BCT1477
3A, 600KHz Synchronous Step-Down Converter

GENERAL DESCRIPTION

BCT1477 is a high efficiency synchronous buck converter with integrated 90mΩ/50mΩ power MOSFET. The BCT1477 design with an ACOT control scheme providing fast transient response and supporting both low equivalent series resistance output capacitors.

The BCT1477 operates in pulse skip mode, which maintains high efficiency during light load operation.

The BCT1477 is also equipped with Power-on-reset, soft start, and whole protections over-temperature, under-voltage, over-current into a single package.

This device, available in FCSOT563 package provides a very compact system solution external components and PCB area.

FEATURES

- 4.5V to 17V operating input voltage range
- 90mΩ/50mΩ internal NFET (when Vin>5V), efficiency: up to 94%
- ACOT Control with fast transient response
- 600kHz Switching Frequency
- Pulse-skip mode
- Cycle-by-cycle current limit
- Internal soft start 1ms
- Startup from Pre-Biased Output Voltage
- Short-circuit protection
- Thermal shutdown
- Available in FCSOT563 package

APPLICATIONS

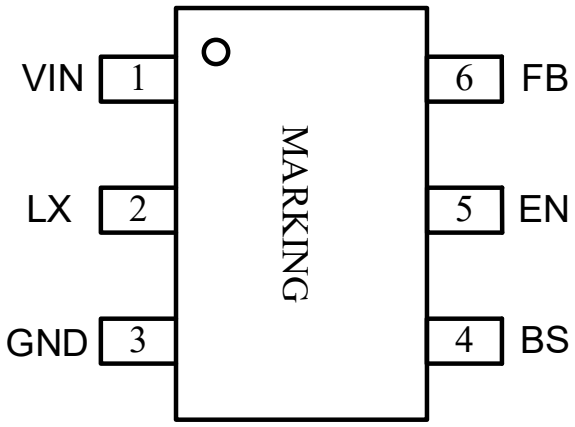
- Point of load DC/DC
- Set-top-box
- DVD players/recorders
- Digital photo frames

ORDERING INFORMATION

Order Number	Package Type	Temperature Range	Marking	QTY/Reel
BCT1477EYT-TR	FCSOT563	-40°C to +85°C	POXX	5000

Note:
1. "XX" in Marking will be appeared as the batch code.

PIN CONFIGURATION (TOP VIEW)

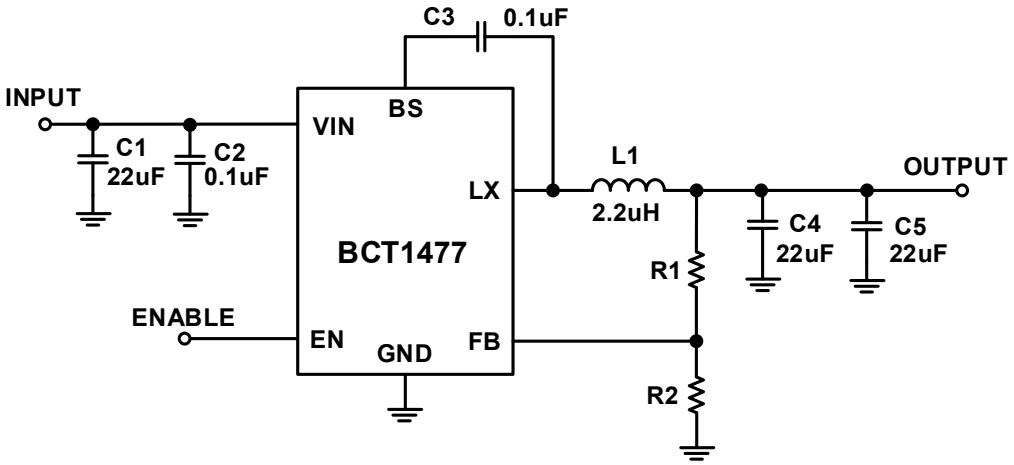


FCSOT563

PIN DESCRIPTION

PIN	NAME	FUNCTION
3	GND	Power ground pin.
2	LX	Power Switching Output. Connect an inductor to internal high side NMOS and low side NMOS.
1	VIN	Power Supply Input.
6	FB	Output feedback pin. Connect a resistive divider at FB.
5	EN	Enable input control. Active high.
4	BS	High-side Gate driver supply Voltage input. The BS supplies the voltage to drive the high-side N-channel MOSFET.

