CT431

XtremeSense™ TMR Current Sensor with Ultra-Low Noise and <0.7% Total Error

FEATURES AND BENEFITS

- Integrated contact current sensing for low to medium current ranges:
  - □ 0 to 20 A □ ±30 A □ ±50 A
  - □ ±20 A □ ±40 A □ 0 to 65 A
  - □ 0 to 30 A □ 0 to 50 A □ ±65 A
- Integrated current carrying conductor (CCC)
- Linear analog output voltage
- Total error output ≤ ±1.0% FS, –40°C to 125°C
- 1 MHz bandwidth
- Response time: ~300 ns
- UL/IEC 62368-1 and UL1577 certification
  - □ Rated isolation voltage: 5 kV_{RMS}
  - □ Working voltage for basic isolation: 1287 V_{RMS}
  - □ Working voltage for reinforced isolation: 647 V_{RMS}
- IEC 61000-4-5 certified
- Low noise: 9.5 to 19.0 mA_{RMS} @ f_{BW} = 100 kHz
- Reference voltage output for AC/DC current measurements
- $V_{OUT} – V_{REF}$ < ±1.0% FS, –40°C to 125°C
- Immunity to common mode fields: –54 dB
- Supply voltage: 3.0 to 3.6 V
- Overcurrent detection
  - □ Out of range currents
- AEC-Q100 grade 1

PACKAGE:

Not to scale

16-lead SOICW

DESCRIPTION

The CT431 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 consumer, enterprise, and industrial applications. The device supports nine current ranges where the integrated current carrying conductor (CCC) will handle up to 65 A of current and generates a current measurement as a linear analog output voltage. The device achieves a total output error of less than ±1.0% full-scale (FS) over voltage and the full temperature range.

The device has a ~300 ns output response time while the current consumption is ~6.0 mA and is immune to common mode fields. The CT431 has an integrated overcurrent detection (OCD) circuitry to identify out of range currents (OCD) with the result output to the fault-bar ($\overline{FLT}$) pin. The $\overline{FLT}$ is an open drain, active low digital signal that is activated by the CT431 to alert the microcontroller that a fault condition has occurred.

The CT431 is offered in an industry-standard 16-lead SOIC wide package that is green and RoHS compliant.

APPLICATIONS

- Solar/power inverters
- UPS, SMPS, and telecom power supplies
- Battery management systems
- Motor control
- White goods
- Power utility meter
- Overcurrent fault protection

TÜV Certificate No.: R 72226133 0001

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

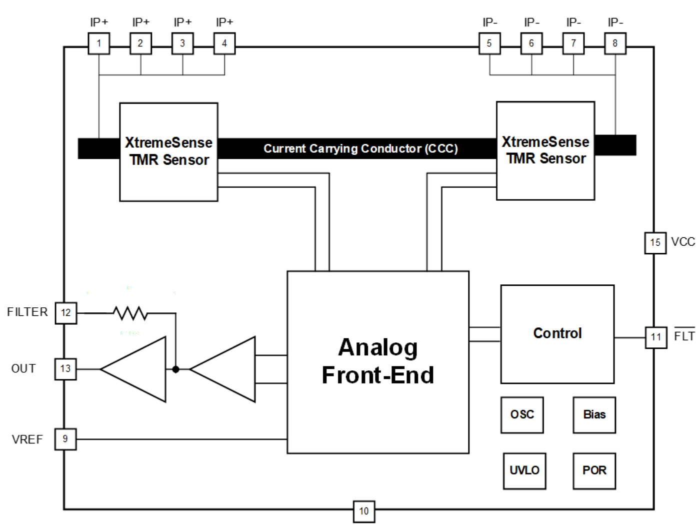

Figure 1: CT431 Functional Block Diagram for 16-lead SOICW Package

SELECTION GUIDE

Part Number	Current Range (I_{PMAX}) (A)	Sensitivity (mV/A)	Operating Temperature Range (°C)	Package	Packing
CT431-HSWF20MR	±20	50	–40 to 125	16-lead SOICW 10.21 mm × 10.31 mm × 2.54 mm	Tape and Reel
CT431-HSWF30MR	±30	33.3			
CT431-HSWF40MR	±40	25			
CT431-HSWF50MR	±50	20			
CT431-HSWF65MR	±65	15.4			
CT431-HSWF20DR	20	100			
CT431-HSWF30DR	30	66.7			
CT431-HSWF50DR	50	40			
CT431-HSWF65DR	65	30.8			
AEC-Q100 GRADE 1					
CT431-ASWF20MR	±20	50	Grade 1 –40 to 125	16-lead SOICW 10.21 mm × 10.31 mm × 2.54 mm	Tape and Reel
CT431-ASWF30MR	±30	33.3			
CT431-ASWF50MR	±50	20			
CT431-ASWF65MR	±65	15.4			
CT431-ASWF20DR	20	100			
CT431-ASWF30DR	30	66.7			
CT431-ASWF50DR	50	40			
CT431-ASWF65DR	65	30.8			

EVALUATION BOARD SELECTION GUIDE

Part Number	Current Range (A)	Operating Temperature Range (°C)
CTD431-20DC	0 to 20	–40 to 125
CTD431-20AC	±20	
CTD431-30DC	0 to 30	
CTD431-30AC	±30	
CTD431-50DC	0 to 50	
CTD431-50AC	±50	
CTD431-65DC	0 to 65	
CTD431-65AC	±65	

Table of Contents

Allegro MicroSystems
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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°C	70	A
Dielectric Surge Strength Test Voltage	V_{SURGE}	IEC 61000-4-5: Tested ±5 Pulses at 2/60 seconds, 1.2 µs (rise) and 50 µs (width)	6.0 (min)	kV
Surge Strength Test Current	I_{SURGE}	Tested ±5 Pulses at 3/60 seconds, 8.0 µs (rise) and 20 µs (width)	3.0 (min)	kA
Electrostatic Discharge Protection Level	ESD	Human Body Model (HBM) per JESD22-A114	±2.0	kV
		Charged Device Model (CDM) per JESD22-C101	±0.5	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 CT431 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}		–	–	±1.0	mA
Operating Ambient Temperature	T_A	Extended Industrial	–40	25	125	°C
		Automotive	–40	25	125	°C

[1] The Recommended Operating Conditions table defines the conditions for actual operation of the CT431. Recommended operating conditions are specified to ensure optimal performance to the specifications. Allegro does not recommend exceeding them or designing to absolute maximum ratings.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	Value	Unit
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	Junction-to-ambient thermal resistance is a function of application and board layout and is determined in accordance to JEDEC standard JESD51 for a four (4) layer 2s2p FR-4 printed circuit board (PCB) with 4 oz. of copper (Cu). Special attention must be paid not to exceed junction temperature $T_{J(MAX)}$ at a given ambient temperature T_A.	15	°C/W
Junction-to-Case Thermal Resistance	$R_{\theta JC}$		10	°C/W

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ISOLATION RATINGS

Characteristic	Symbol	Notes	Rating	Unit
Rated Isolation Voltage	V_{ISO}	Agency Tested per IEC 62368 [1] for 60 seconds. Production Tested at V_{ISO} for 1 second per IEC 62368.	5.0	kV_{RMS}
		Agency Tested per UL1577 for 60 seconds. Production Tested at V_{ISO} for 1 second per UL1577.	5.0	kV_{RMS}
Working Voltage for Basic Isolation	V_{WORK_ISO}	Tested per IEC 62368 [1].	1820	V_{PK}
			1287	V_{RMS}
Working Voltage for Reinforced Isolation	V_{WORK_RI}	Tested per IEC 62368 [1].	915	V_{PK}
			647	V_{RMS}
Creepage Distance	D_{CR}	Minimum distance along package body from IP pins to I/O pins.	9.21	mm
Clearance Distance	D_{CL}	Minimum distance through air from IP pins to I/O pins.	8.79	mm
Distance Through Isolation	D_{ISO}	Minimum internal distance through isolation	110	µm
Comparative Tracking Index	CTI	Material Group II	400 to 599	V

[1] IEC 62368 is the succeeding standard to IEC 60950-1 (Edition 2) for isolation testing specifications and as such it will be compliant to the latter standard.

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PINOUT DIAGRAM AND TERMINAL LIST

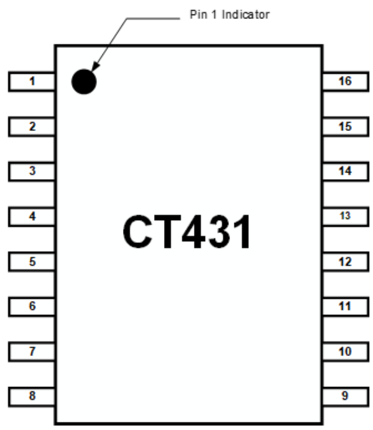

Figure 2: CT431 Pinout Diagram for 16-lead SOICW Package (Top-Down View)

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	VREF	Reference voltage output. If not used, then do not connect.
10	GND	Ground.
11	$\overline{\text{FLT}}$	Active low output fault signal (open drain output) to indicate that the following parameters are outside of normal operational bounds: • Overcurrent Detection • UVLO If not used, then a 1.0 nF capacitor must be connected from the pin to ground.
12	FILTER	Filter pin to improve noise performance by connecting an external capacitor to set the cut-off frequency. If not used, then do not connect the pin (no connect).
13	OUT	Analog output voltage that represents the measured current.
14	N/C	No connect.
15	VCC	Supply voltage.
16	N/C	No connect.

