

# 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 detection

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:

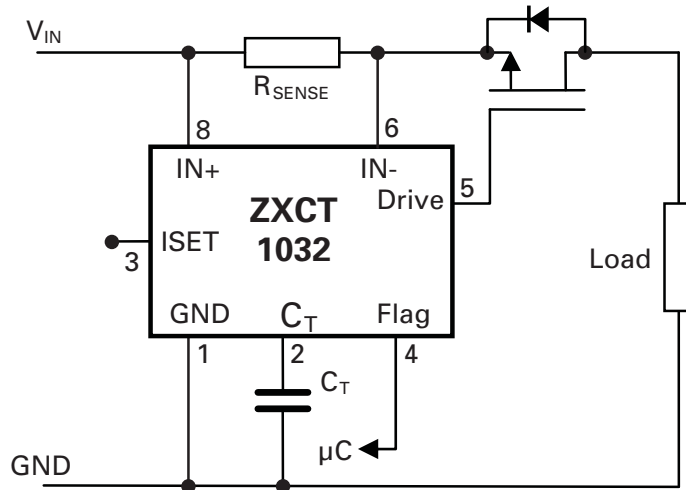
Determines the load current trip level or constant current level.  $ISET$  can be left open circuit (internal 2.1V reference) or driven via a DC voltage or µC PWM output. Its source impedance is 50kΩ.

### Applications

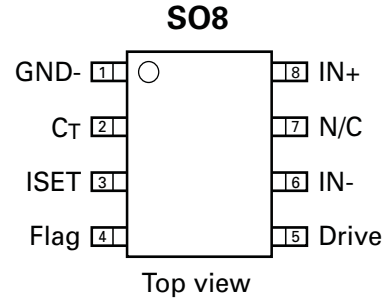
- Electronic fuse
- Short circuit protected supply feed
- Hot swap
- Power over twisted pair

# ZXCT1032

## Typical application circuit



## Pinout connections



## Pin description

Pin	Name	Description
1	GND	Ground reference for I <sub>SET</sub> and Flag pins. Most negative terminal of the device. No other pin should go below this voltage.
2	C <sub>T</sub>	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 <sub>OUT</sub> = 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 <sub>SENSE</sub> and I <sub>SET</sub> 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<sup>(a)</sup> ..... 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		kΩ
$V_{FLAGL}$	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

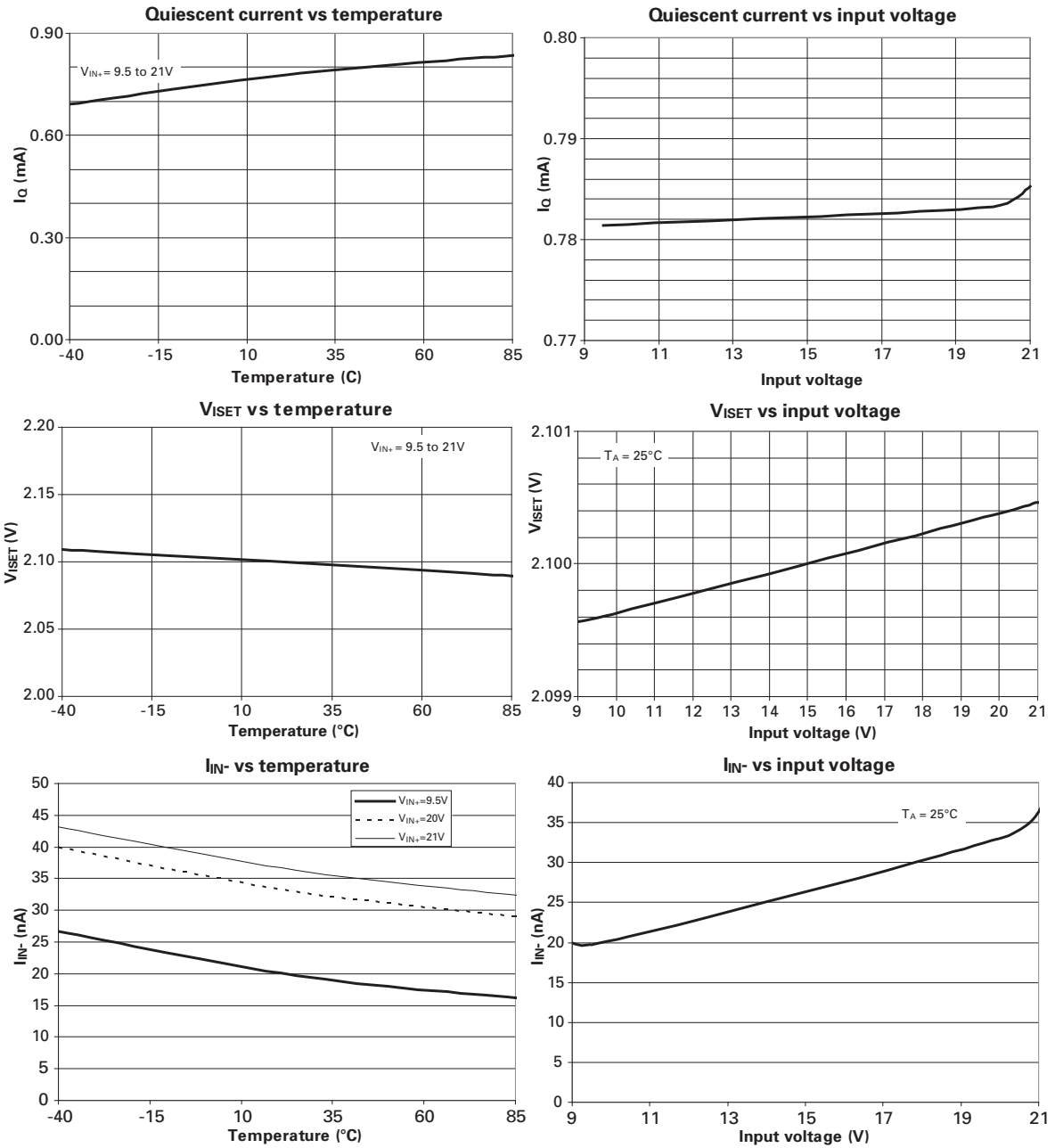
### NOTES:

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

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

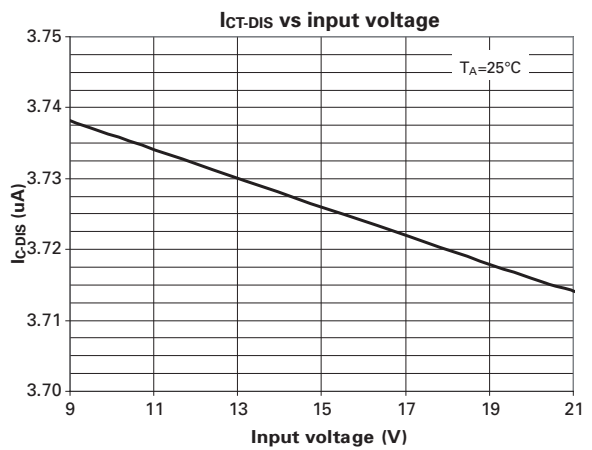
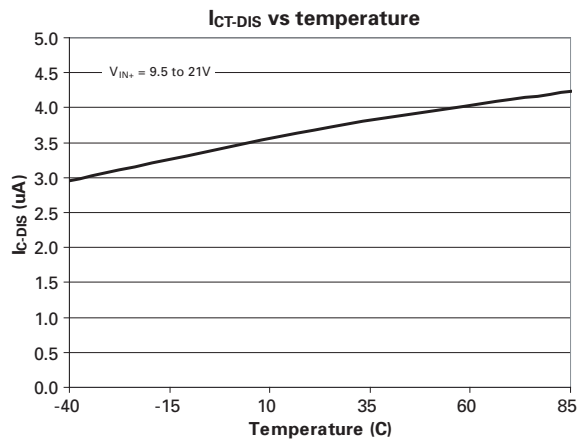
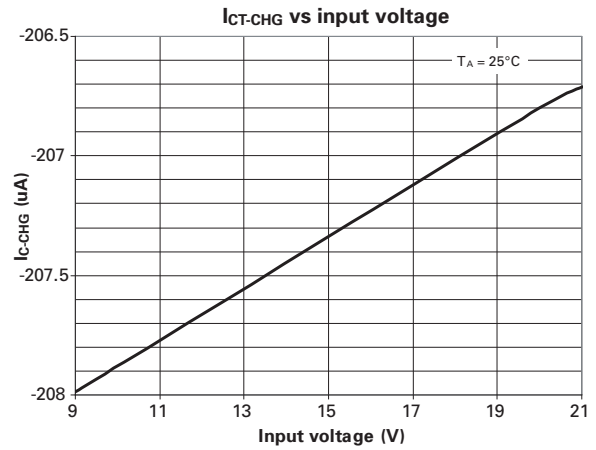
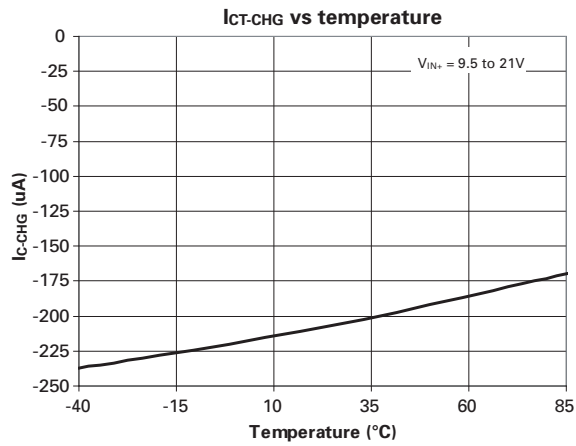
## Typical characteristics

