

ZXCT1032

High-side inrush controller and electronic fuse

Description

The ZXCT1032 is a high-side current monitor that drives a PMOS or PNP transistor to provide in-rush current limit and over-current protection. The ZXCT1032 includes a high accuracy high-side current monitor, a start-up timer and a re-try inhibit timer.

The ZXCT1032 takes the voltage developed across a current shunt resistor and compares this with an externally set trip point. It works in three modes:

- Linear soft-start
- Over-current detector
- Over-current disconnect/fuse

Linear soft-start

Upon power up the ZXCT1032 enters a linear soft-start mode. During which the output current ramps up from zero to a maximum user defined trip point. The trip point is set by the voltage on I_{SET} pin and R_{SENSE}.

The ramp rate is determined by capacitor C_T. The soft start ensures that capacitive loads are smoothly charged without causing excessive power supply startup transients.

Over-current detector

When external capacitor C_T has charged up above the V_{ISET} the ZXCT1032 switches from its soft-start mode to its over-current detection mode. During this mode the external MOSFET will be fully enhanced reducing the its voltage drop and power dissipation.

Features

- Accurate high-side current sensing
- User defined and dynamically adjustable trip current
- Load switch control
- Fault flag logic output
- User defined ramp and inhibit timers
- SO8 package
- Temperature range -40 to 85°C

Ordering information

| Order code | Pack | Part mark | Reel size | Tape width | Quantity per reel |
|--------------|------|-----------|-----------|------------|-------------------|
| ZXCT1032N8TA | SO8 | 1032 | 7" | 12mm | 500 |

While in this mode the internal current monitor continually checks the output current and compares it to the trip-current level determined by V_{ISET}.

Over-current disconnect/fuse

If the trip current limit is exceeded at any time the ZXCT1032 enters its Over-current disconnect mode. The drive pin is driven high, turning the pass MOSFET off; the flag output goes low indicating a fault.

The drive and flag outputs are latched in these states for a period determined by C_T, V_{ISET} and the internally set discharge current (3µA typical). After C_T has discharged to 80mV the ZXCT1032 will restart into its linear soft-start mode.

The C_T charge and discharge times have been ratioed to so that the power dissipation in the pass MOSFET should allow indefinite operation in the event of a continuous load failure.

Pin 3 description:

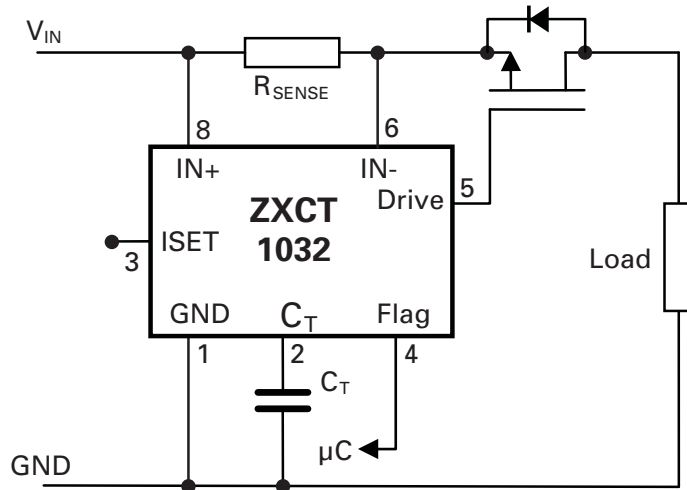
Determines the load current trip level or constant current level. ISET can be left open circuit (internal 2.1V reference) or driven via a DC voltage or µC PWM output. Its source impedance is 50kΩ.