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ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
POWER SUPPLIES						
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	–	kΩ
Internal Filter Resistance	R_{FILTER}		–	15	–	kΩ
Primary Conductor Resistance [1]	R_{IP}		–	0.5	–	mΩ
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
ANALOG OUTPUT (OUT)						
OUT Voltage Linear Range, Typical	V_{OUT}	V_{SIG_AC} = ±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°C	V_{CC} – 0.30	V_{CC} – 0.25	–	V
Common Mode Field Rejection Ratio [1]	CMFRR		–	–54	–	dB
			–	0.5	–	mA/G
REFERENCE VOLTAGE (VREF)						
Reference Voltage	V_{REF}	DC Current (Unipolar)	–	0.65	–	V
		AC Current (Bipolar)	–	1.65	–	V
VREF Capacitive Load [1]	C_{L_VREF}		–	–	10	pF
VREF Resistive Load [1]	R_{L_VREF}		–	10	–	kΩ
VREF Maximum Drive Capability [1]	I_{VREF}		–50	–	50	µA
FAULT OUTPUT ($\overline{FLT}$)						
$\overline{FLT}$ Voltage Low	$V_{FLT\#\_OL}$	$I_{FLT\#\_OUT}$ ≤ 20 mA	0	–	0.5	V
High-Impedance Output Leakage Current	$I_{LEAK\_FLT\#}$	$V_{FLT\#\_OH}$ = V_{CC}	–	5	–	µA
$\overline{FLT}$ Pull-Up Resistor	R_{PU}		–	100	–	kΩ
TIMINGS						
Power-On Time [1]	t_{ON}	V_{CC} ≥ 2.50 V	–	100	200	µs
Rise Time [1]	t_{RISE}	I_P = $I_{RANGE(MAX)}$, T_A = 25°C, C_L = 100 pF	–	200	–	ns
Response Time [1]	$t_{RESPONSE}$	I_P = $I_{RANGE(MAX)}$, T_A = 25°C, C_L = 100 pF	–	300	–	ns
Propagation Delay [1]	t_{DELAY}	I_P = $I_{RANGE(MAX)}$, T_A = 25°C, C_L = 100 pF	–	250	–	ns
$\overline{FLT}$ Response Time	$t_{FLT\#}$		–	250	–	ns

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

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ELECTRICAL CHARACTERISTICS (continued): Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
PROTECTION						
Undervoltage Lockout	V_{UVLO}	Rising V_{DD}	–	2.50	–	V
		Falling V_{DD}	–	2.45	–	V
UVLO Hysteresis	V_{UV_HYS}		–	50	–	mV
Overcurrent Detection (OCD) for DC Current (Unipolar)	I_{OCD_U}	Rising I_P	–	1.1 × $I_{RANGE(MAX)}$	–	A
		Falling I_P	–	0.9 × $I_{RANGE(MAX)}$	–	A
Overcurrent Detection (OCD) for AC Current (Bipolar)	I_{OCD_B}	Rising I_P	–	1.1 × $I_{RANGE(MAX)}$	–	A
		Falling I_P	–	0.9 × $I_{RANGE(MAX)}$	–	A
Overcurrent Detection Hysteresis	I_{OCD_HYS}		–	0.2 × $I_{RANGE(MAX)}$	–	A

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ELECTRICAL CHARACTERISTICS

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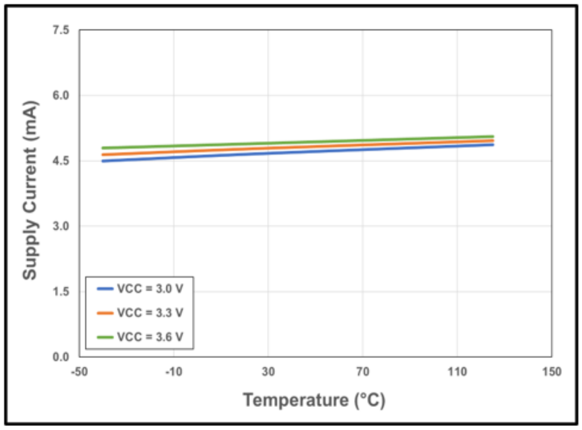

Figure 3: CT431 Supply Current vs. Temperature vs. Supply Voltage

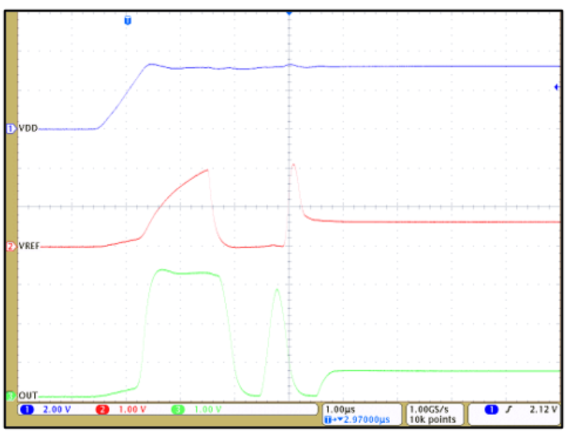

Figure 4: CT431 Startup Waveforms for V_{OQ} = 0.65 V

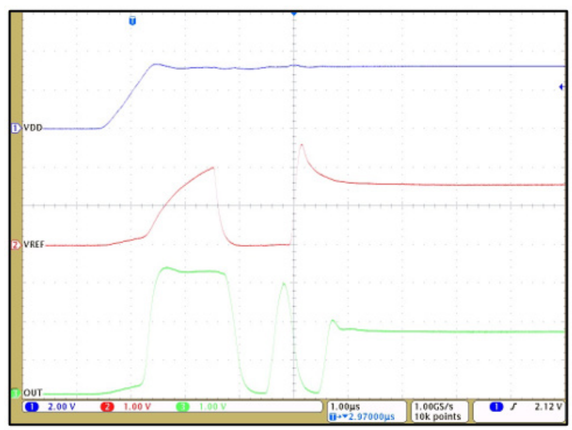

Figure 5: CT431 Startup Waveforms for V_{OQ} = 1.65 V (AC Current)

ELECTRICAL CHARACTERISTICS (continued)

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

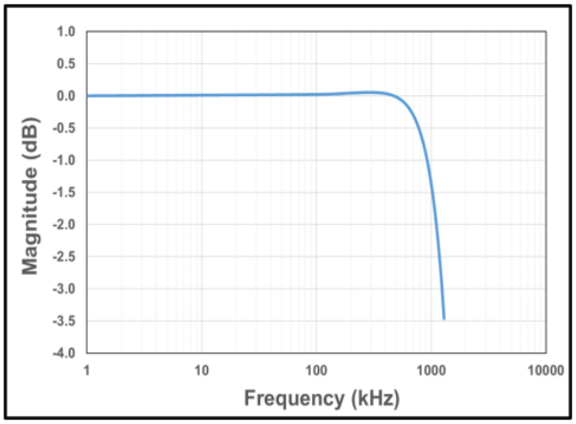

Figure 6: CT431 Bandwidth with C_{FILTER} = 1.0 pF

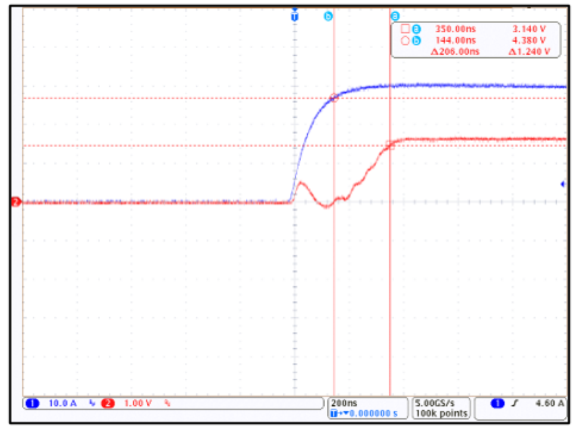

Figure 7: CT431 Response Time; I_P = 30 A_{PK} and C_L = 100 pF (Blue = I_{CCC}, Red = V_{OUT})

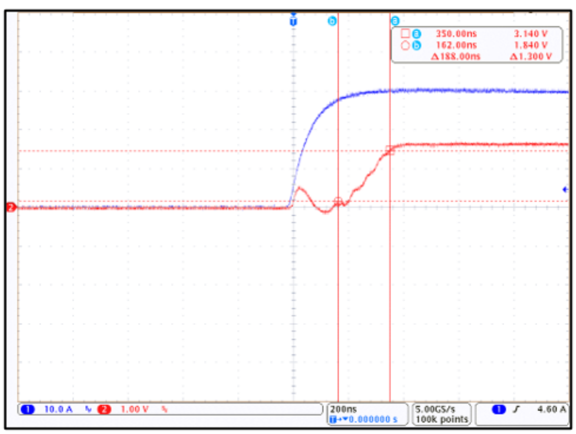

Figure 8: CT431 Rise Time; I_P = 30 A_{PK} and C_L = 100 pF (Blue = I_{CCC}, Red = V_{OUT})

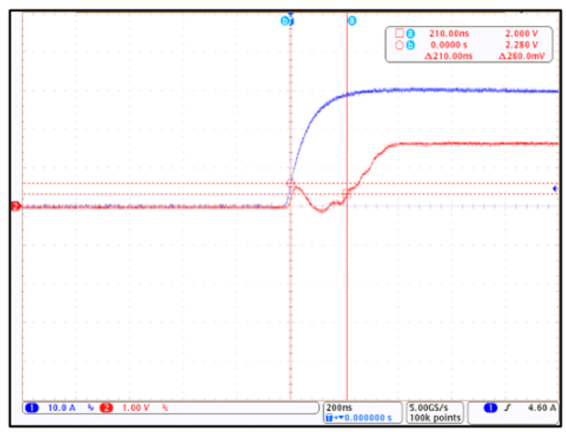

Figure 9: CT431 Propagation Delay; I_P = 30 A_{PK} and C_L = 100 pF (Blue = I_{CCC}, Red = V_{OUT})

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ELECTRICAL CHARACTERISTICS (continued)

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

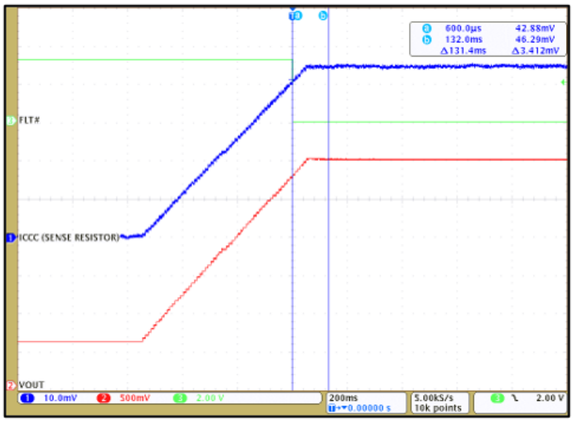

Figure 10: CT431 OCD enabled at 110% of 50 A_{DC} and FLT# is Low

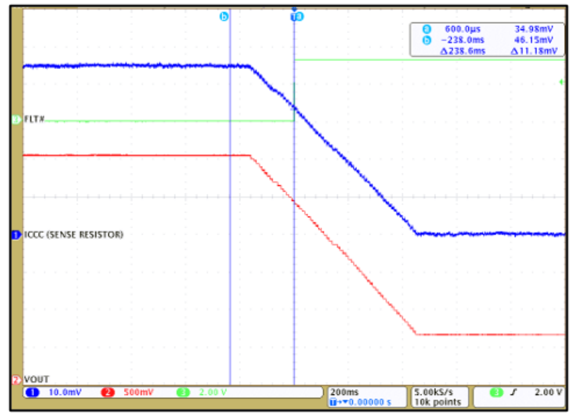

Figure 11: CT431 OCD disabled at 90% of 50 A_{DC} and FLT# is High

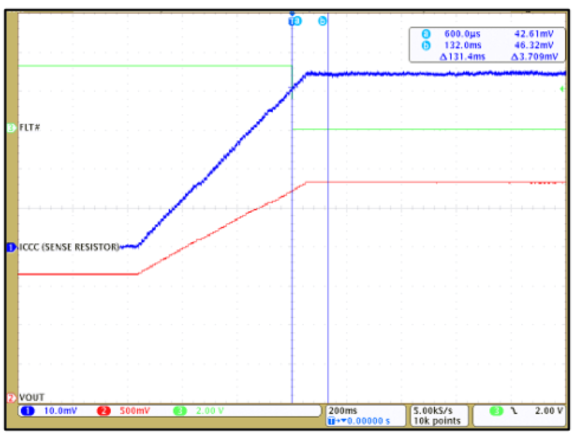

Figure 12: CT431 OCD enabled at 110% of 50 A_{PK} and FLT# is Low

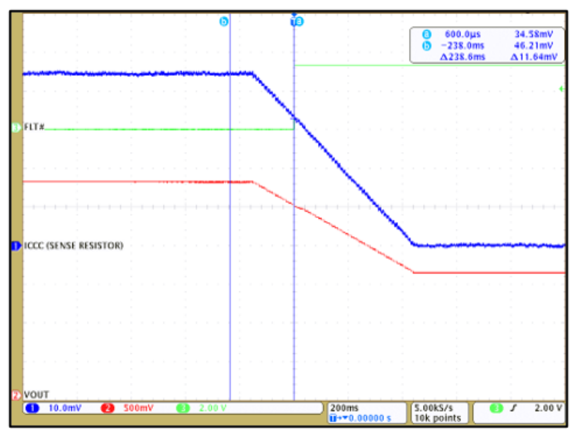

Figure 13: CT431 OCD disabled at 90% of 50 A_{PK} and FLT# is High

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ELECTRICAL CHARACTERISTICS (continued)

