	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 26$	–	mV

<sup>[1]</sup> Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

<sup>[2]</sup> Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF30MR: ±30 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		-30	-	30	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	1.645	1.650	1.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	-	33.3	-	mV/A
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	-	12.5	-	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	-	-	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 0.1$	-	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	-	$\pm 0.2$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	-	$\pm 1.4$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	-	$\pm 1.4$	-	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	-	$\pm 1$	-	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	-	$\pm 13$	-	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	-	$\pm 14$	-	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 2.1$	-	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 27$	-	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF40MR: ±40 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		-40	-	40	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	1.645	1.650	1.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	-	25	-	mV/A
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	-	19.0	-	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	-	-	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 0.1$	-	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	-	$\pm 0.2$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	-	$\pm 1.5$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	-	$\pm 1.4$	-	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	-	$\pm 1$	-	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	-	$\pm 13$	-	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	-	$\pm 17$	-	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 2.2$	-	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 31$	-	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF50DR: 0 to 50 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		0	–	50	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	0.645	0.650	0.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	–	40	–	mV/A
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	–	11.0	–	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	–	–	$\pm 1.5$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	–	$\pm 0.2$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	–	$\pm 1.6$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	–	$\pm 1.4$	–	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	–	$\pm 2$	–	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	–	$\pm 10$	–	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	–	$\pm 14$	–	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 2.4$	–	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 2.4$	–	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 27$	–	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF50MR: ±50 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		-50	-	50	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	1.645	1.650	1.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	-	20	-	mV/A
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	-	19.0	-	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	-	-	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 0.2$	-	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	-	$\pm 0.2$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	-	$\pm 1.2$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	-	$\pm 1.1$	-	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	-	$\pm 2$	-	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	-	$\pm 12$	-	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	-	$\pm 18$	-	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 30$	-	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF65DR: 0 to 65 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		0	–	65	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	0.645	0.650	0.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	–	30.8	–	mV/A
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	–	11.5	–	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	–	–	$\pm 1.5$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 0.2$	–	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	–	$\pm 0.3$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	–	$\pm 1.7$	–	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	–	$\pm 1.6$	–	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	–	$\pm 1$	–	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	–	$\pm 11$	–	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	–	$\pm 13$	–	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 2.5$	–	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 2.4$	–	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	–	$\pm 26$	–	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF65MR: ±65 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		-65	-	65	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	1.645	1.650	1.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	-	15.4	-	mV/A
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	-	19.0	-	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	-	-	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 0.1$	-	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	-	$\pm 0.2$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	-	$\pm 1.4$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	-	$\pm 1.5$	-	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	-	$\pm 2$	-	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	-	$\pm 14$	-	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	-	$\pm 17$	-	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 2.1$	-	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 30$	-	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

**CT433-xSWF70MR: -70 to 70 A – PERFORMANCE CHARACTERISTICS:** Valid for  $V_{CC} = 3.0$  to  $3.6$  V,  $C_{BYP} = 1.0$   $\mu$ F, and  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Unit
Current Range	$I_{RANGE}$		-70	-	70	A
Voltage Output Quiescent	$V_{OQ}$	$T_A = 25^\circ\text{C}$ , $I_P = 0$ A	1.645	1.650	1.655	V
Sensitivity	S	$I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$	-	14.3	-	mV/A
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	-	19.0	-	$\text{mA}_{RMS}$
<b>OUT ACCURACY PERFORMANCE</b>						
Total Output Error	$E_{TOT}$	$I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$	-	-	$\pm 1.0$	% FS
Linearity Error	$E_{LIN}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 0.1$	-	% FS
Sensitivity Error	$E_{SENS}$	$I_P = I_{P(MAX)}$ , $T_A = 25^\circ\text{C}$	-	$\pm 0.3$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = 125^\circ\text{C}$	-	$\pm 1.8$	-	%
		$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$	-	$\pm 1.5$	-	%
Offset Voltage Error	$V_{OE}$	$I_P = 0$ A, $T_A = 25^\circ\text{C}$	-	$\pm 2$	-	mV
		$I_P = 0$ A, $T_A = 125^\circ\text{C}$	-	$\pm 14$	-	mV
		$I_P = 0$ A, $T_A = -40^\circ\text{C}$	-	$\pm 17$	-	mV
<b>LIFETIME DRIFT</b>						
Total Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 1.9$	-	% FS
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{P(MAX)}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 2.5$	-	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	$I_P = 0$ A, $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$\pm 30$	-	mV

[1] Typical values are the mean  $\pm 3$  sigma of production distributions. These are formatted as mean  $\pm 3$  sigma.

