Built-In OVP White LED Step-up Converter in Tiny Package

Description

The FP6739 is a step-up DC/DC converter specifically designed to drive white LEDs with a constant current. The device can drive up to 4 LEDs in series from a Li-ion cell. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. The FP6739 switches at 1.3MHz, allowing the use of tiny external components. The output capacitor can be as small as 0.68uF, saving space and cost versus alternative solutions. A low 200mV feedback voltage minimizes power loss in the current setting resistor for better efficiency.

The FP6739 is available in low profile TSOT-23-6 and SOT-23-6 packages.

Features

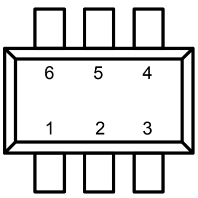
- Inherently Matched LED Current
- High Efficiency: 91%
- 20V Internal Switch
- Fast 1.3MHz Switching Frequency
- Uses Tiny 1mm Tall Inductors
- Needs Only 0.68μF Output Capacitor
- Low Profile TSOT-23-6 and SOT-23-6 Packages
- Analog / PWM Dimming by EN Pin
- Over-Current Protection
- Over-Temperature Protection
- Over-Voltage Protection
- RoHS Compliant

Applications

- Cellular Phones
- Digital Cameras
- Portable DVDs
- Car TVs
- GPS Receivers
- PDAs, Handheld Computers

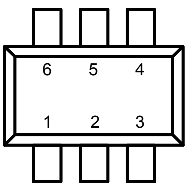
Pin Assignments

S9 Package (TSOT-23-6)



TOP VIEW
1. SW
2. GND
3. FB
4. EN
5. OVP
6. VIN

S6 Package (SOT-23-6)



TOP VIEW
1. SW
2. GND
3. FB
4. EN
5. OVP
6. VIN

Figure 1. Pin Assignment of FP6739

Ordering Information

FP6739□□□

- TR: Tape / Reel
  Blank: Tube
- P: Pb Free with Commercial Standard (RoHS Compliant)
- Package Type
  S9: TSOT-23-6
  S6: SOT-23-6

TSOT-23-6 Marking

Part Number	Product Code
FP6739S9P	CW

SOT-23-6 Marking

Part Number	Product Code
FP6739S6P	D3

Typical Application Circuit

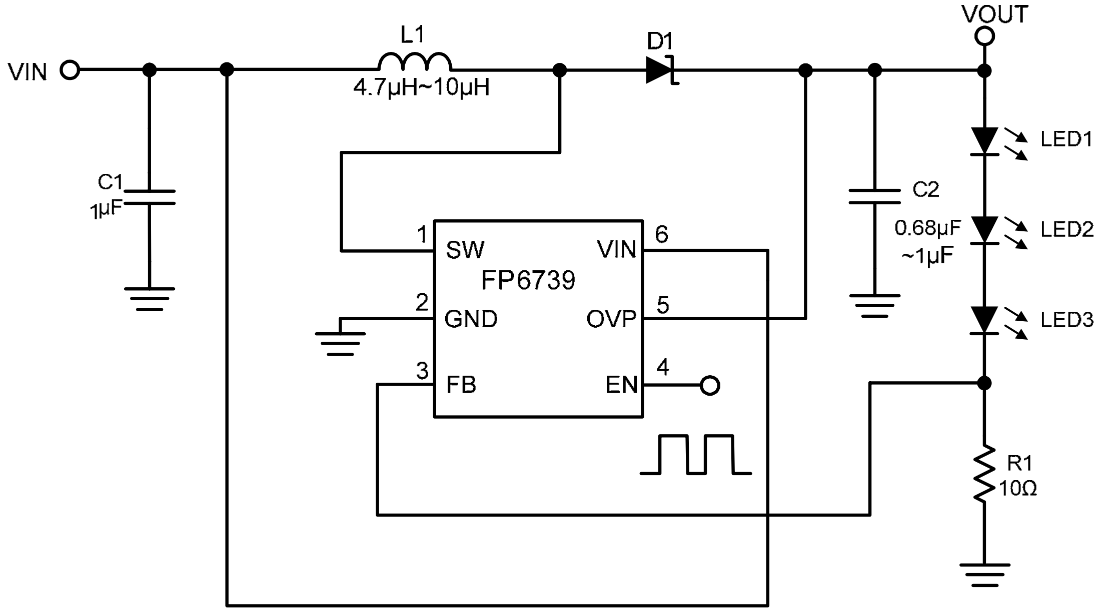


Figure 2. Typical Application Circuit of FP6739

Functional Pin Description

Pin Name	Pin Function
SW	Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 20V.
GND	Ground.
FB	Feedback Input. The FP6739 regulates the voltage across the current sense resistor between FB and GND. Connect a current sense resistor from the cathode of the LED string to GND. Connect the cathode of the LED string to FB. The regulation voltage is 200mV.
EN	Enable dimming control. 1.Enable: a logic high enables the device, logic low forces the device into shutdown mode 2 Analog dimming control : apply 0.9V to 1.5V DC voltage signal 3 Digital dimming control : apply external PWM pulse signal
OVP	Over Voltage Input. OVP measures the output voltage for open circuit protection. Connect OVP to the output at the top of the LED string.
VIN	Input Supply Pin. Must be locally bypassed.

