

## General Description

QX5241 is a step-down high-brightness LED constant-current driver with high accuracy.

A high-side current-sense resistor adjusts the output current, which minimizes the number of external components while delivering an LED current with  $\pm 1\%$  accuracy, and a dedicated PWM input (DIM) makes a wide range of pulsed dimming feasible.

A hysteretic control algorithm ensures excellent input-supply rejection and fast response to load transients and PWM dimming. QX5241 features a 20% inductor current ripple and operates up to 1MHz switching frequency.

QX5241 is well suited for applications requiring a wide input voltage range from 5.5V to 36V, and operates over the  $-20^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  automatic temperature range.

## Features

- Maximum Output Current: 2.5A
- High Efficiency: 96%
- High-side Current Sense
- Maximum Dimming Frequency: 5KHz
- Hysteretic Control: No Compensation
- Maximum Operating frequency: 1MHz
- High Current Accuracy: Up to  $\pm 1\%$
- Wide input voltage range: 5.5V to 36V
- Maximum Output Power: 25W
- 5V, 5mA On-chip Regulator

## Applications

- Architectural, Industrial, and Ambient Lighting
- MR16 and Other LED Bulbs
- Automotive Lighting

## Typical Application

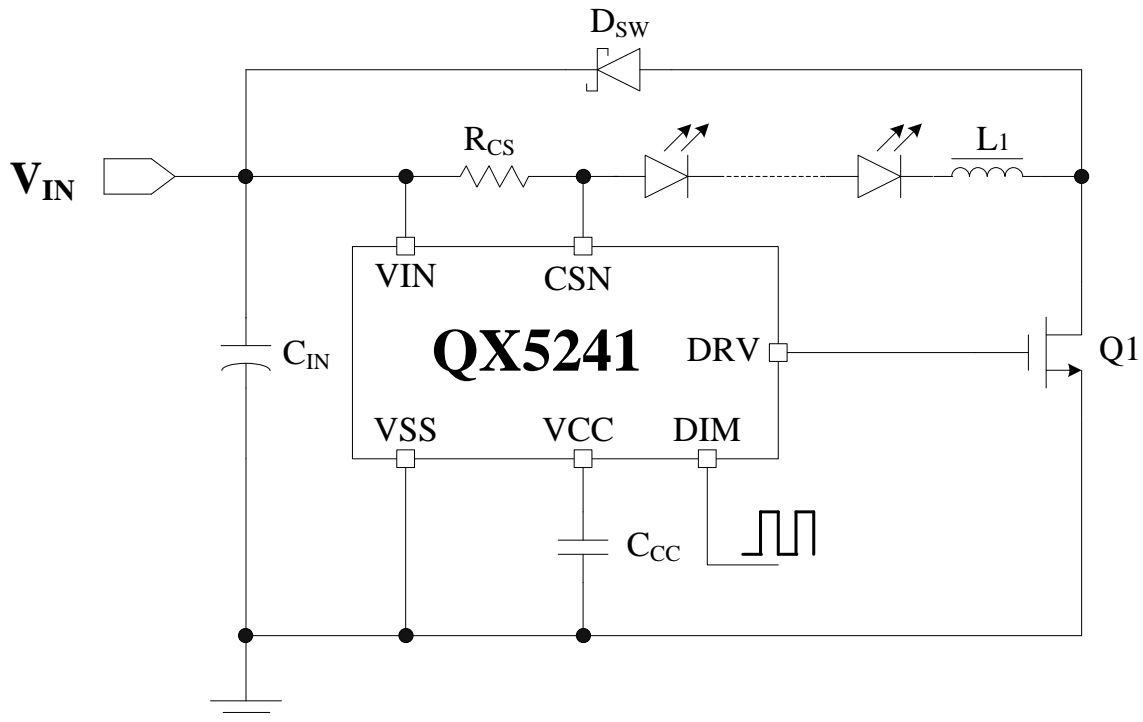


Figure 1: Typical Application Circuit Diagrams of QX5241

## Ordering Information

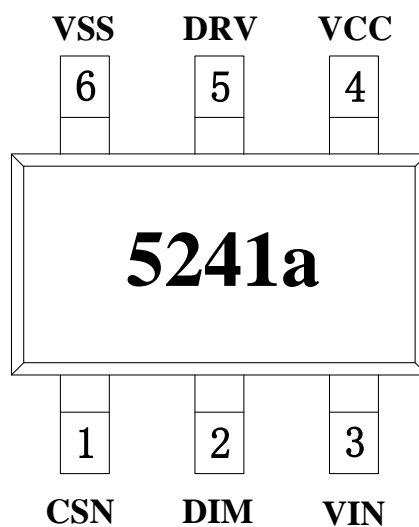
Type Number

**QX5241**

Package Marking

**5241a**

Pin Assignments



**SOT23-6**

## Pin Description

Pin	Pin Name	Pin Type	Description
1	CSN	Input	Current Sense Input
2	DIM	Input	Dimming Control Input
3	VIN	Power Supply	Power Supply Voltage
4	VCC	Output	LDO Output: 5V, 5mA
5	DRV	Output	Power MOSFET Gate Drive
6	VSS	Ground	Ground

## Functional Block Diagram

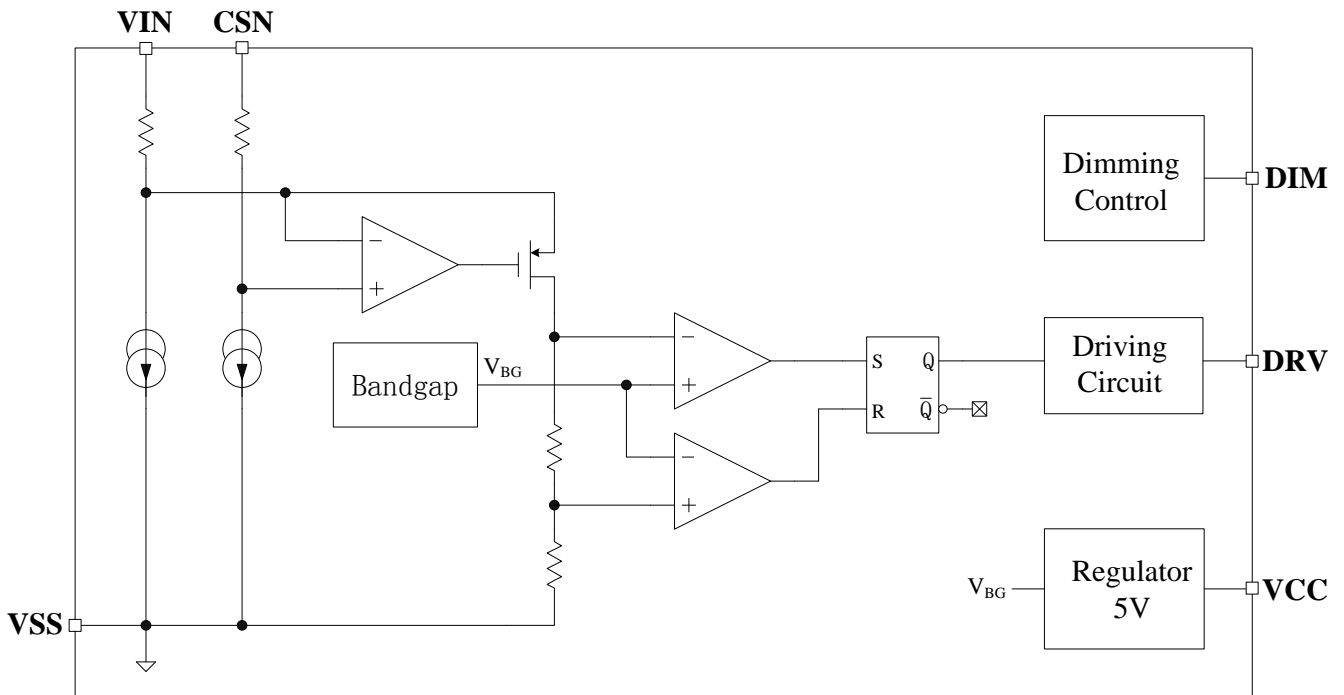


Figure 2: Functional Block Diagram of QX5241

## Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Description	Min	Max	Unit
Voltage	$V_{MAX1}$	Maximum Voltage On Pins Excluded DIM and VCC		40	V
	$V_{MAX2}$	Maximum Voltage On DIM and VCC Pins		7	V
Current	$I_{MAX}$	Maximum Current On CSN and DIM Pins		20	mA
Power Dissipation	$P_{SOT23-6}$	Maximum Power Dissipation for SOT23-6 Package		0.3	W
Thermal	$T_A$	Operating Temperature Range	-20	85	°C
	$T_{STG}$	Storage Temperature Range	-40	120	°C
	$T_{SD}$	Soldering Temperature Rang (less than 30 sec)	230	240	°C
ESD	$V_{HBM}$	HBM		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

