High-Efficiency White LED Driver with Dimming Control

Description

The FP6753 is a step-up DC/DC converter specifically designed for driving WLEDs with a constant current. Series connection of LEDs provides identical LED current for uniform brightness and minimizes the number of traces to the LEDs. The FP6753 uses current mode, fixed switching frequency architecture to regulate the LED current through an external current sense resistor. The low feedback voltage of 300mV can minimize power dissipation. PWM dimming input that can accept an external control signal with a duty ratio of 0-100% and a frequency of up to a few kilohertz.

Other features include open LED protection, thermal shutdown protection, and under-voltage lockout (UVLO) function, and over-voltage function, which can shut off the device if output voltage reaches above 2V reference voltage.
The FP6753 is available in space saving SOP-8 / SOP-8(Exposed Pad) package.

Features

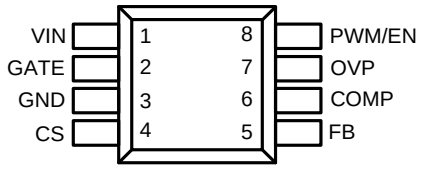
- Wide Range for PWM Dimming, Ranging from 100Hz to 1KHz
- High Efficiency: 90%
- Drives up to 18 pcs High Power WLEDs
- Adjustable Switching Frequency
- Low 300mV Feedback Voltage
- Over Voltage Protection for Open LED Detection.
- High PWM Dimming Ratio
- Built-in Soft Start Function
- Over Temperature Protection
- Low Profile SOP-8 and SOP-8(Exposed Pad) Packages

Applications

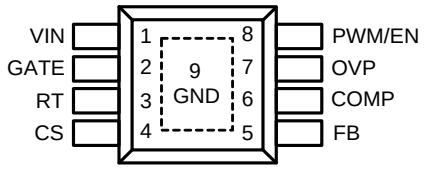
- LCD TV
- LCD Monitor
- Flat Panel Display

Pin Assignments

ASO Package (SOP-8 with A version)



BSP Package (SOP-8 Exposed Pad with B version)



CSP Package (SOP-8 Exposed Pad with C version)

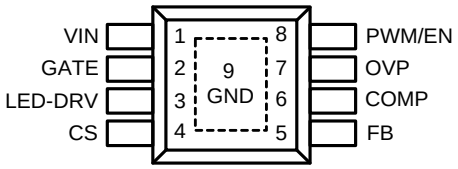


Figure 1. Pin Assignment of FP6753

Ordering Information

FP6753□

Package Type
ASO: SOP-8
BSP: SOP-8 (Exposed Pad)
CSP: SOP-8 (Exposed Pad)