Typical Operating Circuit



ABSOLUTE MAXIMUM RATINGS

VIN,EN to GND.....-0.3V to 19V
LX to GND…….....-1V to 19V
BS to GND.....V_{LX}-0.3V to V_{LX}+6V
Storage Temperature Range.....-65℃ to +150℃
Junction Temperature.....150℃
Lead Temperature (Soldering, 10 sec).....260℃
FCSOT563 Package Thermal Resistance(θ_{JA}).....130℃/W
FCSOT563 Package Thermal Resistance(θ_{JC}).....60℃/W

CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. Broadchip recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ESD Protection

Human Body Model.....3000V
Charged-device model.....1500V

NOTE:

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Broadchip reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact Broadchip sales office to get the latest datasheet.

RECOMMENDED OPERATING CONDITIONS

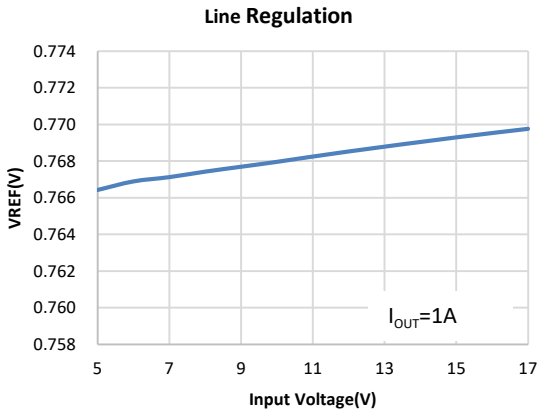
Symbol	Parameter	Range	Unit
V_{IN}	VIN Supply Voltage	4.5 to 17	V
V_{OUT}	Converter Output Voltage	0.768 to 6.5	V
I_{OUT}	Converter Output Current	0 to 3	A
T_A	Ambient Temperature	-40 to 85	°C
T_J	Junction Temperature	-40 to 125	°C

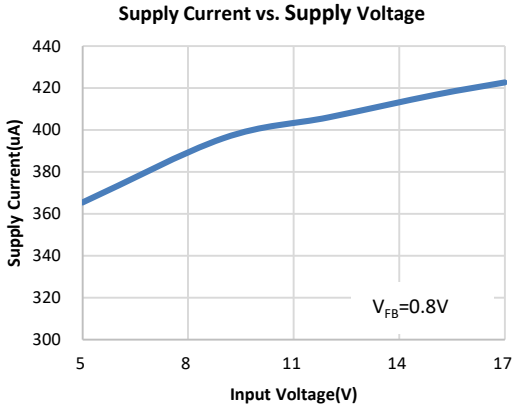
ELECTRICAL CHARACTERISTICS

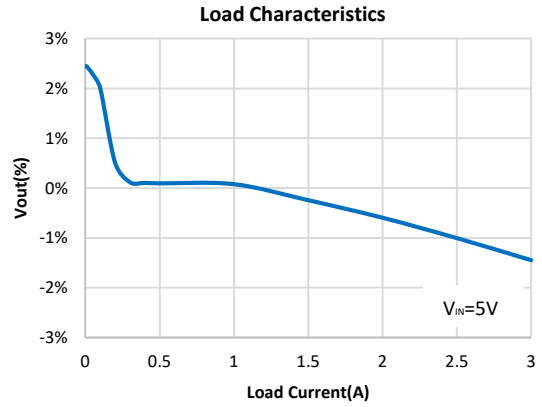
V_{IN}= 12V, T_A = 25℃, unless otherwise specified.