[2] Lifetime drift characteristics are based on a statistical combination of production distributions and worst case distribution of parametric drift of individuals observed during AEC-Q100 qualification.

FUNCTIONAL DESCRIPTION

Overview

The CT433 is a high accuracy contact current sensor with an integrated current-carrying conductor that handles up to 70 A. It has high sensitivity and a wide dynamic range with excellent accuracy (low total output error) across temperature. This current sensor supports nine current ranges:

- 0 to 20 A
- ±20 A
- 0 to 30 A
- ±30 A
- ±40 A
- 0 to 50 A
- ±50 A
- 0 to 65 A
- ±65 A
- ±70 A

When current is flowing through the current-carrying conductor, the XtremeSense TMR sensors inside the chip senses the field which in turn generates differential voltage signals that then goes through the Analog Front-End (AFE) to output a current measurement with less than ±1.0% full-scale total output error (E<sub>OUT</sub>).

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 CT433 is 1.0 MHz. Even with a high bandwidth, the chip consumes a minimal amount of power.

Linear Output Current Measurement

The CT433 provides a continuous linear analog output voltage which represents the current measurement. The output voltage range of OUT is from 0.65 to 2.65 V with a V<sub>OQ</sub> of 0.65 V and 1.65 V for unidirectional and bidirectional currents, respectively. Figure 9 illustrates the output voltage range of the OUT pin as a function of the measured current.

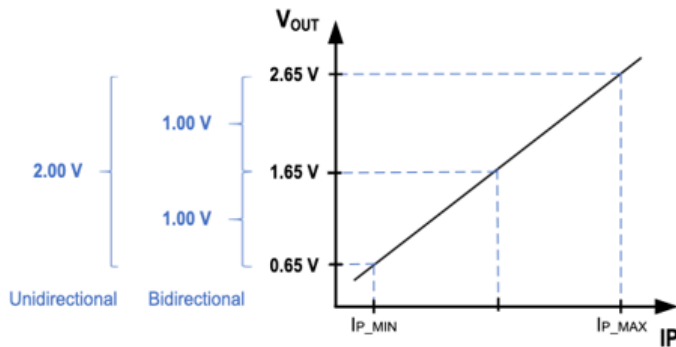


Figure 9: Linear Output Voltage Range (OUT) vs. Measured Current (IP)

Total Output Error

The Total Output Error (E<sub>OUT</sub>) 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<sub>OUT</sub> 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<sub>OUT</sub> incorporates all sources of error and is a function of the sensed current (I<sub>p</sub>) from the current sensor.

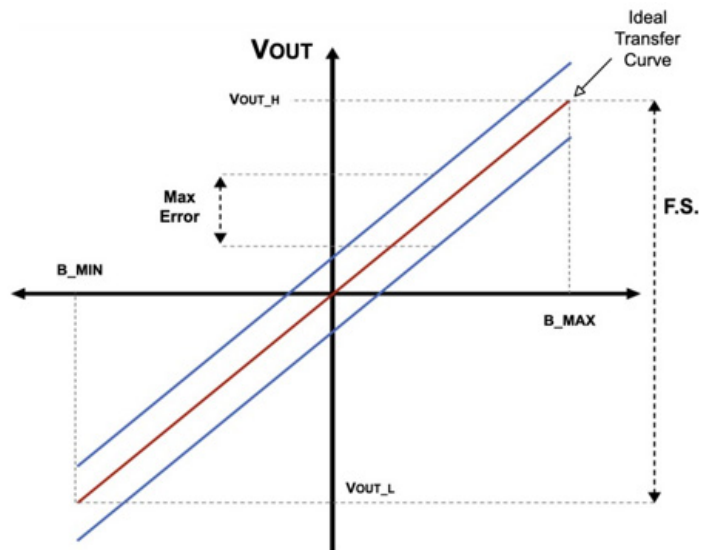


Figure 10: Total Output Error (E<sub>OUT</sub>) vs. Sensed Current (I<sub>p</sub>)

The CT433 achieves a total output error (E<sub>OUT</sub>) that is less than ±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 current measurements regardless of the operating conditions.

