# ALLEGRO microsystems

# CT430

## XtremeSense™ TMR Current Sensor
## with Ultra-Low Noise and <1% Total Error

## 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
  - □ 0 to 50 A
  - □ ±50 A
  - □ 0 to 65 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: 1100 V$_{RMS}$
  - □ Working voltage for reinforced isolation: 550 V$_{RMS}$
- Low noise: 9 to 15 mA$_{RMS}$ @ f$_{BW}$ = 100 kHz
- Reference voltage output
- Immunity to common mode fields: –54 dB
- Supply voltage: 4.75 to 5.50 V
- Overcurrent detection
  - □ Out of range currents
- AEC-Q100 grade 1

## PACKAGE:

*Not to scale*

16-lead SOICW

## DESCRIPTION

The CT430 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 eight 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 CT430 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 CT430 to alert the microcontroller that a fault condition has occurred.

The CT430 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
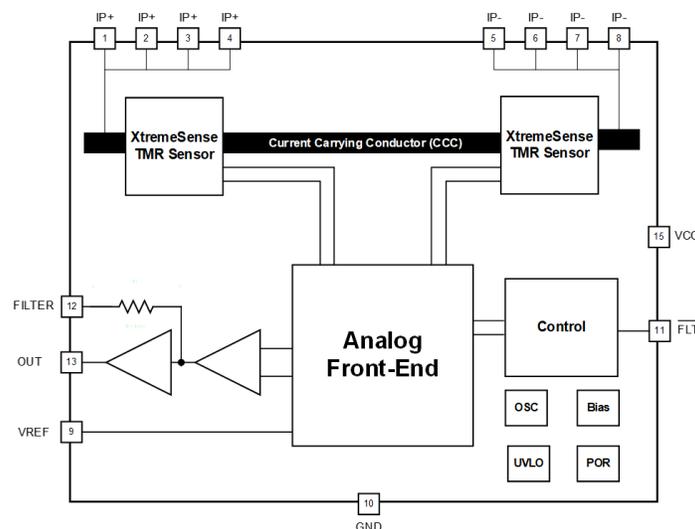
UL Certificate No.: UL-CA-2201235-0



**Figure 1: CT430 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 |
|---|---|---|---|---|---|
| CT430-HSWF20MR | ±20 | 100 | –40 to 125 | 16-lead SOICW 10.21 mm × 10.31 mm × 2.54 mm | Tape and Reel |
| CT430-HSWF30MR | ±30 | 66.7 | | | |
| CT430-HSWF50MR | ±50 | 40 | | | |
| CT430-HSWF65MR | ±65 | 30.8 | | | |
| CT430-HSWF20DR | 20 | 200 | | | |
| CT430-HSWF30DR | 30 | 133.3 | | | |
| CT430-HSWF50DR | 50 | 80 | | | |
| CT430-HSWF65DR | 65 | 61.5 | | | |
| **AEC-Q100 GRADE 1** | | | | | |
| CT430-ASWF20MR | ±20 | 100 | Grade 1 –40 to 125 | 16-lead SOICW 10.21 mm × 10.31 mm × 2.54 mm | Tape and Reel |
| CT430-ASWF30MR | ±30 | 66.7 | | | |
| CT430-ASWF50MR | ±50 | 40 | | | |
| CT430-ASWF65MR | ±65 | 30.8 | | | |
| CT430-ASWF20DR | 20 | 200 | | | |
| CT430-ASWF30DR | 30 | 133.3 | | | |
| CT430-ASWF50DR | 50 | 80 | | | |
| CT430-ASWF65DR | 65 | 61.5 | | | |

## Table of Contents

## 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 CT430 and may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

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

## RECOMMENDED OPERATING CONDITIONS [1]

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

[1] The Recommended Operating Conditions table defines the conditions for actual operation of the CT430. 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 | $V_{IMPULSE}$ | Tested ±5 pulses at 2/minute in compliance to IEC 61000-4-5  1.2 µs (rise) / 50 µs (width) | 8000 | $V_{PK}$ |
| Dielectric Withstand Voltage | $V_{ISO}$ | Agency rated for 60 seconds per UL 62368-1:2014 (edition 2) and per UL 1577[1] | 5000 | $V_{RMS}$ |
| Working Voltage for Basic Isolation | $V_{WVBI}$ | Maximum approved working voltage for basic insulation according to UL 62368-1:2014 (edition 2) | 1556 | $V_{PK}$ |
| | | | 1100 | $V_{RMS}$ |
| Working Voltage for Reinforced Isolation | $V_{WBRI}$ | Maximum approved working voltage for reinforced insulation according to UL 62368-1:2014 (edition 2) | 778 | $V_{PK}$ |
| | | | 550 | $V_{RMS}$ |
| Creepage Distance | $D_{CR}$ | Minimum distance along package body from IP leads to signal leads. | 7.8 | mm |
| Clearance Distance | $D_{CL}$ | 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 accorance with UL 62368-1 (edition 2) and UL 1577.

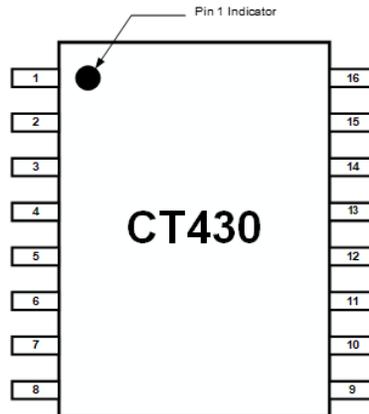## PINOUT DIAGRAM AND TERMINAL LIST



**Figure 2: CT430 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:<br>• Overcurrent Detection<br>• UVLO<br>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.<br>If not used, then do not connect the pin (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 $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, typical values are $V_{CC}$ = 5.00 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] | $R_{IP}$ | | – | 1 | – | 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 | 0.50 | – | 4.50 | 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) | – | 0.50 | – | V |
| | | AC Current (Bipolar) | – | 2.50 | – | 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 (FLT)** | | | | | | |
| 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 |
| 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 |
| 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 $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, typical values are $V_{CC}$ = 5.00 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 |

