ZCX0534A

7.5V to 40V Input Supply, Synchronous Buck Converter

FEATURES

- **Wide 7.5V to 40V Input Voltage Range**
- **Fixed 125kHz Switching Frequency**
- **Duty Cycle Range (0~100%)**
- **CC/CV Mode Control**
- **Up to 3.5A Output Current**
- **High Efficiency Up to 95%**
- **0.8V reference with +/- 1.5% accuracy**
- **Output Over Voltage Protection (~125%)**
- **Output Short Circuit Protection**
- **FB Resistance Short Protection**
- **Nearly Zero Input Current at Short Circuit Protection**
- **Internal Soft-Start**
- **Programmable Output Cable Compensation**
- **Thermal shutdown Protection**
- **Available in SOP-8 Package**
- **RoHS Compliant and Halogen Free**

APPLICATIONS

- Car Charger/Adaptor
- Rechargeable Portable Devices
- Battery Charger

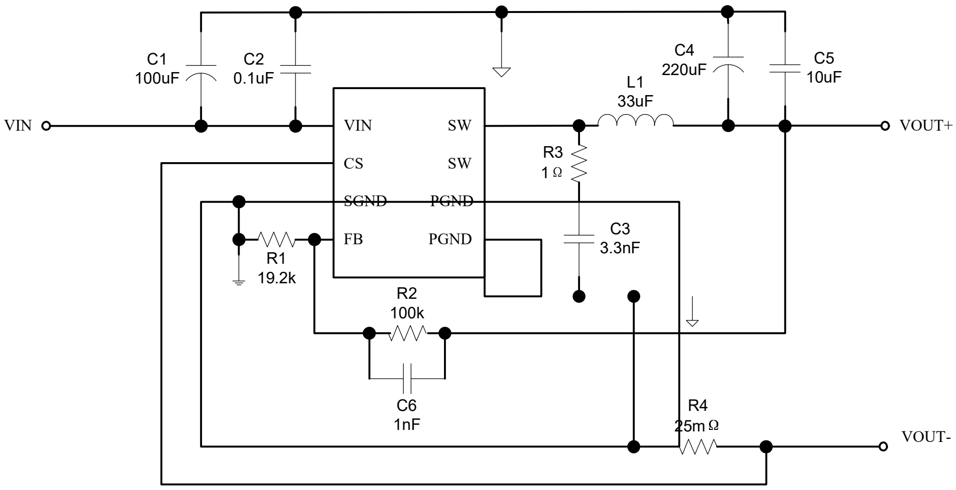
DESCRIPTION

ZCX0534A is a wide input voltage, high efficiency current mode synchronous buck converter that achieves excellent load and line regulation. The ZCX0534A operates in either CC (Constant Output Current) mode or CV (Constant Output Voltage) mode. The CC current value is set by external sense resistor. ZCX0534A provides up to 3.5A output current at 125kHz switching frequency.
The ZCX0534A is housed in a SOP-8 Package.

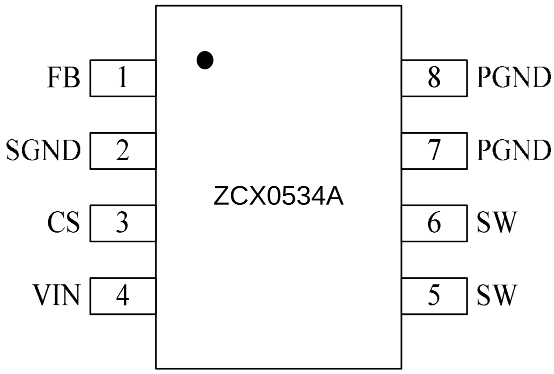
ORDERING INFORMATION

Order Information	Top Marking
ZCX0534A SA 8 Extension Code · Package Type ES: SOP-8 · Pin Count	ZCX0534A → Part Number X J X X X X Day Month Year Wafer version code Assembly house code Production code