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

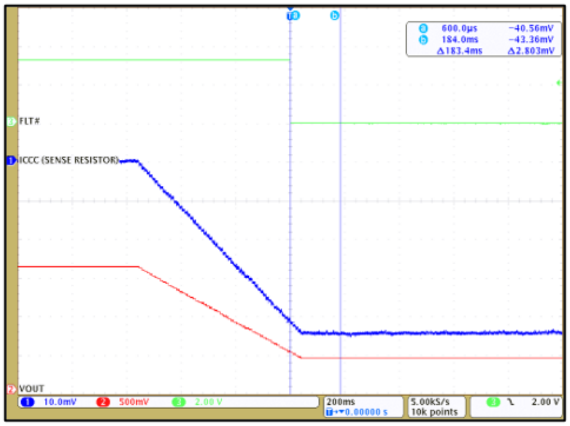

Figure 14: CT431 OCD enabled at –110% of –50 A_{PK} and FLT# is Low

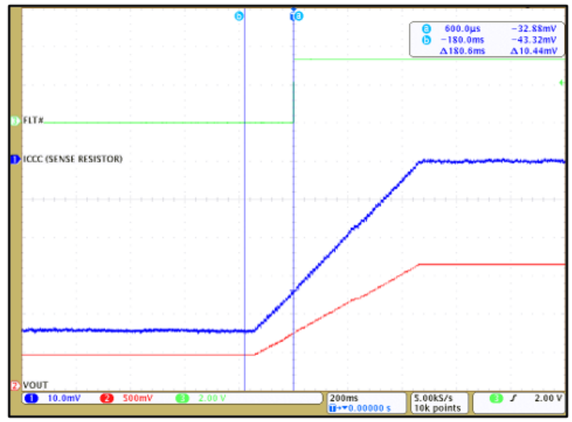

Figure 15: CT431 OCD disabled at –90% of –50 A_{PK} and FLT# is High

CT431-xSWF20DR: 0 to 20 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		0	–	20	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	9.5	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.7	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.1	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.6	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±6.0	–	mV
			–	±0.3	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF20DR

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

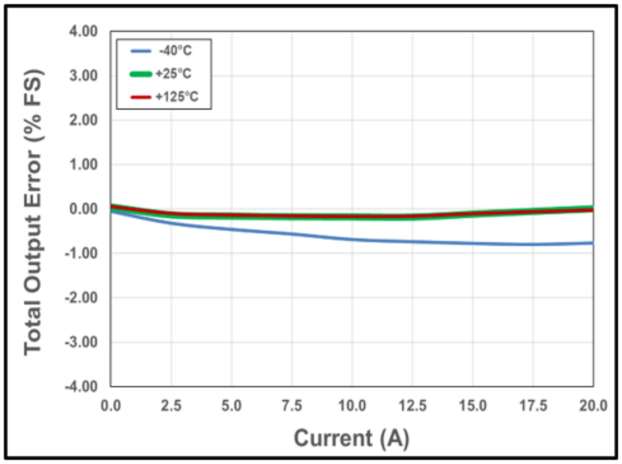

Figure 16: Total Output Error vs. Current vs. Temperature

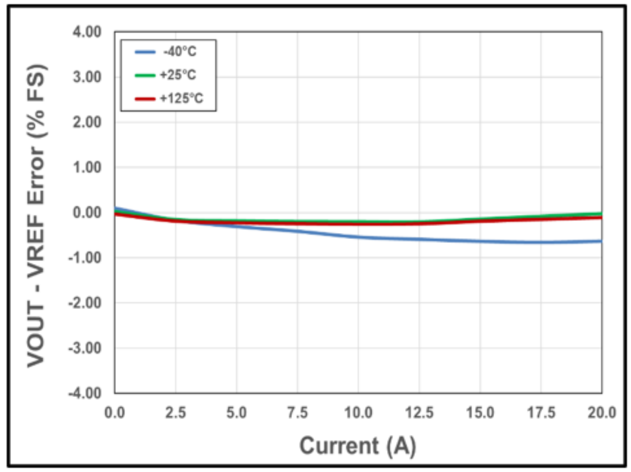

Figure 17: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

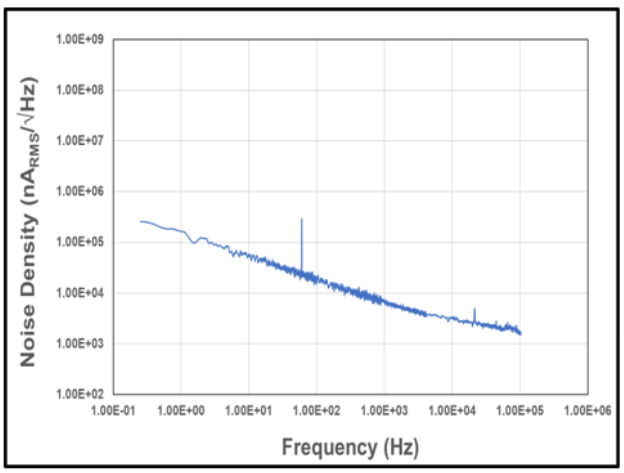

Figure 18: Noise Density vs. Frequency

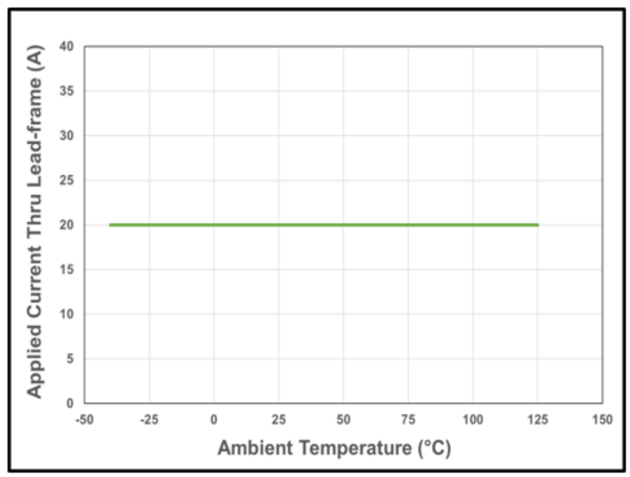

Figure 19: CT431 Current Derating Curve for 20 A_{DC}

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Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		–20	–	20	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	11.0	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.5	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.1	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.4	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±8.3	–	mV
			–	±0.4	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF20MR

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

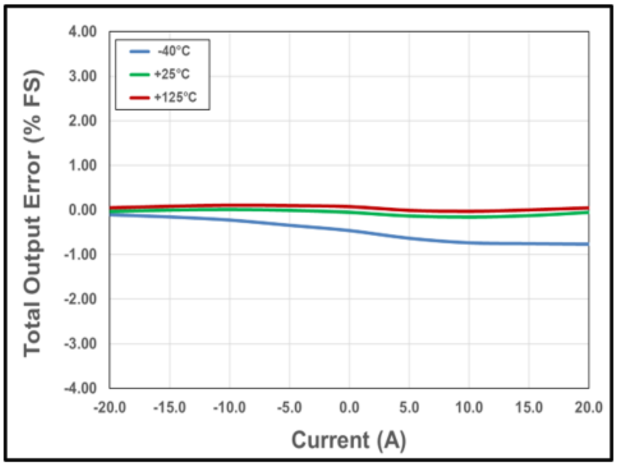

Figure 20: Total Output Error vs. Current vs. Temperature

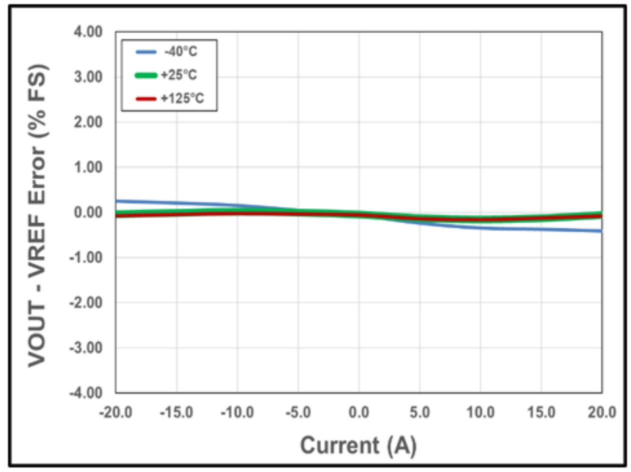

Figure 21: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

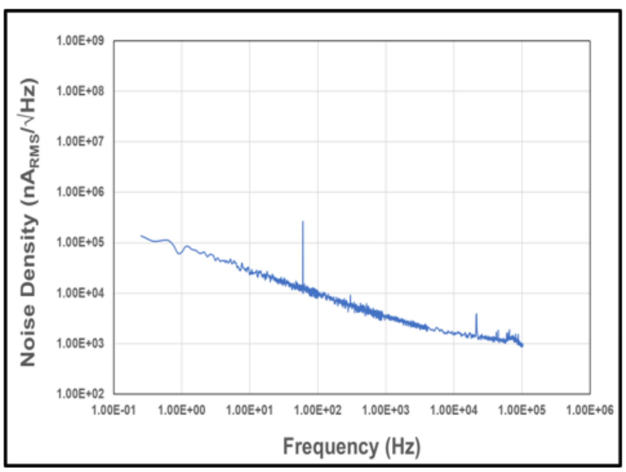

Figure 22: Noise Density vs. Frequency

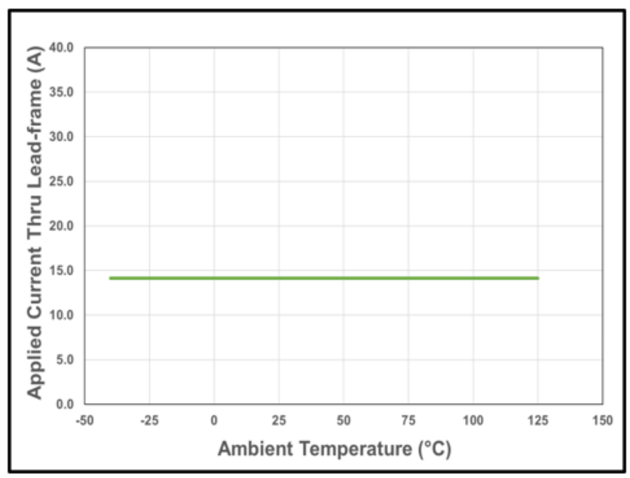

Figure 23: CT431 Current Derating Curve for 20 A_{PK} (14.1 A_{DC})