Applications

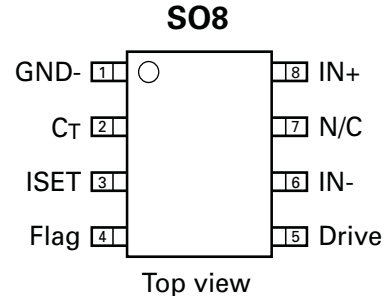
- Electronic fuse
- Short circuit protected supply feed
- Hot swap
- Power over twisted pair

ZXCT1032

Typical application circuit



Pinout connections



Pin description

| Pin | Name | Description |
|-----|----------------|--|
| 1 | GND | Ground reference for I _{SET} and Flag pins. Most negative terminal of the device. No other pin should go below this voltage. |
| 2 | C _T | An external capacitor is connected to this pin and is used to determine the period for constant-current mode and the timeout before restarting. To reduce excessive heating during the soft start mode capacitors less than 220nF are recommended. |
| 3 | ISET | Determines the load current trip level or constant current level. This can be driven via a DC voltage or via a µC PWM output. $V_{SENSE} = (V_{ISET} - 150mV) / 10$ An input <100mV will disable the high-side switch (i.e. set I _{OUT} = 0) If left open-circuit, an accurate internal DC reference of 2.1V and source impedance of 50kΩ is used to set the voltage on this pin. (External drivers must take this reference into account.) |
| 4 | Flag | This is an active low open collector output that goes low whenever the current limit set by the choice of R _{SENSE} and I _{SET} is reached or in the event of a shorted load. |
| 5 | Drive | This is the output drive pin to the external high side referred switch on the ZXCT1032, capable of driving PMOS and PNP transistors. |
| 6 | IN- | The load referred input to the current monitor control loop. |
| 7 | N/C | Not connected |
| 8 | IN+ | Acts as both the supply pin to the ZXCT1032 and the supply referred sense input to the current monitor control loop. |

Absolute maximum ratings

| | |
|--|-----------------------------|
| V_{IN+} max ^(a) | 28 V |
| Voltage on any pin relative to GND | -0.6V and $V_{IN+} + 0.5$ V |
| Maximum differential voltage between V_{IN+} and V_{IN-} (V_{SENSE}) | 500 mV |
| Junction temperature range | -40 to 150°C |
| Storage temperature range | -55 to 150°C |

Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, for extended periods, may reduce device reliability.

NOTES:

(a) Up to a maximum of 24 hours

Recommended operating conditions

| Symbol | Parameter | Min. | Max. | Units |
|------------|---------------------------|------|-----------|-------|
| V_{IN+} | Supply range | 9.5 | 21 | V |
| T_A | Ambient temperature range | -40 | 85 | °C |
| V_{FLAG} | Flag voltage range | 0 | V_{IN+} | V |
| V_{ISET} | Voltage on ISET pin | 1 | 2.5 | V |

Electrical characteristics

Test conditions $T_{amb} = 25^\circ\text{C}$, $V_{IN+} = 20\text{V}$. Unless otherwise stated.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|-------------------|---|--|--------------------|--------------------|----------------|---------------|
| I_Q | Quiescent current | $V_{SENSE}^1 = 0\text{V}$, $V_{-ISET} = 2.1\text{V}$ | | 1.6 | 2.5 | mA |
| $V_{STRIP}^{(*)}$ | Flag trip threshold voltage | $V_{ISET} = 1.1\text{V}$ | | 95 | | mV |
| | | $V_{ISET} = 2.1\text{V}$ | 185 | 195 | 205 | |
| V_{ISET} | ISET open voltage | $I_{ISET} = 0$ | 2.0 | 2.1 | 2.2 | V |
| I_{ISET} | ISET output current | $V_{ISET} = 0\text{V}$ | 30 | 45 | 60 | μA |
| V_{DRIVEH} | Drive high output voltage | $V_{ISET} = 2.1\text{V}$, $V_{SENSE} > 205\text{mV}$, $I_{DRIVE} = 0$, | V_{IN-} - 0.4 | V_{IN-} - 0.2 | | V |
| V_{DRIVEL} | Drive low output voltage | $V_{ISET} = 2.1\text{V}$, $V_{SENSE} < 185\text{mV}$, $I_{DRIVE} = 0$, | V_{IN-} - 7 | V_{IN-} - 5.5 | V_{IN-} 4 | V |
| R_{DRIVEL} | Drive low output resistance | $V_{ISET} = 2.1\text{V}$, $V_{SENSE} < 185\text{mV}$ | | 9 | | k Ω |
| V_{FLAGL} | Flag Low output Voltage | $V_{ISET} = 2.1\text{V}$, $V_{SENSE} > 205\text{mV}$ $I_{FLAG} = 100\mu\text{A}$ | | 0.2 | 0.4 | V |
| I_{FLAGZ} | Flag open circuit leakage current | $V_{ISET} = 2.1\text{V}$, $V_{SENSE} < 185\text{mV}$, $V_{FLAG} = 5\text{V}$ | | 1 | 200 | nA |
| I_{IN-} | IN- bias current | $V_{ISET} = 0\text{V}$ | | 100 | 200 | nA |
| $V_{STRIP-TC}$ | Temperature coefficient of trip voltage | See footnote (†) | | 95 | | ppm/°C |
| I_{CT-CHG} | Capacitor C_T charging current | FLAG = Open | 130 | 200 | 270 | μA |
| I_{CT-DIS} | Capacitor C_T discharging current | FLAG = Low | 1.8 | 3.3 | 5.4 | μA |

