General Description

QX5243 is a step-down constant current driver for high brightness LED with high efficiency, operating from a wide supply voltage range between 5.5V and 36V with high PSRR.

QX5243 adopts a built-in power NMOS switch with low on-resistance, and only 5 external components are required for the step-down constant current driving application. QX5243 includes a high-side output current sensing circuit, which uses an external resistor to set the nominal average output current whose accuracy is within±4%, and a DIM input accepts a PWM signal to adjust the brightness of LED.

QX5243 has rapid load transient response due to the Hysteresis-Loop Operating Mode, and the Maximum Operating Frequency is up to 1MHz.

QX5243 is assembled in an ESOP8 package.

Features

- Maximum Output Current: 800mA
- Current Accuracy: ±4%
- High Efficiency: up to 95%
- High-side Output Current Sensing Circuit and Constant Current Output
- Maximum DIM Frequency: 20 KHz
- Hysteresis-Loop Operating Mode: No Compensation
- Maximum Operating Frequency: 1MHz
- Maximum Output Power: 20W
- 5V,2mA Regulator on Chip

Applications

- Architectural, Industrial, Environmental Lighting
- Automotive Lighting
- MR16

Typical Application

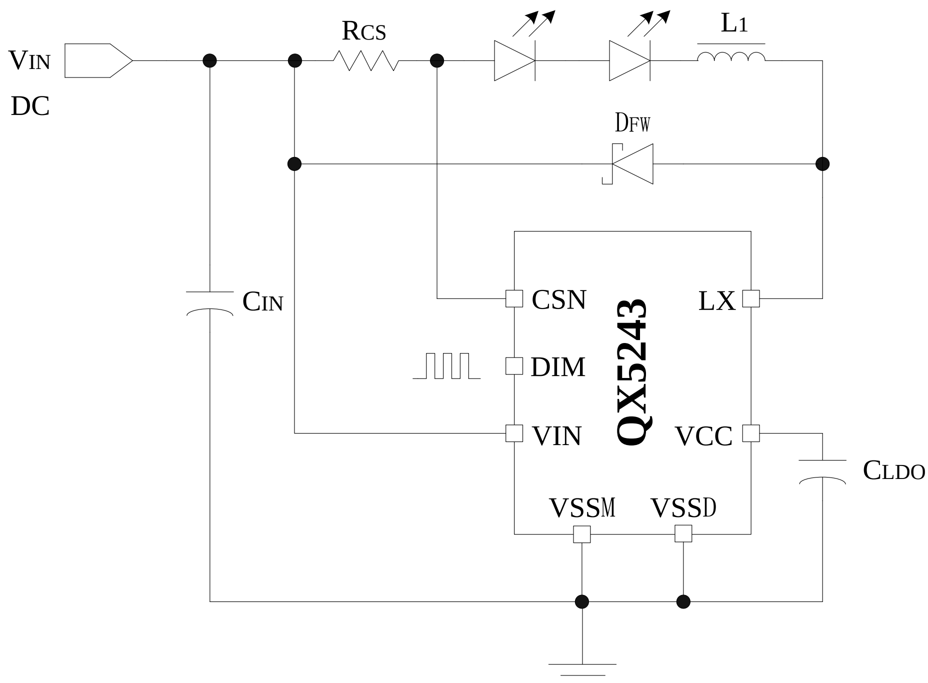


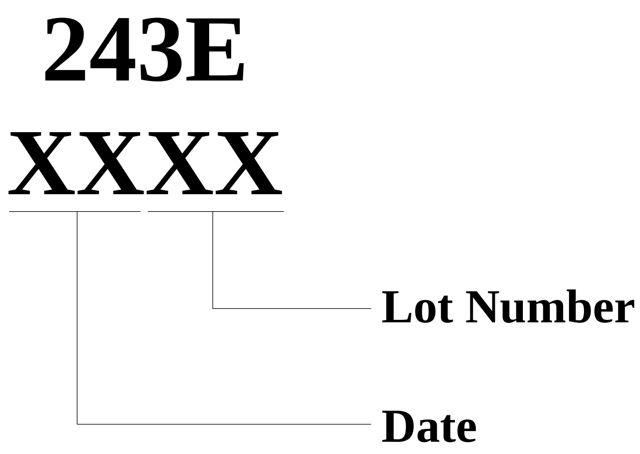
Figure 1: Typical Application Circuit Diagram of QX5243