Typical Application Circuit

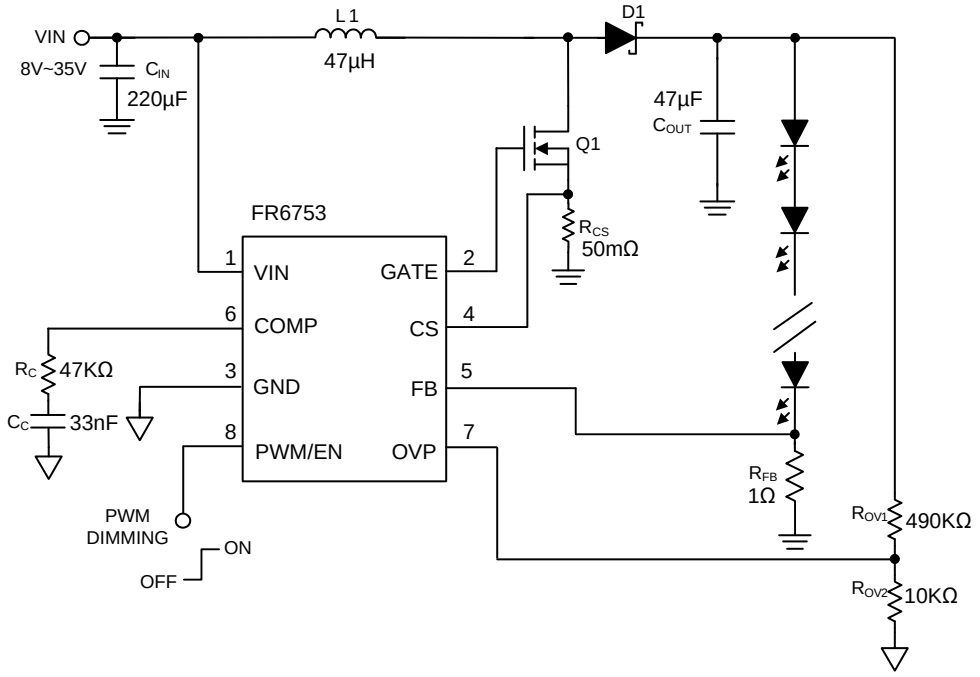


Figure 2. Typical Application Circuit of FP6753A without exposed pad

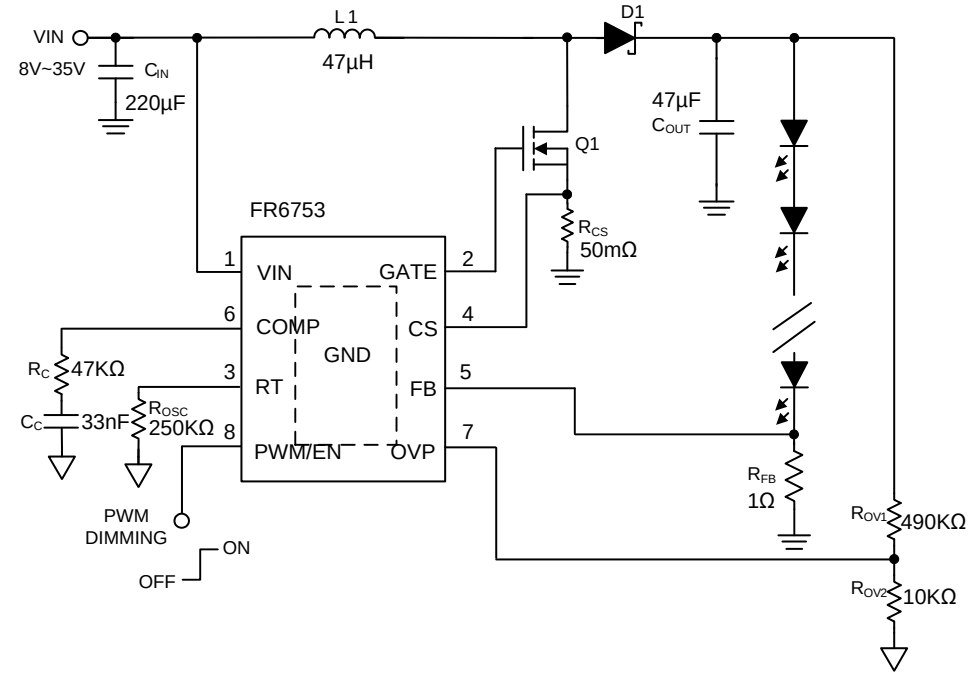


Figure 3. Typical Application Circuit of FP6753B with exposed pad

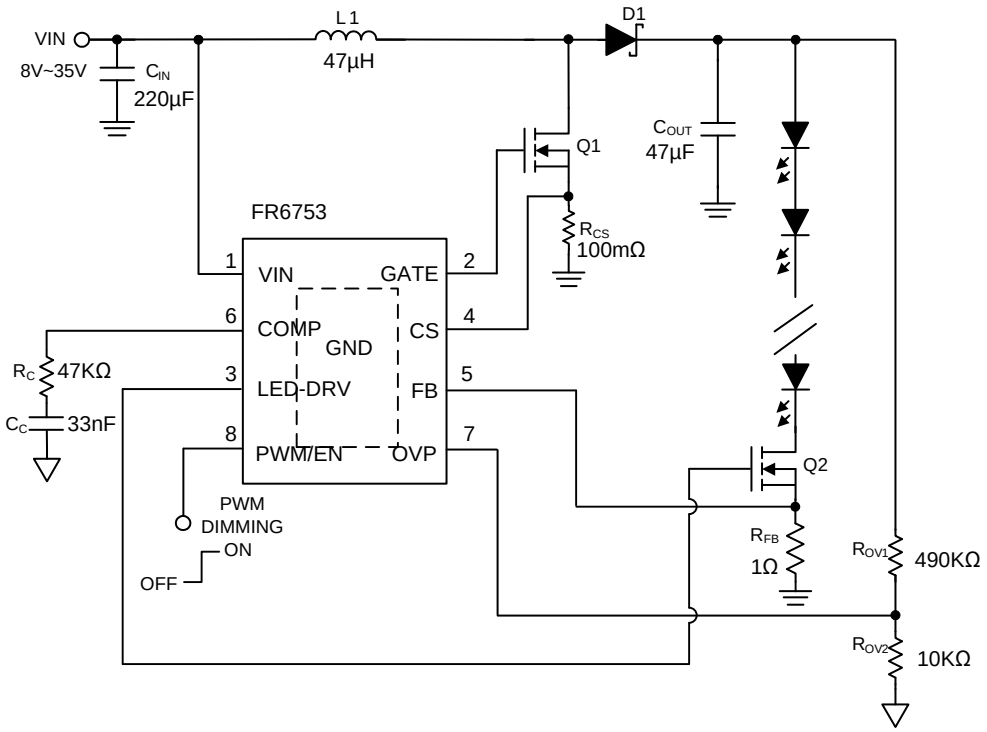


Figure 4. Typical Application Circuit of FP6753C with exposed pad

Functional Pin Description

Pin Name	Pin No.			Pin Function
	Without EP	With EP		
VIN	**1**	**1**	**1**	Power Supply Input Pin. Drive 8V to 35V voltage to this pin to power on this chip.
GATE	**2**	**2**	**2**	This pin is the output gate driver for an external N-channel power MOSFET.
RT	**-**	**3**	**-**	Sets the frequency pin. A resistor between RT and GND will program the circuit in constant frequency mode.
LED-DRV	**-**	**-**	**3**	This pin can be used to drive an external MOSFET in the case of boost converters to disconnect the load from the source.
CS	**4**	**4**	**4**	This pin is used to sense the drain current of the external power FET. It includes a built-in 150ns (min.) blanking time.
FB	**5**	**5**	**5**	LED Current Feedback Pin. Reference voltage is 300mV .LED current sense with a current sense resistor for LED string.
COMP	**6**	**6**	**6**	Compensation Pin. This pin is used to compensate the regulation control loop and soft start function. Connect a series RC network from COMP pin to GND.
