1A Buck/Boost Charge Pump LED Driver

Description

The FP6773 Buck/Boost charge pump LED driver is designed for powering high brightness white LEDs for camera flash applications. The FP6773 automatically switches modes between step-up and step-down ensuring that LED current does not depend on the forward voltage. The FP6773 provides two current levels for TORCH and FLASH modes. In TORCH mode, the current sense reference voltage is 50mV. The LED current can be determined by current sense resistor. In Flash mode, the current sense reference voltage can be adjusted by external resistor. The maximum LED current can be set up to 1A. The FP6773 is available in a space saving TDFN-10 3mm×3mm package.

Features

- Output Current up to 1A
- Up to 94% Efficiency in Torch Mode
- Adjustable FLASH Mode Current
- Minimum External Components: No Inductors
- Automatic Buck/Boost Mode Switchover
- Wide V_{IN} Range: 2.7V to 5.5V
- High Frequency Operation: 2MHz
- 50mV Reference for Low Loss Sensing
- I_Q < 1μA in Shutdown
- PWM Dimming Control
- Automatic Soft Start Limits Inrush Current
- Over-Voltage Protection on Output
- Over-Current Protection
- Over-Temperature Protection
- Low Ripple and EMI
- Ultra-Low Dropout Voltage in Buck Mode
- 1.6 Second Timeout in Flash Mode
- Space Saving 10-Pin DFN 3mm×3mm package

Applications

- White LED Torch/Flash for Mobile Phones, DSCs, and Camcorders
- Generic Lighting/Flash/Strobe Applications
- General Purpose High Current Boost

Pin Assignment

WD Package TDFN-10 (3mmX3mm)

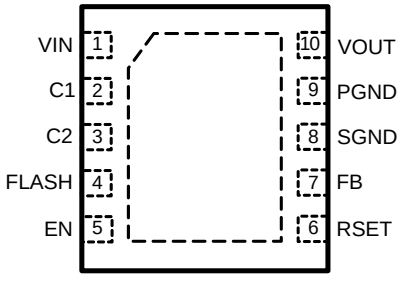


Figure 1. Pin Assignment of FP6773 (Top View)

Ordering Information

FP6773□□□

- TR: Tape / Real
  Blank: Tube
- G: Green
- Package Type
  WD: TDFN-10(3mmX3mm)