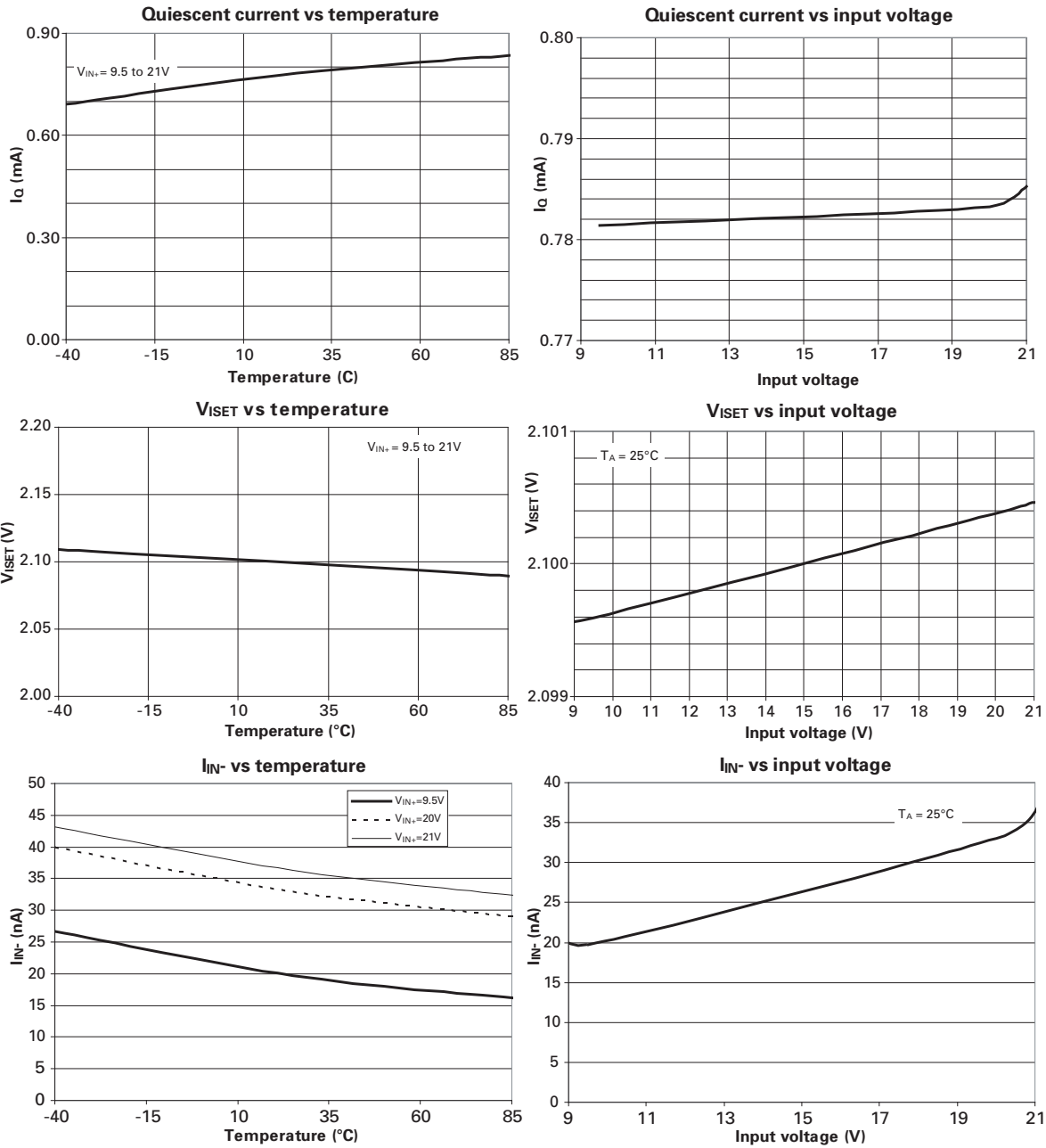
NOTES:

(*) $V_{SENSE} = V_{IN+} - V_{IN-}$. V_{STRIP} is the sense voltage at which the device trips into over-current protection.

(†) Temperature dependent measurements are extracted from characterization and simulation results.

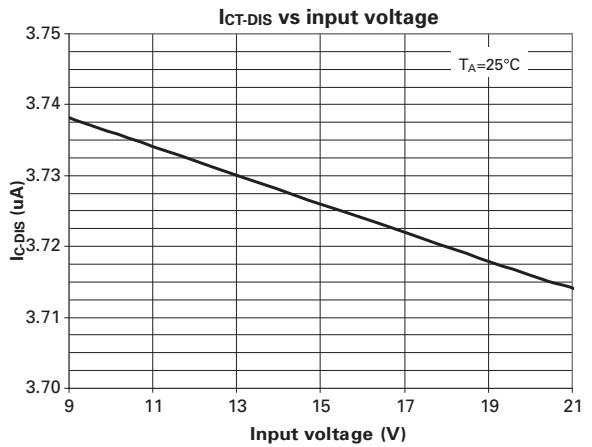
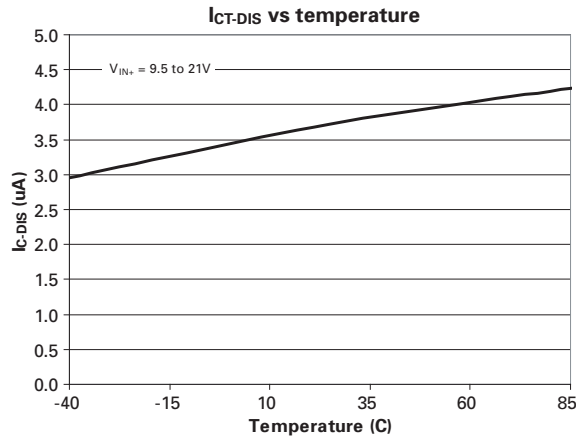
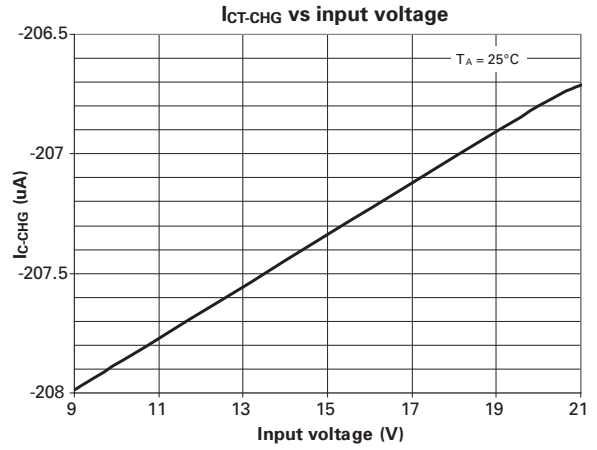
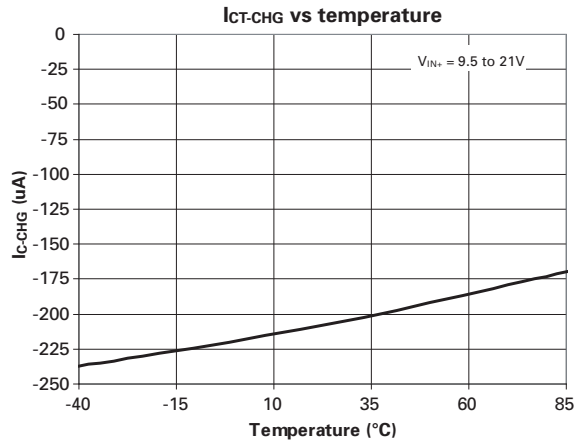
Typical characteristics