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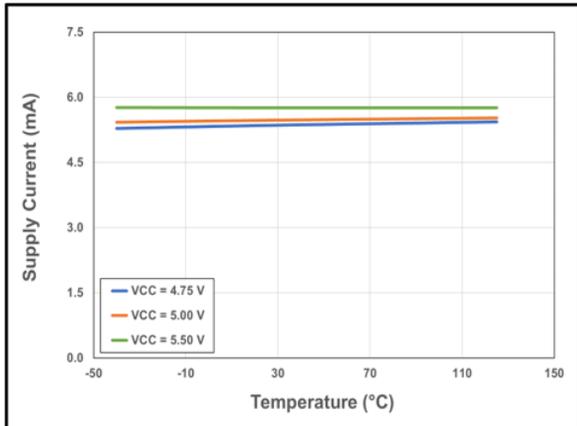


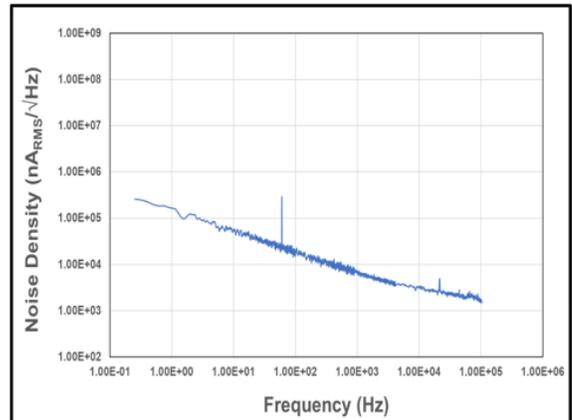Figure 3: CT430 Supply Current vs. Temperature vs. Supply Voltage



Figure 6: Noise Density vs. Frequency



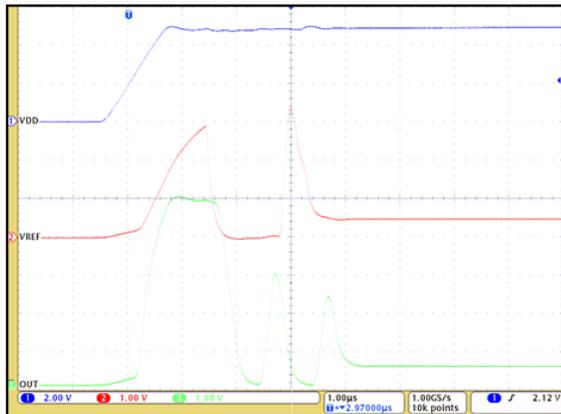Figure 4: CT430 Startup Waveforms for $V_{OQ}$ = 0.50 V (DC Current)

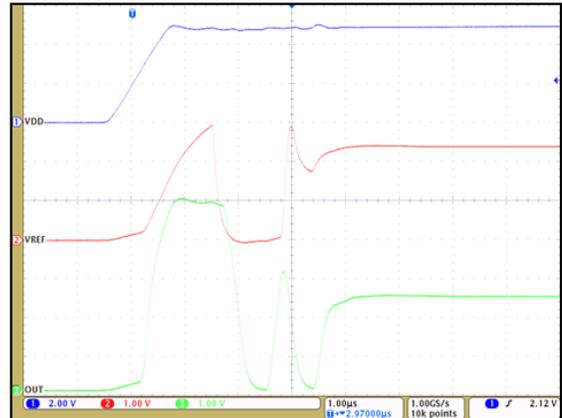

Figure 5: CT430 Startup Waveforms for $V_{OQ}$ = 2.50 V (AC Current)

## ELECTRICAL CHARACTERISTICS (continued)

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



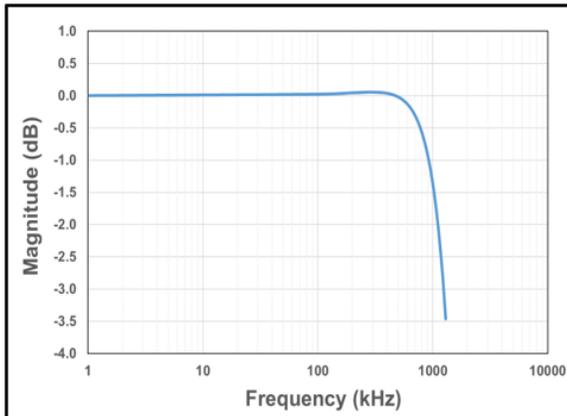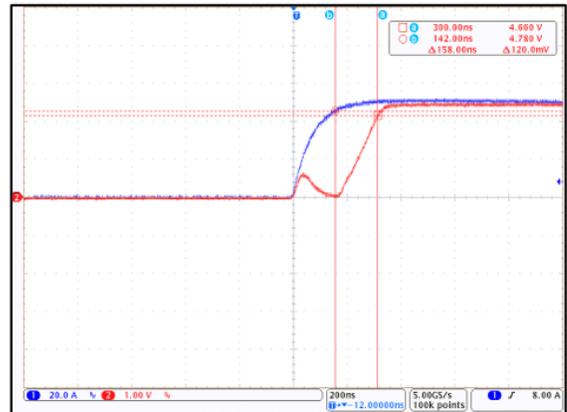**Figure 7: CT430 Bandwidth with $C_{FILTER}$ = 1.0 pF**



**Figure 8: CT430 Response Time; $I_P$ = 50 $A_{PK}$
and $C_L$ = 100 pF (Blue = $I_{CCC}$, Red = $V_{OUT}$)**



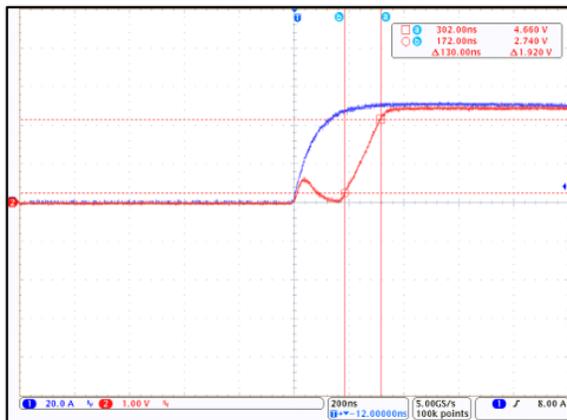**Figure 9: CT430 Rise Time; $I_P$ = 50 $A_{PK}$ and CL = 100 pF
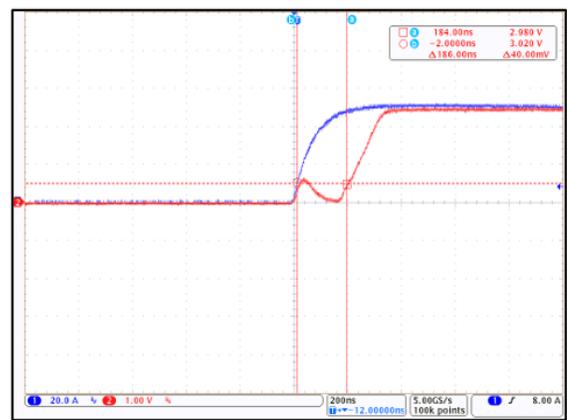(Blue = $I_{CCC}$, Red = $V_{OUT}$)**