OVP	**7**	**7**	**7**	This pin provides the over voltage protection for the converter. When the voltage at this pin exceeds 2V, the gate output of the FP6753 is turned off.
PWM/EN	**8**	**8**	**8**	Enable and dimming control 1. Enable: Logic high enables the device; logic low forces the device into shutdown mode. 2. Digital dimming control: apply external 100Hz to 1KHz PWM pulse signal with amplitude greater than 1.5V.
GND	**3**	**9**	**9**	Ground Pin. The exposed pad must be soldered to a large PCB area and connected to GND for maximum power dissipation.

Block Diagram

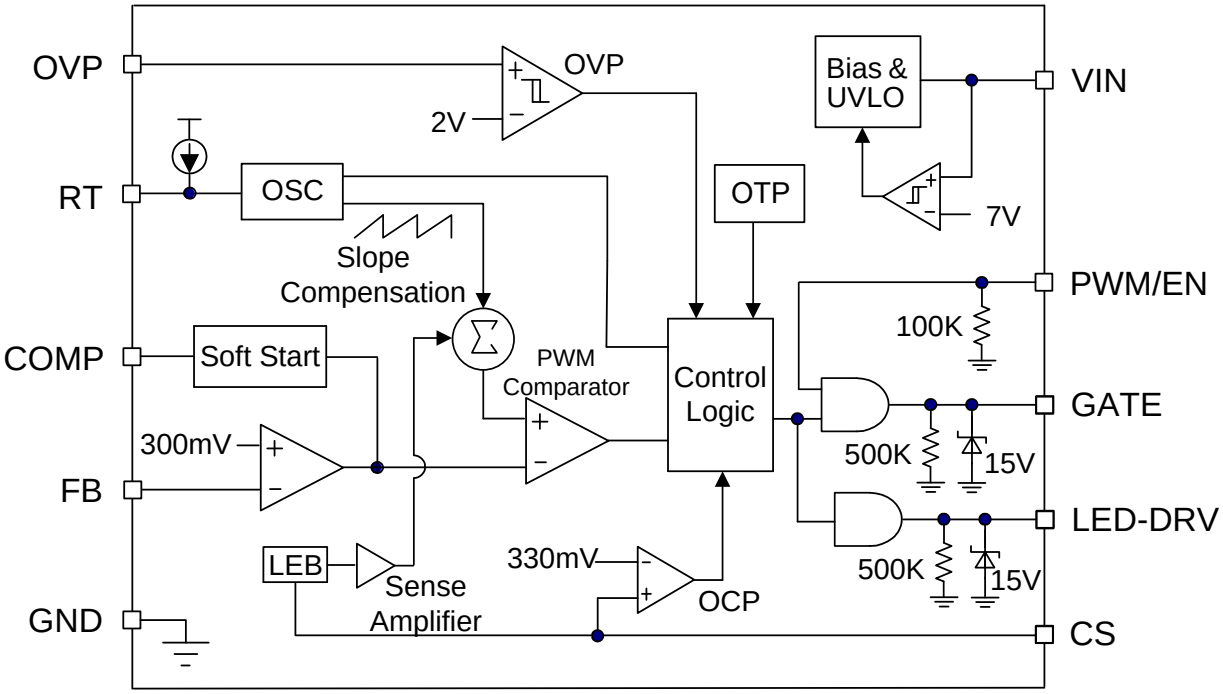


Figure 5. Block Diagram of FP6753

Absolute Maximum Ratings

- VIN ---------- +40V
- Gate Voltage ---------- -0.3V to VIN-2V
- I/O Voltage ---------- +6.5V
- Maximum Junction Temperature (T_J) ---------- +150ºC
- Package Thermal Resistance, (θ_{JA})
  - SOP-8 ---------- +90°C/W
  - SOP-8 (Exposed Pad) ---------- +60°C/W
- Package Thermal Resistance, (θ_{JC})
  - SOP-8 ---------- +39°C/W
  - SOP-8 (Exposed Pad) ---------- +15°C/W
- Lead Temperature (Soldering, 10 sec.) (T_{LEAD}) ---------- +260ºC

Note 1：Stresses beyond those listed under “Absolute Maximum Ratings" may cause permanent damage to the device.