Typical Application Circuit

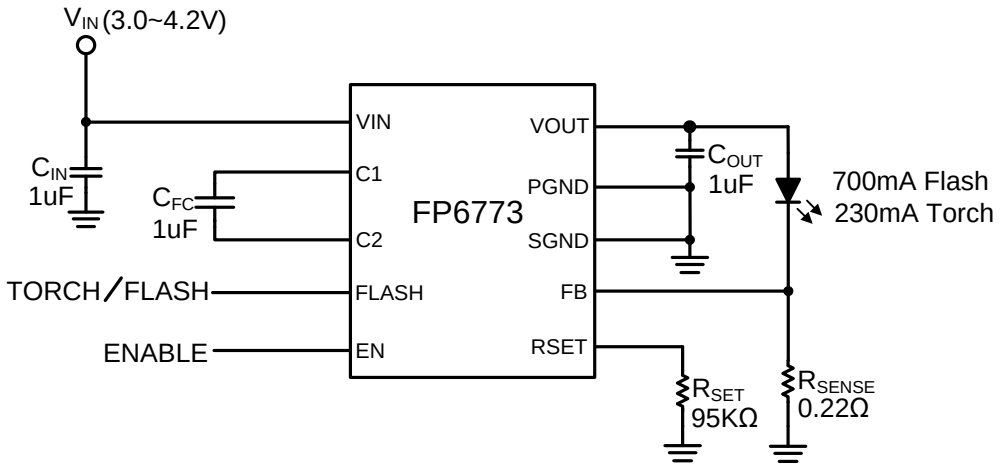


Figure 2. Typical Application Circuit of FP6773

Functional Pin Description

Pin Name	I/O	Pin Function
VIN	**P**	Input voltage for the charge pump. Decouple with 1μF ceramic capacitor close to the pins of the IC.
C1	**I/0**	Positive input for the external flying capacitor. Connect a ceramic 1μF capacitor close to the pins of the IC.
C2	**I/0**	Negative input for the external flying capacitor. Connect a ceramic 1μF capacitor close to the pins of the IC.
FLASH	**I**	Logic input to toggle operation between FLASH and TORCH mode. In TORCH mode (FLASH = low), FB is regulated to the internal 50mV reference. In FLASH mode (FLASH = high), FB reference voltage can be adjusted by changing the resistor from RSET pin to ground. Choose the external current sense resistor (R_{SENSE}) based on desired current in TORCH mode. This pin does not have an internal pull-up/pull-down; do not leave this pin floating.
EN	**I**	Shutdown control input. Connect to VIN for normal operation. Connect to ground for shutdown. This pin does not have an internal pull-up/pull-down; do not leave this pin floating.
RSET	**I/0**	Connect a resistor from this pin to ground. When in FLASH mode (FLASH = high), this resistor sets the current regulation point according to the following formula：V_{FB}= (1.26V/R_{SET})*11.2kΩ
FB	**I**	Feedback input for the current control loop. Connect directly to the current sense resistor.
SGND	**P**	Internal ground pin. Control circuitry returns current to this pin.
PGND	**P**	Power ground pin. Flying capacitor current returns through this pin.
VOUT	**O**	Charge pump output voltage. Decouple with an external capacitor. At least 1μF is recommended. Higher capacitor values reduce output ripple.