Block Diagram

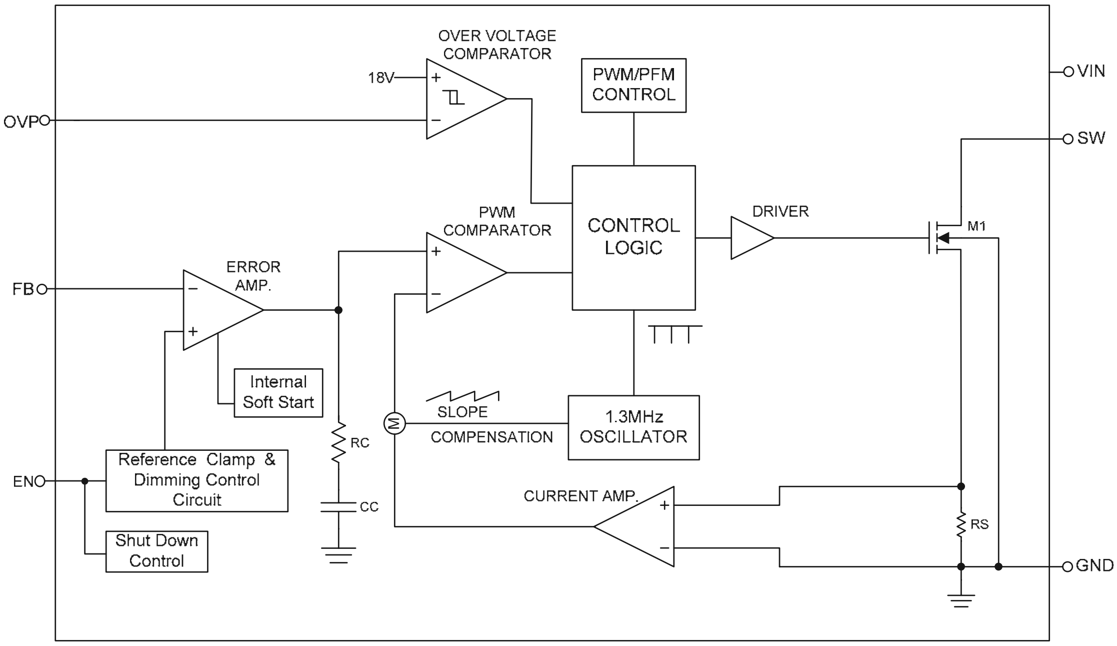


Figure 3. Block Diagram of FP6739

Absolute Maximum Ratings

- Supply Input Voltage (V_{IN}) -- + 6V
- SW, OVP pin Voltage-- + 20V
- FB pin Voltage-- + 6V
- EN pin Voltage-- + 6V
- Maximum Junction Temperature (T_J) -- + 150°C
- Power Dissipation (P_D) @ T_A=25°C, TSOT-23-6 / SOT-23-6 -- + 0.4W
- Package Thermal Resistance (θ_{JA}), TSOT-23-6 / SOT-23-6 -- + 250°C/W
- Storage Temperature Range (T_S) -- - 65 to + 150°C
- Lead Temperature (Soldering, 10 sec.) (T_{LEAD})-- + 260°C

Note：Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

Recommended Operating Conditions

- Input Voltage (V_{IN}) -- + 2.5 to + 5.5V
- Operating Junction Temperature Range-- - 40 to + 85°C

Note : In order to achieve stable switch current limit level, it is recommended to adopt 3.3V Vin for 2 serial LED application.

Electrical Characteristics

(V_{IN}=V_{EN}=5V, T_A= + 25 °C, unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Voltage	V_{IN}		2.5		5.5	V
Supply Current	I_{IN}	Switching		0.5	1	mA
		Non-switching		70	100	uA
		V_{EN}=0V		0.1	1.0	
ERROR AMPLIFIER						
Feedback Voltage	V_{FB}	I_{OUT}=20mA	0.19	0.2	0.21	V
FB Input Bias Current	I_{FB}	V_{FB}=200mV		1		nA
UNDER VOLTAGE LOCKOUT						
VIN Under Voltage Lockout	UVLO	V_{in} Rising		2.2	2.4	V
Under Voltage Lockout Hysteresis				100		mV
OSCILLATOR						
Switching Frequency	f_{OSC}		0.8	1.3	1.6	MHz
Maximum Duty Cycle	DC		85	90		%
POWER SWITCH						
SW On Resistance	$R_{DS(ON)}$	V_{IN}=5.0V, I_{LX}=500mA		0.4		Ω
SW Current Limit (Note 1)	I_{LM}	Duty cycle=60%, note1		1.3		A
Switch Leakage Current	$I_{SW(OFF)}$	V_{SW}=19V		0.01	5	uA
CONTROL INPUT						
EN Voltage High	V_{IH}	ON	1.7			V
EN Voltage Low	V_{IL}	OFF			0.5	V
Analog Dimming Voltage Range	VDIM		0.9		1.5	V
OVER VOLTAGE PROTECTION						
OVP Input Resistance	R_{OVP}			1.2		MΩ
OVP Threshold	V_{OVP}		17	18	19	V
OVER TEMPERATURE PROTECTION						
Thermal Shutdown Threshold	T_{OTP}.	Typical 10 °C hysteresis		160		°C