$V_{IN}=15V$ ,  $C_{CC}=1\mu F$ ,  $C_{DRV}=1nF$ ,  $T_A=25^\circ C$ , unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Supply Voltage</b>						
Maximum Input Voltage	$V_{IN\_MAX}$				36	V
Under-voltage Lockout	$V_{UVLO}$	$V_{IN}=V_{CSN}$ , $V_{DIM}=V_{CC}$ , $V_{IN}$ rises from 0V		5	5.5	V
Under-voltage Lockout Hysteresis	$V_{HYS}$			0.5		V
Supply Current	$I_{IN}$				5	mA
Standby Current	$I_{ST}$				400	uA
<b>Switching frequency</b>						
Maximum Switching frequency	$F_{SW\_MAX}$				1	MHz

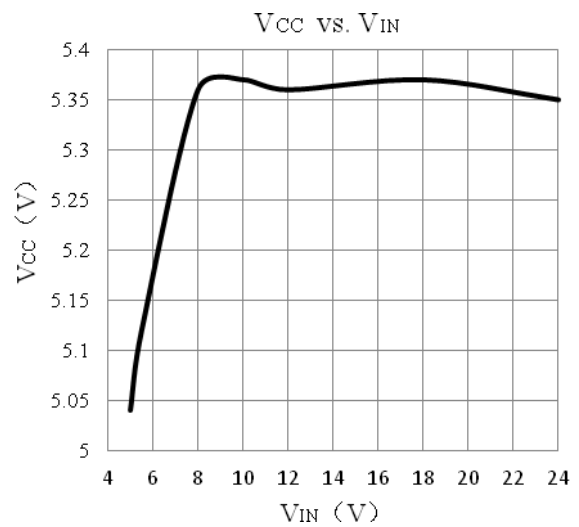
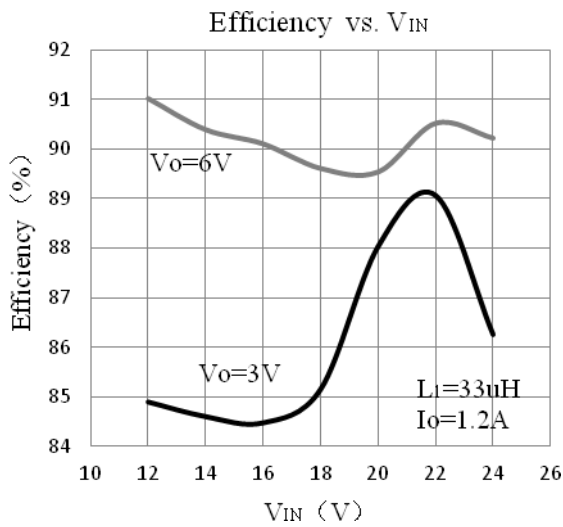
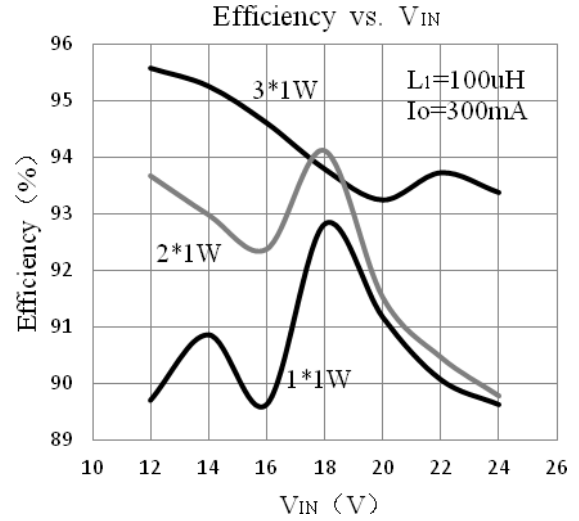
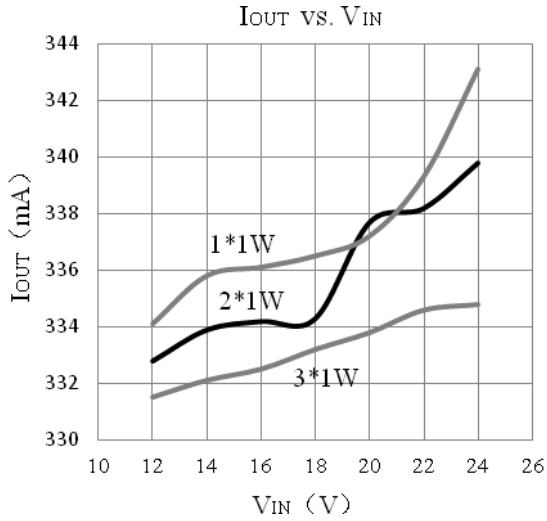
**Electronic Characteristics** (Continued)