## Sensitivity Error

The sensitivity error ( $E_{SENS}$ ) is the sensitivity temperature drift error for unipolar or DC current. It is calculated using the equation below:

$$E_{SENS} = 100 \times \left( \frac{S_{MEASURED}}{S} - 1 \right)$$

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

Power-On Time ( $t_{ON}$ ) of 100  $\mu$ s is the amount of time required by CT433 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 CT433 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.

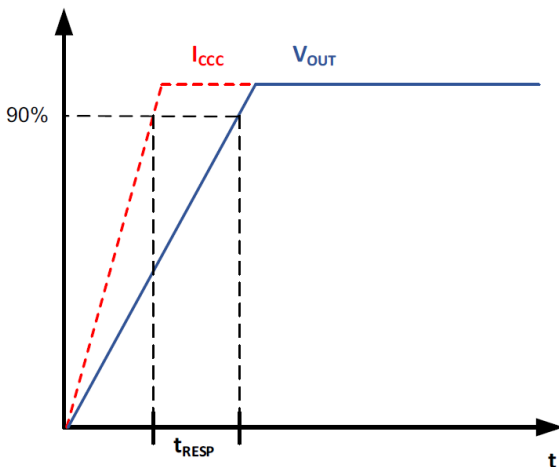


Figure 11: CT433 Response Time Curve

## 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 CT433 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 CT433 has a propagation delay of 250 ns.

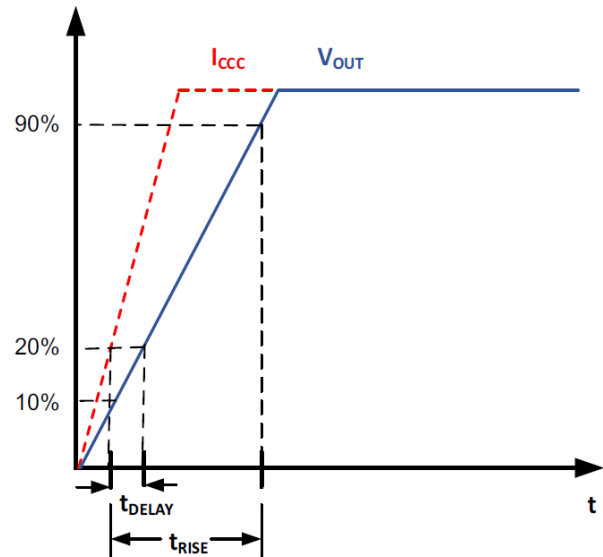


Figure 12: CT433 Propagation Delay and Rise Time Curve

## Undervoltage Lockout (UVLO)

The Undervoltage Lockout protection circuitry of the CT433 is activated when the supply voltage ( $V_{CC}$ ) falls below 2.45 V. The CT433 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 CT433 is not valid. Once  $V_{CC}$  rises above 2.50 V then the UVLO is cleared.

## Immunity to Common Mode Fields

The CT433 is housed in custom plastic package that uses a U-shaped leadframe to reduce the common mode fields generated by external stray magnetic fields. With the U-shaped leadframe, the stray fields cancel one another thus reducing electro-magnetic interference (EMI). The CT433 is able to achieve -54 dB of Common Mode Rejection Ratio (CMFRR). Also, good PCB layout of the CT433 will optimize performance and reduce EMI.

## Creepage and Clearance

Two important terms as it relates to isolation provided by the package are: creepage and clearance. Creepage is defined as the shortest distance across the surface of the package from one side the leads to the other side of the leads. The definition for clearance is the shortest distance between the leads of opposite side through the air.

## Fuse Time vs. Current

Since the CT433 is a contact current sensor, it dissipates heat as current is conducted through its leadframe. The CT433 leadframe has 0.5 mΩ resistance (typ) which results in low power dissipation during normal operation.