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CT431-xSWF30DR: 0 to 30 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		0	–	30	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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, C_{FILTER} = 5 pF	–	1.0	–	MHz
Noise [1]	e_N	T_A = 25°C, f_{BW} = 100 kHz	–	10.0	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.7	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.1	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.6	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±8.9	–	mV
			–	±0.4	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF30DR

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

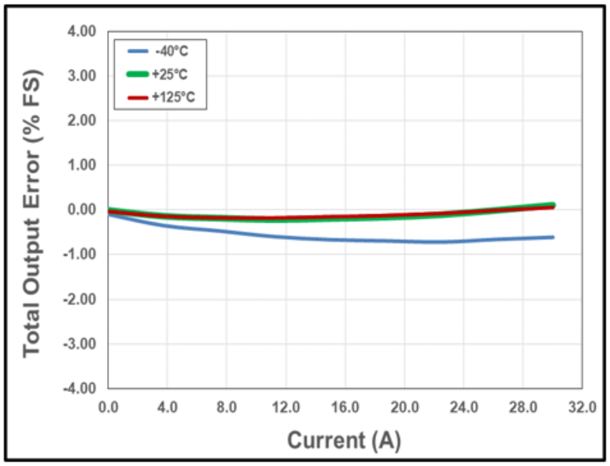

Figure 24: Total Output Error vs. Current vs. Temperature

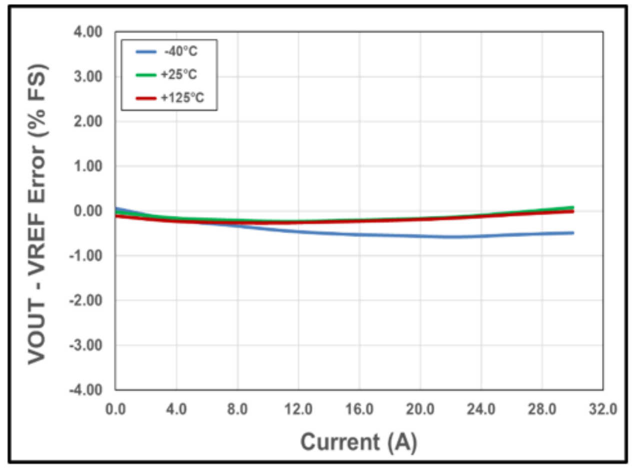

Figure 25: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

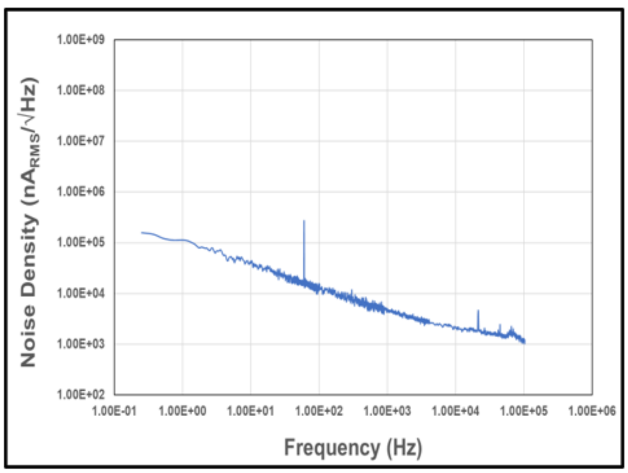

Figure 26: Noise Density vs. Frequency

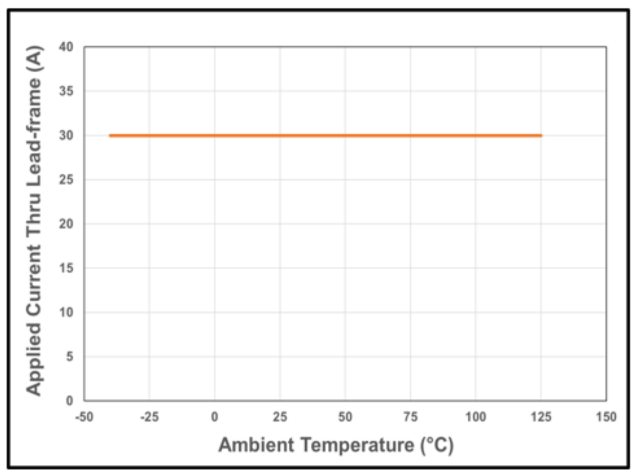

Figure 27: CT431 Current Derating Curve for 30 A_{DC}

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CT431-xSWF30MR: ±30 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		–30	–	30	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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, C_{FILTER} = 5 pF	–	1.0	–	MHz
Noise [1]	e_N	T_A = 25°C, f_{BW} = 100 kHz	–	12.5	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.5	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.1	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.6	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±5.0	–	mV
			–	±0.2	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF30MR

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

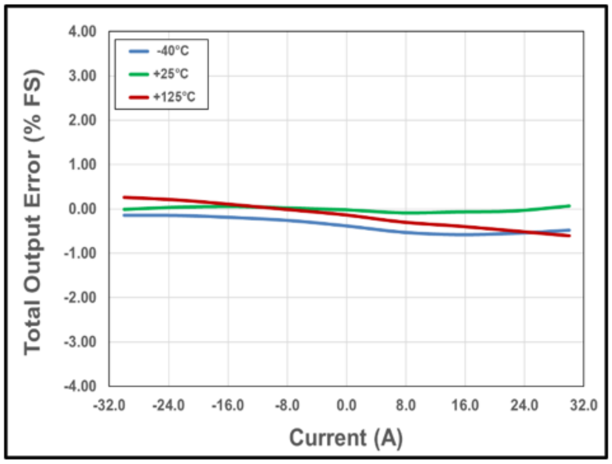

Figure 28: Total Output Error vs. Current vs. Temperature

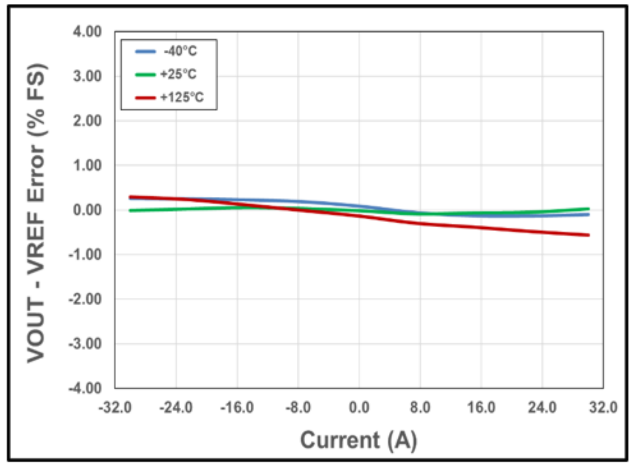

Figure 29: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

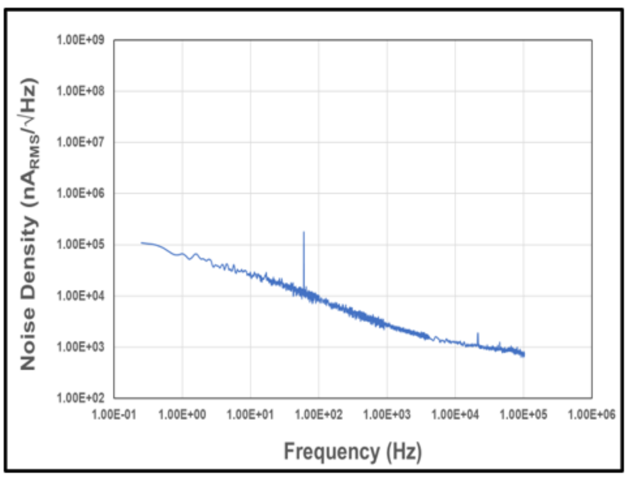

Figure 30: Noise Density vs. Frequency

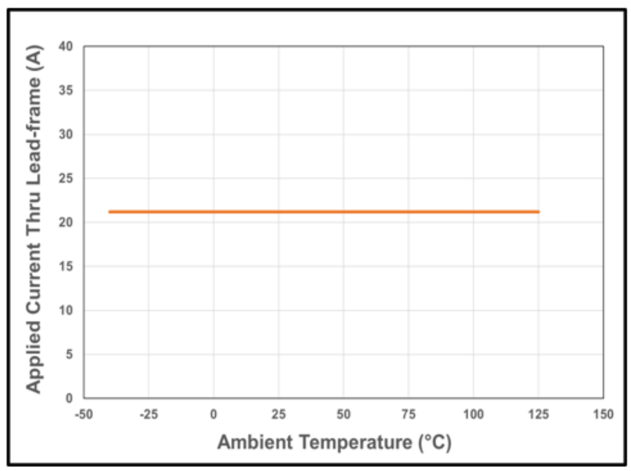

Figure 31: CT431 Current Derating Curve for 30 A_{PK} (21.2 A_{DC})

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CT431-xSWF40MR: ±40 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		–40	–	40	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	19.0	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.5	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.1	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.5	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±6.0	–	mV
			–	±0.3	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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CT431-xSWF50DR: 0 to 50 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		0	–	50	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	11.0	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±1.0	±1.5	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.2	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.7	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±8.8	–	mV
			–	±0.4	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF50DR