TYPICAL APPLICATION



PIN CONFIGURATION



SOP-8

ABSOLUTE MAXIMUM RATINGS

(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

VIN to SGND..–0.3V to 44V
SW (DC) to SGND...............................–1.0V to (VIN+1)V
FB, CS to SGND... –0.3V to 7V
Operating Temperature Range ....–40°C to 85°C
Maximum Junction Temperature...........................150°C
Storage Temperature Range ....–55°C to 150°C
ESD Rating
HBM (Human Body Mode) 2KV
MM (Machine Mode) 200V

PIN DESCRIPTION

PIN #	NAME	DESCRIPTION
1	FB	Feedback Input
2	SGND	Signal Ground and Output Current-Sense (-) Pin
3	CS	Output Current-Sense (+) Pin.
4	VIN	Input
5,6	SW	Inductor Connection. Connect an inductor Between SW and the regulator output.
7,8	PGND	Power Ground

Note: Connect the exposed pad of the package to a large ground copper area.

ELECTRICAL CHACRACTERISTICS

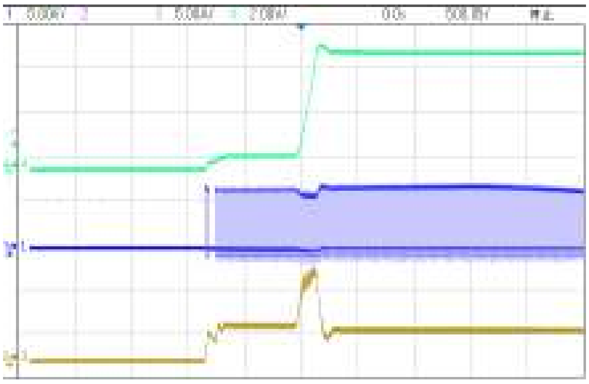
(V_{IN} = 12V, unless otherwise specified. Typical values are at T_A = 25 ˚C.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		7.5		40	V
Input UVLO	V_{IN} rising		7		V
Input UVLO Hysteresis	V_{IN} falling		1		V
Input Supply Current	V_{FB} =1V		1.2		mA
	V_{OUT}=5V, No load		7.0		mA
FB Feedback Voltage		788	800	812	mV
Internal Soft-Start Time			1		ms
Switching Frequency			125		kHz
Maximum Duty Cycle				100	%
Current Limit	Duty=62%		6		A
Current-Sense Voltage	V_{CS}	77.8	81	84.2	mV
SW Leakage Current	V_{SW}=0V		1	10	µA
High-Side R_{DSON}			45		mΩ
Low-Side R_{DSON}			30		mΩ
FB OVP Voltage			1		V
FB UVP Voltage			385		mV
Fault Recycle Time	V_{FB}<0.385V		550		ms
Over Temperature Shutdown	Temperature Rising		160		˚C
Over Temperature Shutdown Hysteresis	Temperature Falling		20		˚C

TYPICAL CHARACTERISTICS

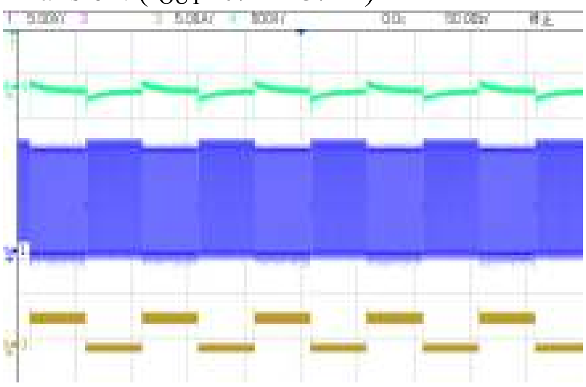
(Typical values are at VIN=12V, VOUT=5V, T_A = 25°C unless otherwise specified)