However, when the current surges above the rated nominal values of the CT433 due to short circuit or transient current spikes for a specific duration of time, the leadframe will be permanently damaged.

Figure 13 illustrates the CT433 fuse time for 100 A, 200 A, and 300 A current levels. The CT433 tolerates 100 A for 32 seconds, while at 200 A and 300 A, the fuse times are 194 ms and 45 ms, respectively.

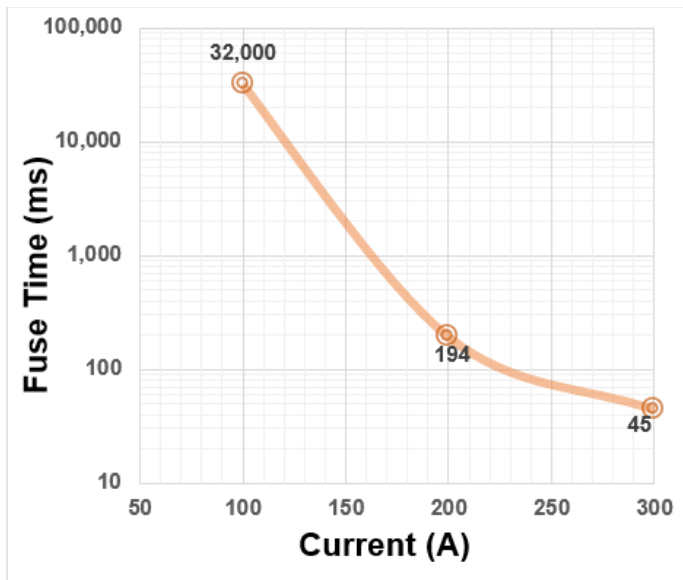


Figure 13: CT433 Fuse Time vs. Current

## Thermal Rise vs. Primary Current

Self-heating due to the flow of current should be considered during the design of any current sensing system. The sensor, printed circuit board (PCB), and contacts to the PCB will generate heat as current moves through the system.

The thermal response is highly dependent on PCB layout, copper thickness, cooling techniques, and the profile of the injected current.

The current profile includes peak current, current on-time, and duty cycle. While the data presented in this section was collected with direct current (DC), these numbers may be used to approximate thermal response for both AC signals and current pulses.

The plot in Figure 14 shows the measured rise in steady-state die temperature of the current sensor versus continuous current at an ambient temperature,  $T_A$ , of 25 °C. The thermal offset curves may be directly applied to other values of  $T_A$ .