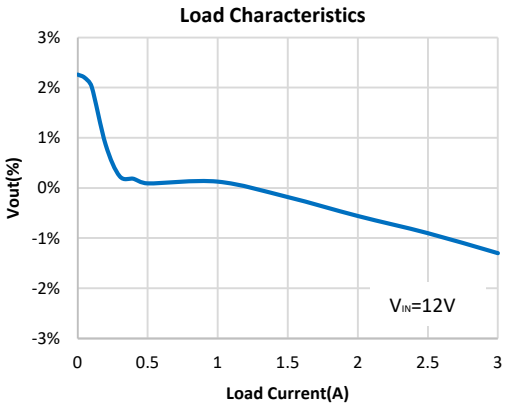
SYM	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
SUPPLY CURRENT						
I_Q	VIN Supply Current	V_{IN}=12V, V_{EN}=5V, V_{FB}=0.8V, non-switching		380	520	uA
I_{SD}	VIN Shutdown Supply Current	V_{EN}=0V		1	10	uA
UVLO						
V_{IN_MIN}	V_{IN} UVLO Threshold	VIN Rising	3.5	3.8	4.1	V
$V_{IN\_MIN\_HYST}$	V_{IN} UVLO Hysteresis	VIN Falling		0.2		V
REFERENCE VOLTAGE						
V_{FB}	Feedback Voltage	V_{OUT}=1.05V, I_{OUT} =10mA, DCM mode		774		mV
V_{FB}	Feedback Voltage	V_{OUT}=1.05V, CCM mode	749	768	787	mV
I_{FB}	FB Input current	V_{FB}=0.8V		0	1	uA
FREQUENCY						
F_{SW}	Switch Frequency	V_{OUT}=1.05V, CCM mode		600		KHz
POWER MOSFET						
$R_{DS(ON)T}$	Top Switch On-Resistance	VBS – LX = 5.5 V		90		mΩ
$R_{DS(ON)B}$	Bottom Switch On-Resistance	T_A=25°C		50		mΩ
I_{LIM}	Current Limit	V_{OUT}=1.05V, L=2.2μH	3.3	4.2	5.1	A
PROTECTIONS						
T_{SD}	Thermal Shutdown Threshold			170		℃
T_{HYS}	Thermal Shutdown Hysteresis			35		℃
ON-TIME TIMER CONTROL						
T_{Off_MIN}	Minimum Off Time			220	310	ns
SOFT-START						
t_{SS}	Soft-Start Time			1		ms
LOGIC THRESHOLD						
V_{EN_H}	EN Rising threshold voltage	V_{EN} rising	1.6			V
V_{EN_L}	EN Falling threshold	V_{EN} falling			0.8	V
R_{IN}	EN Pin Resistance	V_{EN} =12V	225	400	900	kΩ