Block Diagram

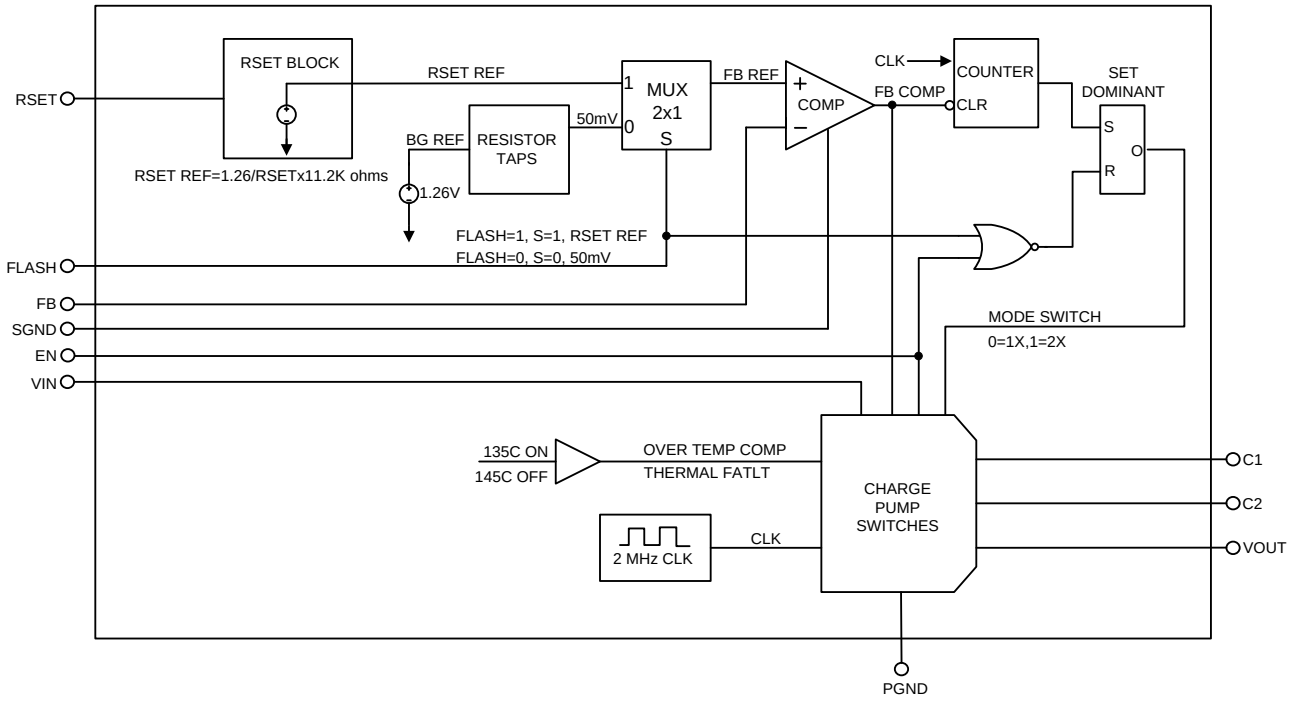


Figure 3. Block Diagram of FP6773

Absolute Maximum Ratings

- Supply Voltage (V_{IN}) ---------- -0.3V to +6V
- Output Pin Voltage (V_{OUT}) ---------- -0.3V to +6V
- EN, FLASH Pin Voltage (V_{EN}, V_{FLASH}) ---------- 0 to +6V
- Output Pin Current Pulse (Flash) ---------- 1200mA
- Output Pin Current Continuous (Torch) ---------- 400mA
- Power Dissipation @ T_A=25°C, TDFN-10 (3mmx3mm) (P_D) ---------- +1.54W
- Package Thermal Resistance, TDFN-10 (3mmx3mm) (θ_{JA}) ---------- +65°C/W
- Junction Temperature (T_J) ---------- +150°C
- Operating Temperature (T_{OP}) ---------- -40°C to +85°C
- Storage Temperature (T_{STG}) ---------- -65°C to +150°C
- Lead Temperature (Soldering, 10sec.) ---------- +260°C

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

Electrical Characteristics

(V_{IN} =3.6V, C_{IN} =1μF, C_{FC} =1μF, C_{OUT} =1μF, V_{EN} =V_{IN}, T_A=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Input Voltage	V_{IN}		2.7		5.5	V
Quiescent Current	I_Q	VIN = 2.7 ~ 5.5V, FLASH = GND, 1X mode, I_{LOAD} = 100μA		0.5	3	mA
		FLASH = High, 2X mode		2	3.5	
Shutdown Current	I_{SHDN}	VIN = 5.5V, VEN = 0V			1	μA
Oscillator Frequency	F_{OSC}			2		MHz
Charge Pump Equivalent Resistance (x2 mode)	R_{CH1}	V_{FB} = 0V, V_{IN}= 3.6V		5		Ω
Charge Pump Equivalent Resistance (x1 mode)	R_{CH2}	V_{IN} = 3.6V		0.4	0.7	Ω
FB Reference Voltage	V_{FB}	FLASH = GND	45	50	55	mV
		FLASH = High, R_{SET} = 95kΩ.	138	150	162	mV
FB Reference Voltage Range		FLASH = High, Guaranteed by design	100		400	mV
FB Pin Current	I_{FB}	VFB = 0.3V			0.5	μA
EN, FLASH Logic Low	V_{OH}				0.4	V
EN, FLASH Logic High	V_{OL}		1.3			V
EN, FLASH Pin Current	I_{EN}				0.5	μA
V_{OUT} Turn-On Time	T_{OUT}	V_{IN} = 3.6V, FB within 90% of regulation		250	500	μs
Maximum Flash ON time	T_{FLASH_ON}	FLASH = High		1.6		s
Thermal Shutdown Temperature	T_{SD}			145		°C

Typical Performance Curves

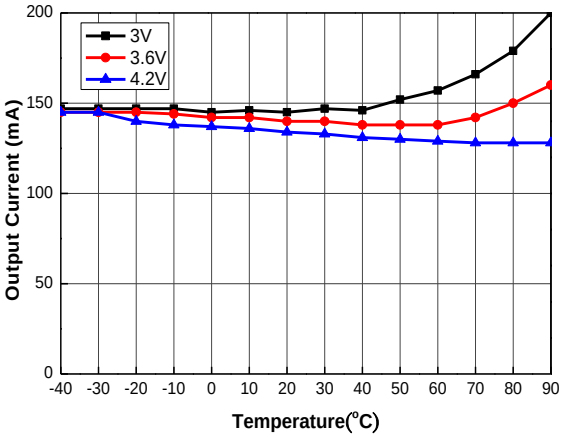


Figure 4. Torch Mode Output Current vs. Temperature
(C_{IN}=1μF, C_{FC}=1μF, C_{OUT}=1μF)

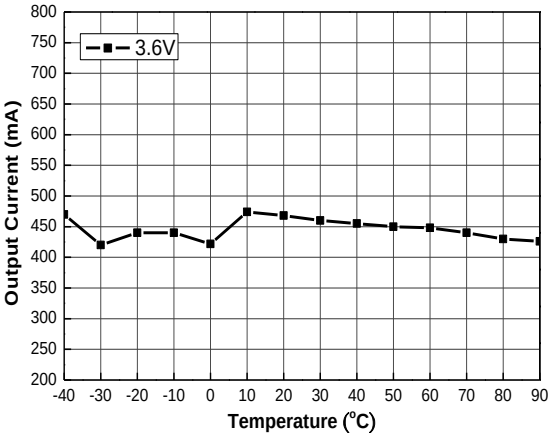


Figure 5. Flash Mode Output Current vs. Temperature
(C_{IN}=1μF, C_{FC}=1μF, C_{OUT}=1μF)