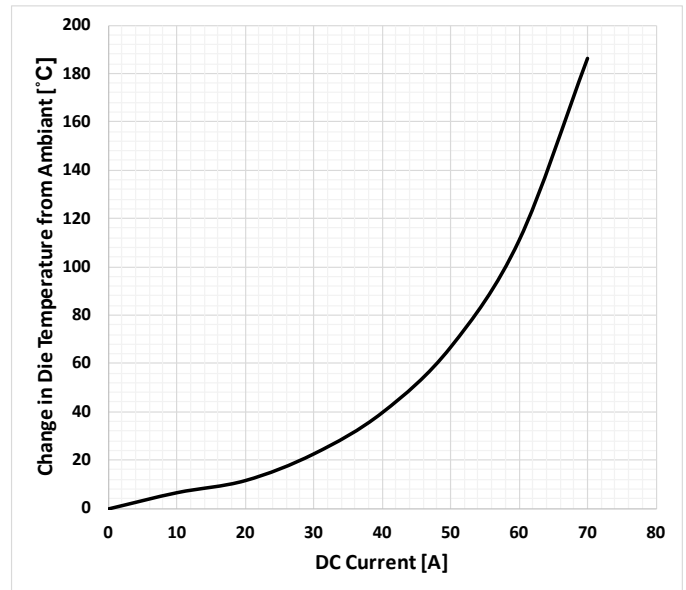


Figure 14: Self Heating in the LA Package Due to Current Flow

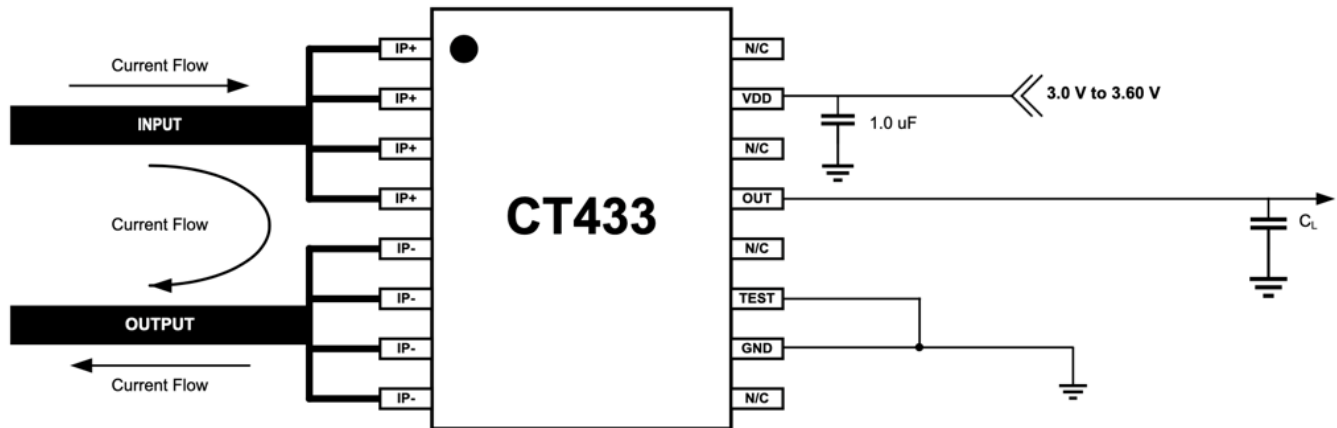


Figure 15: CT433 Application Block Diagram

### Application

The CT433 is an integrated contact current sensor that can be used in many applications from measuring current in power supplies to motor control to overcurrent fault protection. It is a plug-and-play solution in that no calibration is required, and it can output to a microcontroller a simple linear analog output voltage which corresponds to a current measurement value. Figure 15 is an application diagram of how CT433 would be implemented in a system.

The device is designed to support an operating voltage range of 3.0 V to 3.6 V, but it is ideal to use a 3.3 V power supply where the output tolerance is less than  $\pm 5\%$ .

### Overcurrent Detection

The TEST pin of the CT433 can be used as a  $\overline{\text{FLT}}$  pin to detect when the primary measured current is higher than the sensor maximum range. This pin is an open drain output. It requires a pull-up resistor value of 100 k $\Omega$  to be connected from the pin to VCC and also a 1.0 nF capacitor to be connected from the pin to ground.

The  $\overline{\text{FLT}}$  pin is not user-programmable and has fixed trigger value of  $1.1 \times I_{\text{RANGE(MAX)}}$  or 110% the maximum linear sensing range of the CT433.

Not grounding the TEST pin will reduce the sensor immunity to high dV/dt events.