($T_A = 25^\circ\text{C}$ and $V_{IN+} = 20\text{V}$ unless otherwise stated)



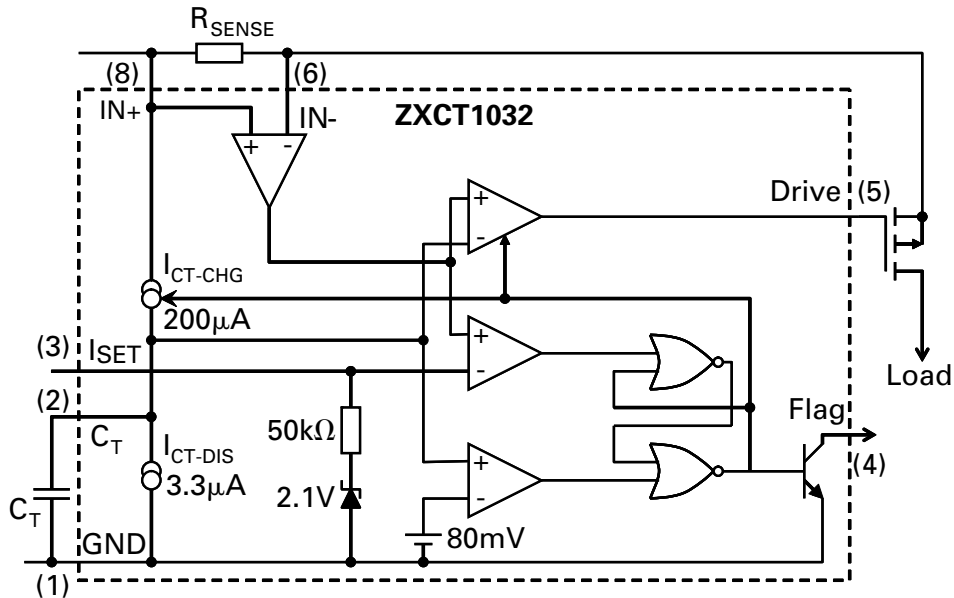
Typical characteristics

($T_A = 25^\circ\text{C}$ and $V_{IN+} = 20\text{V}$ unless otherwise stated)