**Figure 10: CT430 Propagation Delay; $I_P$ = 50 $A_{PK}$
and $C_L$ = 100 pF (Blue = $I_{CCC}$, Red = $V_{OUT}$)**

## ELECTRICAL CHARACTERISTICS (continued)

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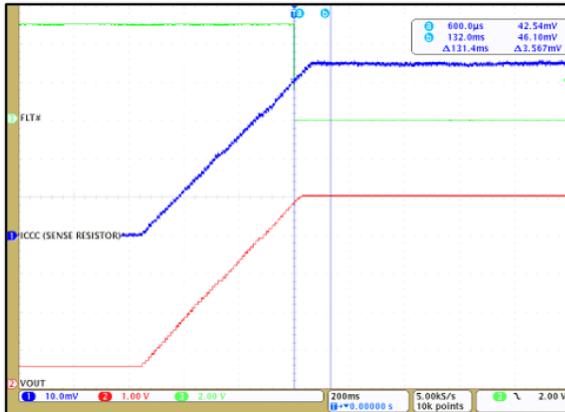


**Figure 11: CT430 OCD enabled at 110% of 50 $A_{DC}$ and $\overline{FLT}$ is Low**



**Figure 12: CT430 OCD disabled at 90% of 50 $A_{DC}$ and $\overline{FLT}$ is High**



**Figure 13: CT430 OCD enabled at 110% of 50 $A_{PK}$ and $\overline{FLT}$ is Low**
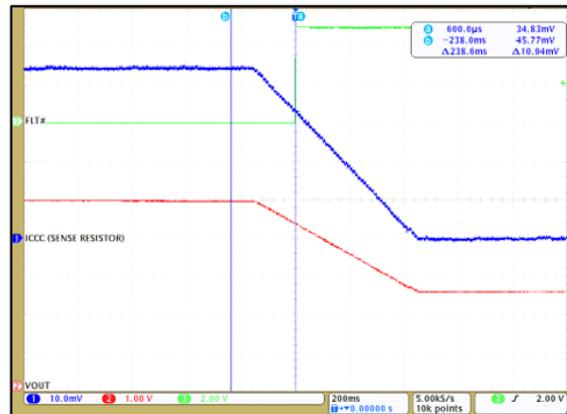


**Figure 14: CT430 OCD disabled at 90% of 50 $A_{PK}$ and $\overline{FLT}$ is High**

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## ELECTRICAL CHARACTERISTICS (continued)

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



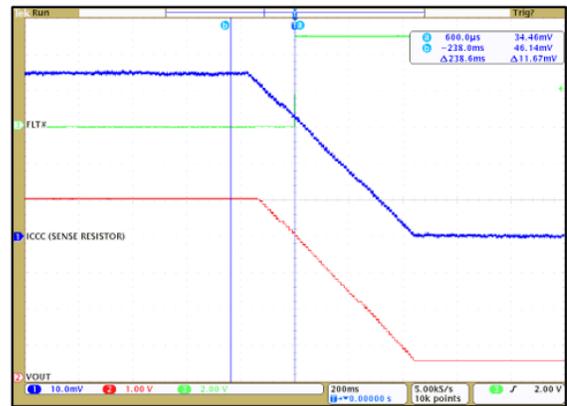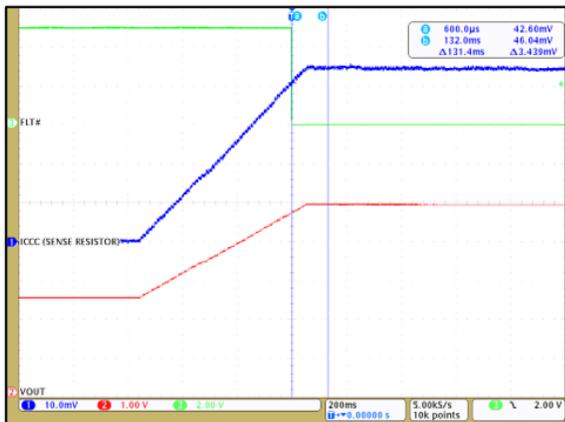**Figure 15: CT430 OCD enabled at –110% of –50 $A_{PK}$ and $\overline{FLT}$ is Low**



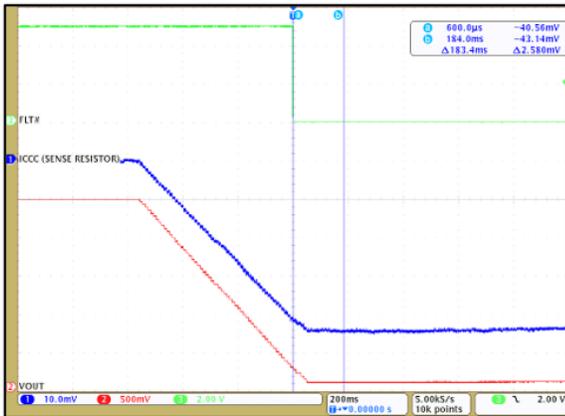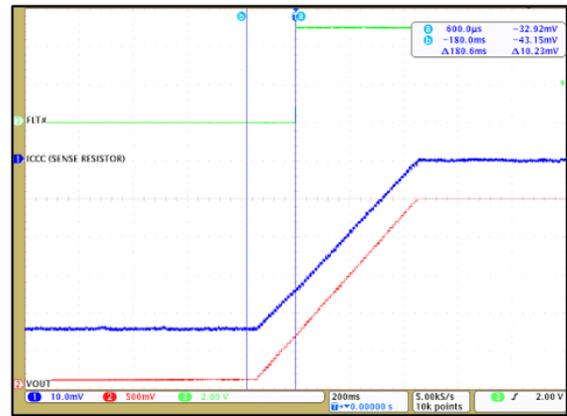**Figure 16: CT430 OCD disabled at –90% of –50 $A_{PK}$ and $\overline{FLT}$ is High**