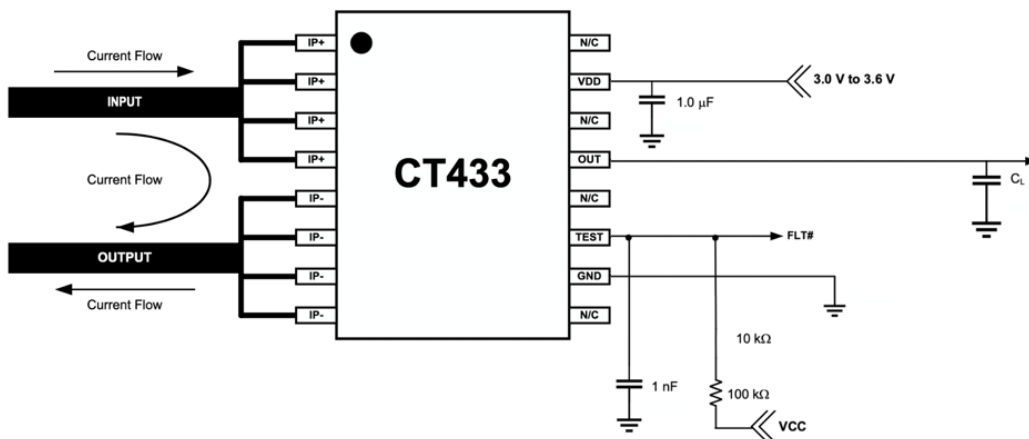


Figure 16: CT433 Application Block Diagram – With Overcurrent Detection

**PACKAGE OUTLINE DRAWING**

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

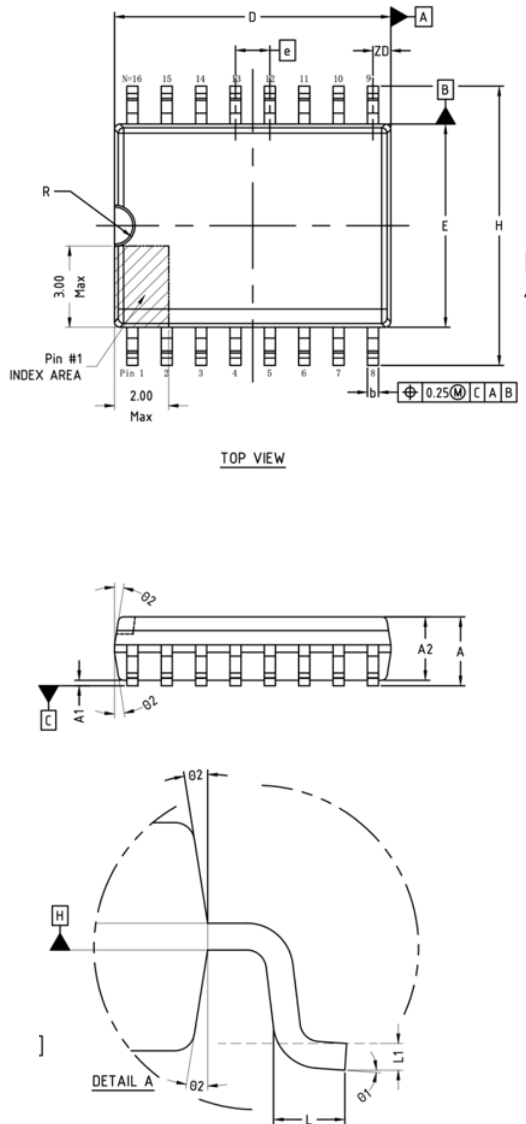


Table 1: CT433 SOICW-16 Package Dimensions

Symbol	Dimensions in Millimeters (mm)		
	Min.	Typ.	Max.
A	2.44	2.54	2.64
A1	0.10	0.20	0.30
A2	2.24	2.34	2.44
b	0.36	0.41	0.46
C	0.23	–	0.32
D	10.11	10.21	10.31
E	7.40	7.50	7.60
e	1.27 BSC		
H	10.11	10.31	10.51
h	0.31	0.51	0.71
L	0.51	0.76	1.01
L1	0.25 BSC		
R	0.76 REF		
theta1	0.25 BSC	0.25 BSC	0.25 BSC
theta2	0.76 REF	0.76 REF	0.76 REF
ZD	0.66 REF		
N	16		

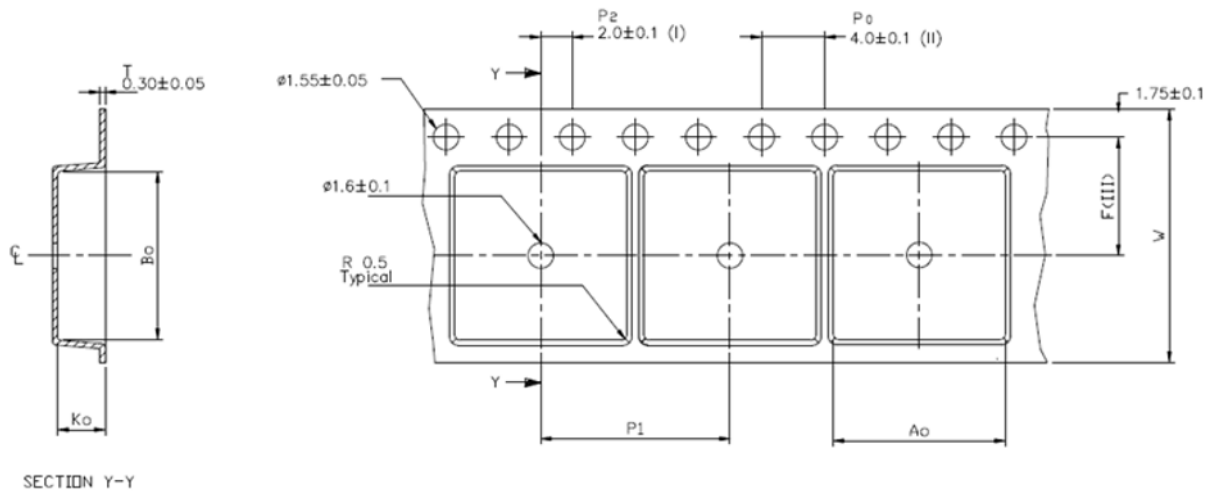
Figure 17: SOICW-16 Package Drawing and Dimensions