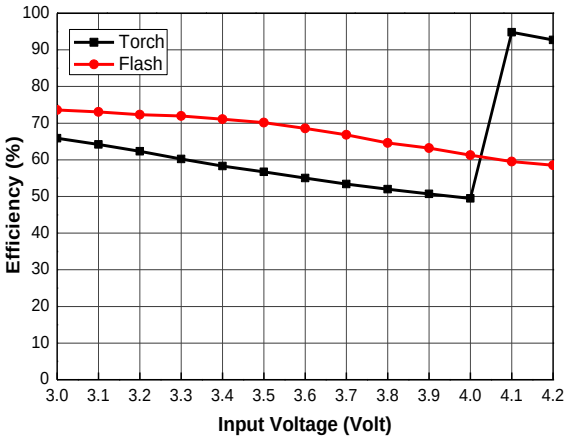


Figure 6. Efficiency vs. Input Voltage
(200mA Torch, 300mA Flash, V_F=4.0V)

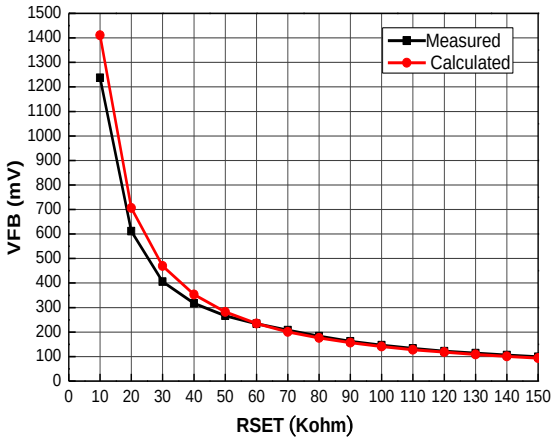


Figure 7. V_{FB} vs. R_{SET}

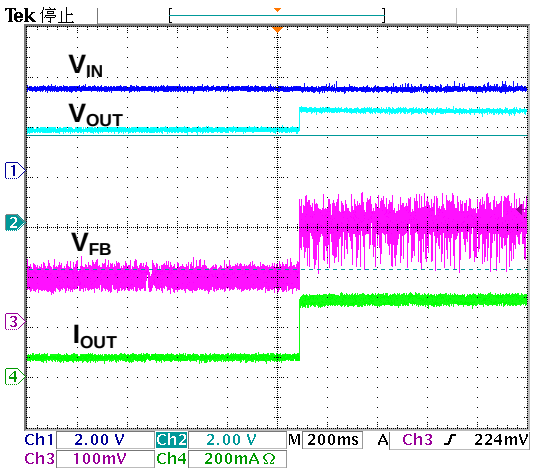


Figure 8. Torch in 1X to Flash in 2X Mode, V_{IN}=3V

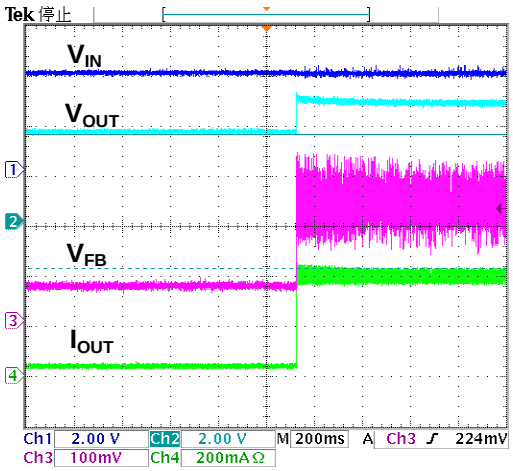


Figure 9. Torch in 1X to Flash in 2X Mode, V_{IN}=3.6V

Typical Performance Curves (Continued)