**CT430-xSWF20DR: 0 to 20 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | 0 | – | 20 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 0.495 | 0.500 | 0.505 | V |
| Sensitivity | S | $I_{RANGE(MIN)}$ < $I_P$ < $I_{RANGE(MAX)}$ | – | 200 | – | 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 | – | 9.0 | – | mA$_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.2 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.2 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.3 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.2 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±3 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±19 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±13 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.0 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±26 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

**CT430-xSWF20MR: ±20 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | –20 | – | 20 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 2.495 | 2.500 | 2.505 | 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 | – | 10.0 | – | $mA_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.1 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.1 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.4 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.4 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±2 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±13 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±16 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.2 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±29 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

**CT430-xSWF30DR: 0 to 30 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | 0 | – | 30 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 0.495 | 0.500 | 0.505 | V |
| Sensitivity | S | $I_{RANGE(MIN)}$ < $I_P$ < $I_{RANGE(MAX)}$ | – | 133.3 | – | 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 | – | 10.0 | – | $mA_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.3 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.2 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.2 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.1 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±2 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±12 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±11 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±25 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

**CT430-xSWF30MR: ±30 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | –30 | – | 30 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 2.495 | 2.500 | 2.505 | 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°C, $f_{BW}$ = 100 kHz | – | 11.5 | – | $mA_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.2 | – | % FS |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.2 | – | % |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.3 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.0 | – | % |
| | | $I_P$ = 0 A, $T_A$ = 25°C | – | ±2 | – | mV |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 125°C | – | ±12 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±19 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.0 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±31 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

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**CT430-xSWF50DR: 0 to 50 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | 0 | – | 50 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 0.495 | 0.500 | 0.505 | V |
| Sensitivity | S | $I_{RANGE(MIN)}$ < $I_P$ < $I_{RANGE(MAX)}$ | – | 80 | – | 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 | – | 10.0 | – | mA$_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.2 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.2 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.6 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.4 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±5 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±10 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±16 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.5 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.2 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±29 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

# CT430

## XtremeSense™ TMR Current Sensor with Ultra-Low Noise and <1% Total Error

**CT430-xSWF50MR: ±50 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | –50 | – | 50 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 2.495 | 2.500 | 2.505 | 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 | – | 14.0 | – | mA$_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.2 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.2 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.2 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.1 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±2 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±12 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±18 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±30 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

# CT430

**CT430-xSWF65DR: 0 to 65 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | 0 | – | 65 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 0.495 | 0.500 | 0.505 | V |
| Sensitivity | S | $I_{RANGE(MIN)} < I_P < I_{RANGE(MAX)}$ | – | 61.5 | – | 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 | – | 10.0 | – | mA$_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P = I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.1 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P = I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.3 | – | % |
| | | $I_P = I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.4 | – | % |
| | | $I_P = I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.5 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±1 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±9 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±12 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P = I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.4 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P = I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.1 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±25 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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.

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# XtremeSense™ TMR Current Sensor with Ultra-Low Noise and <1% Total Error

**CT430-xSWF65MR: ±65 A – PERFORMANCE CHARACTERISTICS:** Valid for $V_{CC}$ = 4.75 to 5.50 V, $C_{BYP}$ = 1.0 µF, and $T_A$ = –40°C to 125°C, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| Current Range | $I_{RANGE}$ | | –65 | – | 65 | A |
| Voltage Output Quiescent | $V_{OQ}$ | $T_A$ = 25°C, $I_P$ = 0 A | 2.495 | 2.500 | 2.505 | 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 | – | 13.5 | – | mA$_{RMS}$ |
| **OUT ACCURACY PERFORMANCE** | | | | | | |
| Total Output Error | $E_{TOT}$ | $I_P$ sweep from $I_{P(MIN)}$ to $I_{P(MAX)}$ | – | – | ±1.0 | % FS |
| Linearity Error | $E_{LIN}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±0.1 | – | % FS |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = 25°C | – | ±0.3 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = 125°C | – | ±1.3 | – | % |
| | | $I_P$ = $I_{P(MAX)}$, $T_A$ = -40°C | – | ±1.3 | – | % |
| Offset Voltage Error | $V_{OE}$ | $I_P$ = 0 A, $T_A$ = 25°C | – | ±2 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = 125°C | – | ±15 | – | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C | – | ±19 | – | mV |
| **LIFETIME DRIFT** | | | | | | |
| Total Error Including Lifetime Drift | $E_{TOT(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±1.9 | – | % FS |
| Sensitivity Error Including Lifetime Drift | $E_{SENS(DRIFT)}$ | $I_P$ = $I_{P(MAX)}$, $T_A$ = –40°C to 125°C | – | ±2.0 | – | % |
| Offset Voltage Error Including Lifetime Drift | $V_{OE(DRIFT)}$ | $I_P$ = 0 A, $T_A$ = –40°C to 125°C | – | ±31 | – | mV |

[1] Typicals values are the mean ±3 sigma of production distributions. These are formatted as mean ±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 CT430 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 eight current ranges:

- 0 to 20 A
- ±20 A
- 0 to 30 A
- ±30 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 CT430 is 1.0 MHz. Even with a high bandwidth, the chip consumes a minimal amount of power.

### Linear Output Current Measurement

The CT430 provides a continuous linear analog output voltage which represents the current measurement. The output voltage range of OUT is from 0.50 to 4.50 V with a $V_{OQ}$ of 0.50 V and 2.50 V for unidirectional and bidirectional currents, respectively. Figure 17 illustrates the output voltage range of the OUT pin as a function of the measured current.
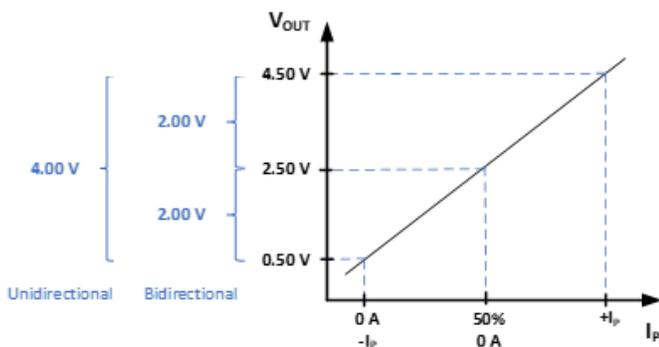