Note 1: The switch current limit threshold is guaranteed by design.

Typical Performance Curves

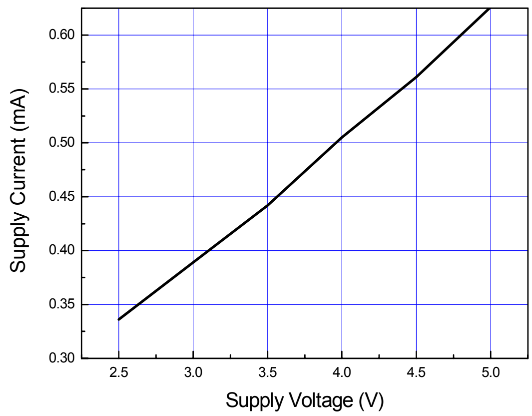


Figure 4. Supply Current vs. Supply Voltage

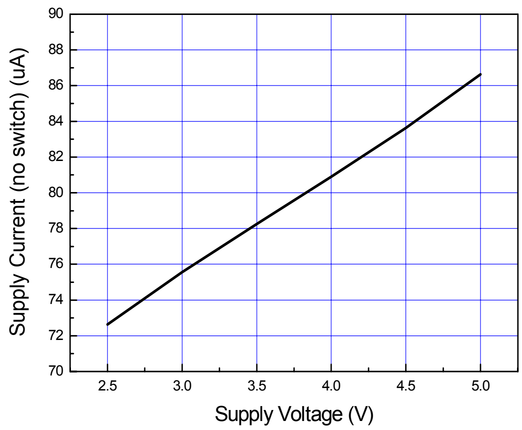


Figure 5. Quiescent Current vs. Supply Voltage

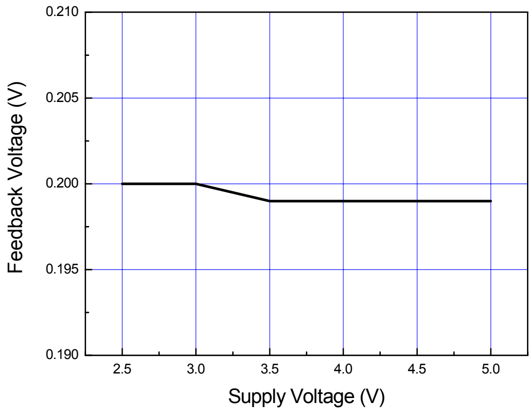


Figure 6. Feedback Voltage vs. Supply Voltage

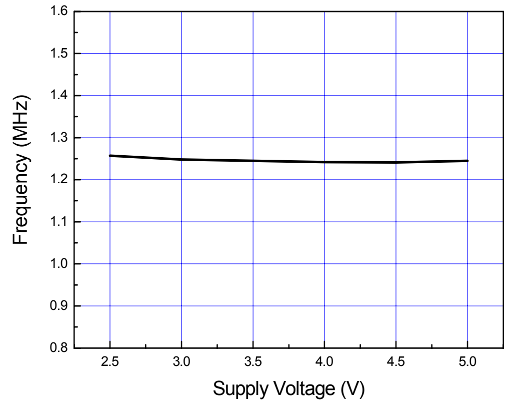


Figure 7. Oscillator Frequency vs. Supply Voltage

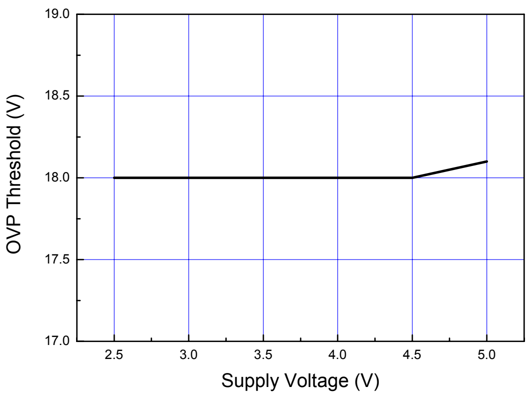


Figure 8. Over Voltage Protect vs. Supply Voltage

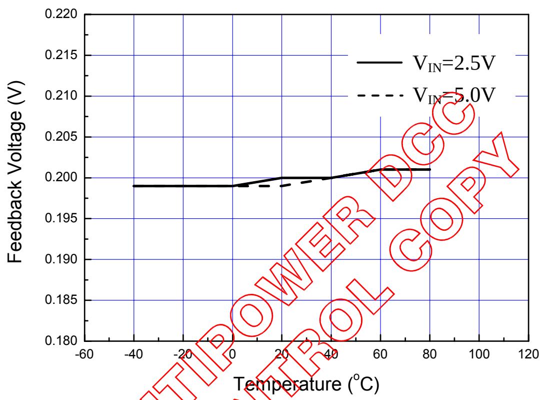