Recommended Operating Conditions

- Input Voltage (V_{IN}) ---------- +8 to +35V
- Operating Temperature Range ---------- -40ºC to +85ºC

Electrical Characteristics

(V_{IN}=12V, T_A = 25°C unless otherwise specified)

Description	Symbol	Conditions	Min	Typ	Max	Unit
Input						
V_{IN} Input Supply Voltage	V_{IN}		8		35	V
V_{IN} Quiescent Current	I_{DDQ}	V_{IN}=12V, PWMD=5V, no load		2.5	3	mA
V_{IN} Shutdown Supply Current	I_{SD}	V_{EN}=0V		100		μA
Input Supply Voltage UVLO Threshold	UVLO	V_{IN} Rising		7		V
Input Supply Voltage UVLO Threshold Hysteresis	ΔUVLO			500		mV
PWM Dimming						
PWMD Input Low Voltage	$V_{PWMD(lo)}$	V_{IN}=8V – 35V			0.4	V
PWMD Input High Voltage	$V_{PWMD(hi)}$	V_{IN} = 8V – 35V	2			V
PWMD Pull-Down Resistance	R_{PWMD}	V_{PWMD} = 5.0V	50	100	150	KΩ
Dimming Frequency Range	F_{PWM}		0.1		1	KHz
GATE						
GATE Output Rise Time	T_{RISE}	C_{GATE} = 0.5nF; V_{IN}= 12V		25		ns
GATE Output Fall Time	T_{FALL}	C_{GATE} = 0.5nF; V_{IN} =12V		25		ns
GATE Pull-Down Impedance	Z_{GATE}			500		KΩ
GATE Voltage Clamping	V_{GATE}			15		V
OSC-ADJ (B version)						
RT Voltage	V_{RT}			500		mV
Oscillator Frequency	fosc	R_T = 250Kohm		200		KHz
LED-DRV (C version)						
LED-DRV Output Rise Time	T_{RISE}	C_{GATE} = 0.5nF; V_{IN}= 12V		500		ns
LED-DRV Output Fall Time	T_{FALL}	C_{GATE} = 0.5nF; V_{IN} =12V		100		ns
LED-DRV Pull-Down Impedance	Z_{LED_DRV}			500		KΩ
LED-DRV Voltage Clamping	V_{LED_DRV}			15		V
Over-Voltage Protection						
OVP Threshold Voltage	V_{OVP}	V_{IN} = 8 – 35V ; OVP rising	1.8	2	2.2	V
OVP Threshold Hysteresis	Δ V_{OVP}			200		mV
Current Sense						
Over Current Sense Voltage	V_{CS}	Threshold of over current protection (duty=90%)		330		mV
Leading Edge Blanking	T_{BLANK}	Guaranteed by Design		200		ns

Electrical Characteristics (Continued)

Description	Symbol	Conditions	Min	Typ	Max	Unit
FB Reference Voltage Accuracy	V_{FB}		289	300	311	mV
Internal Trans-Conductance OP AMP						
Open Loop DC Gain	A_V	Output open		70		dB
Trans-Conductance	gm			100		μA/V
Output source current	I_{SOURCE}			16		μA
Output sink current	I_{SINK}			16		μA
Oscillator						
Oscillator Frequency	f_{OSC}	R_T = TBD	175	200	225	KHz
Maximum Duty Cycle	D_{MAX}		90	95		%
Soft Start						
Soft-Start Slope	I_{SS_SLOPE}			400		mV/ mS
Others						
Thermal Shutdown	T_{SD}		-	150	-	°C
Thermal Shutdown Hysteresis	ΔT_{SD}		-	30	-	°C

Note 1：The specification is guaranteed by design, not production tested.

Typical Performance Curves

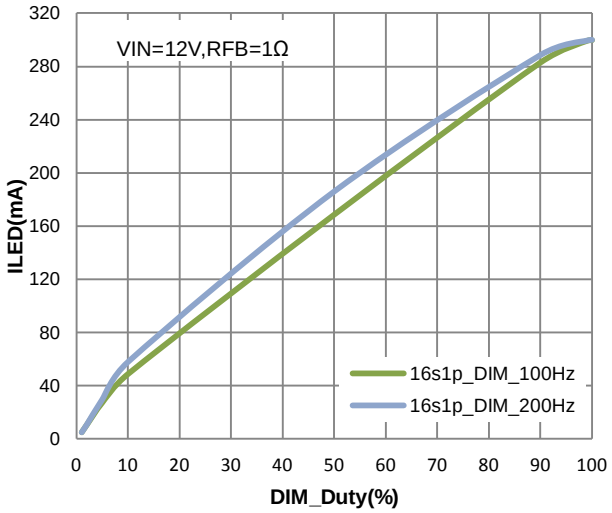


Figure 6. LED Current vs. Duty Cycle(B Version)

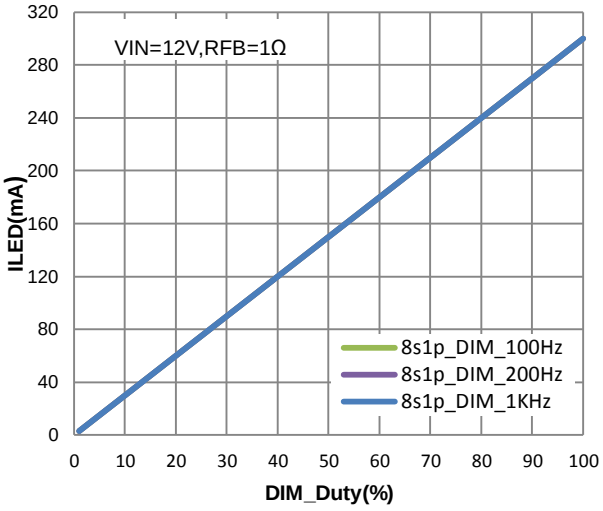


Figure 7. LED Current vs. Duty Cycle(C Version)

