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 detectior

When external capacitor CT 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.

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.

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

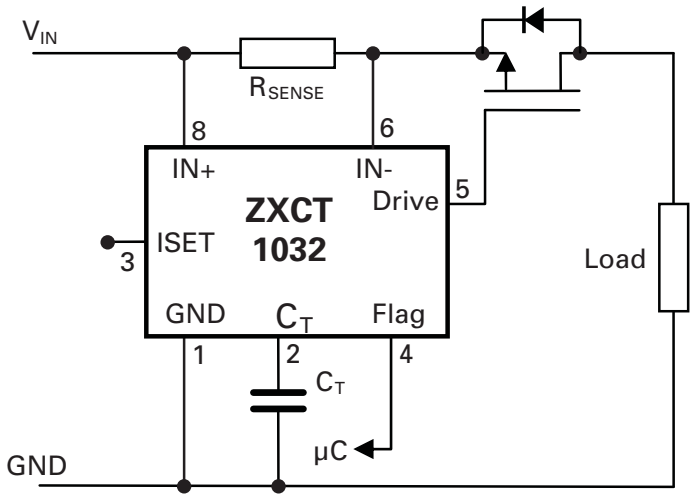
Applications

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

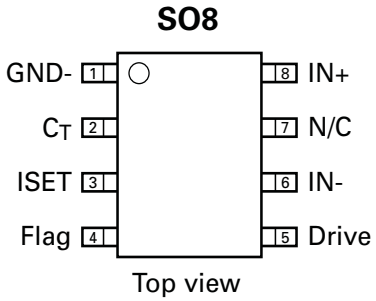
Ordering information

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

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 reocmmended.
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°C, V_{IN+} = 20V. Unless otherwise stated.

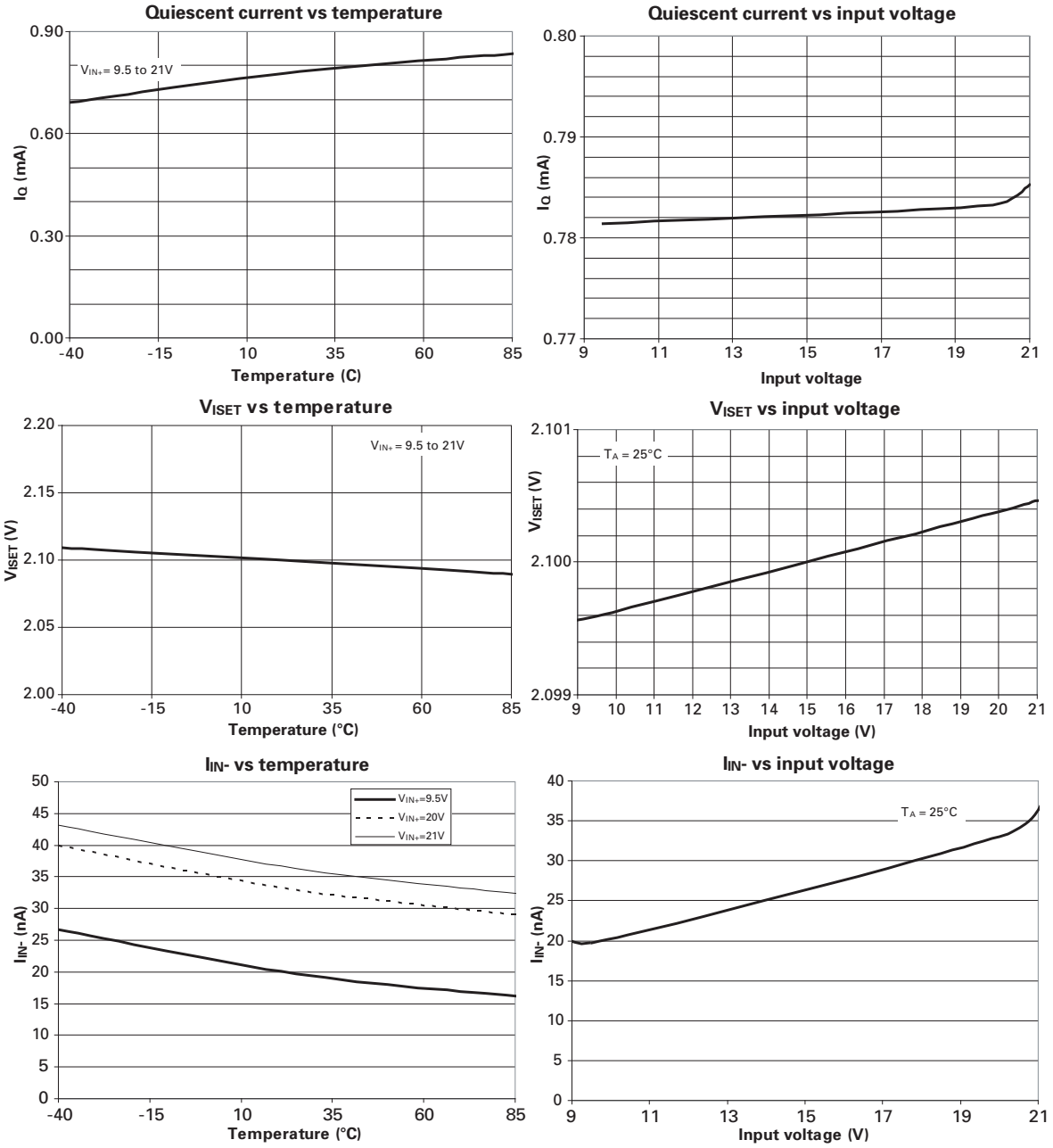
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
I_Q	Quiescent current	V_{SENSE}[1] = 0V, $V_{–ISET}$ = 2.1V		1.6	2.5	mA
V_{STRIP}(*)	Flag trip threshold voltage	V_{ISET} =1.1V		95		mV
		V_{ISET} =2.1V	185	195	205	
V_{ISET}	ISET open voltage	I_{ISET} = 0	2.0	2.1	2.2	V
I_{ISET}	ISET output current	V_{ISET} =0V	30	45	60	µA
V_{DRIVEH}	Drive high output voltage	V_{ISET} = 2.1V, V_{SENSE} > 205mV, I_{DRIVE} = 0,	V_{IN-} – 0.4	V_{IN-} – 0.2		V
V_{DRIVEL}	Drive low output voltage	V_{ISET} = 2.1V, V_{SENSE} < 185mV, I_{DRIVE} = 0,	V_{IN-} - 7	V_{IN-} - 5.5	V_{IN-} - 4	V
R_{DRIVEL}	Drive low output resistance	V_{ISET} = 2.1V, V_{SENSE} < 185mV		9		kΩ
V_{FLAGL}	Flag Low output Voltage	V_{ISET} = 2.1V, V_{SENSE} > 205mV I_{FLAG} = 100µA		0.2	0.4	V
I_{FLAGZ}	Flag open circuit leakage current	V_{ISET} = 2.1V, V_{SENSE} < 185mV, V_{FLAG} = 5V		1	200	nA
I_{IN-}	IN- bias current	V_{ISET} = 0V		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:

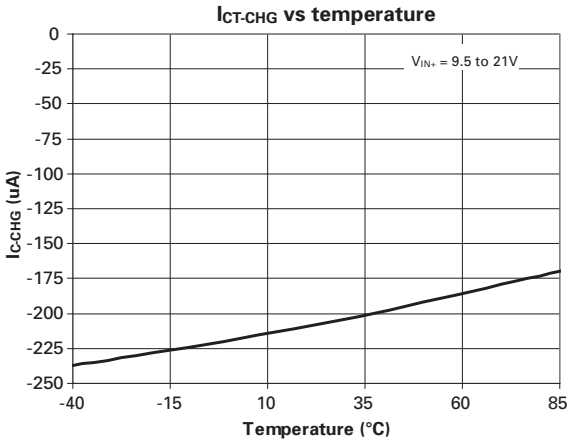
(*) V_{SENSE} = V_{IN+} - V_{IN-}. V_{STRIP} is the sense voltage at which the device trips into over-current protection.

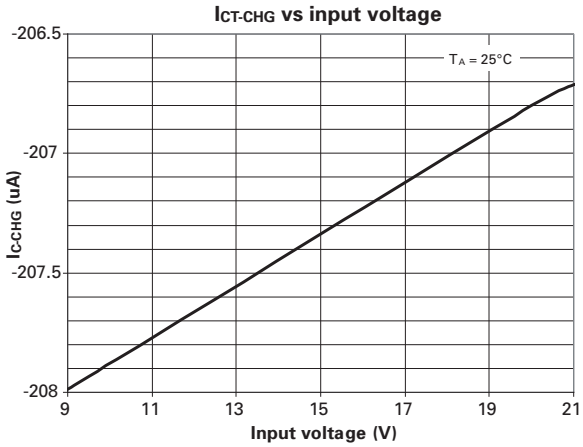
(†) Temperature dependent measurements are extracted from characterization and simulation results.