**TAPE AND REEL POCKET DRAWING AND DIMENSIONS**

**For Reference Only – Not for Tooling Use**

Dimensions in millimeters – NOT TO SCALE

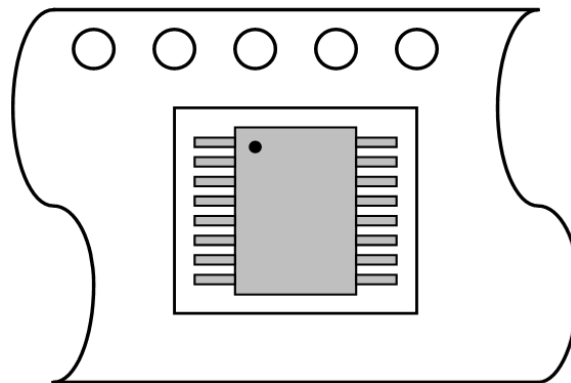
Dimensions exclusive of mold flash, gate burs, and dambar protrusions  
Exact case and lead configuration at supplier discretion within limits shown



Ao	10.90 +/- 0.1
Bo	10.70 +/- 0.1
Ko	3.00 +/- 0.1
F	7.50 +/- 0.1
P1	12.00 +/- 0.1
W	16.00 +/- 0.3

- (I) Measured from centreline of sprocket hole to centreline of pocket.
  - (II) Cumulative tolerance of 10 sprocket holes is ± 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<sup>8</sup> OHM/SQ
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

**Figure 18: Tape and Pocket Drawing for SOICW-16 Package**



**Figure 19: SOICW-16 Orientation in Tape Pocket**

### PACKAGE INFORMATION

**Table 2: CT433 Package Information**

Part Number	Package Type	# of Leads	Package Quantity	Lead Finish	MSL Rating [2]	Operating Temperature (°C) [3]	Device Marking [4]
CT433-HSWF20DR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF20DR YYWWLL
CT433-ASWF20DR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF20DR YYWWLL
CT433-HSWF20MR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF20MR YYWWLL
CT433-ASWF20MR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF20MR YYWWLL
CT433-HSWF30DR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF30DR YYWWLL
CT433-ASWF30DR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF30DR YYWWLL
CT433-HSWF30MR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF30MR YYWWLL
CT433-ASWF30MR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF30MR YYWWLL
CT433-HSWF40MR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF40MR YYWWLL
CT433-HSWF50DR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF50DR YYWWLL
CT433-ASWF50DR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF50DR YYWWLL
CT433-HSWF50MR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF50MR YYWWLL
CT433-ASWF50MR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF50MR YYWWLL
CT433-HSWF65DR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF65DR YYWWLL
CT433-ASWF65DR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF65DR YYWWLL
CT433-HSWF65MR	SOICW	16	1000	Sn	3	-40 to 125	CT433 SWF65MR YYWWLL
CT433-ASWF65MR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF65MR YYWWLL

Continued on next page...

**Table 3: CT433 Package Information (continued)**

Part Number	Package Type	# of Leads	Package Quantity	Lead Finish	MSL Rating [2]	Operating Temperature (°C) [3]	Device Marking [4]
CT433-HSWF70MR	SOICW	16	1000	Sn	3	-40 to 125	CT433A SWF70MR 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  $155^{\circ}\text{C}$ .

