General Description

QX6102 is a built-in NPN Buck type constant-current LED driver with high precision and self-powered. It is suited AC 85V~265V non-isolated LED driver supply.

QX6102 uses self-powered structure, and need no auxiliary winding, with built-in NPN, which can improve cost performance.

QX6102 adopts patented high end current detect, fixed frequency, current mode PWM control techniques, and has excellent line regulation and load regulation.

QX6102 has frequency shuffling function which can improve EMI performance. With internal loop and slope compensation, QX6102 needs no external compensation, which makes the application design easier.

QX6102 has several protect functions, including LED open/short protect, OCP, UVLO, OVP, power clamp and so on.

Features

- Built-in NPN power transistor
- Self-powered: no need auxiliary winding
- LED output current precision: ±3%
- High Efficiency: Up to 93%
- Current mode PWM control
- Fixed operating Frequency
- Frequency shuffling
- Built-in loop compensation and slope compensation
- LED open/short protect
- UVLO protect
- Packages: DIP8 and SOP8

Applications

- LED fluorescent lamp
- Other LED light

Typical Application

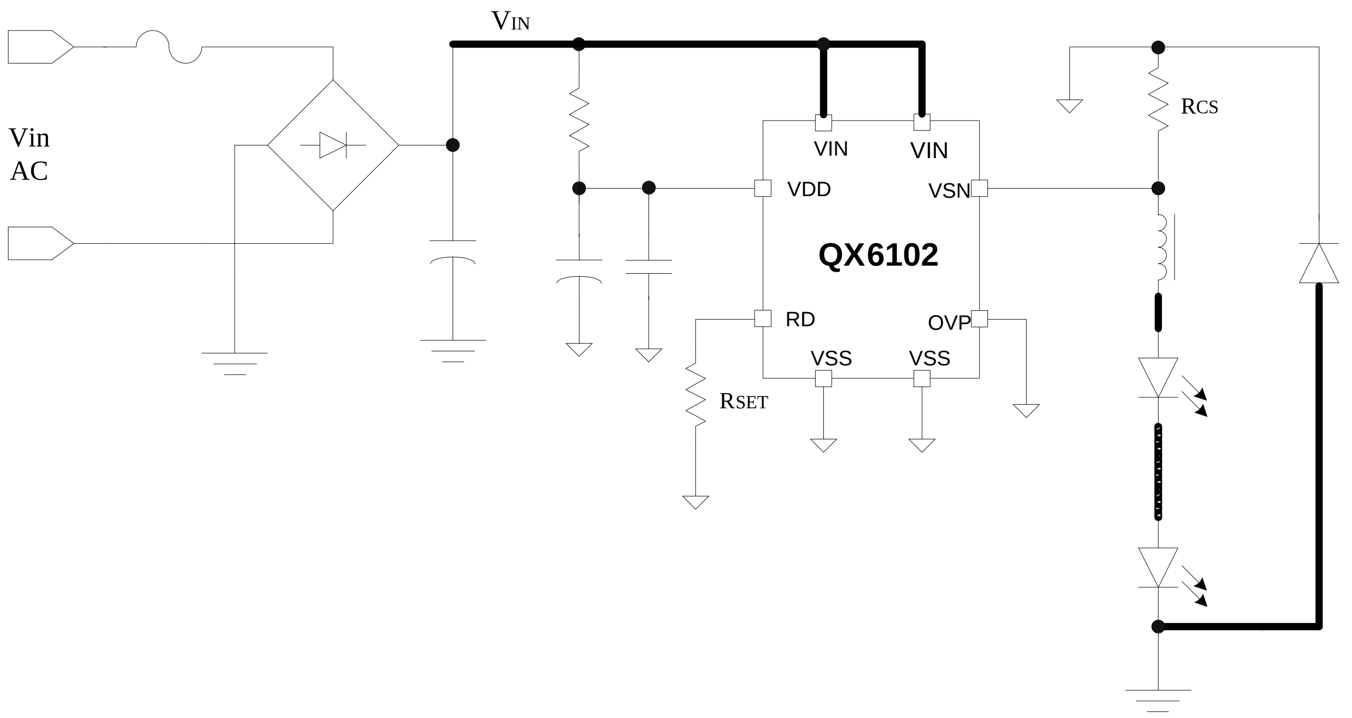


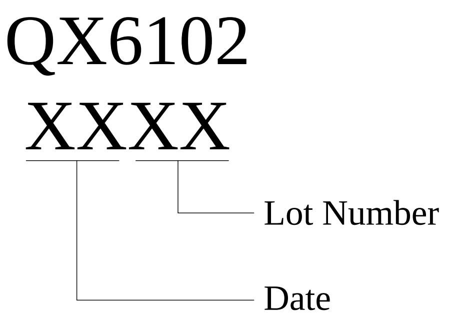
Figure 1：Typical Application Circuit Diagram 1 of QX6102 (without output capacitor)