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



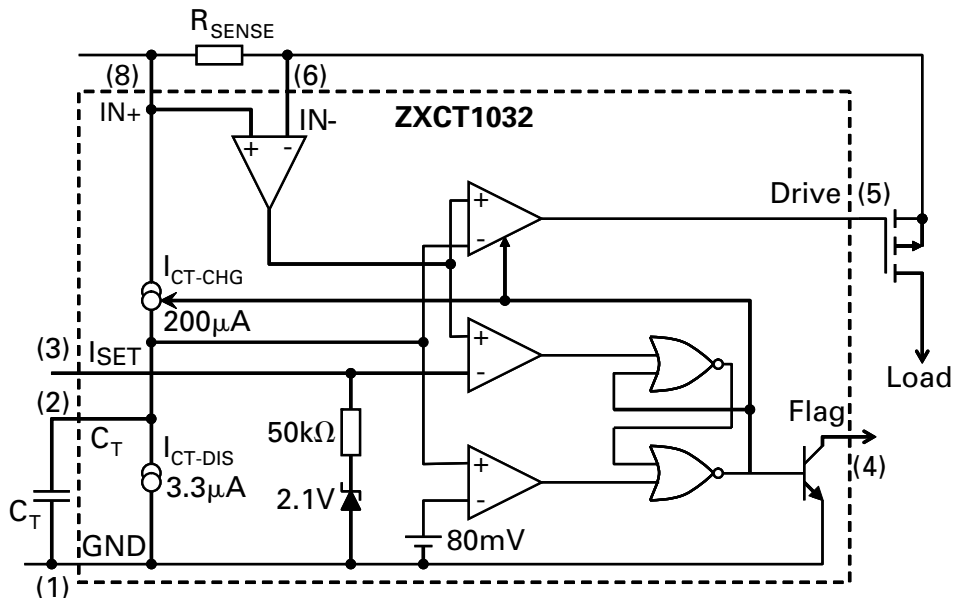
## Typical characteristics

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



## Application information

## ZXCT1032 block diagram and description

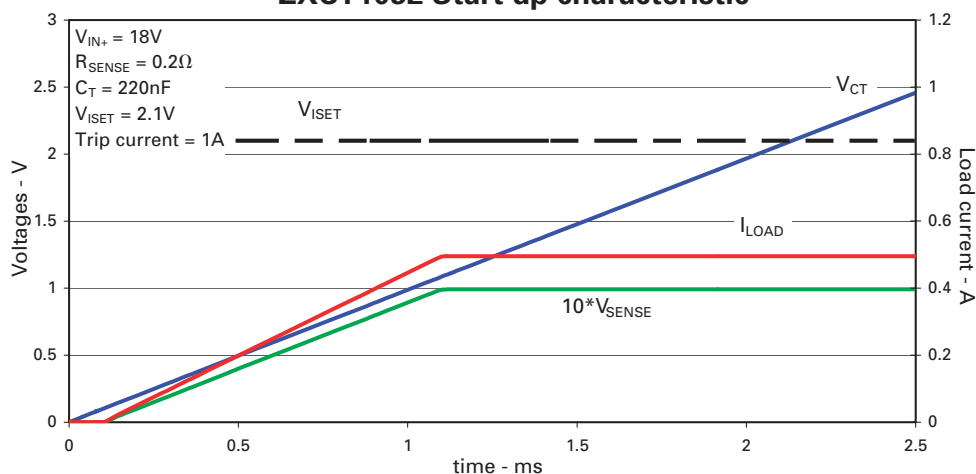


## Operation of the ZXCT1032

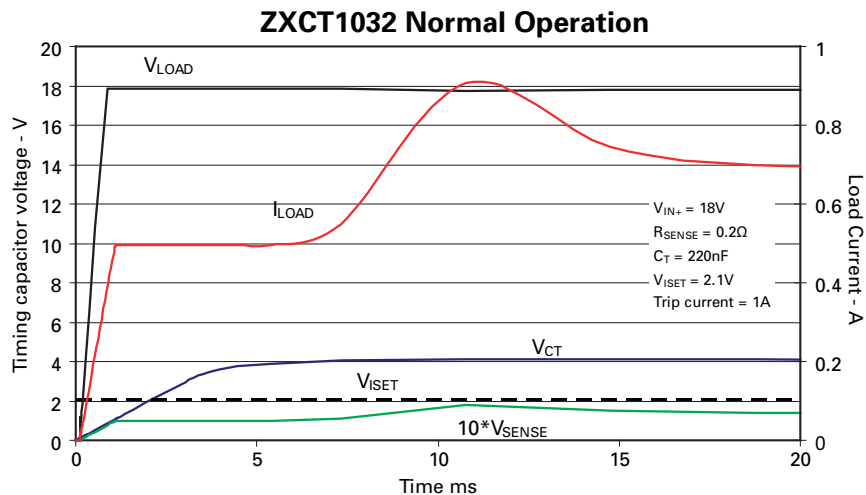
- 1 After power-up, the timing capacitor ( $C_T$ ) is charged up by a  $200\mu\text{A}$  current source. This causes the output amplifier's drive pin to fall in voltage, progressively turning on the PMOS transistor.

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

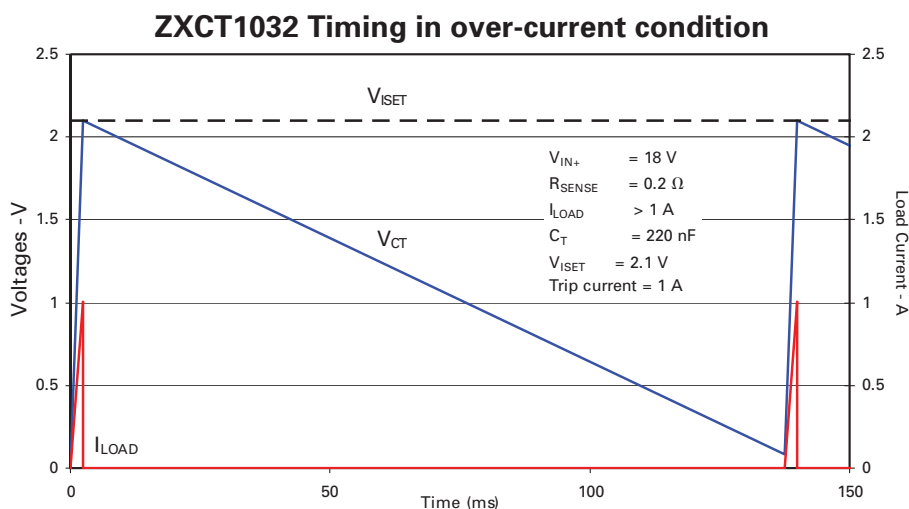


- 2 The output voltage also increases due to the load current powering up the load and charging any capacitance. After the initial soft start (load current stabilizing) the timing capacitor charges up to 