Soft Start



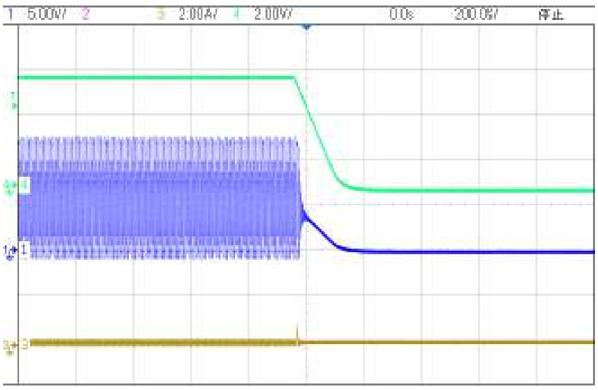
CH1: SW, 5V/div
CH3: I_L, 5A/div
CH4: VOUT, 2V/div
TIME: 500µs/dv

Transient (I_{OUT}=0.1A~3.4A)



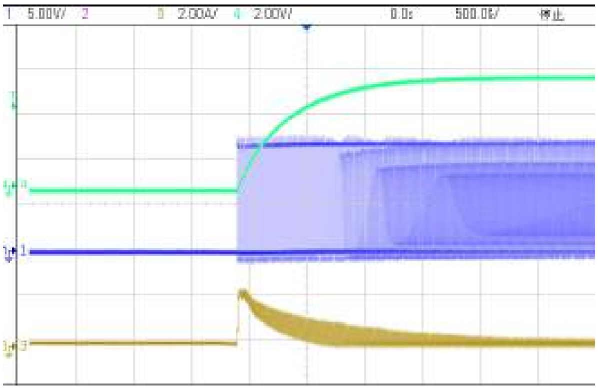
CH1: SW, 5V/div
CH3: I_L, 5A/div
CH4: VOUT，500mV/div
TIME: 50ms/div

VOUT Short Protection

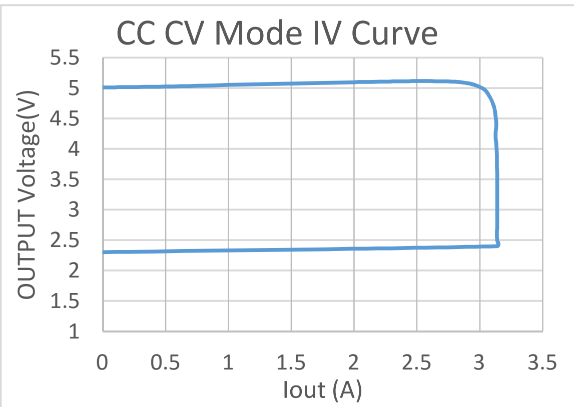


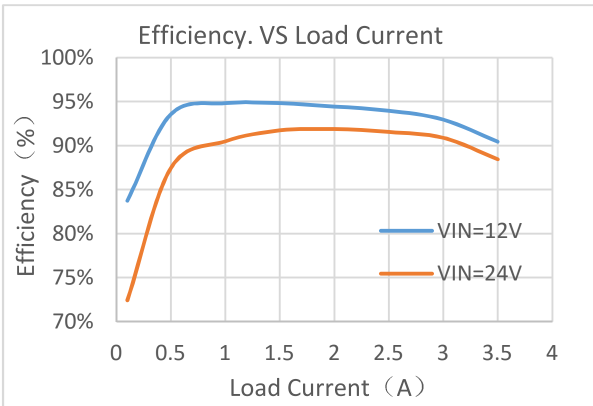
CH1: SW, 5V/div
CH3: I_L, 2A/div
CH4: VOUT, 2V/div
TIME: 500µs/dv