Figure 9. Temperature vs. Feedback Voltage

Typical Performance Curves (Continued)

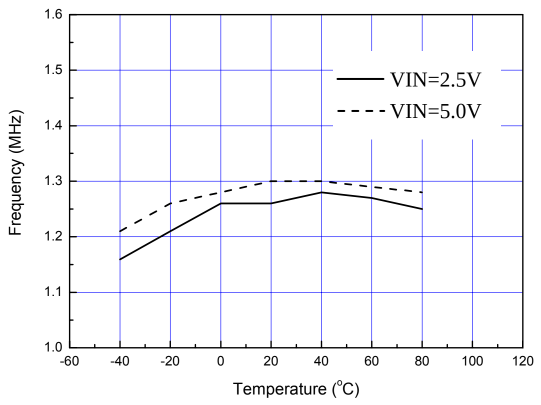


Figure 10. Temperature vs. Frequency

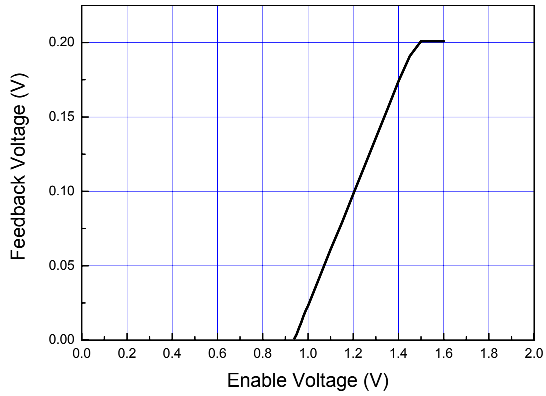


Figure 11. Enable Voltage vs. Feedback Voltage (analog control)

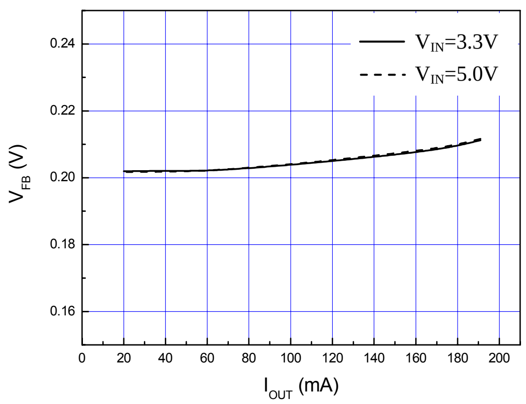


Figure 12. Load Regulation

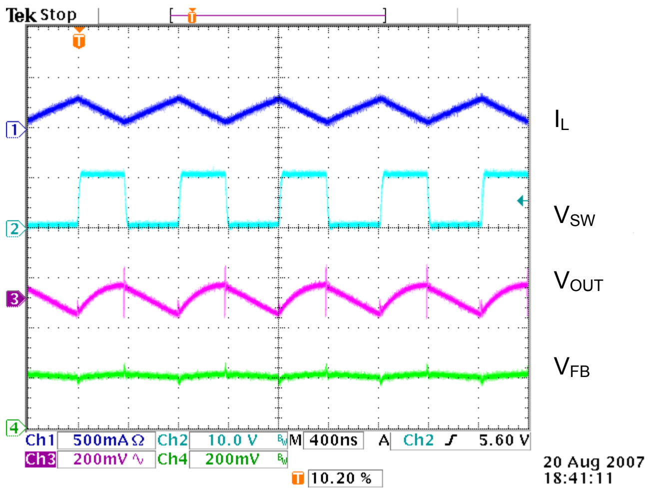


Figure 13. Operation Waveform
Vin=5V, 3LEDs, ILED=100mA, Cout=1uF

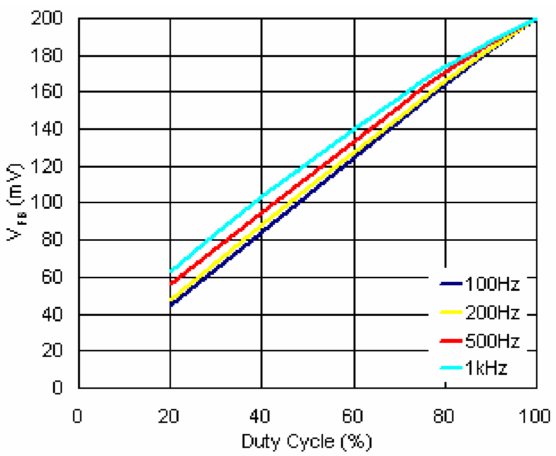


Figure 14. Duty Cycle vs. Feedback Voltage
3.3Vi to 3LEDs (PWM control)