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

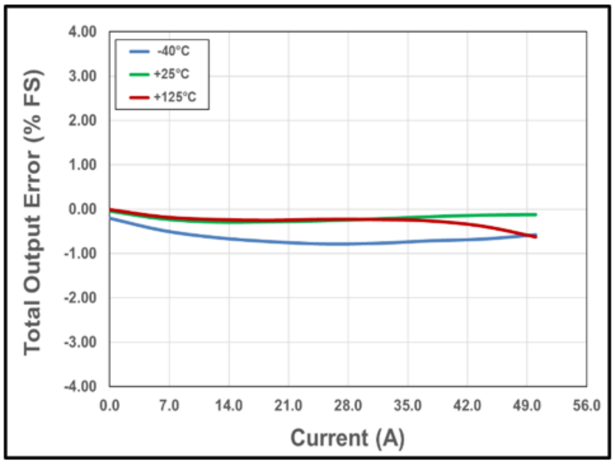

Figure 32: Total Output Error vs. Current vs. Temperature

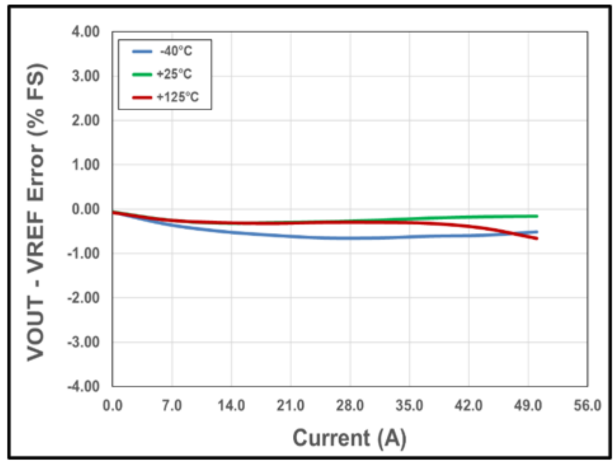

Figure 33: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

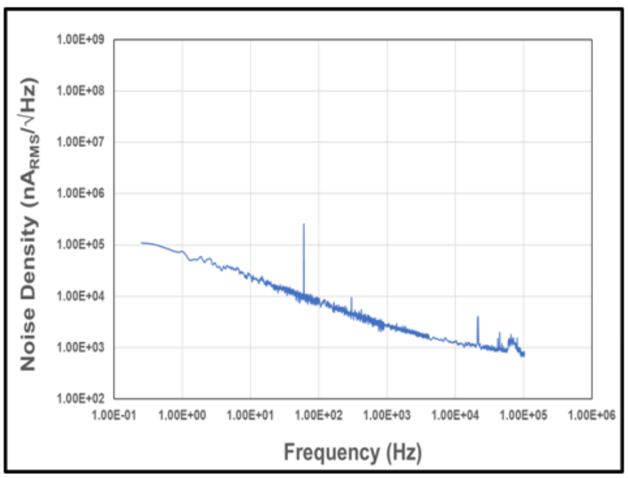

Figure 34: Noise Density vs. Frequency

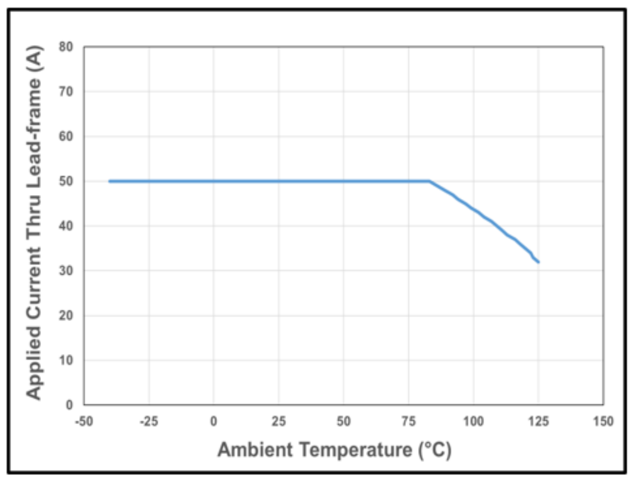

Figure 35: CT431 Current Derating Curve for 50 A_{DC}

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CT431-xSWF50MR: ±50 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		–50	–	50	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	19.0	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.5	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.1	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.5	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±6.0	–	mV
			–	±0.3	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 3.3 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF50MR

V_{CC} = 3.3 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

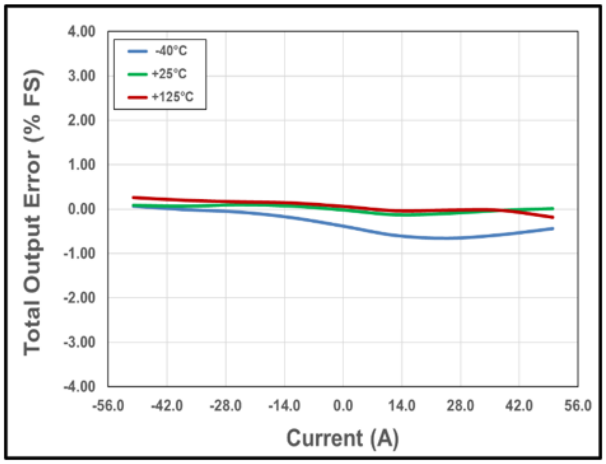

Figure 36: Total Output Error vs. Current vs. Temperature

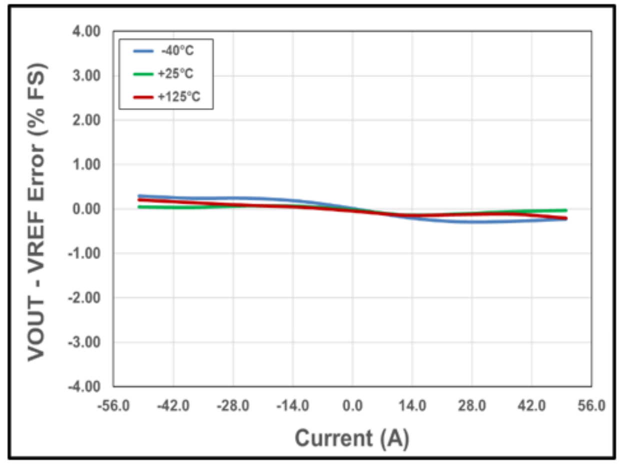

Figure 37: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

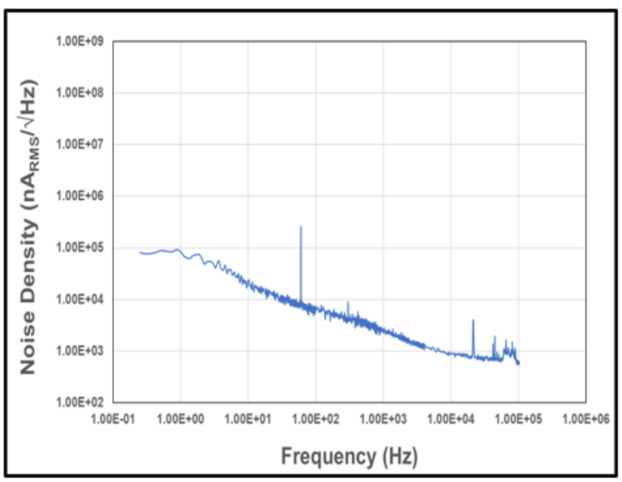

Figure 38: Noise Density vs. Frequency

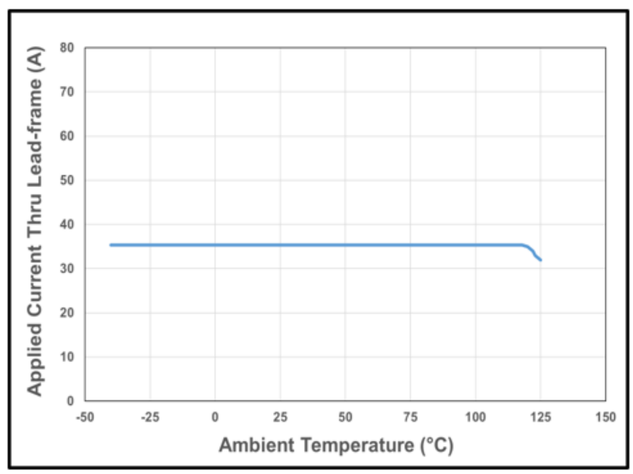

Figure 39: CT431 Current Derating Curve for 50 A_{DC} (35.4 A_{DC})

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CT431-xSWF65DR: 0 to 65 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		0	–	65	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	11.5	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±1.0	±1.5	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.2	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.3	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±2.0	–	mV
			–	±0.1	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 5.0 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 5.0 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF65DR