VOUT Short Protection Recovery

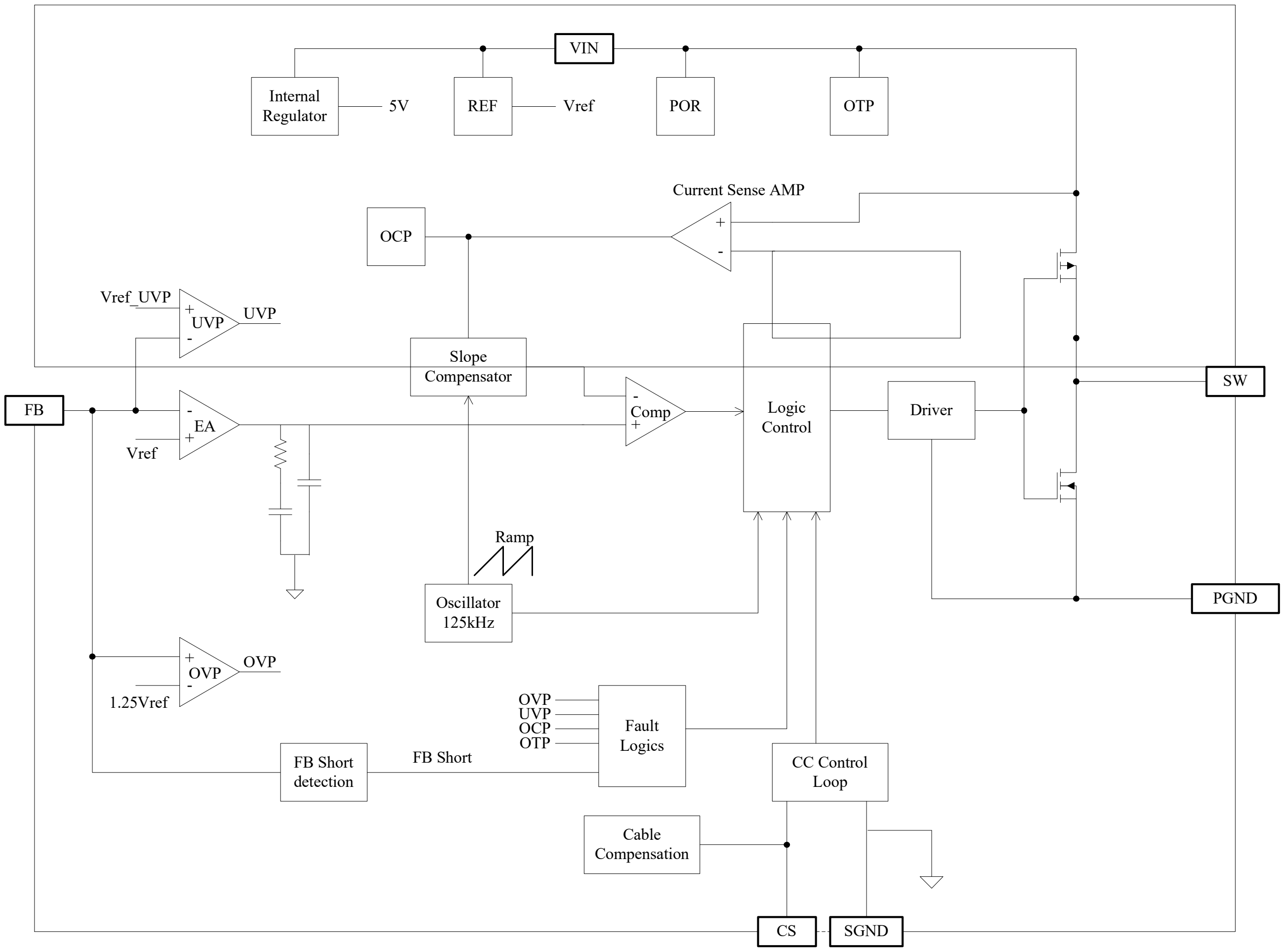


CH1: SW, 5V/div
CH3: I_L, 2A/div
CH4: VOUT, 2V/div
TIME:200µs/dv





BLOCK DIAGRAM



DETAIL DESCRIPTION

The ZCX0534A is a synchronous current-mode buck PWM converter with programmable output CC/CV control.