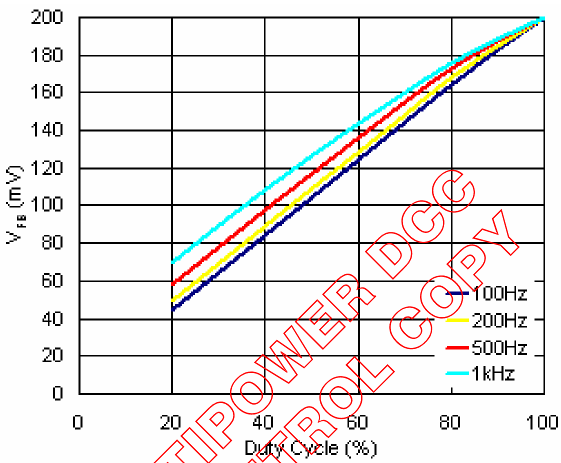


Figure 15. Duty Cycle vs. Feedback Voltage
3.3Vi to 4LEDs (PWM control)

Typical Performance Curves (Continued)

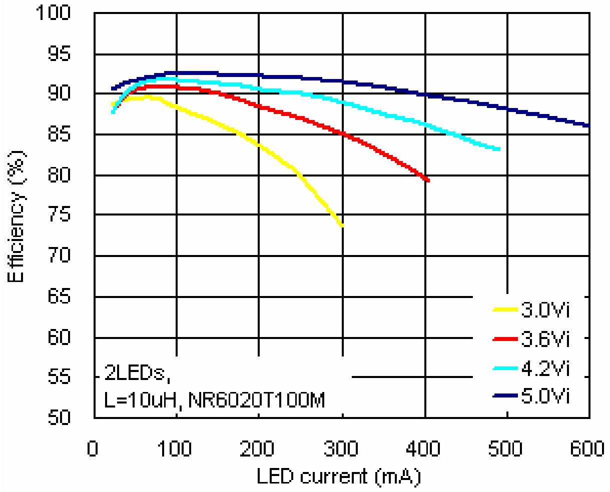


Figure 16. Efficiency vs. LED Current
(Different Input Voltage)

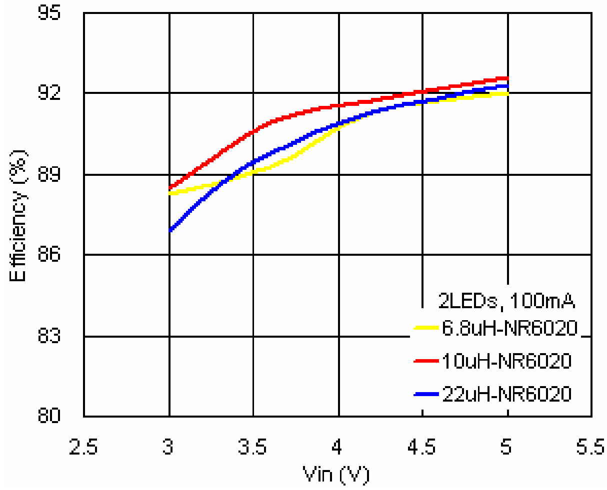


Figure 17. Efficiency vs. Input Voltage
(Different Inductor)

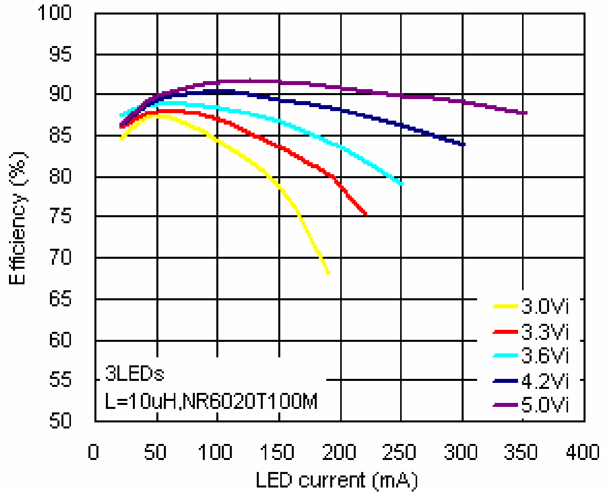


Figure 18. Efficiency vs. LED Current
(Different Input Voltage)