**Figure 17: Linear Output Voltage Range (OUT) vs. Measured Current (IP)**

### Filter Function (FILTER)

The CT430 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 CT430 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 $f_{BW} = \frac{1}{2\pi RC}$ because of the parasitic capacitances due to PCB manufacturing and layout. This is further impacted by the small, picofarad level $C_{FILTER}$ recommendations.
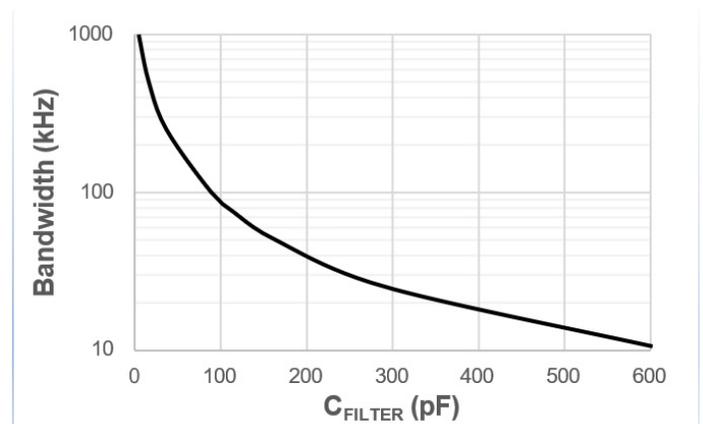


**Figure 18: Experimental Bandwidth vs. $C_{FILTER}$**

### Voltage Reference Function (VREF)

The CT430 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 CT430 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 CT430 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.
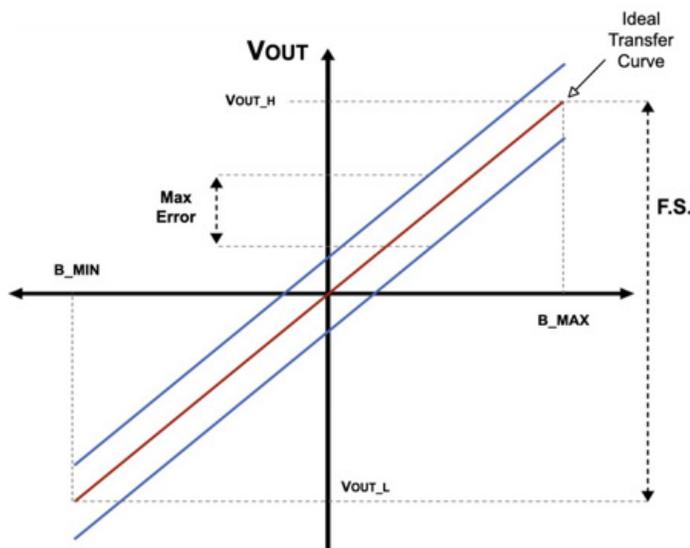


**Figure 19: Total Output Error ($E_{OUT}$) vs. Sensed Current ($I_P$)**

The CT430 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 CT430 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 CT430 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.
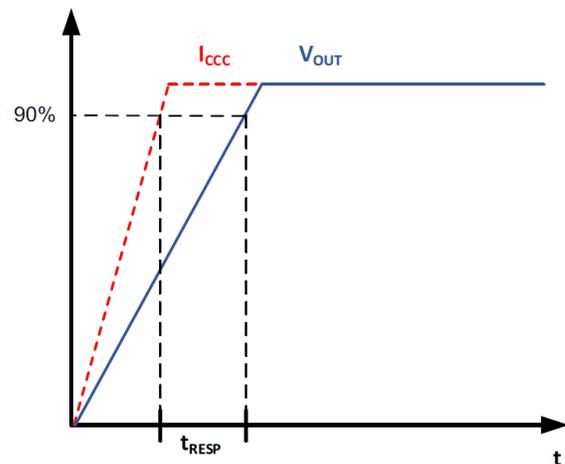


**Figure 20: CT430 Response Time Curve**

## 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 CT430 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 CT430 has a propagation delay of 250 ns.
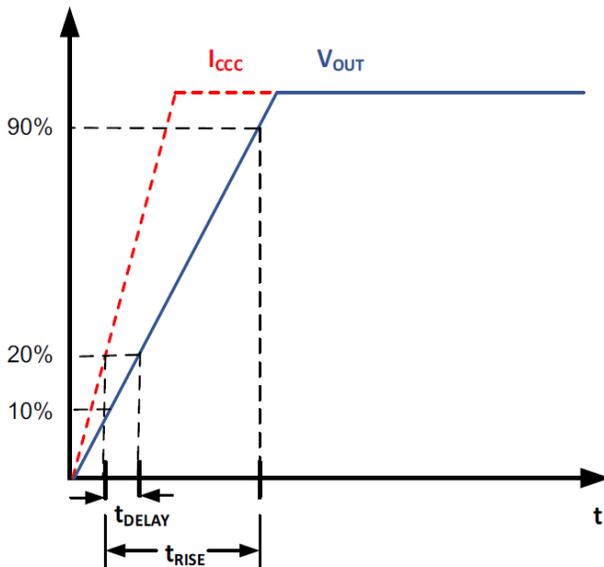


**Figure 21: CT430 Propagation Delay and Rise Time Curve**

## Overcurrent Detection (OCD)

The Overcurrent Detection (OCD) circuitry detects measured current values that are 110% above the maximum current range value of the CT430 for the unipolar (DC current) variant. For the bipolar (AC current) variant of the CT430 it is greater than ±110% of the maximum current range. This will generate a fault signal via the Fault# Interrupt ($\overline{FLT}$) 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 $\overline{FLT}$ pin will go high.

## Undervoltage Lockout (UVLO)

The Undervoltage Lockout protection circuitry of the CT430 is activated when the supply voltage (V$_{CC}$) falls below 2.45 V. The CT430 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 CT430 is not valid, and the $\overline{FLT}$ pin will go low. Once V$_{CC}$ rises above 2.50 V then the UVLO is cleared, and the $\overline{FLT}$ pin will be high.

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

The CT430 generates an active LOW digital fault signal via the $\overline{FLT}$ 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 $\overline{FLT}$ signal will be asserted low whenever one of the above fault events occur. In the case of an UVLO event, the $\overline{FLT}$ pin will stay low until the fault is cleared and then go high.