Application information

ZXCT1032 block diagram and description

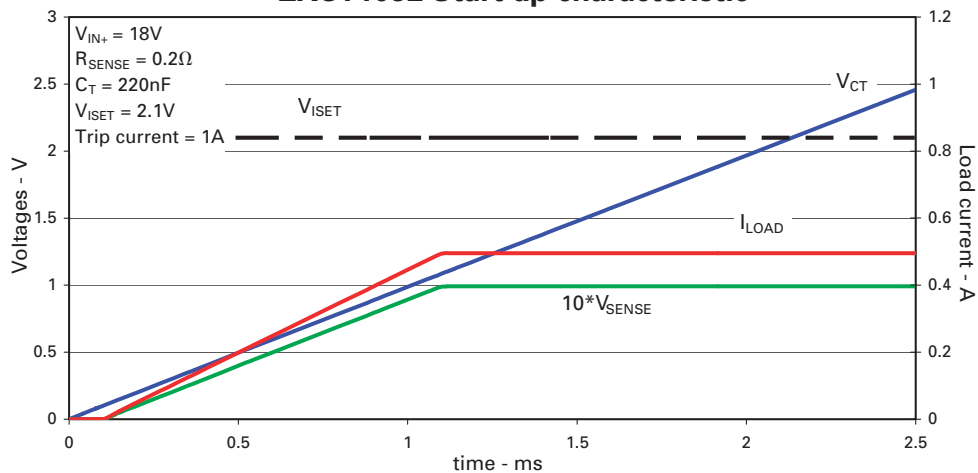


Operation of the ZXCT1032

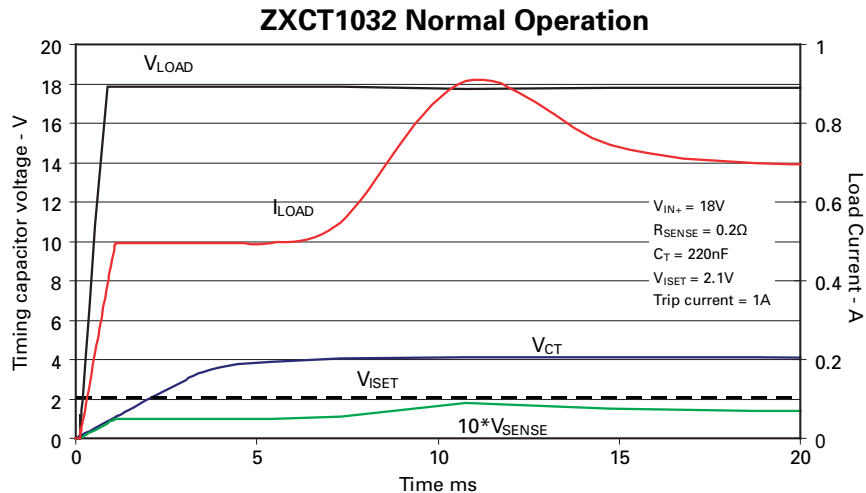
- 1 After power-up, the timing capacitor (C_T) is charged up by a $200\mu\text{A}$ current source. This causes the output amplifier's drive pin to fall in voltage, progressively turning on the PMOS transistor.

The load current is monitored by the current monitor and the amplifier control loop controls the load current allowing it to increase gradually (soft-start mode) as the voltage on C_T increases. During the soft-start phase the load current will start to build up while there is a large voltage across the pass MOSFET; this can lead to large power dissipation if large capacitive loads are driven and/or large C_T is used.

ZXCT1032 Start up characteristic

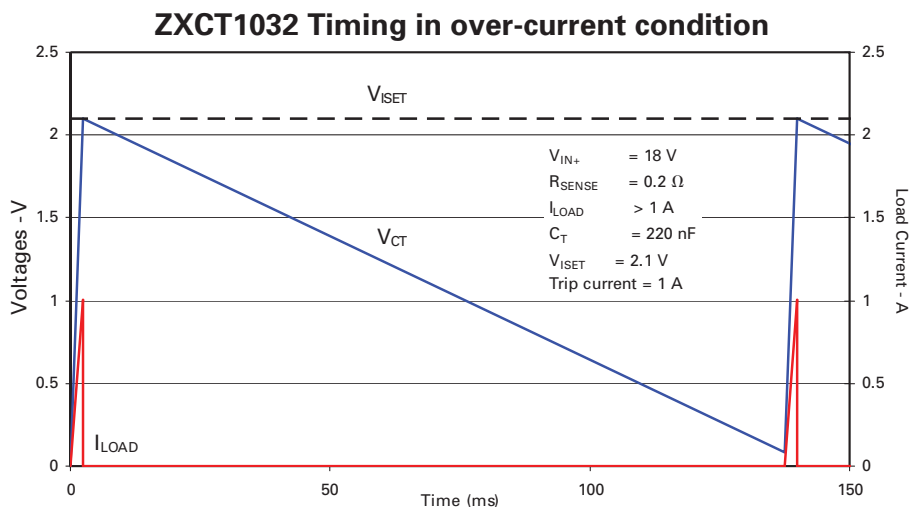


- 2 The output voltage also increases due to the load current powering up the load and charging any capacitance. After the initial soft start (load current stabilizing) the timing capacitor charges up to 4V and the device enters its normal mode of operation. The external MOSFET will be now fully enhanced minimizing any serial voltage drop.