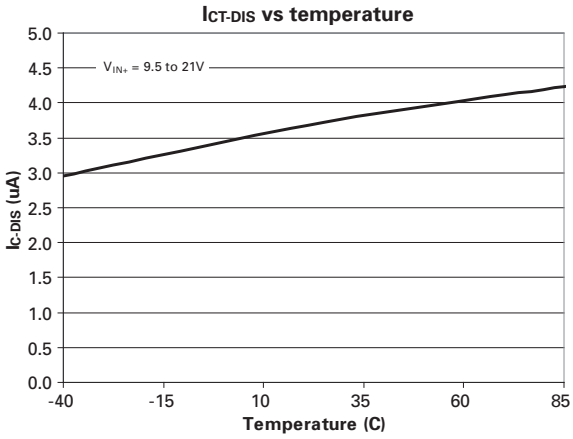
Typical characteristics
(T_A = 25°C and V_{IN+} = 20V unless otherwise stated)

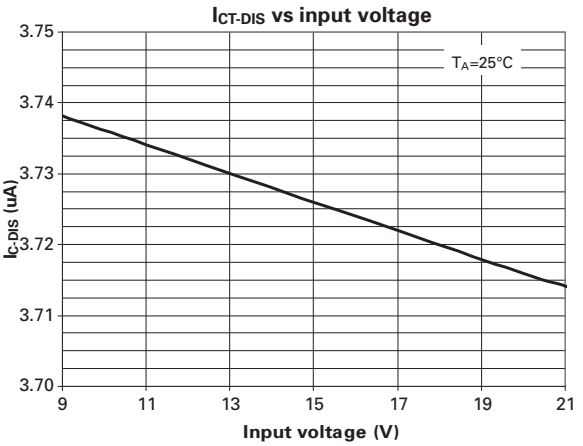


Typical characteristics
(T_A = 25°C and V_{IN+} = 20V unless otherwise stated)