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

## Immunity to Common Mode Fields

The CT430 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 CT430 is able to achieve –54 dB of Common Mode Rejection Ratio (CMFRR). Also, good PCB layout of the CT430 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.
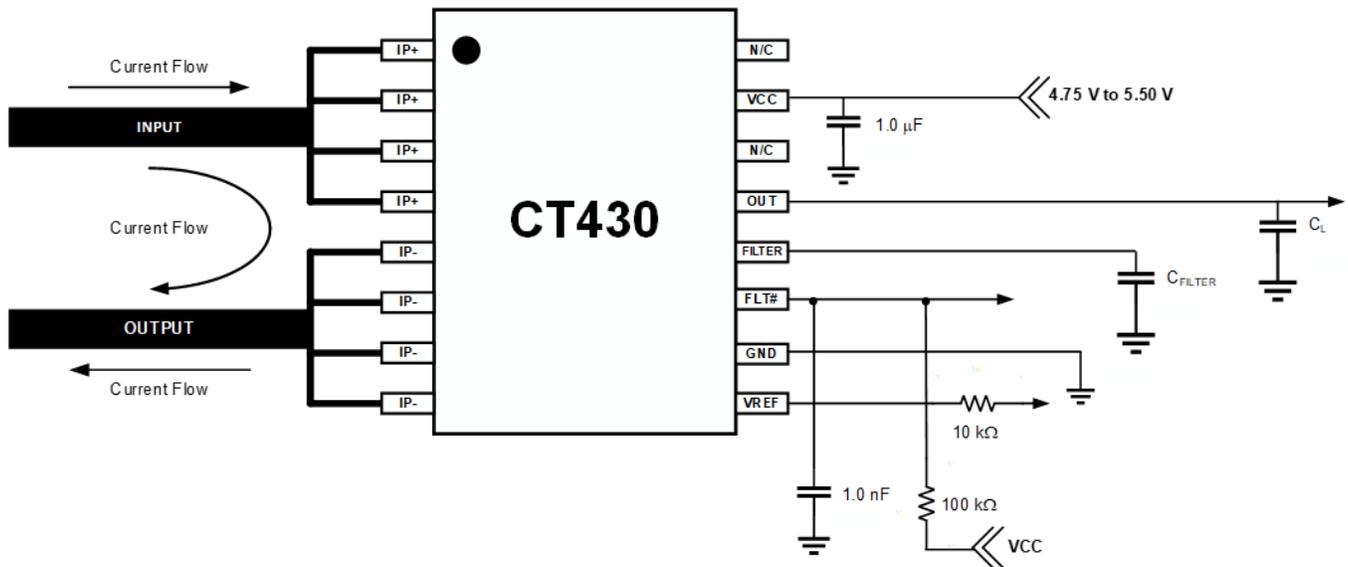
**Figure 22: CT430 Application Block Diagram**

## Application

The CT430 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 CT430. Figure 22 is an application diagram of how CT430 would be implemented in a system. The third output is the VREF which provides the output reference voltage of the CT430.

The device is designed to support an operating voltage range of 4.75 V to 5.50 V, but it is ideal to use a 5.0 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 CT430 to minimize inductance and resistance between the two devices.

## Filter Capacitor

A capacitor may be added to the FILTER pin of the CT430 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 CT430, 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 CT430 can measure up to 65 A of current, special care must be taken in the printed circuit board (PCB) layout of the CT430 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-

per be used for PCB traces when the CT430 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 23 and Figure 24 show the recommended the PCB layout for the 20 A, 30 A, 50 A, and 65 A variants of the CT430. Note that the traces connected to the IP+ and IP- pins of the CT430 are very wide with multiple vias such that it can handle the high current.
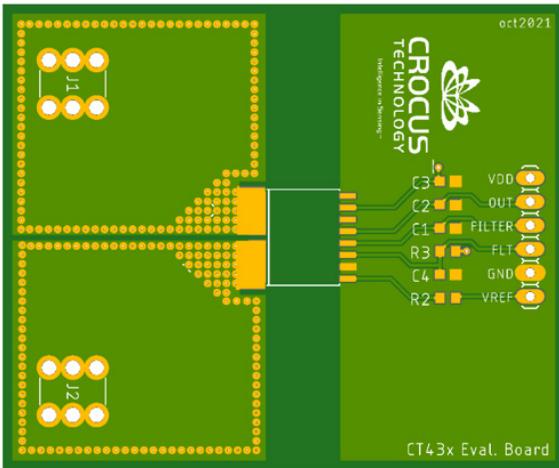


**Figure 23: Recommended PCB Layout (Top Layer) for the 20 A to 65 A variants of the CT430**
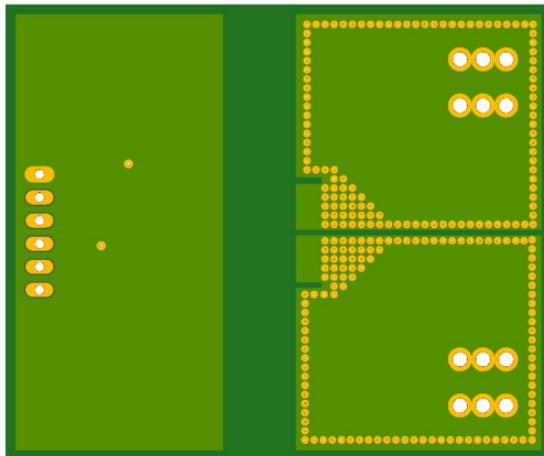


**Figure 24: Recommended PCB Layout (Bottom Layer) for the 20 A to 65 A variants of the CT430**

## Fuse Time vs. Current

Since the CT430 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 CT430 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 CT430 due to short circuit or transient current spikes for a specific duration of time, the leadframe will be permanently damaged.
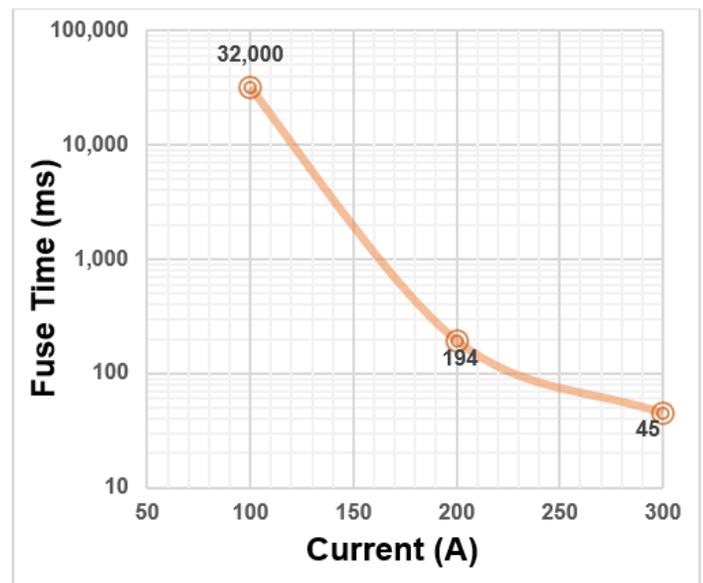