Ordering Information

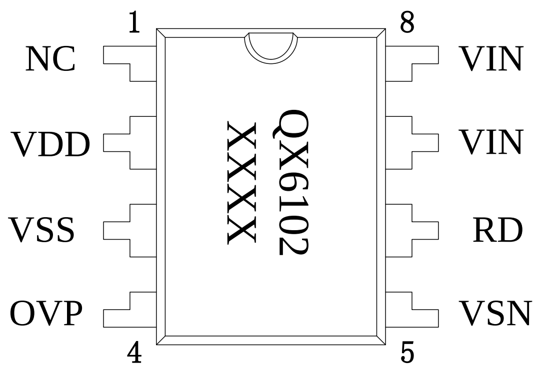
Type Number

QX6102

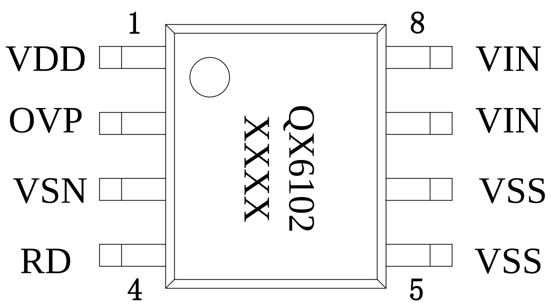
Package Marking



Pin Assignment



DIP8

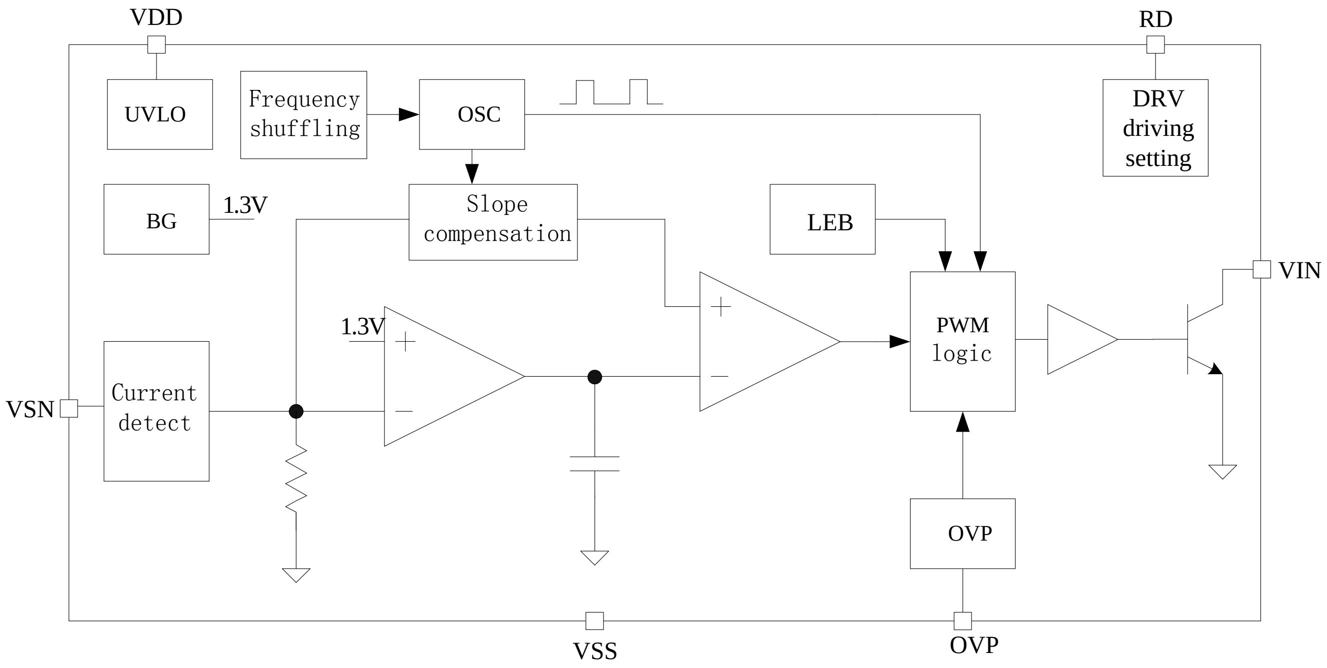


SOP8

Pin Description

Package and pin		Pin Name	Pin Type	Description
DIP8	SOP8			
1	-	NC	NC	No connection
2	1	VDD	Supply	Power Supply
3	5，6	VSS	Ground	Ground
4	2	OVP	Input	LED over voltage detect terminal
5	3	VSN	Input	Connect current sampling resistor
6	4	RD	Input	Connect resistor, setting NPN base current
7，8	7，8	VIN	Input	Collector of Built-in NPN, connect to bus voltage

Functional Block Diagram



Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Description	Min	Max	Unit
Voltage	V_{MAX}	Maximum Voltage On VIN Pin		400	V
		Maximum Voltage On Other Pins	-0.3	6	V
Current	I_{DD_MAX}	Maximum Current On VDD Pin		15	mA
	I_{VIN}	Maximum Current On VIN Pin		1500	mA
Power Dissipation	P_{DIP8}	Maximum Power Dissipation for DIP8 Package		1	W
	P_{SOP8}	Maximum Power Dissipation for SOP8 Package		0.75	W
Temperature	T_A	Operating Temperature Range	-20	85	^oC