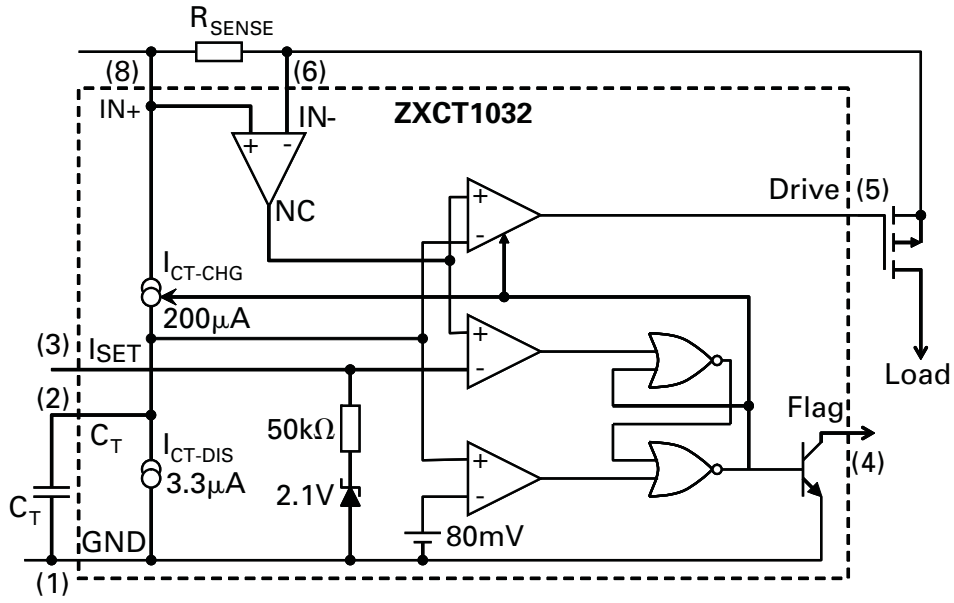






Application information

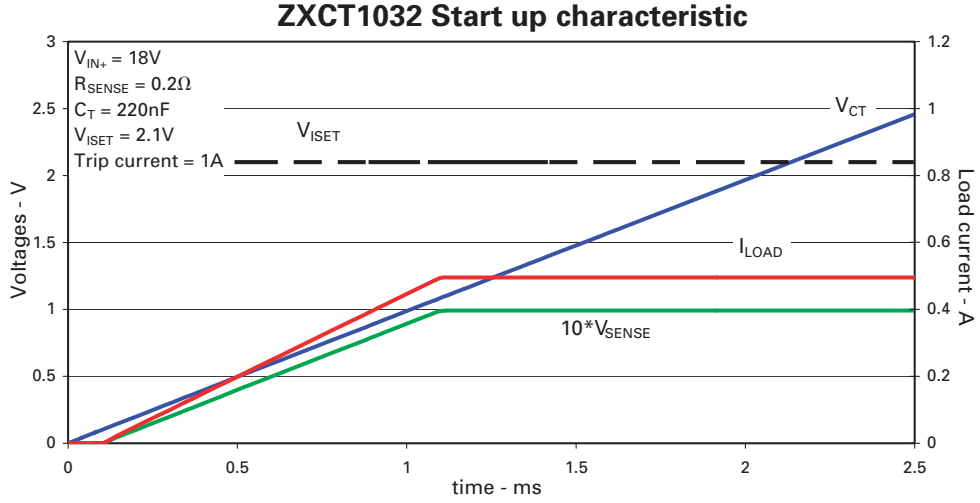
ZXCT1032 block diagram and description



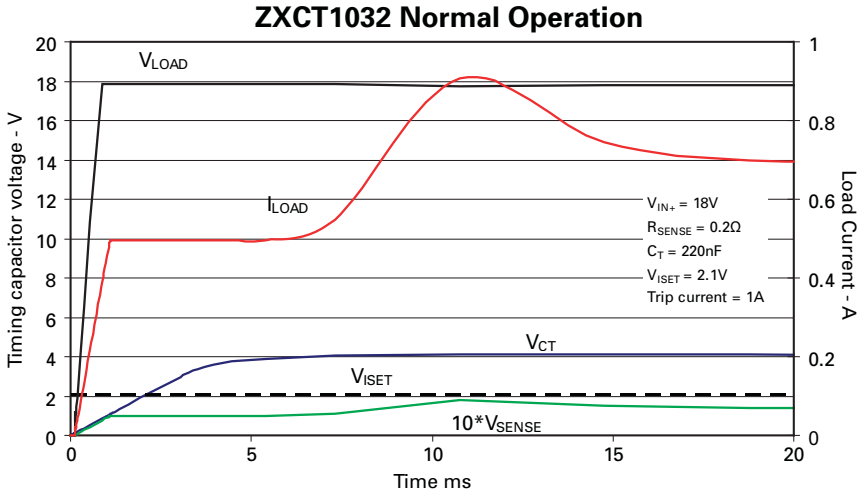
Operation of the ZXCT1032

1 After power-up, the timing capacitor (C_T) is charged up by a 200µA 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.



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.



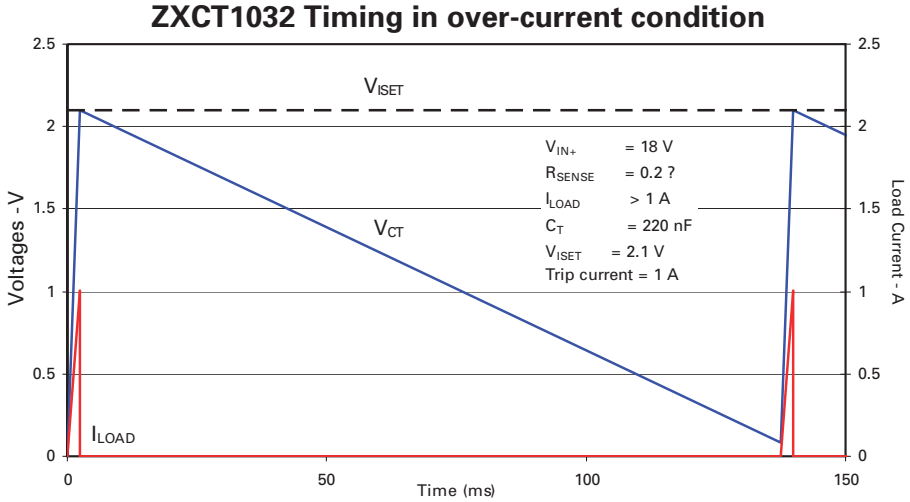
The ZXCT1032 has now entered its over-current detector mode; it is effectively "transparent" to the load until the current monitor output exceeds the trip point.

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 200µA current source is turned off and C_T starts to discharge slowly via a 3.3µA current source.