 $V_{IN}=15V$ ,  $C_{CC}=1\mu F$ ,  $C_{DRV}=1nF$ ,  $T_A=25^{\circ}C$ , unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Current Sense Comparator</b>						
Sense Voltage High Threshold	$V_{CSNH}$	$(V_{IN} - V_{CSN})$ rises from 0.1V until DRV pin outputs low level		220		mV
Sense Voltage Low Threshold	$V_{CSNL}$	$(V_{IN} - V_{CSN})$ falls from 0.3V until DRV pin outputs high level		180		mV
Current Sense Input Current	$I_{CSN}$			5		$\mu A$
Propagation Delay to Output High	$T_{DPDH}$			80		ns
Propagation Delay to Output Low	$T_{DPLD}$			80		ns
<b>Dimming Control</b>						
Maximum Dimming Frequency	$F_{DIM}$				5	KHz
Input High Level	$V_{IH}$	$V_{IN}=V_{CSN}$ , increasing DIM input level until DRV pin outputs high level	2.8			V
Input Low Level	$V_{IL}$	$V_{IN}=V_{CSN}$ , decreasing DIM input level until DRV pin outputs low level			0.6	V
DIM Hysteresis	$V_{DIMHYS}$			200		mV
DIM Input Current	$I_{DIM}$	$V_{DIM}=V_{CC}$			5	$\mu A$
<b>LDO Characteristic</b>						
Output Voltage	$V_{CC}$	$V_{IN}=5.5V\sim 36V$ , $I_{CC}=0.1mA\sim 5mA$	4.5		5.5	V
Load Regulation		$I_{CC}=0.1mA\sim 5mA$ , $V_{IN}=12V$		4		$\Omega$
Linear Regulation		$V_{IN}=6V\sim 36V$ , $I_{CC}=5mA$		11		mV
Power Supply Rejection Ratio	PSRR	$V_{IN}=12V$ , $I_{CC}=5mA$ , $F_{IN}=10KHz$		-35		dB
Startup Time	$T_{START}$	$V_{CC}$ rises from 0V to 4.5V		350		$\mu s$

## Typical Electrical Curves

$T_A = 25^\circ\text{C}$ , unless otherwise specified



## Applications Information

### Output Current Setting

QX5241 features a programmable LED current adjusted by an external resistor connected between VIN and CSN pins. The equation to calculate the output current is as follows:

$$I_{LED} = \frac{0.22 + 0.18}{2 * R_{CS}} = \frac{0.2}{R_{CS}}$$

### Inductor Selection

The inductance value of inductor affects switching frequency, that is, a smaller inductor value leads to a higher switching frequency. The equation to determine the Operating Frequency is as follows:

$$F_{SW} = \frac{(V_{IN} - V_{LED}) * V_{LED}}{0.2 * V_{IN} * I_{LED} * L1}$$

It is strongly recommended that the Operating Frequency is below 1MHz for stabilization and reliability.

### Dimming Control

QX5241 allows dimming with a PWM signal at the DIM pin. A logic level below 0.6V at the DIM pin forces the DRV pin to output low level and turn off the LED current. To turn the LED current on, the logic level at the DIM pin must be at least 2.8V. If the dimming function is not wanted, then the DIM pin can be connected to the VCC pin.