	T_{STG}	Storage Temperature Range	-40	125	^oC
	T_{SD1}	Soldering Temperature Rang for SOP8 Package （less than 30 sec）	230	240	^oC
	T_{SD2}	Soldering Temperature Rang for DIP8 Package （less than 5 sec）	250	260	^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_{DD} =5V, T_A =25 °C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage						
Operating Voltage	V_{DD}			5		V
Threshold of start voltage	V_{DD_ON}	V_{DD} rises up	4.8	5	5.2	V
Threshold of UVLO	V_{DD_UVLO}	V_{DD} falls down	3.8	4	4.2	V
Clamp Voltage of VDD	V_{DD_CLAMP}			5.5		V
Supply Current						
Start-up Current	$I_{STARTUP}$	V_{DD} = 4V		40		uA
Standby Current	$I_{STANDBY}$	V_{OVP} = 0V， R_{SET} = 68KΩ		1.1		mA
Current Sensing						
Average Voltage of Current Detect Resistor	V_{SEN}		194	200	206	mV
Limit of V_{SEN} Voltage	V_{SEN_LMT}			520		mV
LEB	T_{LEB}			350		ns
OSC Operation Frequency						
Typical Operation Frequency	F_{OSC}			65		KHz
Range of Frequency Shuffling	ΔF_{OSC}		-3		3	%
NPN DRIVER						
Voltage of RD	V_{RD}		1.225	1.3	1.345	V
Base current of NPN	I_{DRV}	R_{SET} = 68KΩ		30		mA