Ordering Information

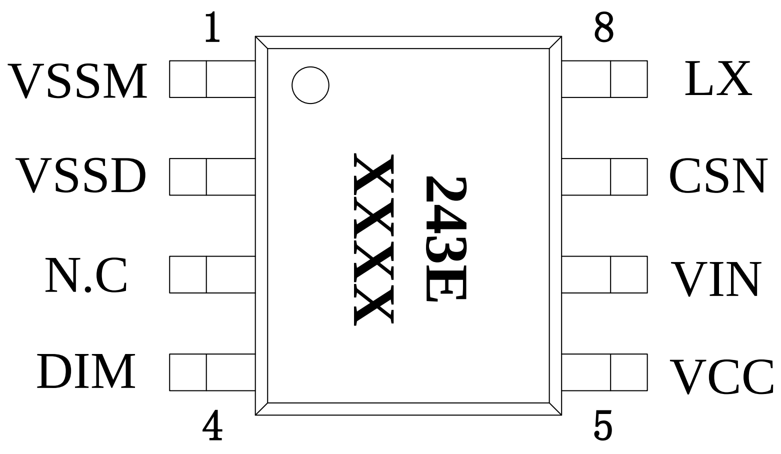
Type Number

QX5243

Package Marking



Pin Assignments



ESOP8

Pin Description

Pin	Pin Name	Pin Type	Description
1	VSSM	Ground	Analog Ground
2	VSSD	Ground	Digital Ground
3	N.C	Float	No Connection
4	DIM	Input	Brightness Adjustment Input Terminal
5	VCC	Output	Output Terminal of The Internal LDO
6	VIN	Input	Supply Voltage Input
7	CSN	Input	Current Sensing Terminal
8	LX	Input	Drain of The Built-in Power NMOS