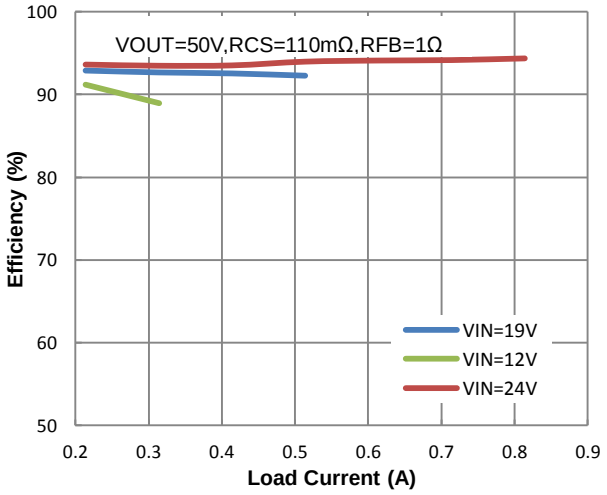


Figure 8. Efficiency vs. Load Current.

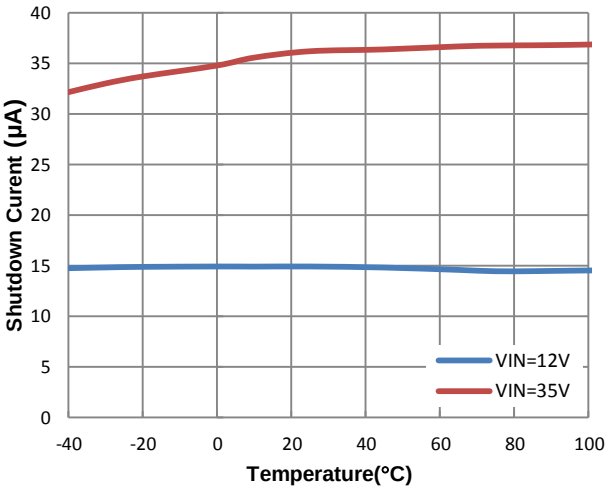


Figure 9. Shutdown Current vs. Temperature

Typical Performance Curves (Continued)