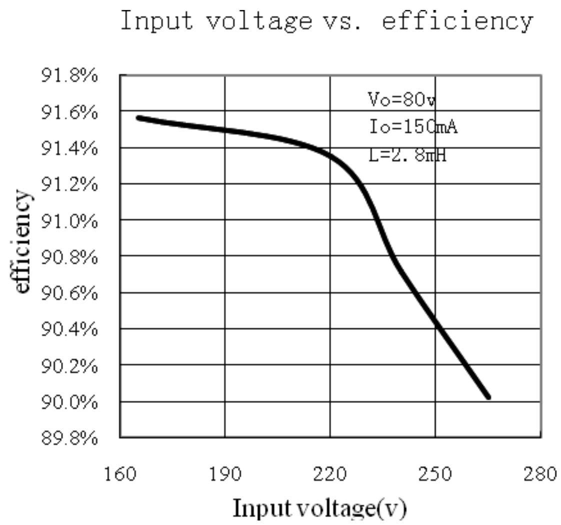
Electronic Characteristics (Continued)

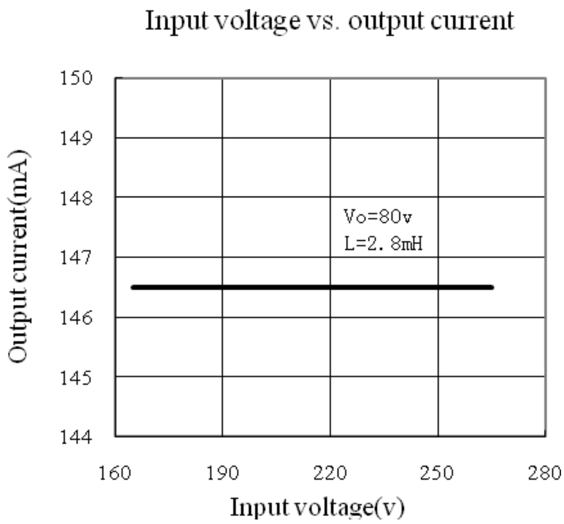
V_{DD} =5V, T_A =25 °C, unless otherwise specified

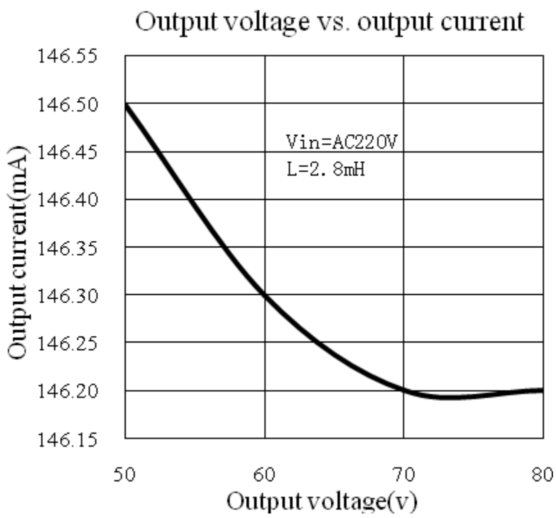
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
OVP						
Threshold Voltage of OVP	V_{OVP_TH}			1.3		V
OVP Clamp Voltage	V_{OVP_CLAMP}	I_{OVP} = 2mA		5.7		V
		I_{OVP} = -2mA		-0.7		V
Built-in NPN						
Voltage of C-E	V_{CEO}		400			V
Current of Collector	I_C				1.5	A
Gain of current	β	V_{CE} =5V，I_C =0.2A	15		30	
Current Application Range						
Output Current	I_O	SOP8 package, 8~24 LED in series	200		240	mA
		DIP8 package, 8~24 LED in series	200		250	mA
		SOP8 & DIP8 ≥12 LED in series	120		200	mA