Functional Block Diagram

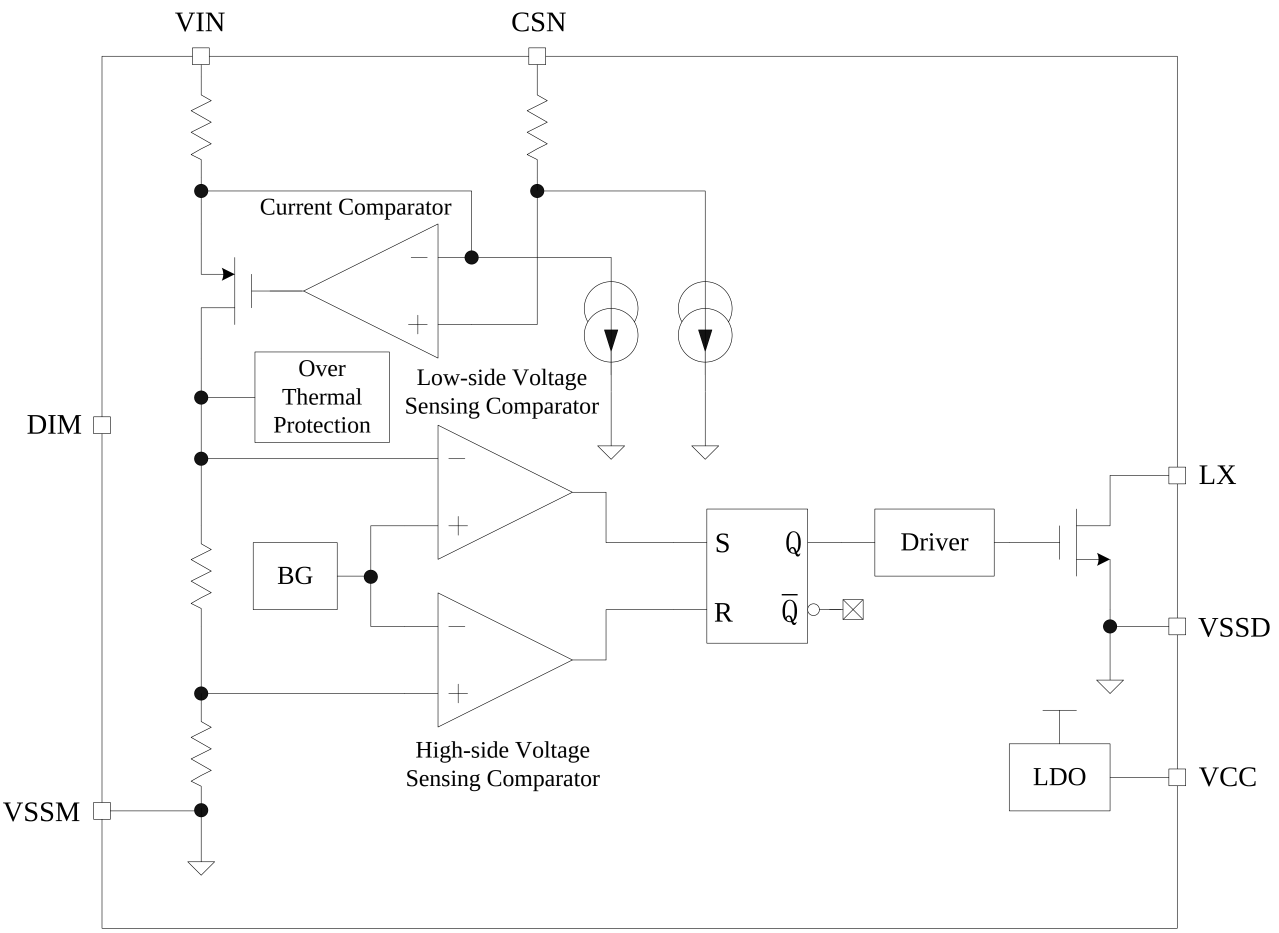


Figure 2： Functional Block Diagram of QX5243

Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Description	Min	Max	Unit
Maximum Voltage	V_{MAX1}	Maximum Voltage On VIN,CSN and LX Pins		40	V
	V_{MAX2}	Maximum Voltage On DIM and VCC Pins		7	V
Maximum Current	I_{MAX}	Maximum Current On All Pins Excluding VIN,VCC and LX		20	mA
Power Dissipation	P_{ESOP8}	Maximum Power Dissipation for ESOP8 Package		1.2	W
Thermal	T_J	Junction Temperature Range	-20	125	^oC
	T_A	Operating Temperature Range	-20	85	^oC
	T_{STG}	Storage Temperature Range	-40	120	^oC
	T_{SD}	Soldering Temperature Rang（less than 30 sec）	230	240	^oC
ESD	V_{ESD}	ESD Voltage for Human Body Mode		2000	V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Electronic Characteristics

V_{IN} =15V, C_{LDO} =1uF, L_1 =47uH, R_{CS} =0.62Ω, T_A =25°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage						
Input Voltage	V_{IN}		5.5		36	V
Under Voltage Lock Out Voltage	V_{UVLO}	$V_{IN} = V_{CSN}$, $V_{DIM} = V_{CC}$, V_{IN} decreases from 6V, and rises again from V_{UVLO} after Under Voltage Lock Out has happened		4.5	5.0	V
Under Voltage Lock Out Hysteresis Voltage	V_{HYSUV}			0.5		V
Supply Current						
Standby Current	I_{IN}	$V_{DIM} < 0.6V$			300	uA
Operating Current	I_{GND}	LX is unconnected			5	mA

Electronic Characteristics (Continued)