4V and the device enters its normal mode of operation. The external MOSFET will be now fully enhanced 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:
  - a The output drive is disabled.
  - b The open collector Flag output goes low to indicate a fault condition.
  - c 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

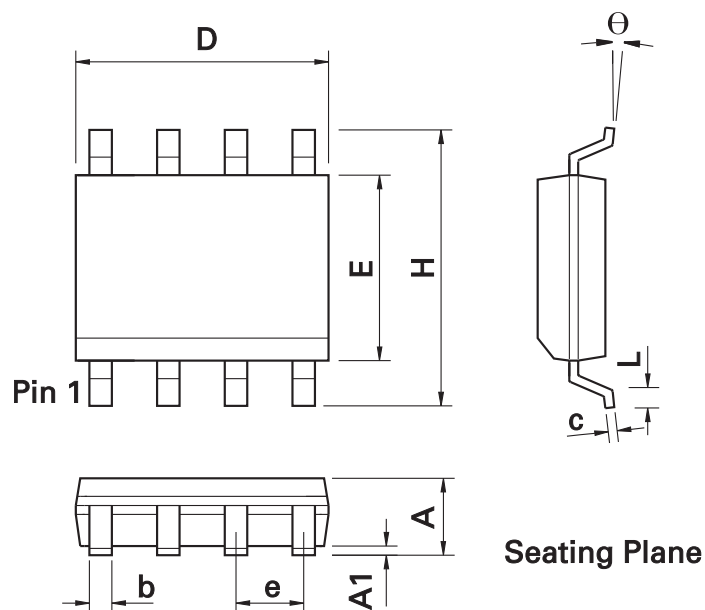
- 4 When  $C_T$  has discharged to "zero" ( $< 80\text{mV}$ ) the latch is reset which re-enables the output drive and allows the device to re-enter soft-start mode.
- 5 In the event of an overload or short circuit, stages 3 and 4 repeat indefinitely until the fault is removed.

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  $0\text{V}$ , 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	$\theta$	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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