[4] Device Marking for CT433 is defined as CT433 SWFxxZR YYWWLL where the first 2 lines = part number, YY = year, WW = work week, and LL = lot code.

### DEVICE MARKING

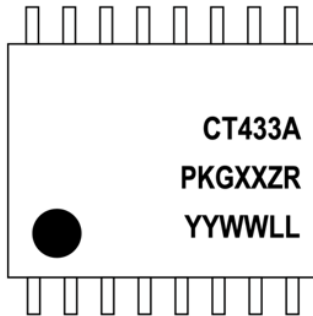
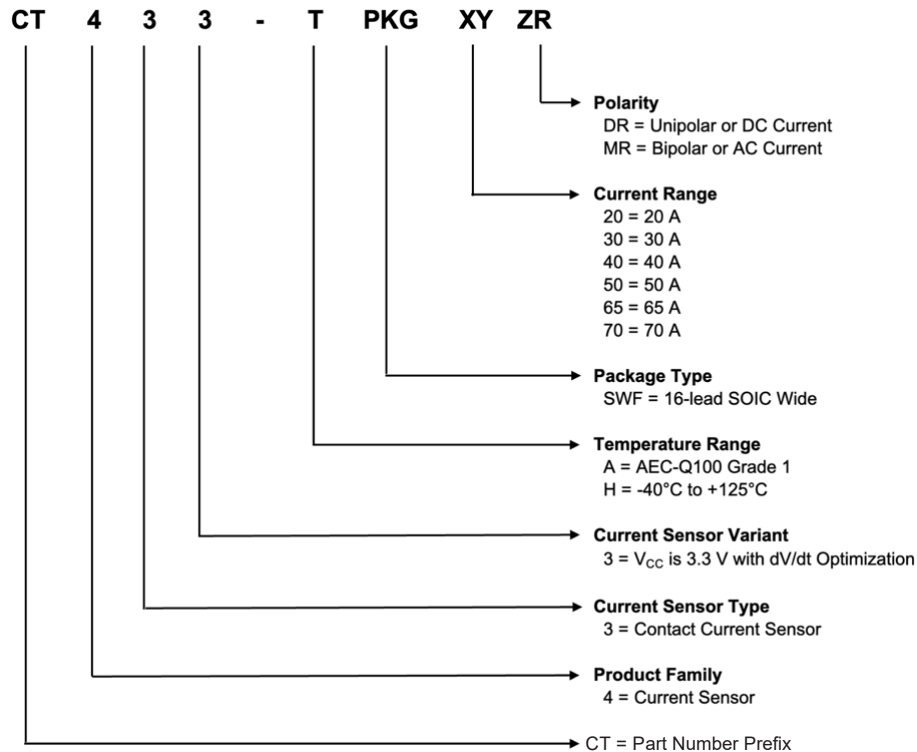


Figure 20: CT433 Device Marking for 16-lead Package

Table 4: CT433 Device Marking Definition for 16-lead SOICW Package

Row No.	Code	Definition
3	•	Pin 1 Indicator
1	CT433	Allegro Part Number
1	A	AEC-Q100 Qualified
2	PKG	Package Type
2	XX	Maximum Current 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
2	November 2, 2023	Document rebranded and minor editorial updates
3	April 26, 2024	Updated Description and Features and Benefits (page 1); updated Table of Contents (page 2); removed Thermal Characteristics table (page 3); removed IEC 61000 reference (pages 1 and 3); updated Isolation Ratings table (page 4); updated Primary Conductor Resistance (page 6); updated Sensitivity Error, Offset Voltage Error, Sensitivity Error Including Lifetime Drift, and Offset Voltage Error Including Lifetime Drift values (page 13); updated Total Output Error values (pages 14 and 16); updated Sensitivity Error and Sensitivity Error Including Lifetime Drift values (page 18); added Thermal Rise vs. Primary Current section (page 20); Fixed 70DR typo to 70MR in Package Information table (page 26); removed performance graph pages.
4	June 5, 2024	Added notes to package drawings (pages 23 and 24)

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