V_{IN} =15V, C_{LDO} =1uF, L_1 =47uH, R_{CS} =0.62Ω, T_A =25°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Current Sensing Comparator						
High-side Sensing Voltage	V_{SNSHI}	(V_{IN} -V_{CSN}) increases from 0V till V_{LX} =(V_{IN}+V_{FD}) (Note 3)		240		mV
Low-side Sensing Voltage	V_{SNSLO}	(V_{IN} -V_{CSN}) decreases from 0.26V till V_{LX} is lower than 0.5V		160		mV
Output High Level Delay	T_{DPDH}			80		ns
Output Low Level Delay	T_{DPDL}			80		ns
Input Current	I_{CSN}			5		uA
Sensing Threshold Hysteresis Voltage	V_{CS_HYS}			80		mV
Brightness Adjustment via DIM Pin						
Maximum DIM Frequency	F_{DIM}				20	KHz
DIM Input High Level	V_{IH}	V_{CSN}=V_{IN}, increase the voltage on DIM pin till V_{LX} is lower than 0.5V	2.8			V
DIM Input Low Level	V_{IL}	V_{CSN}=V_{IN}, decrease the voltage on DIM pin till V_{LX}=(V_{IN}+V_{FD})			0.6	V
Hysteresis Voltage	V_{DIM_HYS}			200		mV
DIM 'On' Time	T_{DIMON}	The time from the rise edge of DIM signal to the moment when V_{LX} is lower than 0.5 V		100		ns
DIM 'Off' Time	T_{DIMOFF}	The time from the fall edge of DIM signal to the moment when V_{LX} = (V_{IN}+V_{FD})		100		ns
DIM Input Leakage Current	I_{DIM}	V_{DIM} = 0			10	uA
Pull-up Resistor	R_{DIM}			500		KΩ

Electronic Characteristics (Continued)

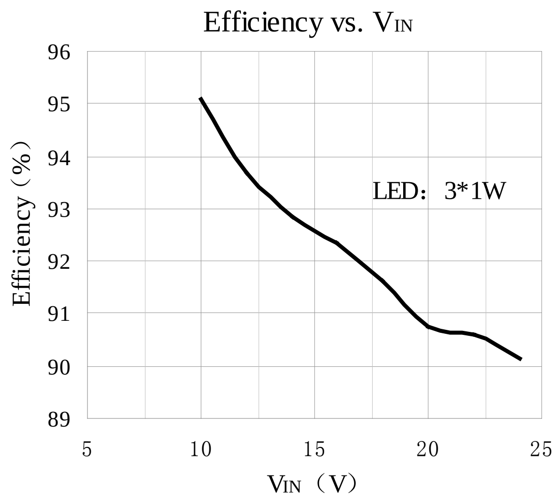
V_{IN} =15V, C_{LDO} =1uF, L_1 =47uH, R_{CS} =0.62Ω, T_A =25°C, unless otherwise specified

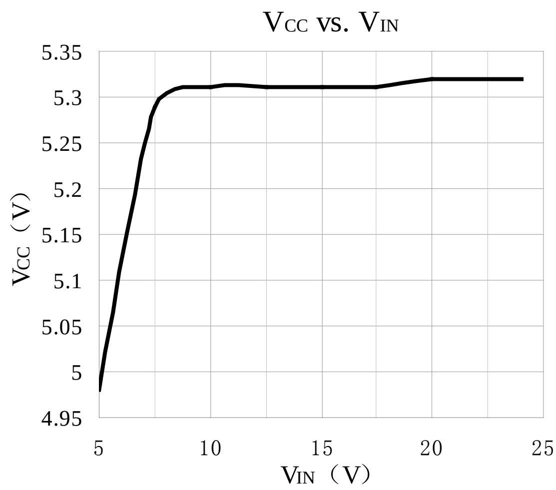
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
LDO Characteristics						
Output Voltage	V_{CC}	V_{IN} ranges from 5.5V to 36V, I_{VCC} ranges from 0.1mA to 5mA	4.5		5.5	V
Load Regulation		V_{IN}= 12V, I_{VCC} ranges from 0.1mA to 5mA		4		Ω
Power Regulation		V_{IN} ranges from 6V to 36V, I_{VCC}= 5mA		11		mV
Power Supply Rejection Ratio	PSRR	V_{IN} =12V, I_{VCC}=2mA, F_{IN} = 10KHz		-35		dB
Start-up Time	T_{STRAT}	V_{CC} increases from 0 V to 4.5V		350		us
Operating Frequency						
Maximum Frequency	F_{SW_MAX}				1	MHz
Power Switching NMOS						
On-Resistance	R_{SW}	V_{IN} =24V		0.45		Ω
		V_{IN} =12V		0.6		Ω
Continuous Current	I_{SW_M}				800	mA
Leakage Current	I_{LEAK}			0.6		uA
Over Thermal Protection						
Over Thermal Protection Threshold	T_{OTP}			130		°C
Over Thermal Protection Hysteresis	T_{HYS}			15		°C

Note 3: V_{FD} is the forward voltage drop of the diode D_{FW}.