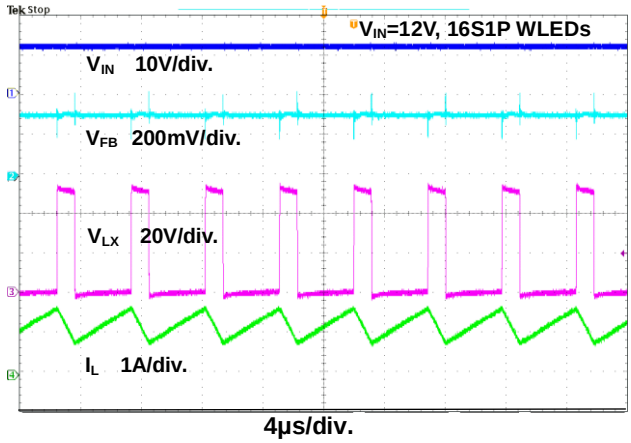


Figure 10. Switching waveform

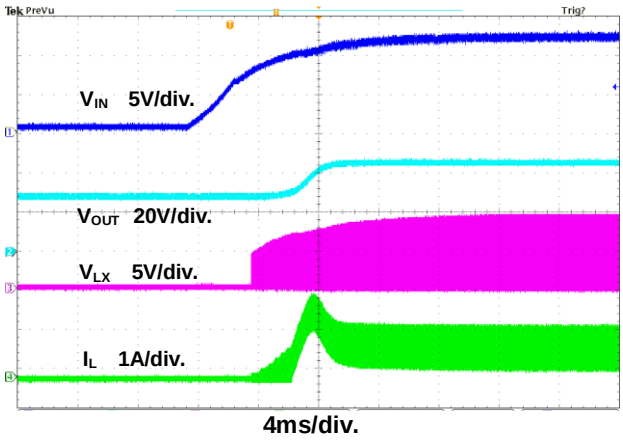


Figure 11. Power On Response Waveforms

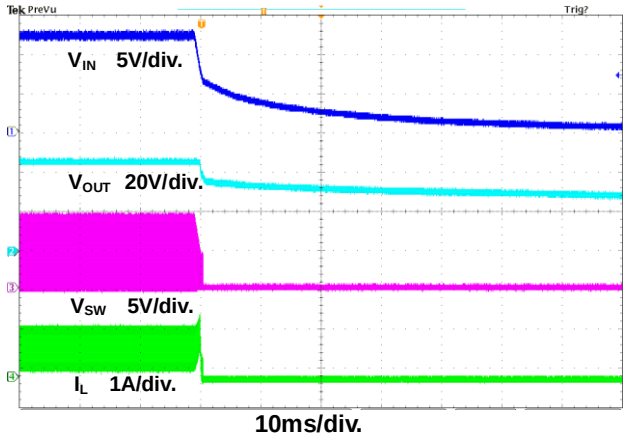


Figure 12. Power Off Response Waveforms

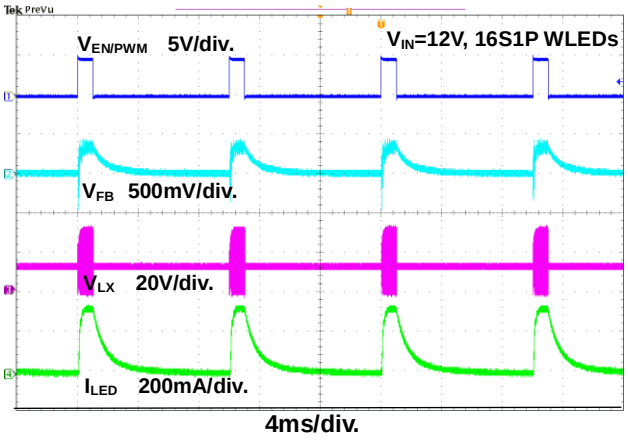


Figure 13. PWM Dimming Response Waveforms at a frequency of 100Hz(Duty10%)

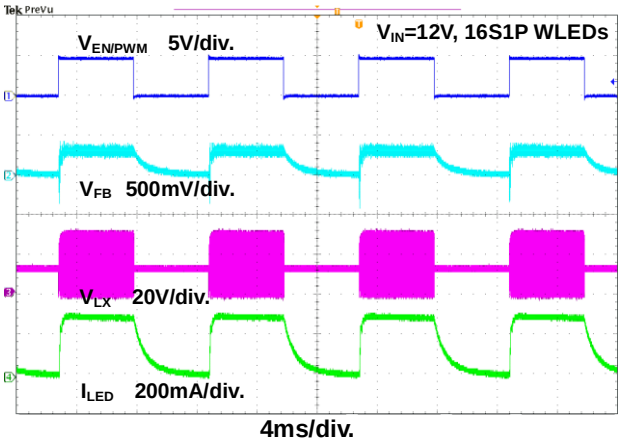


Figure 14. PWM Dimming Response Waveforms at a frequency of 100Hz(Duty50%)

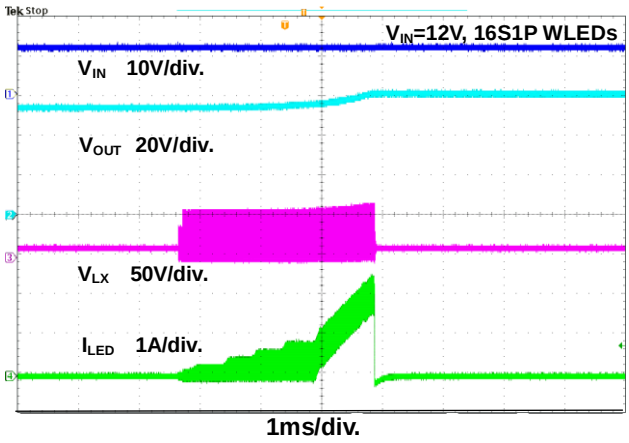


Figure 15. Open load Protection Waveforms

Application Information

Under Voltage Lockout

The under voltage lockout (UVLO) circuit provides the save operation to keeps the device from turning on when V_{IN} is smaller than typically 7V (typ.).

Soft-Start

Soft-start allows a gradual incensement of the internal current-limit level for the step-up controller during power-up to reduce input surge currents. As the error amplifier output charges the external compensation capacitor at COMP/SS pin, the peak N-MOS current is limited by the voltage on the COMP/SS.

Current Limit Protection

The FP6753 provides cycle-by-cycle over-current protection. Current limit is accomplished by sensing voltage drop across the drain to source of power switch. If the current sense amplifier output voltage is larger than current-limited threshold level 330mV on CS pin, it will be immediately turned off power MOS. The current-limit feature protects over current fault at the output.

LED Current Setting

The LED current is specified by resistor from the FB pin to ground. The full scale current setting is calculated approximated by the formula

$$I_{LED}(mA) \approx \frac{300mV}{R_{FB}(\Omega)}$$

where:

R_{FB} is a resistor of setting LED current.

PWM Dimming Control

The FP6753 can receive an external Pulse Width Modulation (PWM) signal for the dimming control function to precisely adjust LED brightness. PWM dimming control is achieved by applying an external PWM signal to PWM pin. Typically, a 0.1KHz to 1KHz PWM signal is used. Varying the PWM duty cycle from 0% to 100% controls the LED brightness. But the audio noise may appear when the PWM frequency is smaller than 1KHz.