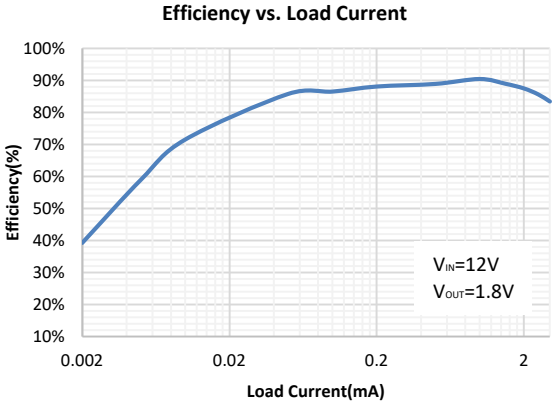
Typical Characteristics

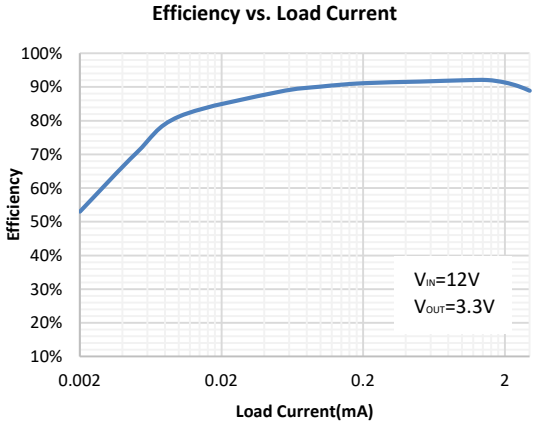




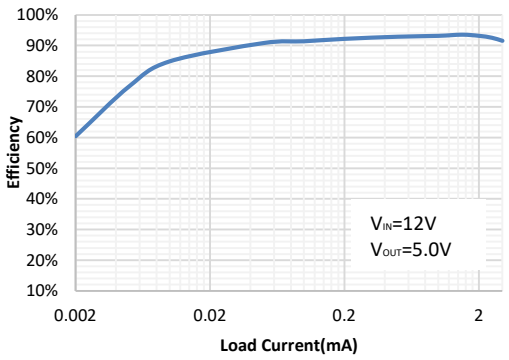




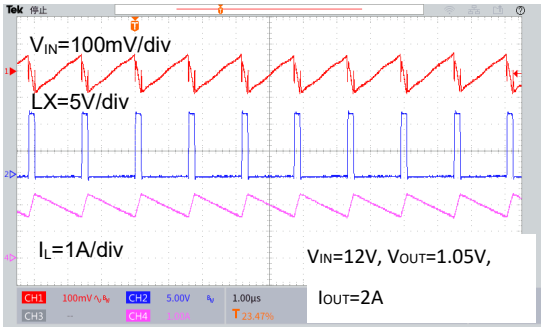




Efficiency vs. Load Current

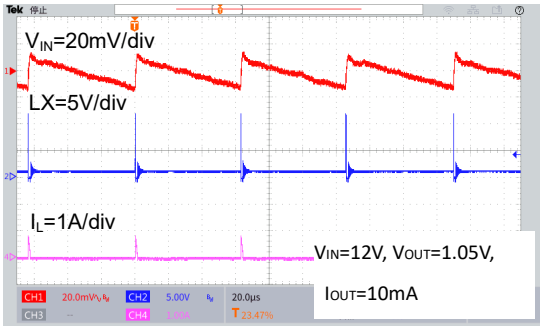


Input Voltage Ripple



Time 1us/div

Output Voltage Ripple



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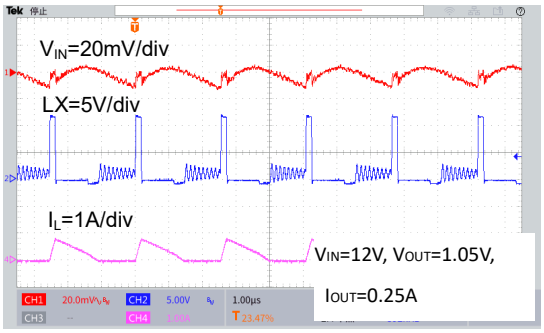
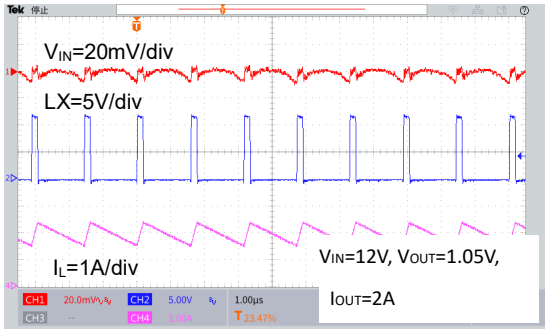
Output Voltage Ripple