Typical Performance Characteristics

V_{IN} =15V, C_{LDO} =1uF, L_1 =47uH, R_{CS} =0.62Ω, T_A =25°C, unless otherwise specified





Applications Information

Detailed Description

QX5243 is a step-down constant current driver for high brightness LED with high efficiency.

As shown in Fig.2, The internal circuits includes a Current Comparator, a High and a Low-side Voltage Comparator, a RS Flip-Flop, a Driver, a Power Switching NMOS, a Over Thermal Protection Circuit, a Bandgap Reference, a LDO and so on, where, the High and Low-side Voltage Comparators and the RS Flip-Flop are composed of a Hysteresis Comparator. The Bandgap Reference supplies the stable Comparing Threshold Voltages, moreover, the internal Trimming Technique ensures the high accuracy and the low temperature drift of the output current. To protect the chip and circuit system and enable the circuits to supply large current safely, the Over Thermal Protection Circuit will automatically reduce the output current when the Junction Temperature on chip exceeds 130°C, which increases the reliability.

Fig.1 shows the typical application circuit of QX5243 and the operation can be best understood by assuming that the DIM pin of the device is left floating. In Fig.1, the chip, in conjunction with the inductor (L_1) and the Current Sense Resistor (R_{CS}), forms a self-oscillating Continuous Current Mode Buck Converter. When input voltage V_{IN} is first applied, the initial current in L_1 and R_{CS} is zero and there is no output current, under this condition, the RS Flip-Flop output a high level, therefore, the internal Power Switching NMOS is turned on, causing the output current to flow from V_{IN} to ground via R_{CS}, LED(s), L_1 and the internal Power Switching NMOS, this current increases with a slope determined by V_{IN}, L_1 and the voltage drop across LED(s), and this current produce a voltage drop (V_{IN}-V_{CSN}) across $R_{CS,}$ when (V_{IN}-V_{CSN}) is higher than 0.24V, the RS Flip-Flop output a low level to turn the internal Power Switching NMOS off, and the current in L_1 continues to flows via R_{CS}, LED(s), L_1 and the Freewheeling Diode(D_{FW}) back to V_{IN}, decreasing with a slope determined by L_1, the forward voltage drop of D_{FW} and the voltage drop across LED(s), when (V_{IN}-V_{CSN}) is lower than 0.16V, the internal Power Switching NMOS is turned on again. As described above, the average current flowing through LED(s) is as follows:

$$I_{LED} = \frac{0.16V + 0.24V}{2R_{CS}} = \frac{0.2V}{R_{CS}} \qquad (1)$$

Shutdown Mode

When a voltage of 0.6V or lower is applied to the DIM pin, the circuit system enters the Shutdown Mode, and the current in LED(s) is reduced to zero.

Brightness Adjustment

The DIM pin is the Brightness Adjustment terminal, applying a low level to the DIM pin turns the current in LED(s) off, on the contrary, applying a high level to the DIM pin turns this current on. If the Brightness Adjustment function is not needed, The DIM pin is left floating.

The Brightness Adjustment function is realized by applying a Pulse Width Modulation (PWM) signal to the DIM pin. The PWM dimming is to keep the forward conduction current constant and adjust the brightness in the rang of 0~100% by controlling the turn-on and turn-off ratio of the output current. For example, as shown in Fig.3, to adjust the LED brightness to 90%, in each cycle of the PWM signal, the current is turned on for 90% period. The PWM dimming frequency can range form 100Hz to 20KHz. In order to prevent the LED lamps from flickering, The PWM dimming frequency must be higher than 100Hz.

The advantage of the PWM dimming is that the LED forward conduction current is always constant, therefore, the emission chromaticity of LED will not change like the Analog Dimming, thus the PWM dimming can not only accurately adjust the LED brightness but also ensure the emission chromaticity of LED.