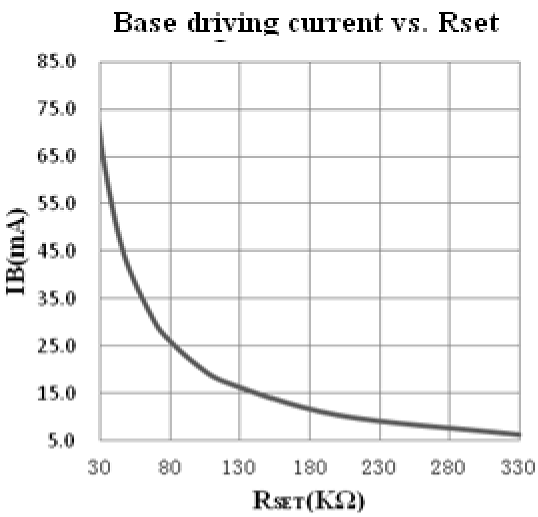
Typical Electrical Curves

V_{IN} =5V, T_A =25 °C, unless otherwise specified









Applications Information

Detailed Description

QX6102 is a BUCK type high precision LED constant current driver with built-in NPN power transistor and self powered function.

QX6102 uses special self-powered circuit, needs no auxiliary winding or other auxiliary power provider, which decrease peripheral elements and save system cost.

QX6102 adopts patented high end current detect, fixed frequency, current mode PWM control, and has excellent line regulation and load regulation.

QX6102 has frequency shuffling function which can improve EMI performance. With internal loop and slope compensation, QX6102 needs no external compensation, which makes the application design easier.

QX6102 has several protect functions, including LED open/short protect, OCP, UVLO, OVP, power clamp and so on.

IC Start Up

When QX6102 is powered on, the capacitor connected at VDD pin is charged by a resistor connecting to bus voltage. The IC consumes only 40uA current when the IC is in the under voltage lockout state. When the voltage of VDD is higher than start-up threshold V_{DD_ON}, the IC starts to work and the self-powered circuit provides current to the VDD pin. The built-in 5.5V clamp circuit is used to clamp VDD pin voltage.

LED Operation Current Setting

The LED current is determined by the resistor connected between the VSS and VSN pin with the formula below:

$$I_{LED} = \frac{V_{SEN}}{R_{CS}}$$

The typical value of V_{SEN} is 200mV.

The Driving Current Setting

The resistor R_{SET} connected at RD pin can be used to set the base current of the built-in NPN transistor. The base current of NPN should be set appropriate to the LED current set by R_{CS}, and the typical voltage of RD pin is 1.3V. When R_{SET}=68KΩ, the base current is about 30mA, which is corresponding to six to seven hundred milli-ampere of LED operation current. If higher current is needed, the R_{SET} should be decreased in proportion, and vice versa. The base current of NPN is determined by the formula bellow:

$$I_{DRV} = \frac{2100}{R_{SET}}(mA)$$

Open Circuit Protection

The LED open state protection is realized by resistors R1 and R2 connected to OVP pin. The threshold voltage of OVP pin is 1.3V, and LED open protection voltage is set by the formulas below:

$$V_{OVP} = \frac{R_1 + R_2}{R_1} * V_{OVP\_TH}$$

$$\text{And} \quad 50uA < \frac{V_{OVP}}{R_1 + R_2} < 500uA$$

QX6102 detects the LED voltage when the POWER NPN is off. We normally set V_{OVP} voltage equal to output voltage V_{LED} times 1.2. When the voltage of LED reaches the protection threshold voltage, QX6102 will cut off the driving signal, until UVLO, then IC restart and redetect.

Short Circuit Protection

When LED is shorted, the system will decrease output frequency, and decrease input current at the same time. As long as the frequency decreases to a certain value, the system will get into UVLO, and then system restart.

Inductor Selection

For certain input voltage, output voltage and output current, the inductor value determines the current ripple of the inductor and the CCM or DCM mode. When system operates in BCM mode, the inductor value is:

$$Lcri = \frac{Vo*(Vi-Vo)}{2Vi*I_{LED}*fs}$$

When inductor value is about Lcri, the system will get better efficiency.