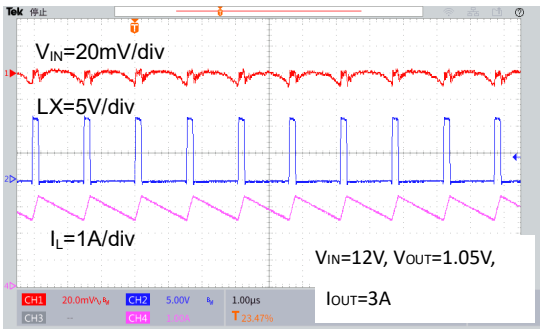
Time 1us/div

Output Voltage Ripple



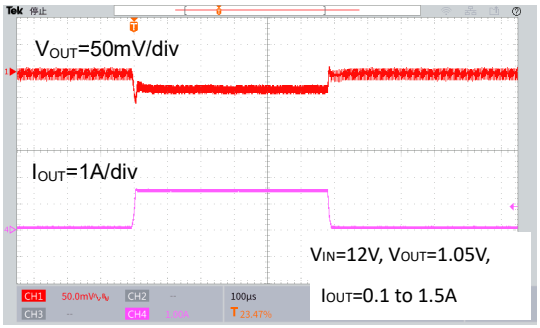
Time 1us/div

Output Voltage Ripple



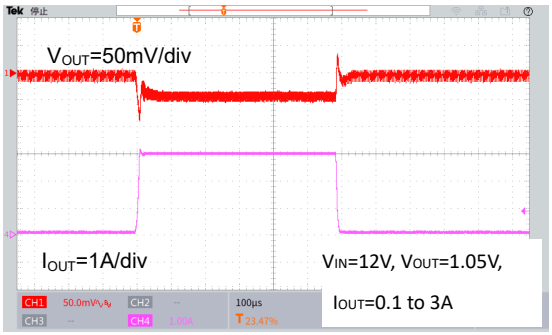
Time 1us/div

Transient Response



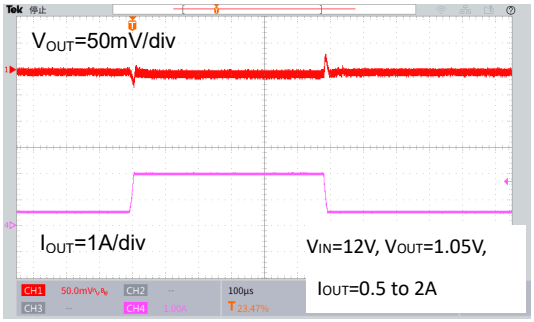
Time 100us/div

Transient Response



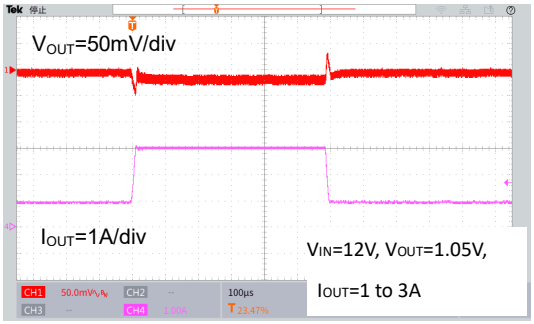
Time 100us/div

Transient Response



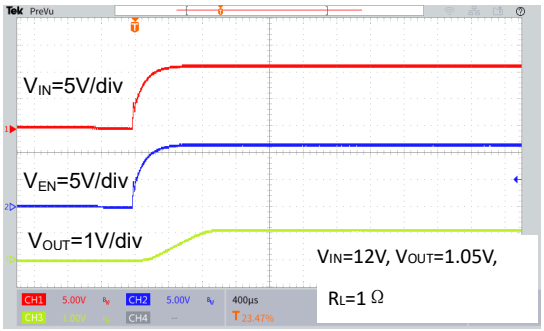
Time 100us/div

Transient Response



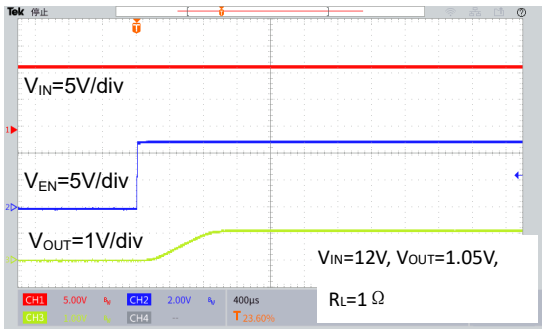
Time 100us/div

Start Up Relative to VIN



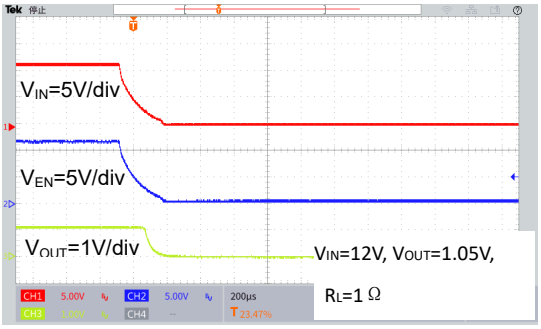
Time 400us/div

Start Up Relative to EN



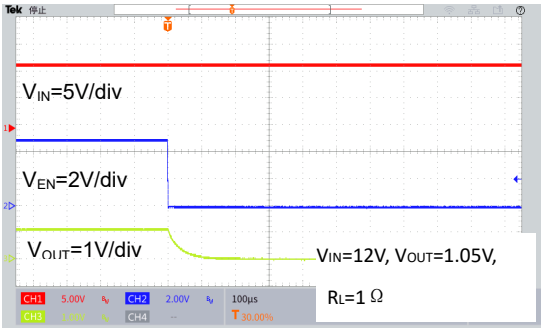
Time 400us/div

Shutdown Relative to VIN



Time 200us/div

Shutdown Relative to EN



Time 100us/div

FUNCTIONAL DESCRIPTION

BCT1477 is a high efficiency synchronous buck converter with integrated 90mΩ/50mΩ power MOSFET. The BCT1477 design with an ACOT control scheme, can convert wide input voltage of 4.5V to 17V to the output voltage adjustable from 0.768V to 6.5V to provide excellent output voltage regulation.