Adjustable Over Voltage Protection

The over-voltage function monitors the output voltage by OVP pin to protection the controller against the LED string open. This will cause N-MOS to switch with a maximum duty cycle and come out output over-voltage. This may cause the output voltage to exceed external MOS maximum voltage rating to damage N-MOS. In the state, the OVP protection circuitry stops the external N-MOS and clamp OVP pin at 2V (typ.). When OVP falls below 200mV (OVP Hysteresis), IC will automatically recover normal operation.

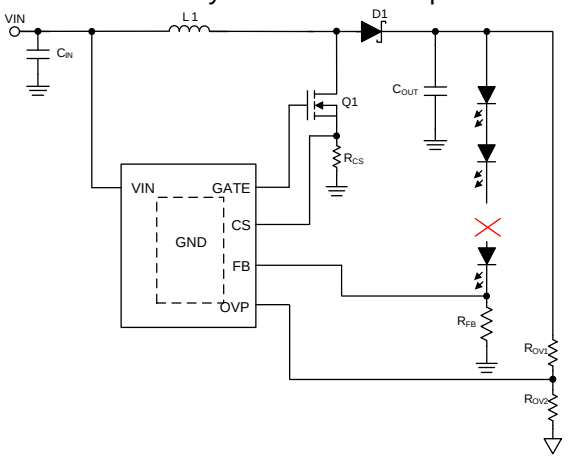


Figure 16. With Open-Circuit Protection

Current Sense

The current sense input of the FP6753 includes a built-in 200ns blanking time to prevent spurious turn-off due to the initial current spike when the MOSFET turns on.

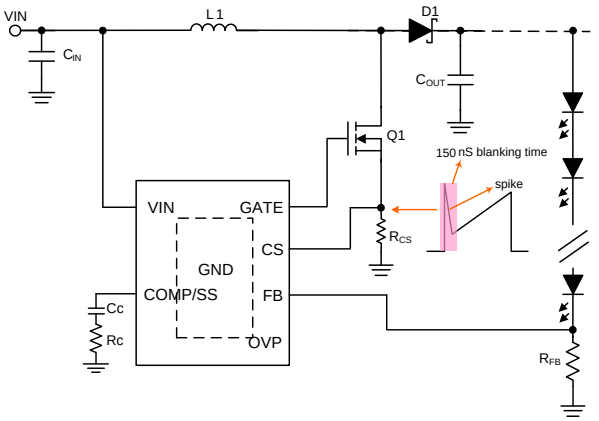
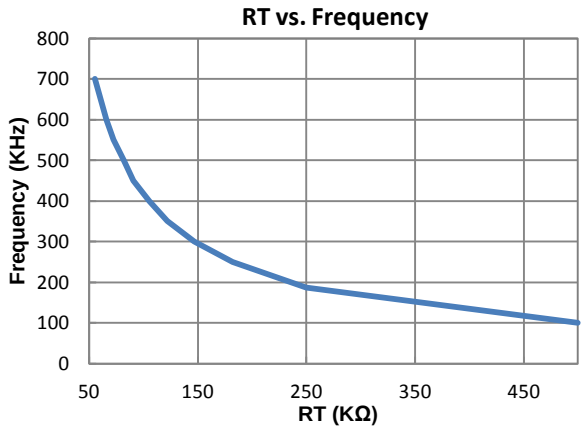


Figure17. With blanking time

Application Information(Continued)

Programmable Operating Frequency

The operating frequency is programmable from 100KHz to 600KHz by connected a resistor from RT pin to GND.



The operating frequency setting is calculated approximated by the Table:

RT Resistance (KΩ)	Frequency (KHz)
65	600
250	200
500	100

where:

R_{RT} is the switching frequency setting resistor.

Thermal Overload Protection

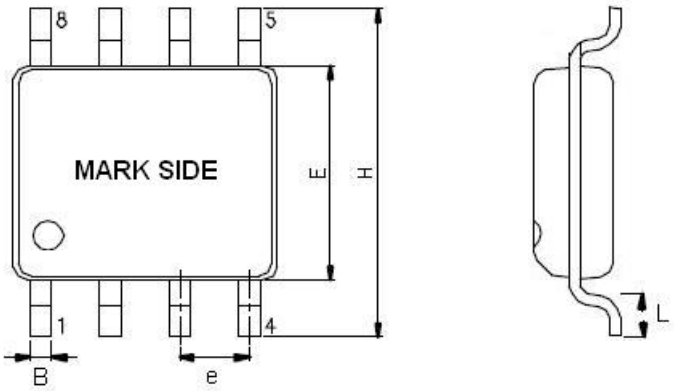
Thermal-overload protection limits total power dissipation in the FP6753. When the junction temperature exceeds Tj= +150°C, a thermal sensor activates the thermal protection, which shuts down the IC, allowing the IC to cool. Once the device cools down by 30 °C, IC will automatically recover normal operation. For continuous operation, do not exceed the absolute maximum junction-temperature rating of Tj=150 °C.

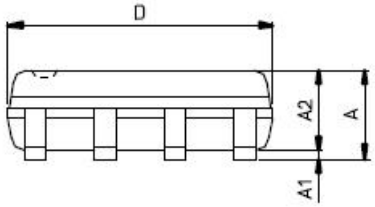
Layout Guideline

The proper PCB layout and component placement are critical for all switching regulators. The careful attention should be taken to minimize excessive electromagnetic interference (EMI) problems and prevent the power supply from being disrupted during surge/ESD tests. Here are some suggestions for the layout of FP6753 design.