When the system use figure 1 without output capacitor, the inductor value should be larger value to ensure the system in CCM mode, and decrease the current ripple in LED. When the system uses figure 2 with output capacitor, the system can work both in CCM mode and DCM mode.

VDD Bypass Capacitor Selection

The bypass capacitor connected at the VDD to VSS should be low ESR, in order to ensure the IC work steadily and low voltage ripple. The 2.2~10uF good temperature characteristic ceramic capacitors are recommended. For the ESR will increase sharply under low temperature, an extra 1uF ceramic capacitor or monolithic capacitor must be connected at VDD pin in order to prevent the start-up problem.

PCB Layout Design

When designing PCB layout, the following rules should be taken into consideration:

The bypass capacitors of VDD pin should be put beside the VDD and VSS of QX6102 as close as possible. X7R ceramic capacitors are proposed under low temperature.

The sampling resistor R_{CS} should be put close to the VSS pin of QX6102, and the wire should be short and wide.

The signals wiring should pay more attention to the following: the wire connected to VIN bus voltage, the wire between inductor and LED lamps, the VSS of LED. Those wires should prevent from too close to QX6102, and avoid parallel wiring with low voltage signals out from QX6102, which are shown in figure 1 and figure 2.

Decrease the layout area of power loop, which can decrease the EMI.