The BCT1477 is equipped with an automatic DCM/CCM mode operation. At light load, the IC operates in the DCM mode to reduce the switching losses. The BCT1477 provides very high efficiency over light to heavy loads with loading-modulated switching frequencies.

The BCT1477 is also equipped with Power-on-reset, soft start, and whole protections (over-temperature, under-voltage, over-current) into a single package.

This device, available in FCSOT563 package, provides a very compact system solution external components and PCB area.

APPLICATION INFORMATION

Inductor Selection

For most designs, the BCT1477 operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_S}$$

Where ΔIL is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current.

Setting the Output Voltage

The internal reference voltage is 0.768V (Typical). The output voltage is divided by a resistor, R1 and R2 to the FB pin. The output voltage is given by:

$$V_{OUT} = 0.768 \times (1 + \frac{R1}{R2})$$

The R1 had be divide into R1_1 and R1_2 in the typical application circuit, This is to facilitate production, the recommended component values in the below table:

VIN(V)	VOUT(V)	R1(kΩ)	R2(kΩ)	L1(uH)	C2(uF)
12	1.0	3.09	10.0	1.5—3.3	44
12	1.05	3.74	10.0	1.5—3.3	44
12	1.2	5.76	10.0	1.5—3.3	44
12	1.5	9.53	10.0	2.2--4.7	44
12	1.8	13.7	10.0	2.2--4.7	44
12	2.5	22.6	10.0	2.2--4.7	44
12	3.3	33.2	10.0	2.2--4.7	44
12	5.0	54.9	10.0	2.2--4.7	44
12	6.5	75.00	10.0	3.3--4.7	44

Input Capacitor Selection

Because buck converters have a pulsating input current, a low ESR input capacitor is required. This results in the best input voltage filtering, minimizing the interference with other circuits caused by high input voltage spikes. Also, the input capacitor must be sufficiently large to stabilize the input voltage during heavy load transients. For good input voltage filtering, usually a 22uF input capacitor is sufficient. It can be increased without any limit for better input-voltage filtering. Two 10uF Ceramic capacitors show better performance because of the low ESR value. An additional 0.1-μF capacitor is optional to provide additional high frequency filtering. Place the input capacitor as close as possible to the input and GND pin of the device for better performance.

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings. The output voltage ripple can be estimated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times \left(R_{ESR} + \frac{1}{8 \times f_S \times C2}\right)$$