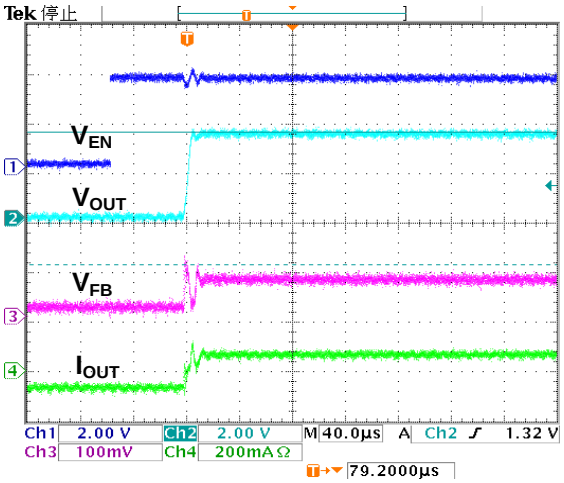


Figure 10. Start Up 150mA Torch, V_{IN}=3.6V

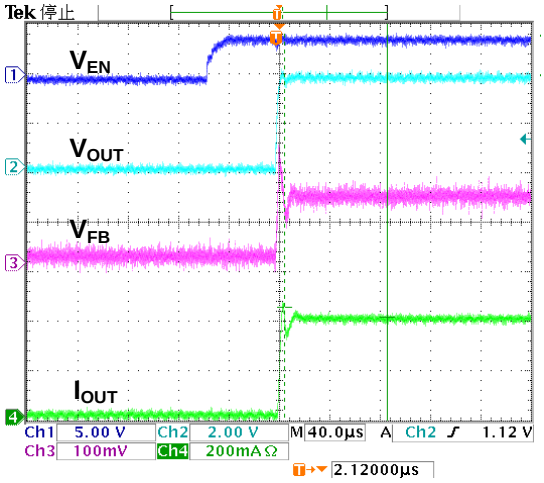


Figure 11. Start Up 400mA Flash, V_{IN}=3.6V

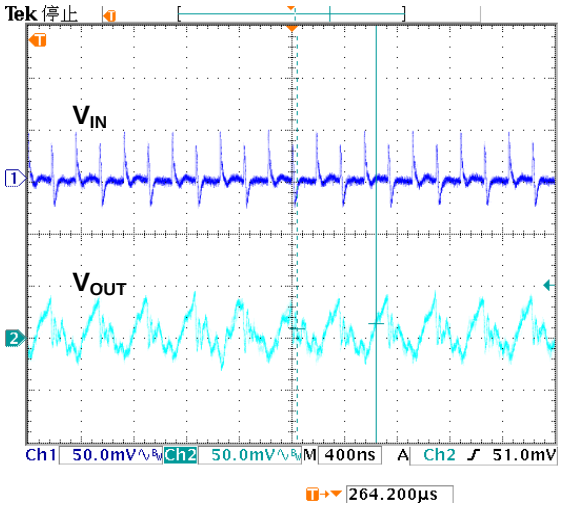


Figure 12. Ripple 2X Torch 150mA,V_{IN}=3V

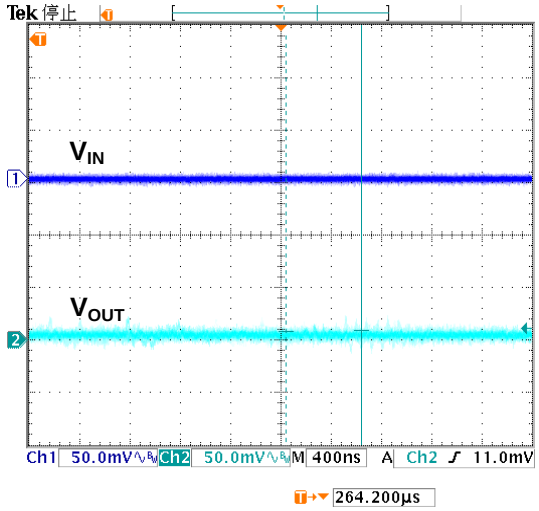


Figure 13. Ripple 1X Torch 150mA,V_{IN}=3.6V

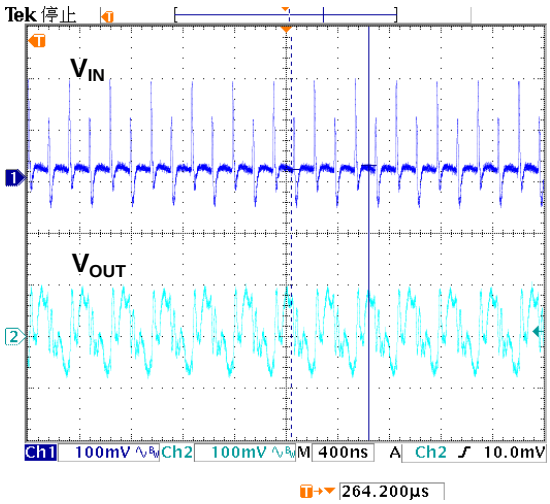


Figure 14. Ripple 2X Flash 700mA,V_{IN}=3.6V

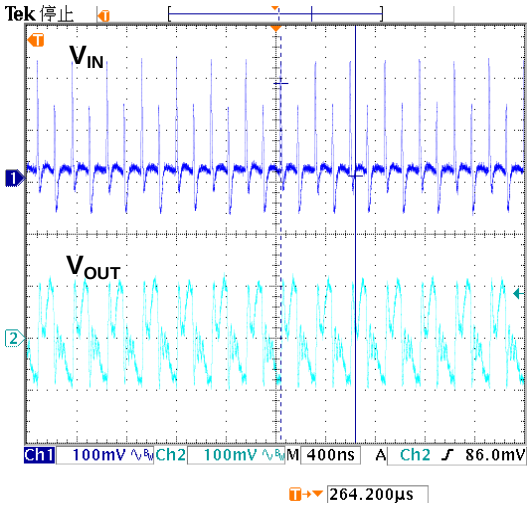


Figure 15. Ripple 2X Flash 1000mA,V_{IN}=4.2V

Function Description

The FP6773 Buck/Boost charge pump is designed for converting a Li-Ion battery voltage of 2.7V to 4.2V to drive a white LED used in digital still camera Flash and Torch applications. The FP6773 has two modes (TORCH and FLASH). Torch mode can be used continuously at a lower output current than Flash and is often used for several seconds in a digital still camera “movie” mode. Flash mode is usually used with a pulse of about 200 to 300 milliseconds to generate a high intensity Flash.

The FP6773 also has two modes of operation to control the output current: the 1X mode and 2X mode. Operation begins after the enable pin EN receives a logic high, then FP6773 starts in the 1X mode, which acts like a linear regulator to control the output current by continuously monitoring the feedback pin FB. In 1X mode, if the FP6773 auto detects a dropout condition, which is when the FB pin is below the regulation point for more than 32 cycles of the internal clock, the FP6773 automatically switches to the 2X mode. The FP6773 remains in the 2X mode until one of four things happens：1. The enable pin EN has been toggled, 2. The Flash pin has changed from high to low, 3. V_{IN} is cycled or, 4. A thermal fault occurs.

The 2X mode is the charge pump mode where the output can be pumped as high as two times the input voltage, provided the output does not exceed the maximum voltage for the FP6773, which is internally limited to about 5.5V. In the 2X mode, as in the 1X mode, the output current is regulated by the voltage at the FB pin.

In the TORCH mode (Flash = GND), the Flash pin is set to logic low and the FP6773 FB pin regulates to 50mV output:

V_{FB} = 50mV (Torch Mode)