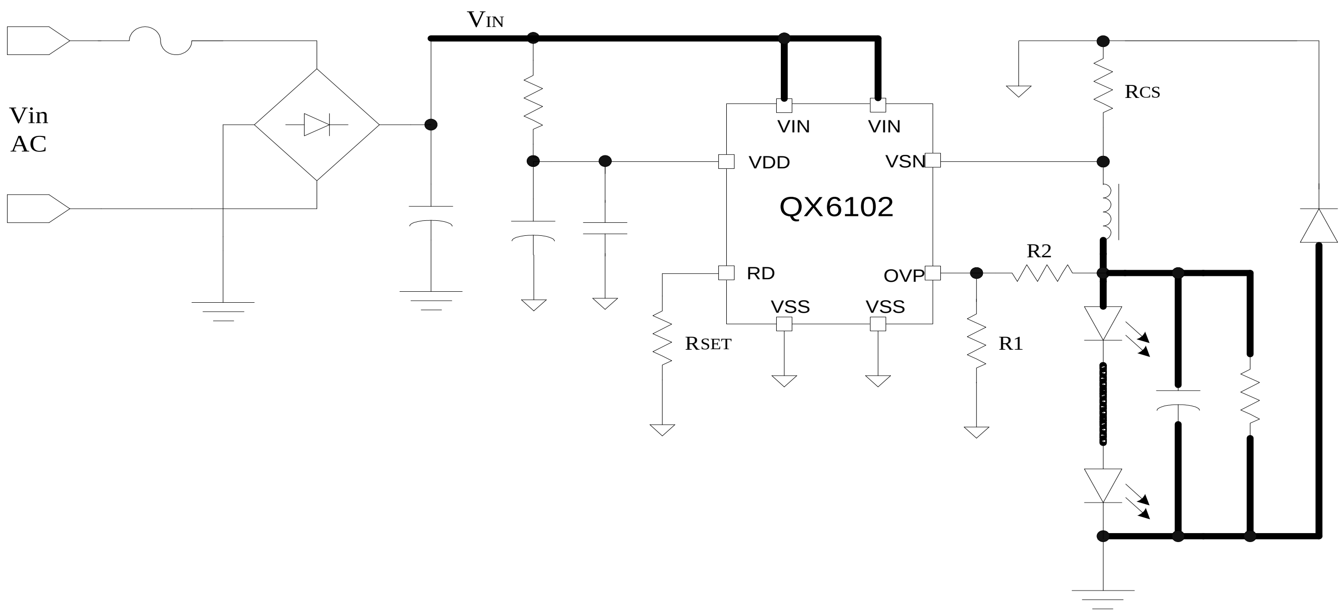
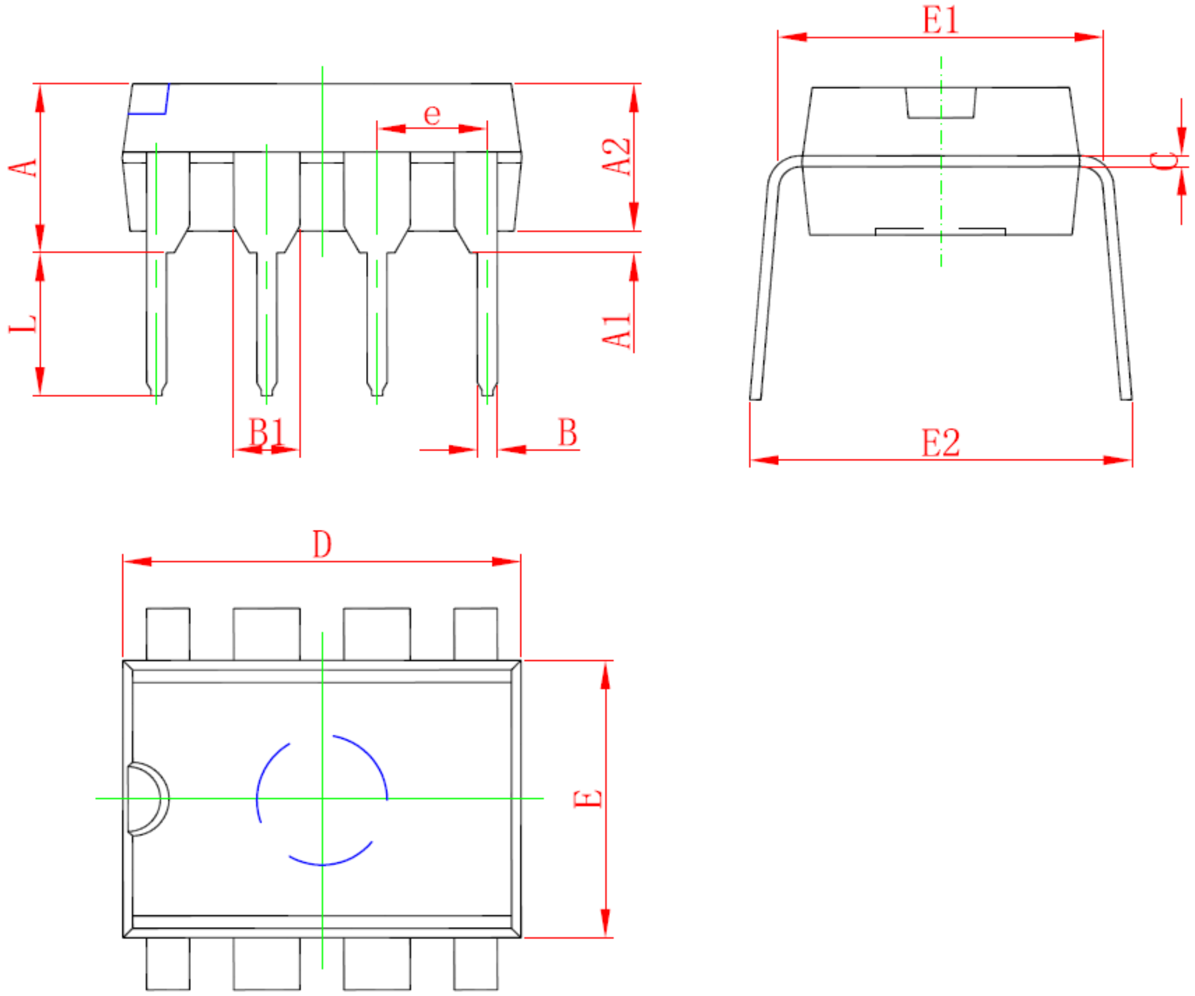