V_{CC} = 5.00 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

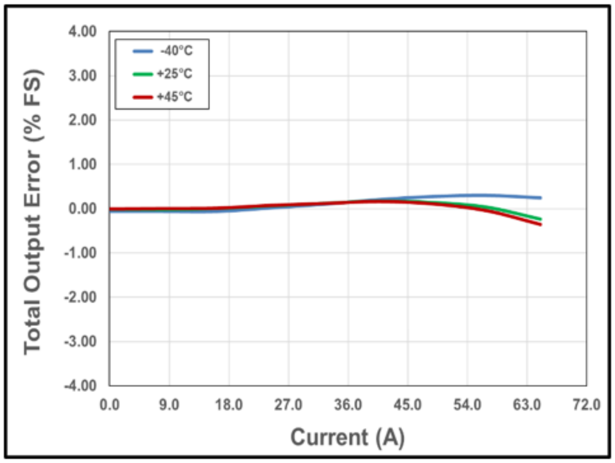

Figure 40: Total Output Error vs. Current vs. Temperature

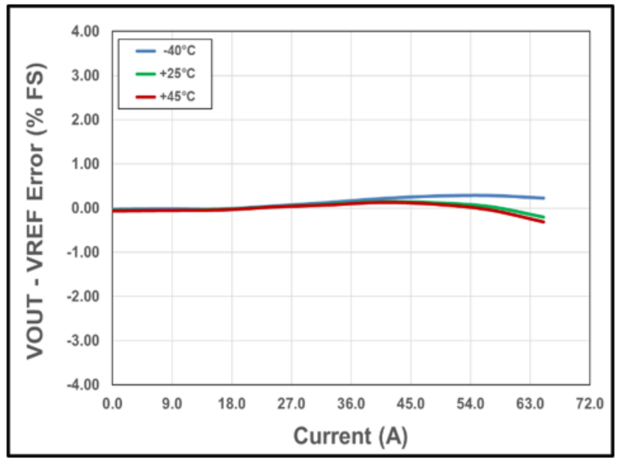

Figure 41: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

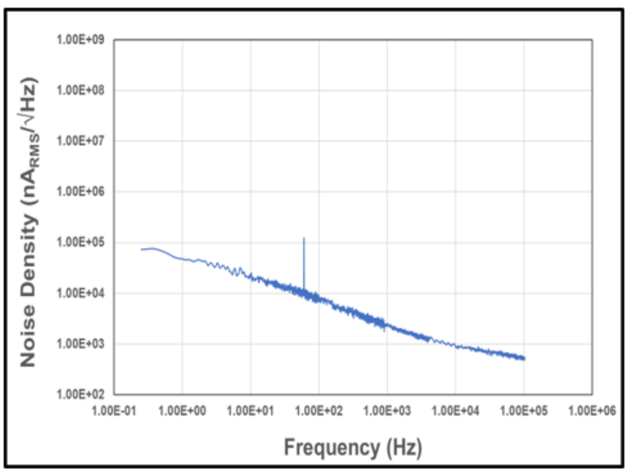

Figure 42: Noise Density vs. Frequency

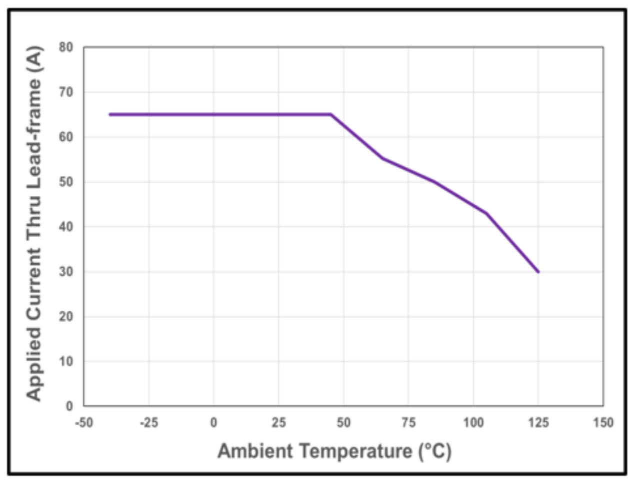

Figure 43: CT431 Current Derating Curve for 65 A_{DC}

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CT431-xSWF65MR: ±65 A – ELECTRICAL CHARACTERISTICS: Valid for V_{CC} = 3.0 to 3.6 V, C_{BYP} = 1.0 µF, and T_A = –40°C to 125°C, typical values are V_{CC} = 3.3 V and T_A = 25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Current Range	I_{RANGE}		–65	–	65	A
Voltage Output Quiescent	V_{OQ}	T_A = 25°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°C, f_{BW} = 100 kHz	–	19.0	–	mA_{RMS}
OUT ACCURACY PERFORMANCE						
Total Output Error	E_{OUT}	$I_P = I_{P(MAX)}$	–	±0.5	±1.0	% FS
Non-Linearity Error [1]	E_{LIN}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.2	–	% FS
Sensitivity Error [1]	E_{SENS}	$I_P = I_{P(MAX)}$, T_A = –40°C to 125°C	–	±0.2	–	% FS
Offset Voltage [1]	V_{OFFSET}	I_P = 0 A, T_A = –40°C to 125°C	–	±3.0	–	mV
			–	±0.1	–	% FS
$V_{OUT} – V_{REF}$ ACCURACY PERFORMANCE						
$V_{OUT} – V_{REF}$ Error	$E_{OUT-VREF}$	$I_P = I_{P(MAX)}$, V_{CC} = 5.0 V, T_A = –40°C to 125°C	–	–	±1.0	% FS
$V_{OUT} – V_{REF}$ Offset Voltage	$V_{OUT} – V_{REF}$	V_{CC} = 5.0 V, T_A = –40°C to 125°C	–	±5.0	–	mV
LIFETIME DRIFT						
Total Output Error Lifetime Drift [1]	E_{TOT_DRIFT}	$I_P = I_{P(MAX)}$	–	±1.0	–	% FS

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

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ELECTRICAL CHARACTERISTICS FOR CT431-xSWF65MR

V_{CC} = 5.00 V, T_A = 25°C, and C_{BYP} = 1.0 µF (unless otherwise specified)

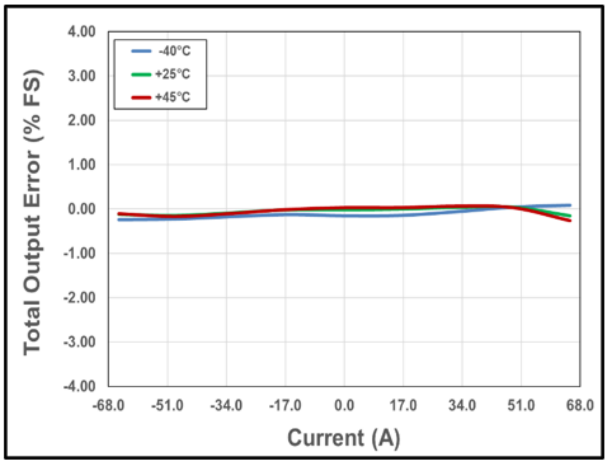

Figure 44: Total Output Error vs. Current vs. Temperature

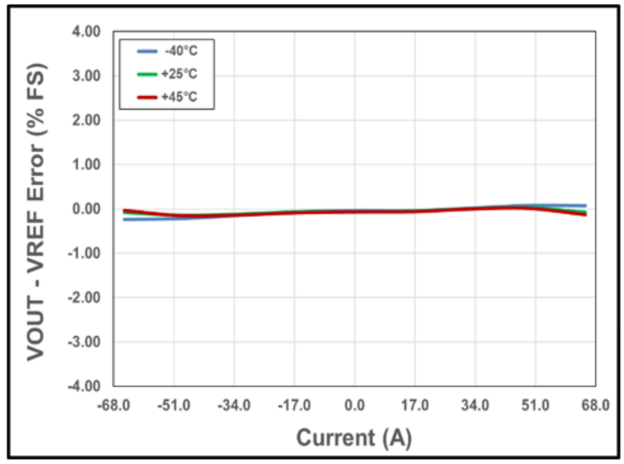

Figure 45: V_{OUT} – V_{REF} Error vs. Current vs. Temperature

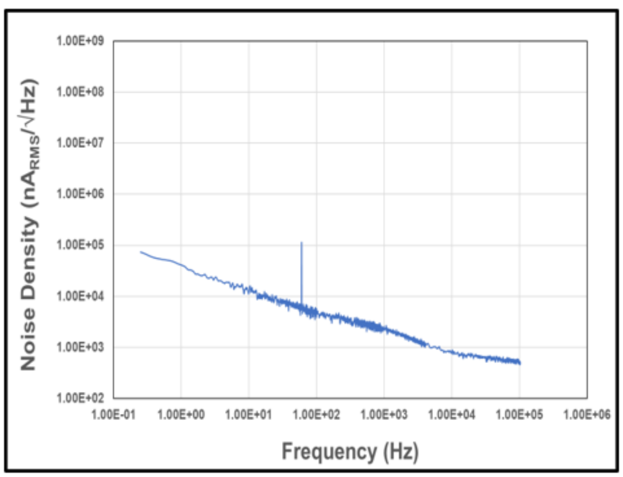

Figure 46: Noise Density vs. Frequency

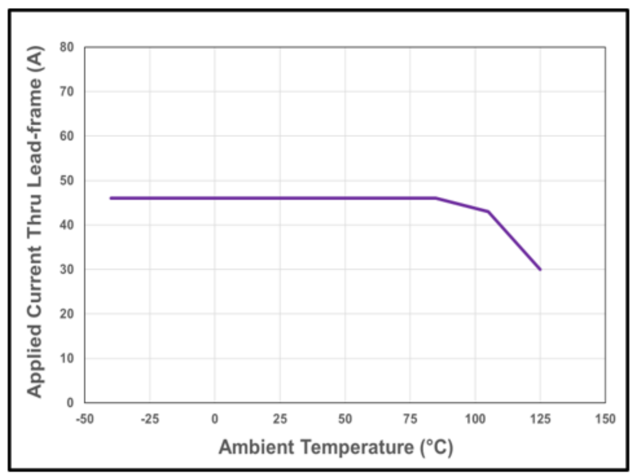

Figure 47: CT431 Current Derating Curve for 65 A_{DC} (46.0 A_{DC})

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FUNCTIONAL DESCRIPTION

Overview

The CT431 is a high accuracy contact current sensor with an integrated current-carrying conductor that handles up to 65 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

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_{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 CT431 is 1.0 MHz. Even with a high bandwidth, the chip consumes a minimal amount of power.

Linear Output Current Measurement

The CT431 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_{OQ} of 0.65 V and 1.65 V for unidirectional and bidirectional currents, respectively. Figure 48 illustrates the output voltage range of the OUT pin as a function of the measured current.

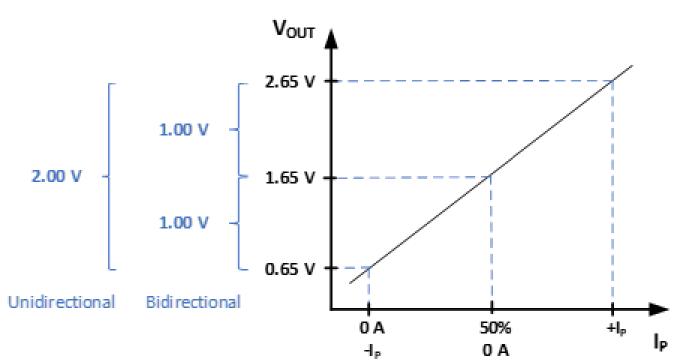

Figure 48: Linear Output Voltage Range (OUT) vs. Measured Current (IP)

Filter Function (FILTER)

The CT431 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 CT431 is 1.0 MHz; however, adding a capacitor to the FILTER pin—which will be in-series with an internal resistance of approximately 15 kΩ—will set the cutoff frequency to reduce noise.

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.

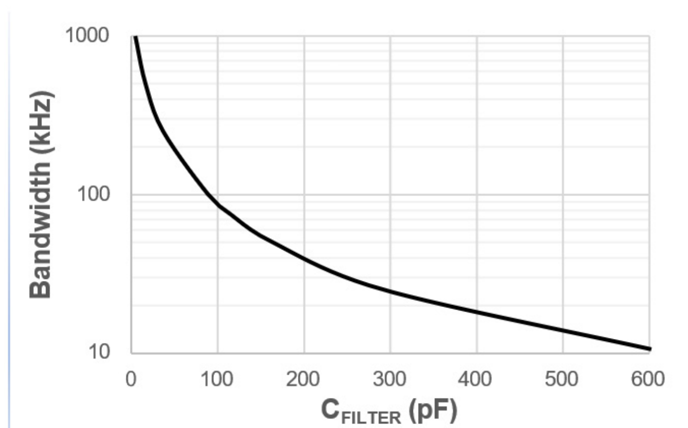

Figure 49: Experimental Bandwidth vs. C_{FILTER}

Voltage Reference Function (VREF)

The CT431 has a reference voltage (VREF) pin that may be used as an output voltage reference for AC or DC current measurements. The VREF pin should be connected to a buffer circuit.

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

Sensitivity

Sensitivity (S) is a change in the CT431 output in response to a change in 1 A of current flowing through the current-carrying conductor. It is defined by the product of the magnetic circuit sensitivity (G/A, where 1.0 G = 0.1 mT) and the chip linear amplifier gain (mV/G). Therefore, the result of this gives a sensitivity unit of mV/A. The CT431 is factory-calibrated to optimize the sensitivity for the full scale of the device dynamic range.

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.

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

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.

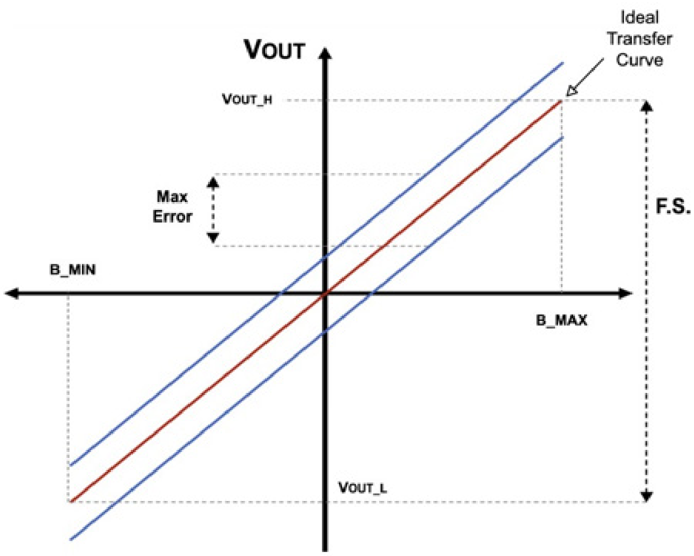

Figure 50: Total Output Error (E_{OUT}) vs. Sensed Current (I_P)

The CT431 achieves a total output error (E_{OUT}) 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:

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

For bipolar or AC current, the E_{SENS} is calculated by dividing the equation by 2.