It is strongly recommended that the Maximum Dimming Frequency is below 5KHz for the linear consistency of the Dimming Control.

### MOSFET Selection

The breakdown voltage of MOSFET should be higher than the Maximum Input Voltage. A MOSFET with small on-resistance helps to improve the efficiency.

### Freewheeling Diode Selection

The breakdown voltage of the freewheeling diode  $D_{SW}$  should be higher than the maximum input power supply voltage. A freewheeling diode with low forward voltage drop helps to improve the efficiency.

### LDO Output

The VCC pin is the output of a 5V regulator on chip, which can supply a maximum current of 5mA.

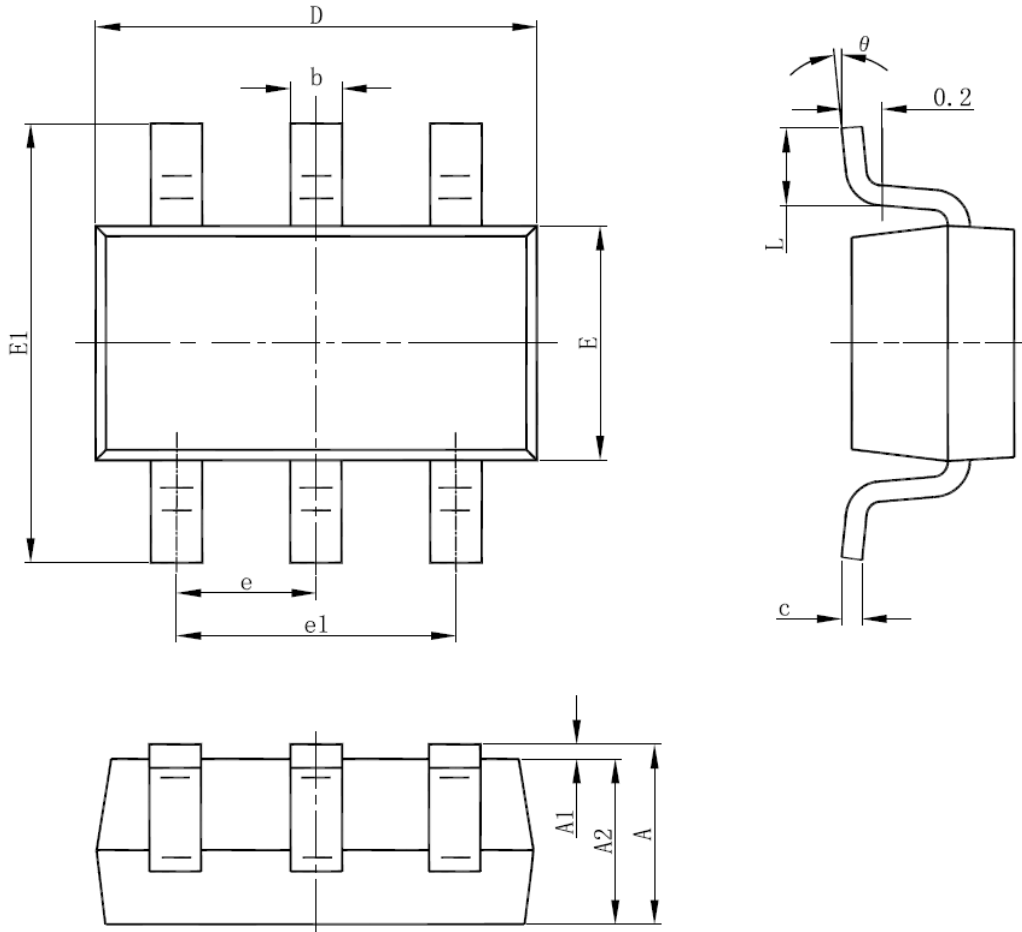
A bypass capacitor must be connected between the VCC pin and the VSS pin, whose capacitance value must be at least 1uF.

### Input Capacitor

A bypass capacitor of 47uF to 100uF must be connected between the VIN pin and the VSS pin, whose nominal withstand voltage should be higher than the Maximum Input Voltage.

## Package Information

Physical Dimensions for SOT23-6 Package:



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
$\theta$	0°	8°	0°	8°



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