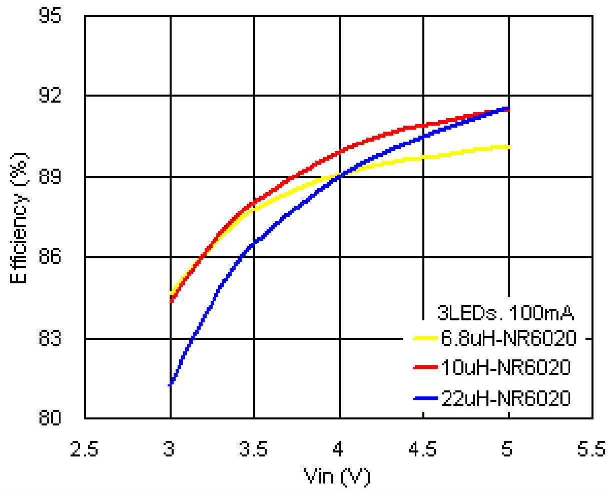


Figure 19. Efficiency vs. Input Voltage
(Different Inductor)

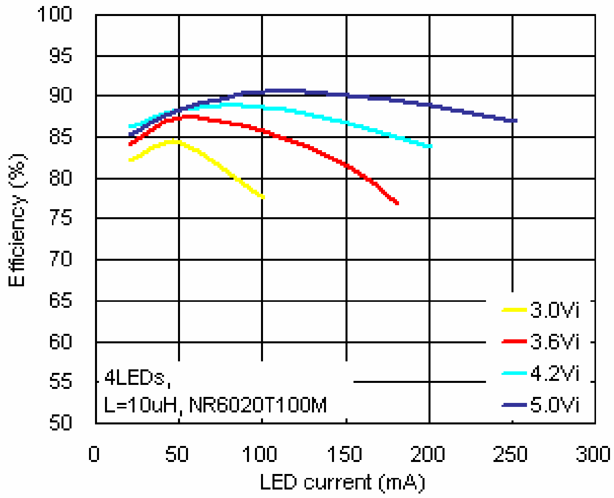


Figure 20. Efficiency vs. LED Current
(Different Input Voltage)

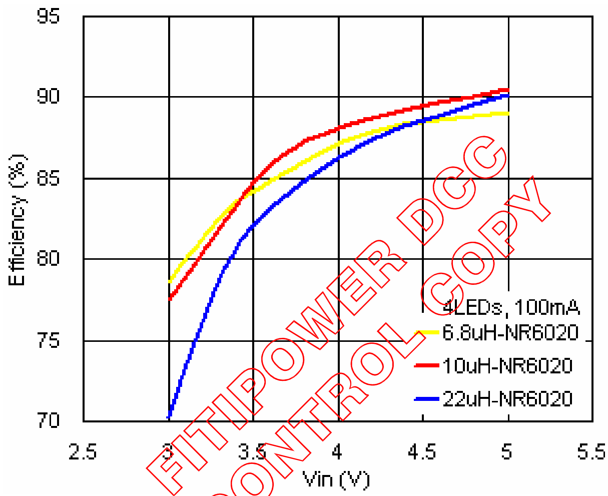


Figure 21. Efficiency vs. Input Voltage
(Different Inductor)

Applications Information

Operation

The FP6739 is designed in a current mode, fixed-frequency pulse-width modulation (PWM) architecture for fast-transient response and low-noise operation to drive up to 4 series-connected LEDs. The functional diagram is shown in Figure 3. At light loads, the FP6739 operates in PFM to maintain the highest efficiency.

The FP6739 operates well with a variety of external components. See the following sections to optimize external components for a particular application.

Inductor Selection

For most applications, a 10uH is recommended for general used. The inductor parameters, current rating, DCR and physical size, should be considered. The DCR of inductor affects the efficiency of the converter. The inductor with lowest DCR is chosen for highest efficiency. The saturation current rating of inductor must be greater than the switch peak current, typically 1.3A. These factors affect the efficiency, transient response, output load capability, output voltage ripple, and cost.

Diode Selection

For diode selection, both forward voltage and diode capacitance need to be considered. The output diode should be rated to the output voltage and peak switch current. Schottky diodes, with their low forward voltage drop and fast reverse recovery, are the ideal choices for FP6739 applications. Make sure the diode's peak current rating is at least IPK and its breakdown voltage exceeds VOUT.

Capacitor Selection

The ceramic capacitor is ideal for FP6739 application. X5R or X7R types are recommended because they hold their capacitance over wide voltage and temperature ranges than other Y5V or Z5U types. The input capacitor can reduced peak current and noise at power source. The output capacitor is typically selected based on the output voltage ripple requirements. For most applications, a 1uF input capacitors with a 1uF output capacitor are sufficient for general used. A higher or lower capacitance may be used depending on the acceptable noise level.