Initialization

The ZCX0534A creates its own internal supplies for use. The POR function continually monitors the input bias supply voltage at the VIN pin. The POR function initiates soft-start operation after VCC supply voltages exceed its POR rising threshold voltage.

Soft-start

The ZCX0534A has an internal soft-start circuitry to reduce supply inrush current during startup conditions. The typical soft-start time is about 1ms. The Power-On-Reset function initiates the soft-start process. Once the VIN voltage falls below 6V, the controller will shut down until the voltage exceeds 7V again.

Switch Frequency

The on-chip oscillator clock switches at 125kHz normally.

CC/CV control and Output Short

Protection

When the load current is less than the current-limit, the ZCX0534A will regulate the output voltage and operates in the constant voltage mode. If the load current increased and reached the current-limit point sensed by the CS pin, then the ZCX0534A will enter the CC mode, the output voltage will decreasing, If the FB pin voltage lower than 385mV, the ZCX0534A will stop switching for a long time before initiating a new soft start, if the output over-current condition or output short condition is not removed, the converter will hiccup. By this long time sleeping at over-current or output under-voltage condition, the input current of the system is nearly zero.

FB Resistance Short Protection

The ZCX0534A detects FB resistance before start-up. When the FB pin short circuit happens, the converter will not work until the FB short circuit condition is removed.

Thermal Shutdown

Over temperature protection limits total power dissipation in the device. When the junction temperature exceeds TJ= +160°C, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 20°C.

DESIGN PROCEDURE

Setting Output Voltages

Output voltages are set by external resistors. The V_{REF} is 0.800V. According to the typical application diagram:

$$V_{OUT} = V_{REF}\left(1 + \frac{R_1}{R_2}\right)$$

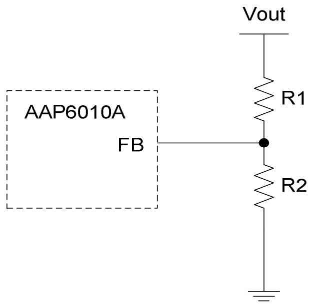


FIGURE 1. Setting VOUT with a Resistor-Divider

Setting Constant-Current Threshold

The output constant-current value is set by a sense resistor between CS pin and GND, according to the following equation:

$$I_{CC} = \frac{81\text{mV}}{R_{CS}}$$

Output Cable Compensation

Output cable compensation voltage can be set by R1 (FIGURE 1).

$$V_{CS} = I_{OUT} \times R_{Sense}$$

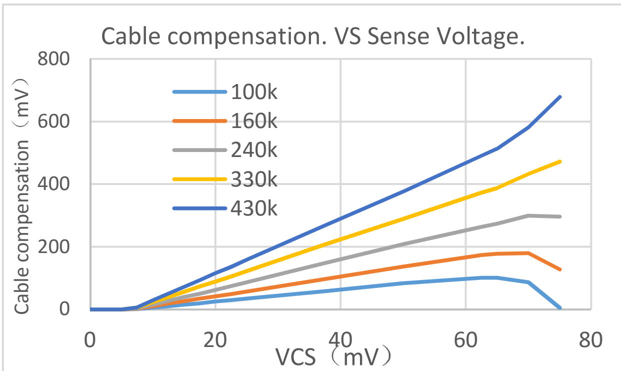


FIGURE 2. Setting Cable compensation

Inductor Selection

The external components required for the step-down are an inductor, input and output filter capacitors, and compensation RC network.