Outline Information

SOP-8 Package (Unit: mm)

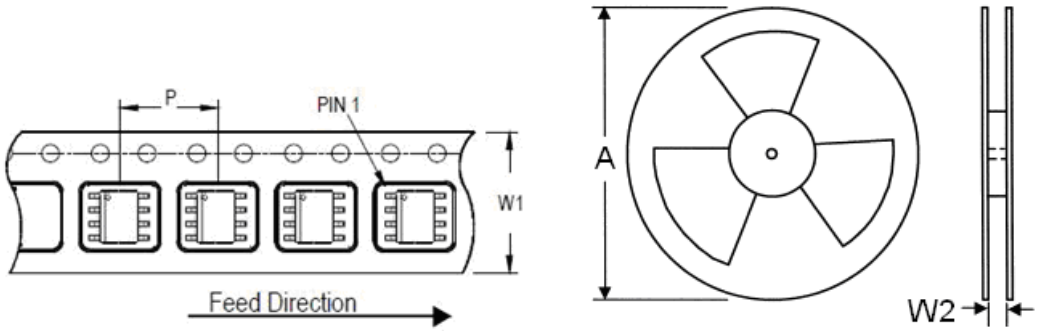




SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	1.40	1.75
A1	0.10	0.25
A2	1.30	1.50
B	0.31	0.51
D	4.80	5.00
E	3.80	4.00
e	1.20	1.34
H	5.80	6.20
L	0.40	1.27

Note：Followed From JEDEC MO-012-E.

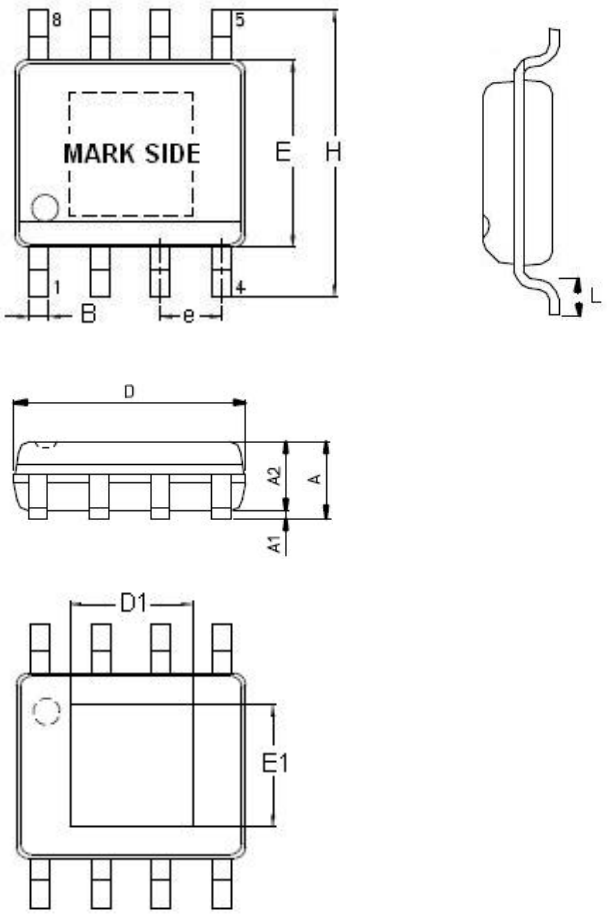
Carrier dimensions



Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A)		Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
		in	mm			
12	8	13	330	12.4	400~1000	2,500

Outline Information (Continued)

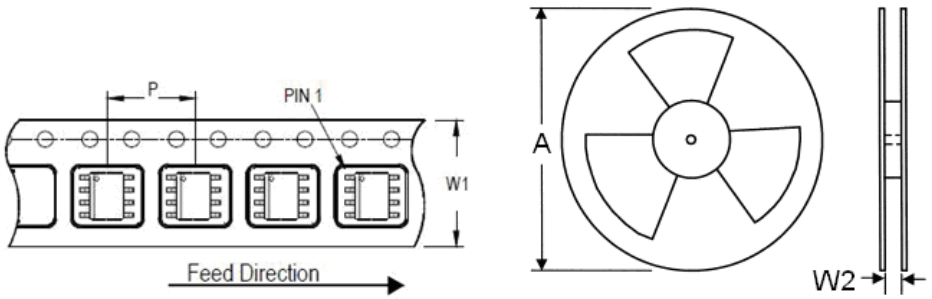
SOP-8 (Exposed Pad) Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	1.25	1.70
A1	0.00	0.15
A2	1.25	1.55
B	0.31	0.51
D	4.80	5.00
D1	3.04	3.50
E	3.80	4.00
E1	2.15	2.41
e	1.20	1.34
H	5.80	6.20
L	0.40	1.27

Note：Followed From JEDEC MO-012-E.

Carrier dimensions



Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A) in	Reel Size (A) mm	Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
12	8	13	330	12.4	400~1000	2,500

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