**Figure 25: CT430 Fuse Time vs. Current**

Figure 25 illustrates the CT430 fuse time for 100 A, 200 A, and 300 A current levels. The CT430 tolerates 100 A for 32 seconds while, at 200 A and 300 A, the fuse times are 194 ms and 45 ms, respectively.

## 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 26 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 $T_A$.
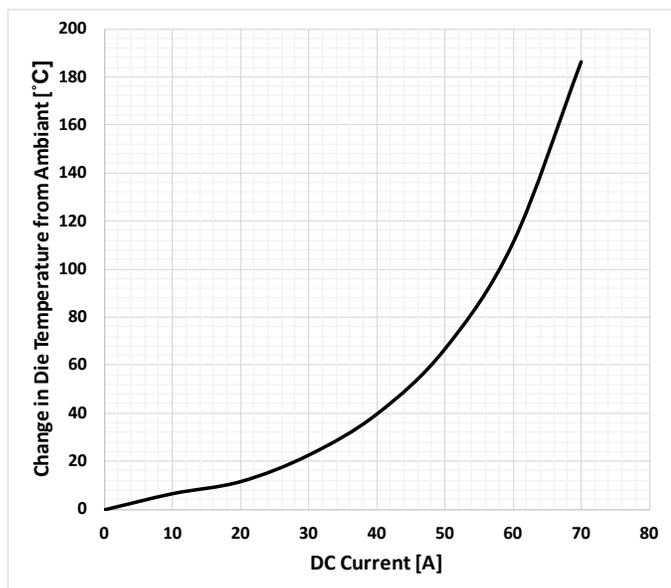


**Figure 26: Self Heating in the LA Package Due to Current Flow**
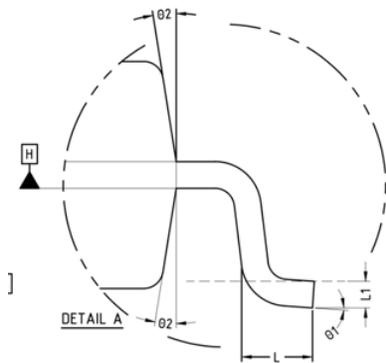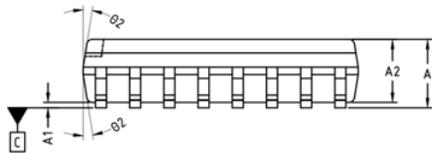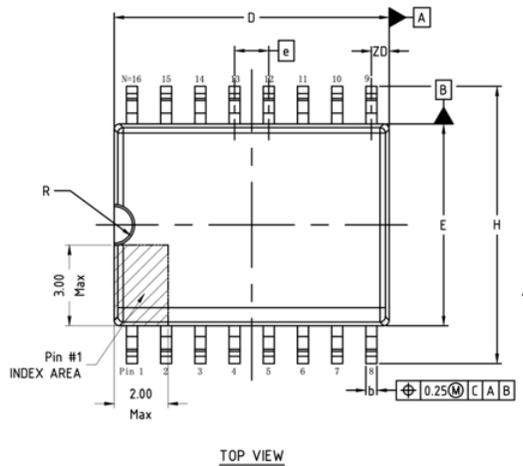
## PACKAGE OUTLINE DRAWING

**Table 1: CT430 SOICW-16 Package Dimensions**

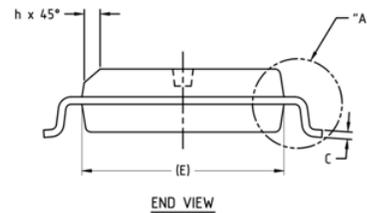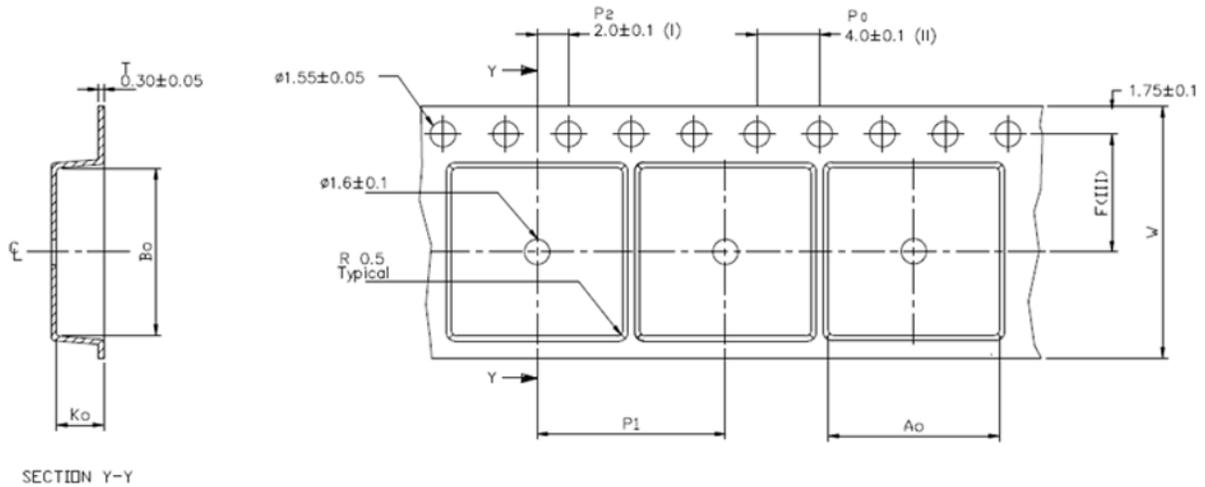| Symbol | Dimensions in Millimeters (mm) | | |
|:---:|:---:|:---:|:---:|
| | Min. | Typ. | Max. |
| A | 2.44 | 2.54 | 2.64 |
| A1 | 0.10 | 0.20 | 0.30 |
| A2 | 2.24 | 2.34 | 2.44 |
| b | 0.36 | 0.41 | 0.46 |
| C | 0.23 | – | 0.32 |
| D | 10.11 | 10.21 | 10.31 |
| E | 7.40 | 7.50 | 7.60 |
| e | 1.27 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 27: SOICW-16 Package Drawing and Dimensions**