Over Voltage Protection

The FP6739 has an internal open-circuit protection circuit. In the cases of output open circuit, when the LEDs are disconnected from the circuit or the LEDs fail open circuit, OVP is clamped at 18V (typ). The FP6739 will then switch, at a very low frequency to minimize input current. The OVP and input current during output open circuit are shown in the Typical Performance Curves.

LED Current Setting

The EN pin controls the feedback voltage as shown in the figure11. For EN higher than 1.5V, the feedback voltage is 200mV, which results in full LED current. In order to have accurate LED current, precision resistors are preferred (1% is recommended). The LED current can be programmed by :

I_{LED}=200mV / R1

Dimming Control

There are three different types of dimming control circuits. The LED current can be set by modulating the EN pin with a DC voltage, PWM signal or a filtered PWM signal.

(1) Using a DC Voltage

The EN pin voltage can be modulated to set the dimming of the LED string. As the voltage on the the EN pin increases from 0.9V to 1.5V, the LED current increases from 0mA to maximum current. As the EN pin voltage exceeds 1.5V, it has no effect on the LED current. Feedback voltage versus Enable voltage is given in the figure11.

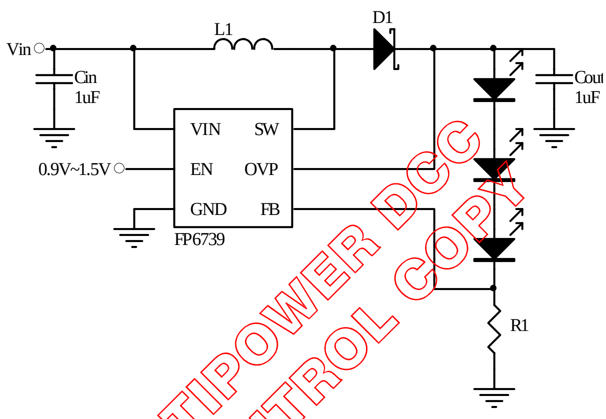


Figure 22. Dimming Control Using a DC Voltage

Applications Information (Continued)

(2) Using a PWM Signal

Changing the LED forward current not only changes the intensity of the LEDs, but also changes the color. Controlling the intensity of the LEDs with a direct PWM signal allows dimming of the LEDs without changing the color.

Dimming the LEDs via a PWM signal essentially involves turning the LED on and off. The LEDs operate at either zero or full current. The average of LED current increases proportionally with the duty cycle of the PWM signal. The color of the LEDs remains unchanged since the LED current value is either zero or a constant value. The typical frequency range of the PWM signal is 100Hz to 1kHz.

Two way of PWM control dimming, drive EN directly or drive FB pin through a resistor. First, drive EN directly shown as figure 23(a). A 0% duty cycle will turn off the FP6739 and corresponds to zero LED current. A 100% duty cycle corresponds to full current. The amplitude of the PWM signal should be higher than the minimum EN voltage. Second, drive FB pin through a resistor shown as figure 23(b). Increase of duty cycle will decrease LED average current. In this application, LED is dimmed by FB pin and turned off completely by EN pin.

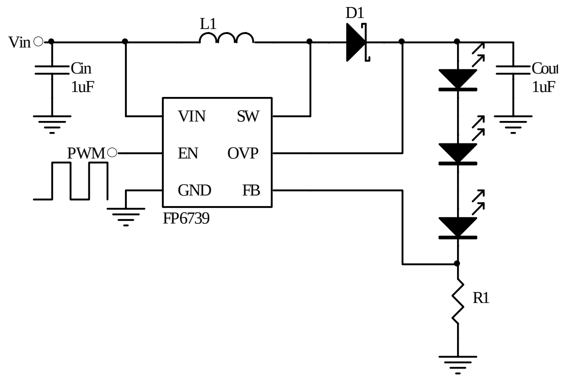


Figure 23(a). Dimming Control Using a PWM Signal

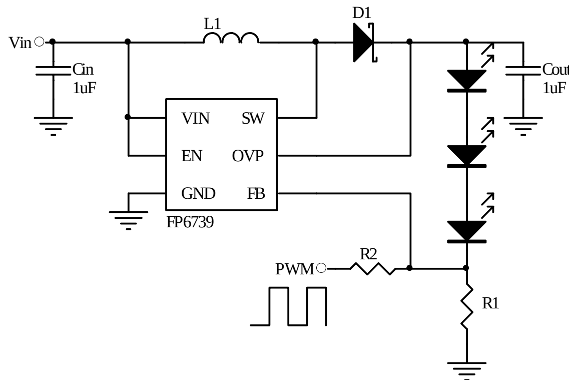


Figure 23(b). Dimming Control Using a PWM Signal

(3) Using a Filtered PWM Signal

If audio noise is concerned or higher PWM frequency is used, a filtered PWM signal can be used to control the brightness of the LED string. The PWM signal is filtered by a RC network. The corner frequency of R, C should be much lower than the frequency of the PWM signal. RF needs to be much smaller than the internal impedance of the EN pin which is 600kΩ (typ). Figure 24 show the two dimming methods of using filtered PWM signal. R2 in figure24(a) extends the available range of duty cycle.