ZCX0534A provides best efficiency with continuous inductor current. A reasonable inductor value (L_{IDEAL}) can be derived from the following:

$$L_{IDEAL} = \frac{V_{IN} D(1-D)}{f_{SW} I_{OUT} K_{RIPPLE}}$$

Where, K_{RIPPLE} is the ratio of the inductor peak-to-peak current to the inductor DC current, usually, we set K_{RIPPLE} between10%-30%. D is the duty cycle:

$$D = \frac{V_{OUT}}{V_{IN}}$$

Given L_{IDEAL}, the peak-to-peak inductor current is $K_{RIPPLE}I_{OUT}$. The absolute-peak inductor current is $I_{OUT}(1+0.5K_{RIPPLE})$. Inductance values smaller than L_{IDEAL} can be used to reduce inductor size; however, if much smaller values are used, inductor current rises, and a larger output capacitance may be required to suppress output ripple. Larger values than L_{IDEAL} can be used to obtain higher output current, but typically with larger inductor size.

Input Capacitor Selection

The input capacitor needs to be carefully selected to maintain sufficiently low ripple at the supply input of the converter. A low ESR capacitor is highly recommended. Since large current flows in and out of this capacitor during normal switching, its ESR also affects efficiency.

Use small ceramic capacitors (C_{HF}) for high frequency decoupling and bulk capacitors to supply the surge current needed each time high-side MOSFET turns on.

Place the small ceramic capacitors (0.1uF) physically between the VIN pin and the PGND pin.

The input buck capacitor should also be placed close to the upper-MOSFET's drain and GND, with the shortest layout traces possible. The important parameters for the buck input capacitor are the voltage rating and the RMS current rating. For reliable operation, select the bulk capacitor with voltage and current ratings above the maximum input voltage and largest RMS current required by the circuit. The capacitor voltage rating should be at least 1.25 times greater than the maximum input voltage and a voltage rating of 1.5 times is a conservative guideline.

The RMS current is given by:

$$I_{RMS} = I_{OUT} \frac{V_{OUT}}{V_{IN}} \sqrt{\frac{V_{IN}}{V_{OUT}} - 1}$$

I_{RMS} has a maximum at $V_{IN}=2V_{OUT}$, where $I_{RMS}=I_{OUT}/2$. This simple worst-case condition is commonly used for design because even significant deviations do not offer much relief.

Output Capacitor Selection

The output capacitor is determined by the required ESR to minimize voltage ripple. Moreover, the amount of bulk capacitance is also a key for C_{OUT} selection to ensure that the control loop is stable. Loop stability can be checked by viewing the load transient response.

The output ripple is given by:

$$\Delta V_{OUT} \le \Delta I_L \left(R_{ESR} + \frac{1}{8F_{SW}C_{OUT}}\right)$$

The output ripple will be highest at maximum input voltage since ΔI_L increases with input voltage. Multiple capacitors placed in parallel may be needed to meet the ESR and RMS current handling requirement.

EMI Consideration

Since parasitic inductance and capacitance effects in PCB circuitry would cause a spike voltage on SW node when high-side MOSFET is turned on/off, this spike voltage on SW may impact on EMI performance in the system. In order to enhance EMI performance, place an RC snubber between SW and GND. It is strongly recommended to reserve the RC snubber during PCB layout for EMI improvement. Moreover, reducing the SW trace area and keeping the main power in a small loop will be helpful on EMI performance.

APPLICAITION INFORMATION

Layout is critical to achieve clean and stable operation. The switching power stage requires particular attention. Follow these guidelines for good PC board layout:

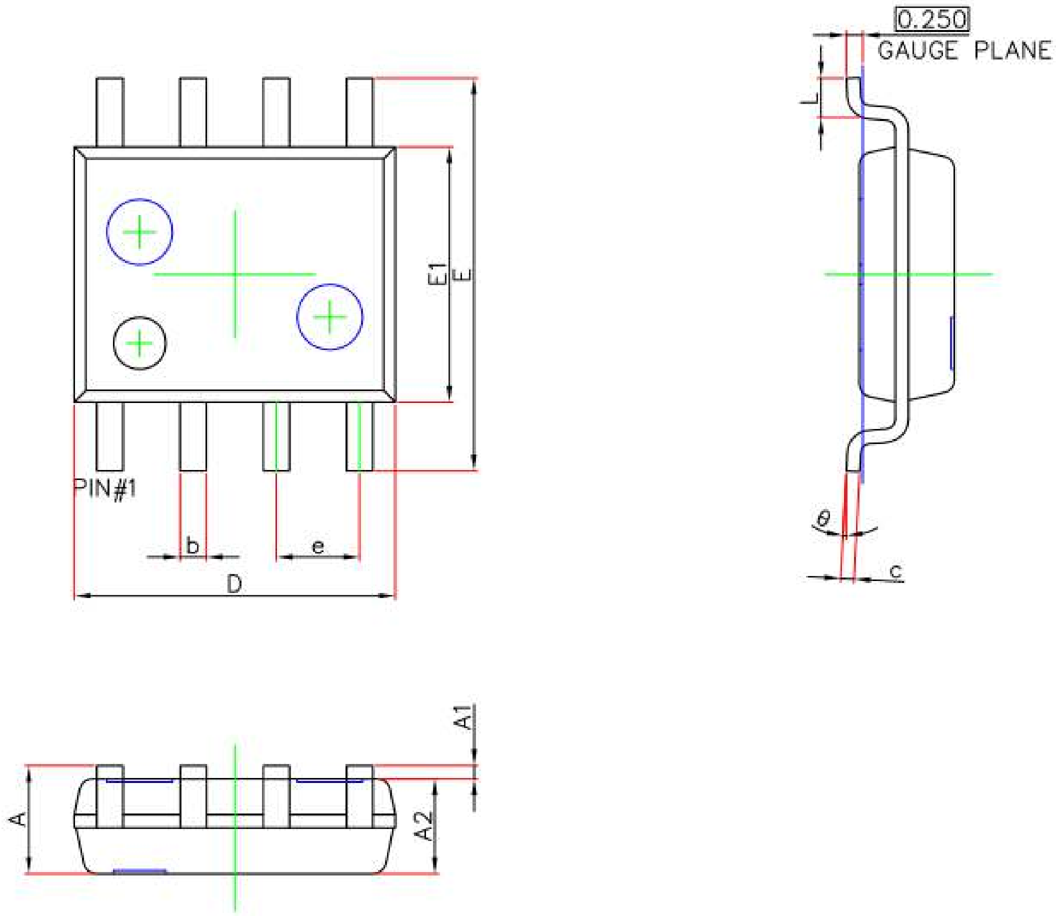
1) Careful component selections, layout of the critical components, and use shorter and wider PCB traces help in minimizing the magnitude of voltage spikes.

2) There are two set of critical components in a DC-DC converter using the ZCX0534A . The switching power components are most critical because they switch large amounts of energy, and as such, they tend to generate equally large amounts of noise. The critical small signal components are those connected to sensitive nodes or those supplying critical bypass current.

3) The power components and the PWM controller should be placed firstly. Place the input capacitors, close to the power switches. Place the output inductor and output capacitors between the MOSFETs and the load. Also locate the PWM controller nearby MOSFETs.

4) If possible, a multi-layer printed circuit board is recommended. The capacitor C_{IN} and C_{OUT} each of them represents numerous capacitors of input and output. Use a dedicated grounding plane and use vias to ground all critical components to this layer. Apply another solid layer as power plane and cut this plane into smaller islands of common voltage levels. The power plane should support the input power and output power nodes. Use copper filled polygons on the top and bottom circuit layers for the PHASE node is subjected to very high dV/dt voltages, the stray capacitance formed between these islands and the surrounding circuitry will tend to couple switching noise. Use the remaining printed circuit layers for small signal routing. The PCB traces between the PWM controller and the gate of MOSFET and also the traces connecting source of MOSFETs should be sized to carry 2A peak currents.

PACKAGE OUTLINE AND DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270(BSC)		0.050(BSC)	
L	0.400	0.800	0.016	0.031
θ	0°	8°	0°	8°