## 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.

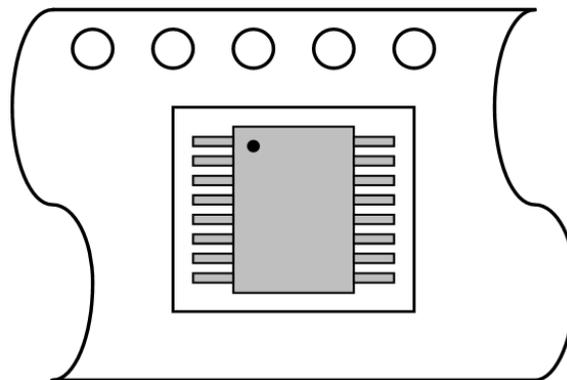**Figure 28: Tape and Pocket Drawing for SOICW-16 Package**



**Figure 29: SOICW-16 Orientation in Tape Pocket**

## PACKAGE INFORMATION

**Table 2: CT430 Package Information**

| Part Number | Package Type | # of Leads | Package Quantity | Lead Finish | MSL Rating [2] | Operating Temperature (°C) [3] | Device Marking [4] |
|---|---|---|---|---|---|---|---|
| CT430-HSWF20DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF20DR YYWWLL |
| CT430-ASWF20DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF20DR YYWWLL |
| CT430-HSWF20MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF20MR YYWWLL |
| CT430-ASWF20MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF20MR YYWWLL |
| CT430-HSWF30DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF30DR YYWWLL |
| CT430-ASWF30DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF30DR YYWWLL |
| CT430-HSWF30MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF30MR YYWWLL |
| CT430-ASWF30MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF30MR YYWWLL |
| CT430-HSWF50DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF50DR YYWWLL |
| CT430-ASWF50DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF50DR YYWWLL |
| CT430-HSWF50MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF50MR YYWWLL |
| CT430-ASWF50MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF50MR YYWWLL |
| CT430-HSWF65DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF65DR YYWWLL |
| CT430-ASWF65DR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A SWF65DR YYWWLL |
| CT430-HSWF65MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430 SWF65MR YYWWLL |
| CT430-ASWF65MR | SOICW | 16 | 1000 | Sn | 3 | –40 to 125 | CT430A 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 CT430 is defined as CT430 SWFxxZR YYWWLL where the first 2 lines = part number, YY = year, WW = work week, and LL = lot code.
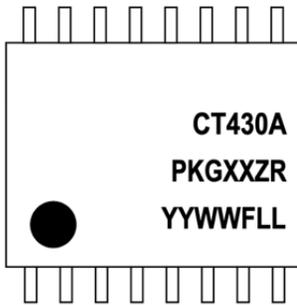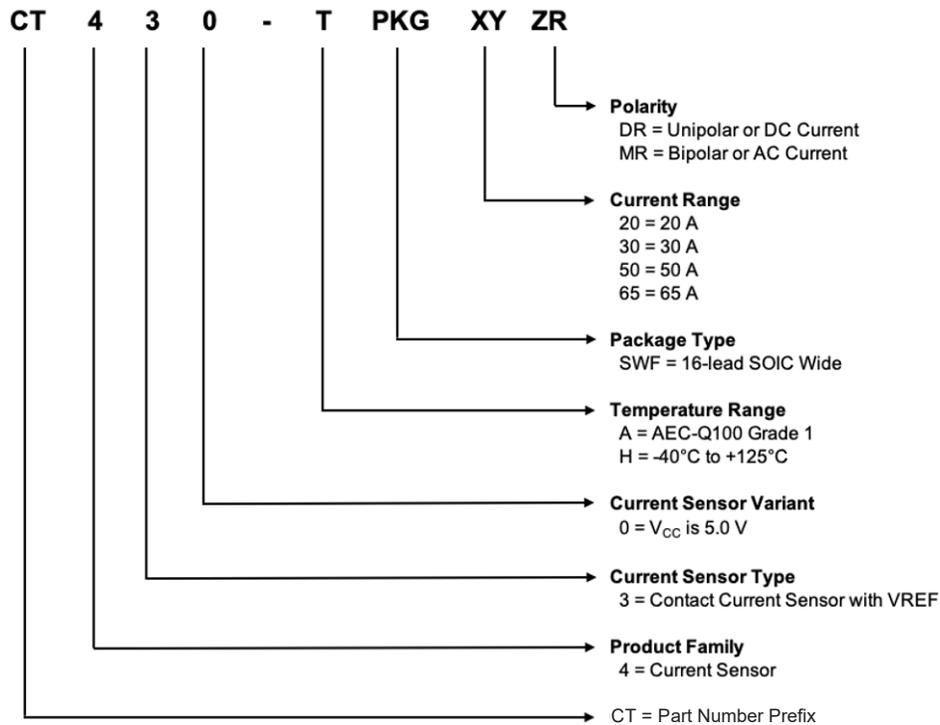
## DEVICE MARKING



Figure 30: CT430 Device Marking for 16-lead Package

Table 3: CT430 Device Marking Definition for 16-lead SOICW Package

| Row No. | Code | Definition |
|---|---|---|
| 3 | • | Pin 1 Indicator |
| 1 | CT430 | 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  0  -  T  PKG  XY  ZR

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

**Current Range**
20 = 20 A
30 = 30 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**
0 = $V_{CC}$ is 5.0 V

**Current Sensor Type**
3 = Contact Current Sensor with VREF

**Product Family**
4 = Current Sensor

CT = Part Number Prefix

## Revision History

| Number | Date | Description |
|--------|------|-------------|
| 3 | November 2, 2023 | Document rebranded and minor editorial updates |
| 4 | April 16, 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); added Thermal Rise vs. Primary Current section (page 25); removed performance graph pages. |
| 5 | April 29, 2024 | Updated Primary Conductor Resistance value (page 6). |

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