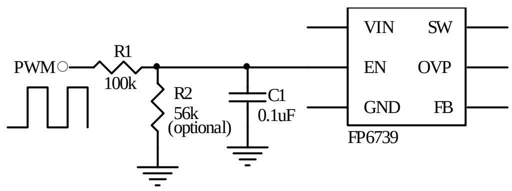


Figure 24 (a). Dimming Control Using a Filtered PWM Signal

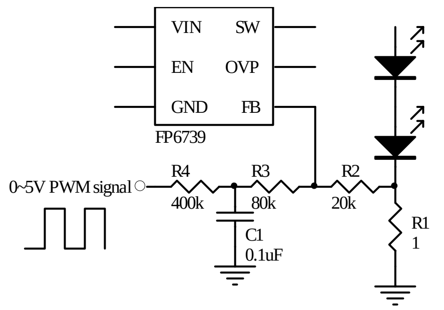


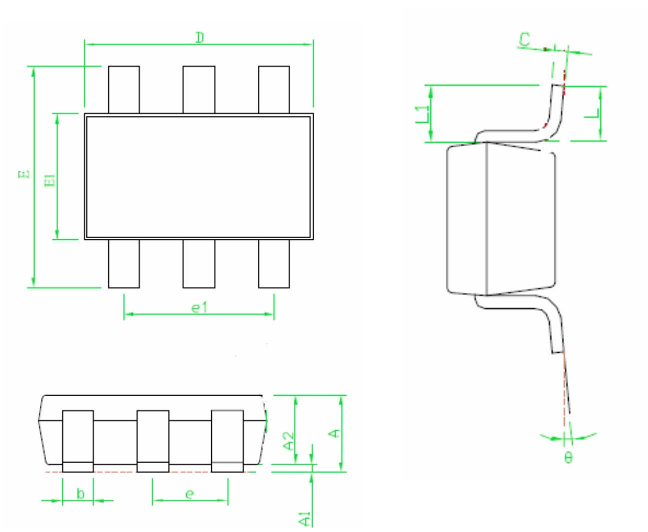
Figure 24(b). Dimming Control Using a Filtered PWM Signal

Layout Consideration

The proper PCB layout and component placement are critical for all switching regulators. The careful attention should be taken to the high-frequency, high current loops to prevent electromagnetic interference (EMI) problems. Minimize the length and area of all traces connected to the SW node. Keep the noise-sensitive feedback and compensation circuitry away from the switching node. Place Cout next to schottky diode as possible.

Outline Information

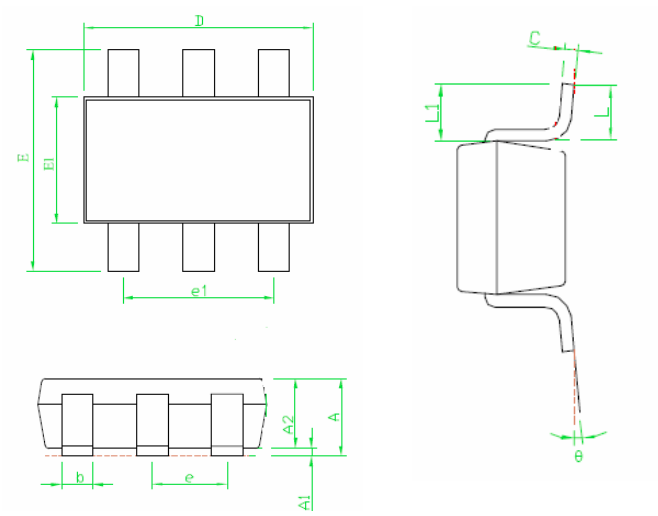
TSOT-23-6 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER		
	MIN	NOM	MAX
A	---	---	1.10
A1	0.00	---	0.10
A2	0.70	0.90	1.00
b	0.30	---	0.50
c	0.08	---	0.20
D	---	2.90	---
E	---	2.80	---
E1	---	1.60	---
e		0.95	
e1		1.90	
L	0.3	0.45	0.60
L1		0.60	
θ	0°	4°	8°

Note 1:Followed From JEDEC MO-193-C.

SOT-23-6 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER		
	MIN	NOM	MAX
A	---	---	1.45
A1	0.00	---	0.15
A2	0.90	1.15	1.30
b	0.30	---	0.50
c	0.08	---	0.22
D	---	2.90	---
E	---	2.80	---
E1	---	1.60	---
e		0.95	
e1		1.90	
L	0.3	0.45	0.60
L1		0.60	
θ	0°	4°	8°

Note 1：Followed From JEDEC MO-178-C.

Life Support Policy
Fitipower's products are not authorized for use as critical components in life support devices or other medical systems.