Power-On Time (t_{ON})

Power-On Time (t_{ON}) of 100 µs is the amount of time required by CT431 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 CT431 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.

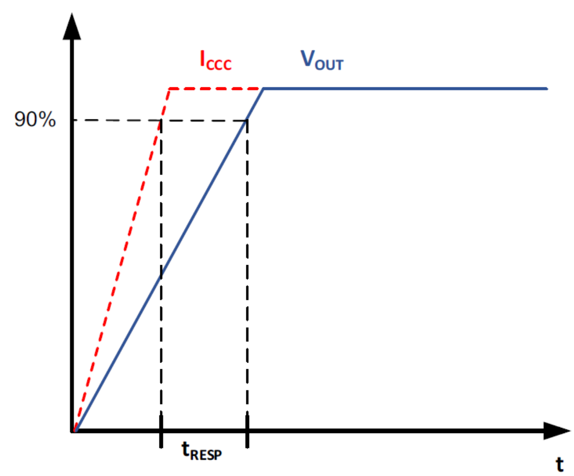

Figure 51: CT431 Response Time Curve

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 CT431 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 CT431 has a propagation delay of 250 ns.

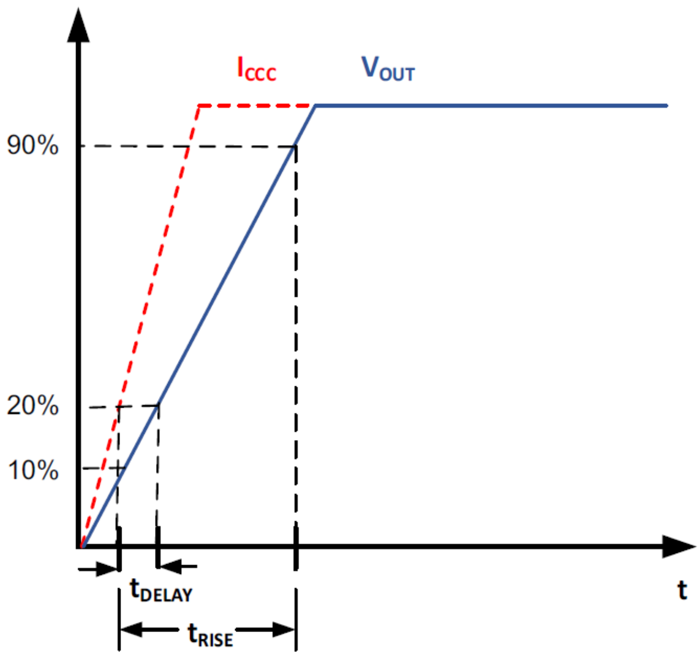

Figure 52: CT431 Propagation Delay and Rise Time Curve

Overcurrent Detection (OCD)

The Overcurrent Detection (OCD) circuitry detects measured current values that are 110% above the maximum current range value of the CT431 for the unipolar (DC current) variant. For the bipolar (AC current) variant of the CT431 it is greater than ±110% of the maximum current range. This will generate a fault signal via the Fault# Interrupt ($\overline{\text{FLT}}$) pin (low) to the host system's microcontroller. Once the measured current falls to 90% of the maximum current range for the DC current variant or ±90% for the AC current version then the fault will be cleared, and the $\overline{\text{FLT}}$ pin will go high.

Undervoltage Lockout (UVLO)

The Undervoltage Lockout protection circuitry of the CT431 is activated when the supply voltage (V_{CC}) falls below 2.45 V. The CT431 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 CT431 is not valid, and the $\overline{\text{FLT}}$ pin will go low. Once V_{CC} rises above 2.50 V then the UVLO is cleared, and the $\overline{\text{FLT}}$ pin will be high.

Fault# Interrupt ($\overline{\text{FLT}}$)

The CT431 generates an active LOW digital fault signal via the $\overline{\text{FLT}}$ pin to interrupt the microcontroller to indicate a fault event has been triggered. It is an open drain output and requires a pull-up resistor with a value of 100 kΩ tied to V_{CC} and a 1.0 nF capacitor is connected to ground. A fault signal will interrupt the host system for these events:

- OCD
- UVLO

The $\overline{\text{FLT}}$ signal will be asserted low whenever one of the above fault events occur. In the case of an UVLO event, the $\overline{\text{FLT}}$ pin will stay low until the fault is cleared and then go high.

If the $\overline{\text{FLT}}$ is not used, then a 1.0 nF capacitor must be connected from the pin to ground.

Immunity to Common Mode Fields

The CT431 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 CT431 is able to achieve –54 dB of Common Mode Rejection Ratio (CMFRR). Also, good PCB layout of the CT431 will optimize performance and reduce EMI. See the Applications Information section in this datasheet for recommendations on PCB layout.

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. Figure 53 illustrates the creepage and clearance for the SOICW-16 package of the CT431.

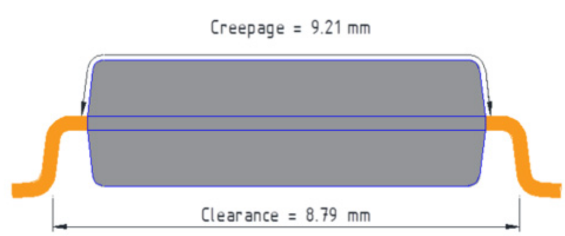

Figure 53: The Creepage and Clearance for the CT431 SOICW-16 package

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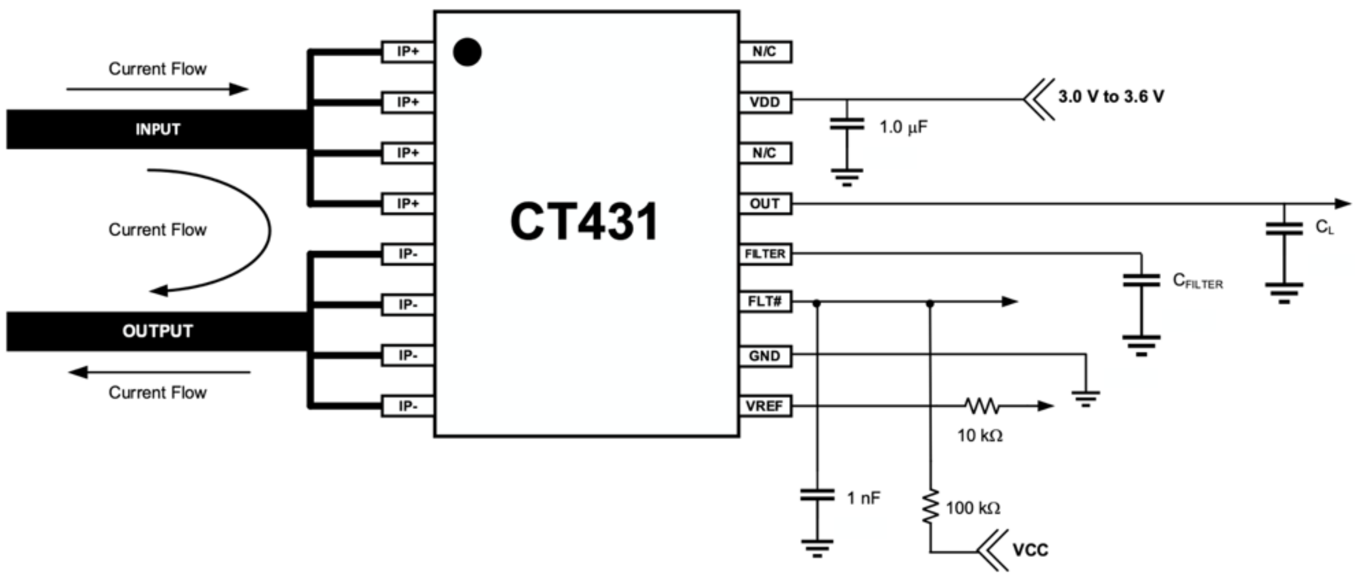

Figure 54: CT431 Application Block Diagram

Application

The CT431 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 outputs to a microcontroller a simple linear analog output voltage which corresponds to a current measurement value. A second output called $\overline{\text{FLT}}$ # alerts the host system to any fault event that may occur in the CT431. Figure 54 is an application diagram of how CT431 would be implemented in a system. The third output is the VREF which provides the output reference voltage of the CT431.

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 ±5%.

Bypass Capacitor

A single 1.0 µF 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 CT431 to minimize inductance and resistance between the two devices.

Filter Capacitor

A capacitor may be added to the FILTER pin of the CT431 if there is a requirement to improve the noise performance. The capacitor will be connected to an internal resistor of 15 kΩ inside the chip to form an R-C filter. This R-C filter produces a cutoff frequency that will reduce the noise over this lower bandwidth.

If the FILTER pin is not used, then it should not be connected (no connect).

$\overline{\text{FLT}}$ and VREF Resistors and Capacitors

For the CT431, the $\overline{\text{FLT}}$ pin is an open drain output. It requires a pull-up resistor value of 100 kΩ to be connected from the pin to VCC and also a 1.0 nF capacitor to be connected from the pin to ground.

In designs where the VREF pin is used, a 10 kΩ 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.

Also, if the $\overline{\text{FLT}}$ pin function is not required in the application, then a 1.0 nF capacitor must be connected from this pin to ground.

Recommended PCB Layout

Since the CT431 can measure up to 65 A of current, special care must be taken in the printed circuit board (PCB) layout of the CT431 and the surrounding circuitry. It is recommended that the CCC pins be connected to as much copper area as possible. For up to 30 A of current, 2 oz (or heavier) of copper can be used for the PCB traces. It is also recommended that 4 oz. or heavier cop-

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per be used for PCB traces when the CT431 is used to measure 50 A and 65 A of current. Additional layers of the PCB should also be used to carry current and be connected using the arrangement of vias. Figure 55 and Figure 56 show the recommended the PCB layout for the 20 A, 30 A, 40 A, 50 A, and 65 A variants of the CT431. Note that the traces connected to the IP+ and IP- pins of the CT431 are very wide with multiple vias such that it can handle the high current.