The ZXCT1032 has now entered its over-current detector mode; it is effectively “transparent” to the load until the current monitor output exceeds the trip point.

- 3 Fuse operation is provided by the trip comparator whose threshold voltage is set by V_{ISET} (internally nominally 2.1V, although this threshold can easily be overdriven). As the load current increases, so does the monitor voltage. When the current monitor output voltage exceeds V_{ISET} , the trip comparator output goes high and sets the latch with the following results:
- The output drive is disabled.
 - The open collector Flag output goes low to indicate a fault condition.
 - The $200\mu A$ current source is turned off and C_T starts to discharge slowly via a $3.3\mu A$ current source.



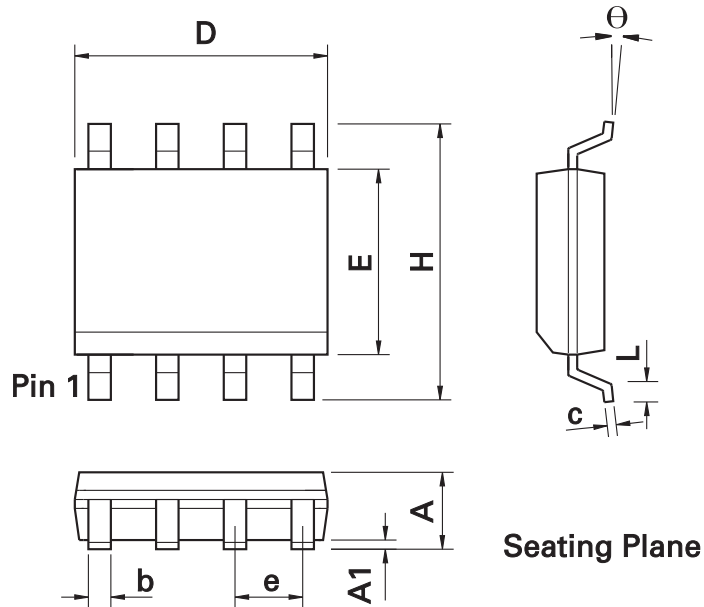
ZXCT1032

- 4 When C_T has discharged to "zero" ($< 80\text{mV}$) the latch is reset which re-enables the output drive and allows the device to re-enter soft-start mode.
- 5 In the event of an overload or short circuit, stages 3 and 4 repeat indefinitely until the fault is removed.

In the case of a permanent fault damage to the PMOS transistor should not occur because it is only on for a short part of the overall cycle.

- 6 The current monitor has an intentional output offset of $+150\text{mV}$. If V_{ISET} is held at 0V , the output of the trip comparator will be permanently high and the output will be completely disabled.

Package outline - SO8



| DIM | Inches | | Millimeters | | DIM | Inches | | Millimeters | |
|-----|--------|-------|-------------|------|-----|-----------|-------|-------------|------|
| | Min. | Max. | Min. | Max. | | Min. | Max. | Min. | Max. |
| A | 0.053 | 0.069 | 1.35 | 1.75 | e | 0.050 BSC | | 1.27 BSC | |
| A1 | 0.004 | 0.010 | 0.10 | 0.25 | b | 0.013 | 0.020 | 0.33 | 0.51 |
| D | 0.189 | 0.197 | 4.80 | 5.00 | c | 0.008 | 0.010 | 0.19 | 0.25 |
| H | 0.228 | 0.244 | 5.80 | 6.20 | Θ | 0° | 8° | 0° | 8° |
| E | 0.150 | 0.157 | 3.80 | 4.00 | h | 0.010 | 0.020 | 0.25 | 0.50 |
| L | 0.016 | 0.050 | 0.40 | 1.27 | - | - | - | - | - |

Note: Controlling dimensions are in inches. Approximate dimensions are provided in millimeters

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| | |
|-----------------------|---|
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