Figure 2：Typical Application Circuit Diagram 2 of QX6102 (with output capacitor)

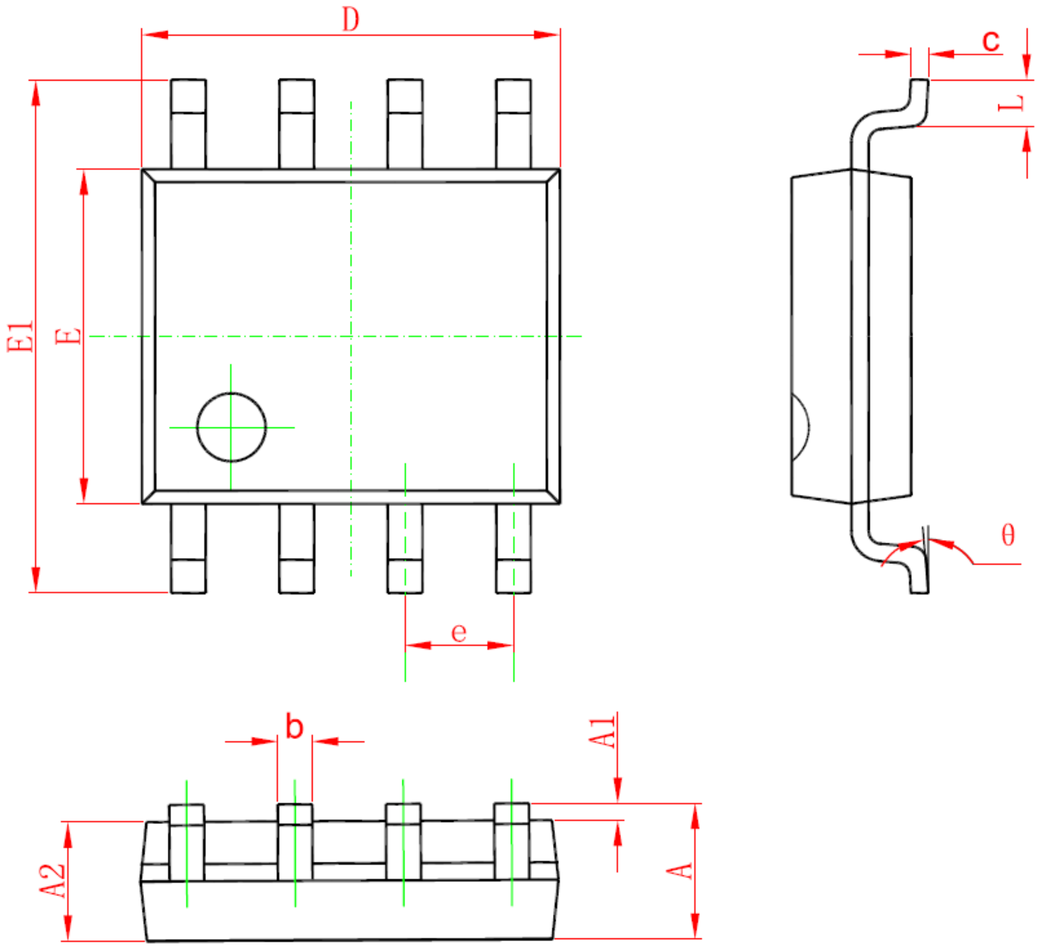
Package Information

Physical Dimensions for DIP8 Package:



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

Physical Dimensions for SOP8 Package:



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	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
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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Customer Service Center

QX Micro Devices Co., Ltd.

Add: 4th Floor, Building 22, Zhiheng Hi-Tech Park, Nantou Guangkou 2nd Road, Nanshan, Shenzhen, Guangdong, China

ZIP Code: 518052

Tel: +86-0755-88852177

Fax: +86-0755-86350858

Web Site: www.qxmd.com.cn