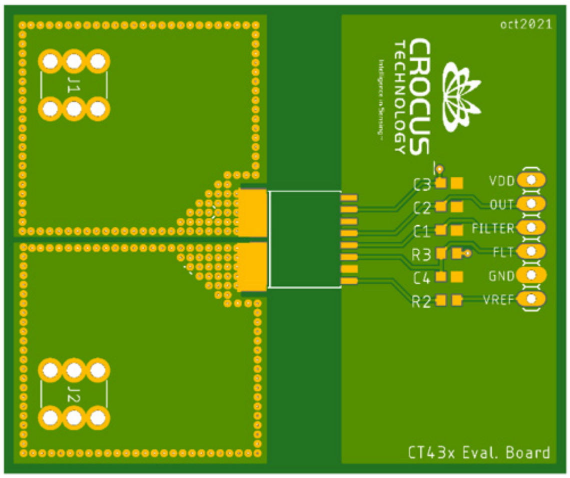


Figure 55: Recommended PCB Layout (Top Layer) for the 20 A to 65 A variants of the CT431

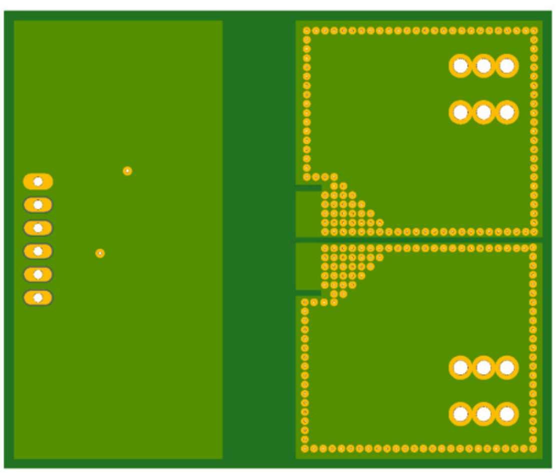


Figure 56: Recommended PCB Layout (Bottom Layer) for the 20 A to 65 A variants of the CT431

Fuse Time vs. Current

Since the CT431 is a contact current sensor, it dissipates heat as current is conducted through its leadframe, this limits the current it can measure which is 65 A. The CT431 leadframe has ~0.5 mΩ resistance which results in very low power dissipation during normal operation.

However, when the current surges above the rated nominal values of the CT431 due to short circuit or transient current spikes for a specific duration of time, the leadframe will be permanently damaged.

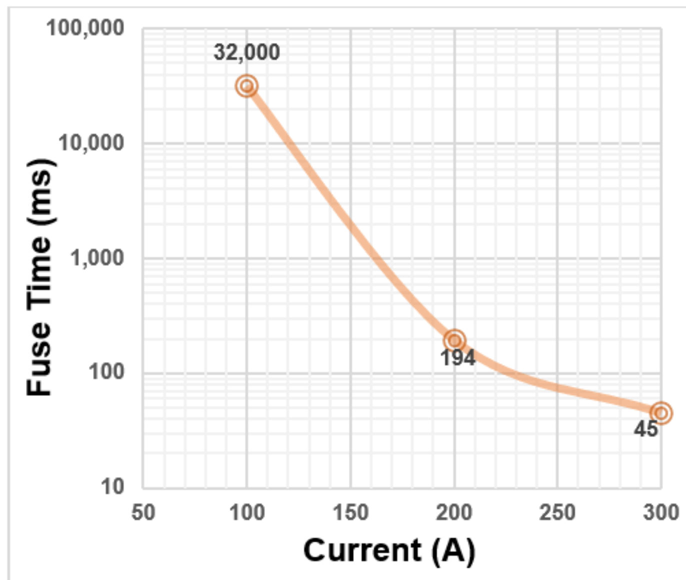
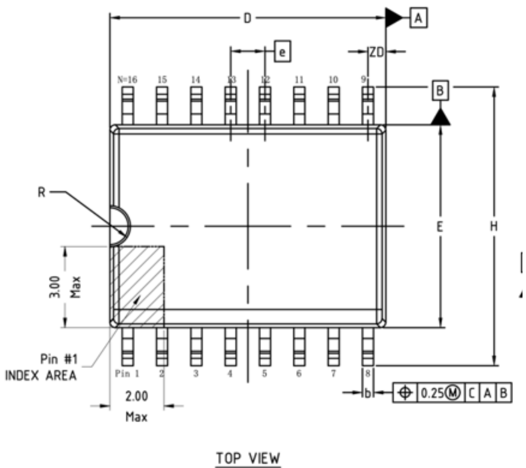


Figure 57: CT431 Fuse Time vs. Current

Figure 57 illustrates the CT431 fuse time for 100 A, 200 A, and 300 A current levels. The CT431 tolerates 100 A for 32 seconds while, at 200 A and 300 A, the fuse times are 194 ms and 45 ms, respectively.

PACKAGE OUTLINE DRAWING



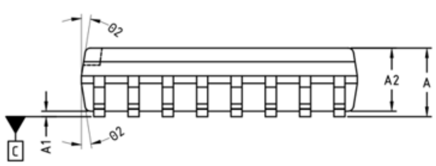
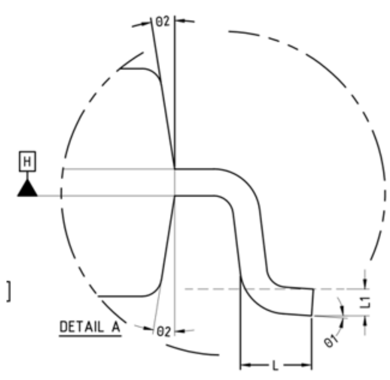


Table 1: CT431 SOICW-16 Package Dimensions

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		
θ1	0.25 BSC	0.25 BSC	0.25 BSC
θ2	0.76 REF	0.76 REF	0.76 REF
ZD	0.66 REF		
N	16		



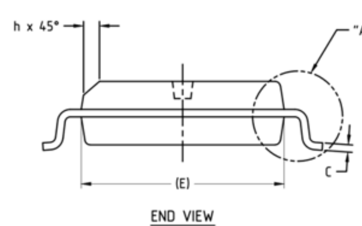


Figure 58: SOICW-16 Package Drawing and Dimensions

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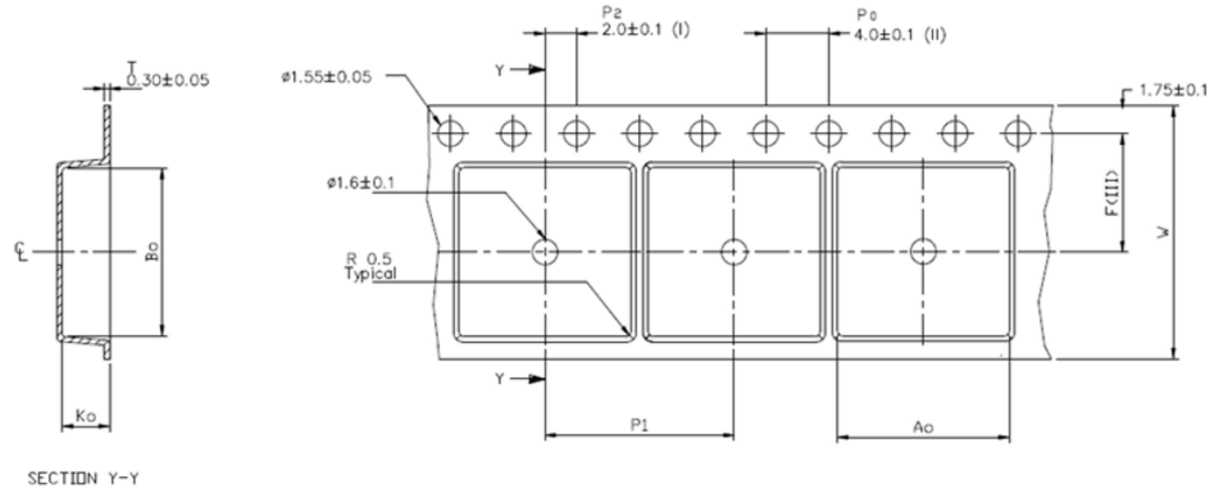
TAPE AND REEL POCKET DRAWING AND DIMENSIONS



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 10^9 OHM/SQ

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

Figure 59: Tape and Pocket Drawing for SOICW-16 Package

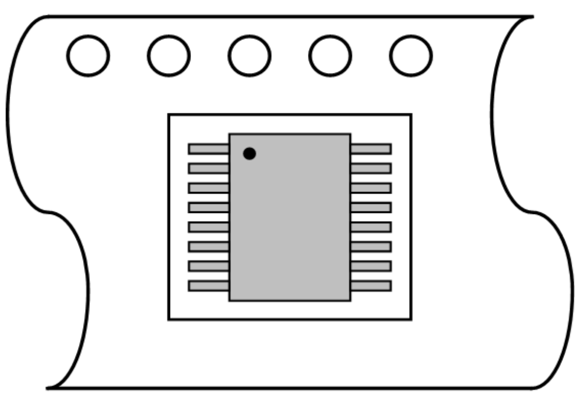


Figure 60: SOICW-16 Orientation in Tape Pocket

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PACKAGE INFORMATION

Table 2: CT431 Package Information

Part Number	Package Type	# of Leads	Package Quantity	Lead Finish	MSL Rating [2]	Operating Temperature (°C) [3]	Device Marking [4]
CT431-HSWF20DR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF20DR YYWWLL
CT431-ASWF20DR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF20DR YYWWLL
CT431-HSWF20MR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF20MR YYWWLL
CT431-ASWF20MR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF20MR YYWWLL
CT431-HSWF30DR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF30DR YYWWLL
CT431-ASWF30DR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF30DR YYWWLL
CT431-HSWF30MR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF30MR YYWWLL
CT431-ASWF30MR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF30MR YYWWLL
CT431-HSWF40MR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF40MR YYWWLL
CT431-HSWF50DR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF50DR YYWWLL
CT431-ASWF50DR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF50DR YYWWLL
CT431-HSWF50MR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF50MR YYWWLL
CT431-ASWF50MR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF50MR YYWWLL
CT431-HSWF65DR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF65DR YYWWLL
CT431-ASWF65DR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF65DR YYWWLL
CT431-HSWF65MR	SOICW	16	1000	Sn	3	–40 to 125	CT431 SWF65MR YYWWLL
CT431-ASWF65MR	SOICW	16	1000	Sn	3	–40 to 125	CT431A SWF65MR 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 ≤ 1,000 ppm.
[2] MSL Rating = Moisture Sensitivity Level Rating as defined by JEDEC standard classifications.
[3] Package will withstand ambient temperature range of –40°C to 125°C and storage temperature range of –65°C to 150°C.
[4] Device Marking for CT431 is defined as CT431 SWFxxZR YYWWLL where the first 2 lines = part number, YY = year, WW = work week, and LL = lot code.

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DEVICE MARKING

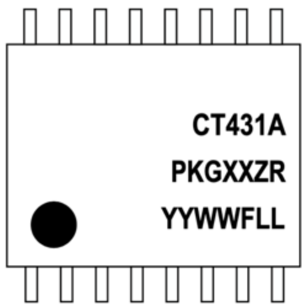

Figure 61: CT431 Device Marking for 16-lead Package

Table 3: CT431 Device Marking Definition for 16-lead SOICW Package

Row No.	Code	Definition
3	•	Pin 1 Indicator
1	CT431	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

CT 4 3 1 - T PKG XY ZR

Polarity
DR = Unipolar or DC Current
MR = Bipolar or AC Current

Current Range
20 = 20 A
30 = 30 A
40 = 40 A
50 = 50 A
65 = 65 A

Package Type
SWF = 16-lead SOIC Wide

Temperature Range
A = AEC-Q100 Grade 1
H = -40°C to +125°C

Current Sensor Variant
1 = V_{CC} is 3.3 V

Current Sensor Type
3 = Contact Current Sensor with VREF

Product Family
4 = Current Sensor

CT = Part Number Prefix

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Revision History

Number	Date	Description
2	November 2, 2023	Document rebranded and minor editorial updates

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