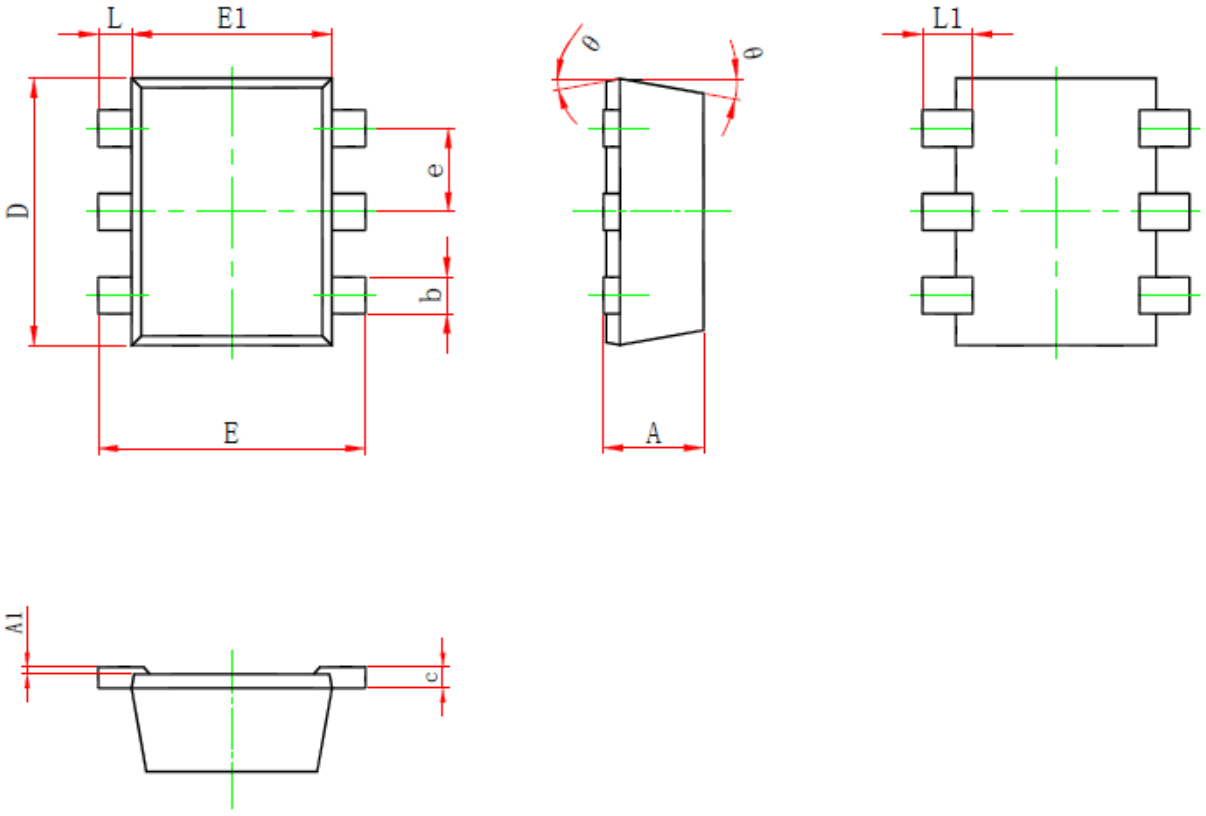
PCB Layout Recommendations

For all switching power supplies, the layout is an important step in the design; especially at high peak currents and switching frequencies. If the layout is not carefully done, the regulator might show noise problems and duty cycle jitter.

1. The input capacitor should be placed close to the VIN and GND. Connecting the capacitor and VIN/GND with short and wide trace without any via holes for good input voltage filtering. The distance between VIN/GND to capacitor less than 2mm respectively is recommended.
2. To minimize copper trace connections that can inject noise into the system, the inductor should be placed as close as possible to the LX pin to minimize the noise coupling into other circuits.
3. The output capacitor should be place closed to converter VOUT and GND.
4. Since the feedback pin and network is a high impedance circuit the feedback network should be routed away from the inductor. The feedback pin and feedback network should be shielded with a ground plane or trace to minimize noise coupling into this circuit.
5. A star ground connection or ground plane minimizes ground shifts and noise is recommended.

PACKAGE OUTLINE DIMENSIONS

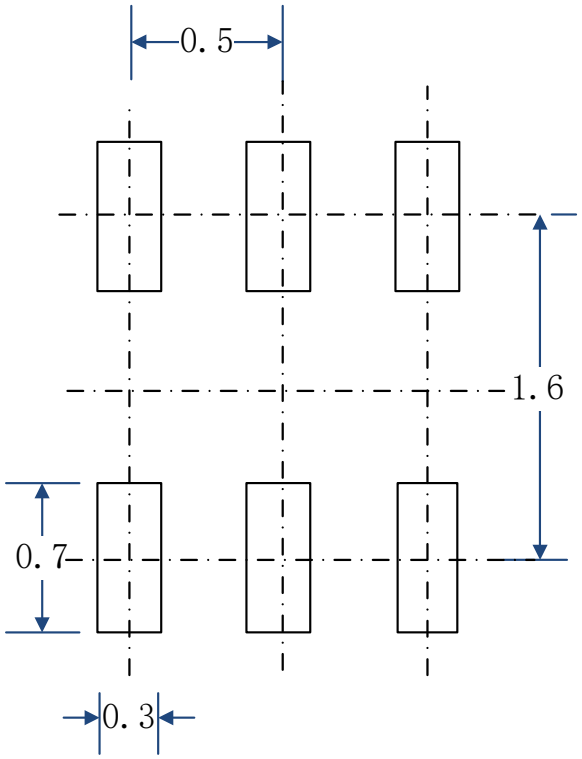
FCSOT563



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.525	0.600	0.021	0.024
A1	0.000	0.050	0.000	0.002
e	0.450	0.550	0.018	0.022
c	0.090	0.180	0.004	0.007
D	1.500	1.700	0.059	0.067
b	0.170	0.270	0.007	0.011
E1	1.100	1.300	0.043	0.051
E	1.500	1.700	0.059	0.067
L	0.100	0.300	0.004	0.012
L1	0.200	0.400	0.008	0.016
θ	9° REF.		9° REF.	

PCB Layout Pattern

FCSOT563



RECOMMENDED PCB LAYOUT PATTERN (Unit: mm)