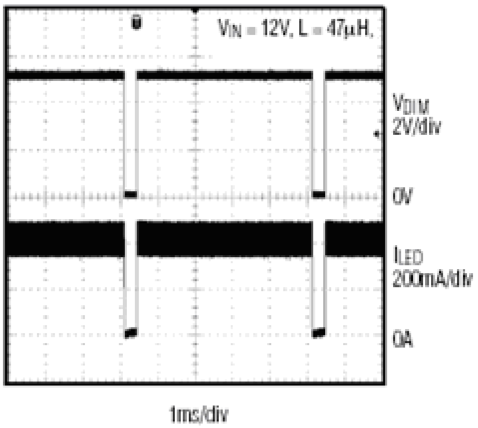


Figure 3：PWM Dimming, 90% Brightness

Under Voltage Lock Out Mode

When the input voltage V_{IN} is lower than V_{UVLO}, the internal Power Switching NMOS is turned off, and when V_{IN} is higher than (V_{UVLO} + 0.5V), the system will start up normally. The input voltage, which is too low, will usually lead to more power dissipation and reduce the efficiency of the whole system, so it must ensure that there exits a appropriate voltage difference between the input and output voltages.

Over Thermal Protection

The internal Over Thermal Protection Circuit will automatically reduce the output current to ensure the chip and circuit system operate steadily and reliably when the Junction Temperature on chip exceeds 130°C, on the contrary, QX5243 will return to the normal working condition when the Junction Temperature on chip is below 115°C.

Output Current Setting

The nominal average output current in LED(s) is determined by the value of the external Current Sense Resistor (R_{CS}) connected between VIN and CSN pins and is calculated by the formula (1). A Current Sense Resistor of 1% accuracy can make the accuracy of the current in LED(s) is within ±4%.

The formula (1) is correct under the condition that the DIM pin is left floating or an external voltage higher than 2.8V and lower than V_{CC} is applied to the DIM pin. In fact, what R_{CS} set is the Maximum Output Current in LED(s), and the actual output current can be adjusted to any values by applying a PWM dimming signal to the DIM pin.

Inductor Selection

The value of inductor will affect the Operating Frequency, that is, a lower value of inductance will result in a higher Operating Frequency, therefore, it should pay attention to the selection of the inductor to meet the Maximum Frequency of QX5243 applications. The Operating Frequency is calculated by the formula (2):

$$f_{SW} = \frac{(V_{IN} - n \cdot V_{LED}) \cdot n \cdot V_{LED}}{V_{IN} \cdot L_1 \cdot I_{LED}} \qquad (2)$$

Where, n is the number of LED and V_{LED} is the forward voltage drop of one LED.

The chosen inductor should have a saturation current higher than the peak output current and have a margin of 30%~50%. It is recommended that a higher value of inductor is used for lower output current. Under the condition that the output current capability is satisfied, a higher value of inductor helps to improve the constant current.

Diode Selection

To achieve the maximum efficiency and the best performance, the Freewheeling Diode (D_{FW}) should be a fast recovery schottky diode with low forward voltage drop, low parasitic capacitance and low leakage. The current capability and the withstanding voltage of D_{FW} should maintain a 30% margin in order to improve reliability. It is very important to consider the reverse leakage of the Freewheeling Diode when the Operating Temperature exceeds 85°C because excess leakage will increase the power dissipation in the device.

Input Filter Capacitor Selection

A low ESR capacitor of 47uF~100uF should be mounted as close to the VIN pin as possible for input filtering, and a higher ESR will result in the greater efficiency loss. This capacitor must be able to supply the relatively high peak current to the inductor and smooth the input current ripple, reducing the impact of the input power supply. The withstanding voltage of the input capacitor should maintain a certain margin.

LDO Output Capacitor Selection

A capacitor of not less than 1uF should be connected to the VCC pin which is the output terminal of the internal LDO, and this LDO can provide a maximum output current about 2mA.

PCB Considerations

A reasonable PCB layout is very important to improve the system stability and reduce the noise. Using the multi-layer PCB board is a very effective way to reduce the noise.

The Input Filter Capacitor (CIN) should be grounded separately and mounted as close to the VIN pin as possible to reduce the noise of the current loop effectively.

The VSSM and VSSD pins should be separately wiring, finally connected to the grounding pin of CIN. To ensure good grounding and heat dissipation, the copper foils of the VSSM and VSSD pins, the heat sink below QX5243 and the ground of the PCB should be connected into a large track land.