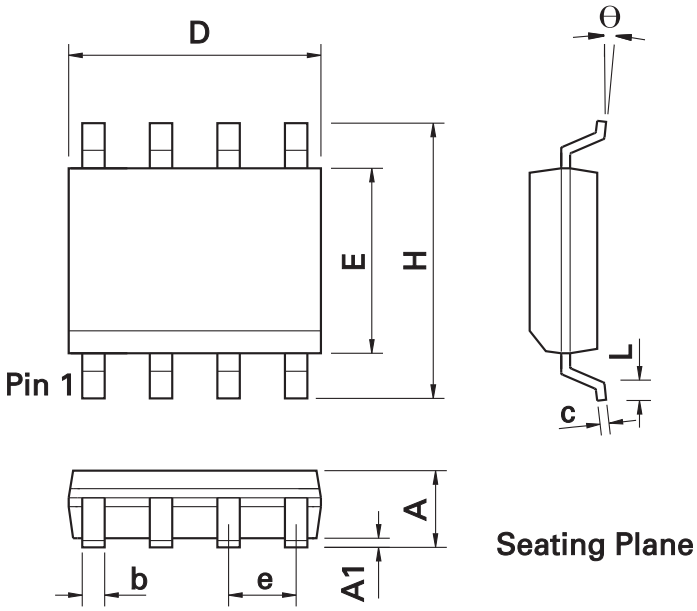
4 When C_T has discharged to "zero" (< 80mV) the latch is reset which re-enables the output drive and allows the device to re-enter soft-start mode.

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 +150mV. 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

Definitions

Product change

Zetex Semiconductors reserves the right to alter, without notice, specifications, design, price or conditions of supply of any product or service. Customers are solely responsible for obtaining the latest relevant information before placing orders.

Applications disclaimer

The circuits in this design/application note are offered as design ideas. It is the responsibility of the user to ensure that the circuit is fit for the user's application and meets with the user's requirements. No representation or warranty is given and no liability whatsoever is assumed by Zetex with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Zetex does not assume any legal responsibility or will not be held legally liable (whether in contract, tort (including negligence), breach of statutory duty, restriction or otherwise) for any damages, loss of profit, business, contract, opportunity or consequential loss in the use of these circuit applications, under any circumstances.

Life support

Zetex products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Zetex Semiconductors plc. As used herein:

A. Life support devices or systems are devices or systems which:
   1. are intended to implant into the body

or

   2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labelling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Reproduction

The product specifications contained in this publication are issued to provide outline information only which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned.

Terms and Conditions

All products are sold subjects to Zetex' terms and conditions of sale, and this disclaimer (save in the event of a conflict between the two when the terms of the contract shall prevail) according to region, supplied at the time of order acknowledgement.

For the latest information on technology, delivery terms and conditions and prices, please contact your nearest Zetex sales office.

Quality of product

Zetex is an ISO 9001 and TS16949 certified semiconductor manufacturer.

To ensure quality of service and products we strongly advise the purchase of parts directly from Zetex Semiconductors or one of our regionally authorized distributors. For a complete listing of authorized distributors please visit: **www.zetex.com/salesnetwork**

Zetex Semiconductors does not warrant or accept any liability whatsoever in respect of any parts purchased through unauthorized sales channels.

ESD (Electrostatic discharge)

Semiconductor devices are susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

Green compliance

Zetex Semiconductors is committed to environmental excellence in all aspects of its operations which includes meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.

All Zetex components are compliant with the RoHS directive, and through this it is supporting its customers in their compliance with WEEE and ELV directives.

Product status key:

"Preview"	Future device intended for production at some point. Samples may be available
"Active"	Product status recommended for new designs
"Last time buy (LTB)"	Device will be discontinued and last time buy period and delivery is in effect
"Not recommended for new designs"	Device is still in production to support existing designs and production
"Obsolete"	Production has been discontinued

Datasheet status key:

"Draft version"	This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.
"Provisional version"	This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice.
"Issue"	This term denotes an issued datasheet containing finalized specifications. However, changes to specifications may occur, at any time and without notice.

Zetex sales offices

Europe	Americas	Asia Pacific	Corporate Headquarters
Zetex GmbH Kustermann-park Balanstraße 59 D-81541 München Germany	Zetex Inc 700 Veterans Memorial Highway Hauppauge, NY 11788 USA	Zetex (Asia Ltd) 3701-04 Metroplaza Tower 1 Hing Fong Road, Kwai Fong Hong Kong	Zetex Semiconductors plc Zetex Technology Park, Chadderton Oldham, OL9 9LL United Kingdom
Telefon: (49) 89 45 49 49 0 Fax: (49) 89 45 49 49 49 europe.sales@zetex.com	Telephone: (1) 631 360 2222 Fax: (1) 631 360 8222 usa.sales@zetex.com	Telephone: (852) 26100 611 Fax: (852) 24250 494 asia.sales@zetex.com	Telephone: (44) 161 622 4444 Fax: (44) 161 622 4446 hq@zetex.com