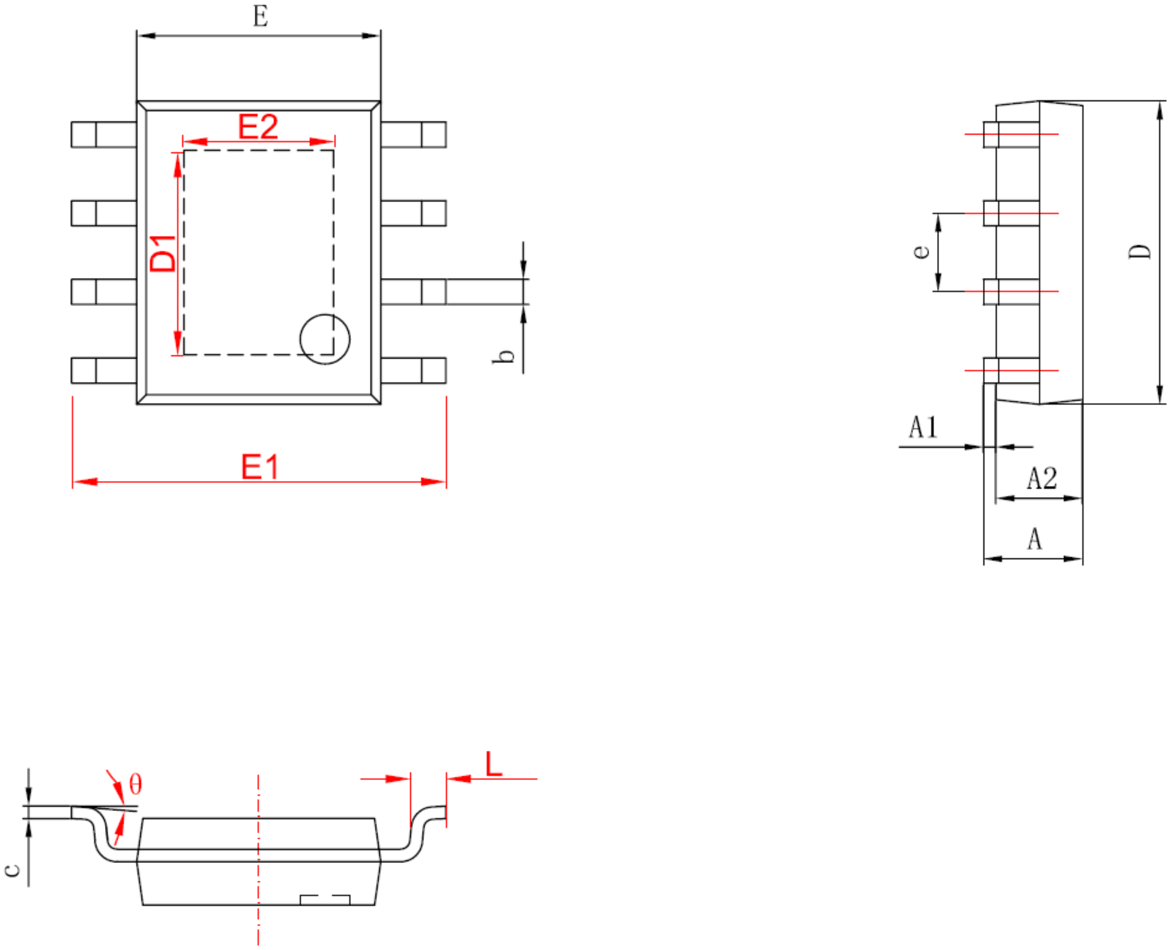
The parasitic resistance produced by the tracks in series with the Current Sense Resistor (R_{CS}) should be minimized to ensure the accuracy of the output current.

It is particularly important to mount the inductor as close to the VIN and LX pins as possible to minimize parasitic resistance and inductance, which will degrade the efficiency.

The LX pin of the device is a fast switching node, so PCB tracks should be kept as short as possible.

Package Information

Physical Dimensions for ESOP8 Package:



字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.002	0.006
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	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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