In the FLASH mode, (Flash = V_{IN}), the FB regulation voltage is set by the external resistor (R_{SET}) connected between the RSET pin and SGND and the equation:

$$V_{FB} = \frac{1.26}{R_{SET}} \times (R_{SET} + 11.2k) \quad \text{(Flash Mode)}$$

Where 1.26V is the internal band gap reference voltage and 11.2kΩ is an internal resistance used to scale the R_{SET} current. Typical values of R_{SET} are 40kΩ to 180kΩ for a range of V_{FB} = 300mV to 75mV in Flash mode.

The output current is then set in either Flash or Torch mode by the equation:

$I_{OUT} = V_{FB} / R_{SENSE}$

Flash Timeout Protection

Due to the high currents typically available in Flash mode, it is necessary to protect the white LED from damage if left on too long. The FP6773 has a timeout in Flash mode of approximately 1.6 seconds after which it will shut down operation. Operation will not begin again in Flash mode until the EN pin or FLASH pin have been set Low and then High again.

Over-Current Protection

The over-current protection circuitry monitors the average current out of the FB pin. If the average current exceeds the two times set current, then the over current protection circuitry shuts off the output switches to protect the chip.

Over-Voltage Protection

The over-voltage protection monitors the output voltage. When the output voltage rises above 5.5V, the over-voltage protection shuts off all of the output switches to prevent the output voltage from rising further. When the output decreases below 5.5V, the device resumes normal operation.

Brightness Control Using PWM

Dimming control can be achieved by applying a PWM control signal to the EN pin. The brightness of the white LEDs is controlled by increasing and decreasing the duty cycle of the PWM signal. While the operating frequency range of the PWM control is from 60Hz to 700Hz, the recommended maximum brightness frequency range of the PWM signal is from 60Hz to 200Hz. A repetition rate of at least 60Hz is required to prevent flicker.

Application Information

The FP6773 charge pump circuit requires 3 capacitors: 1μF input, 1μF output and 1μF fly capacitors are typically recommended. For the input capacitor, a value of 10μF will help reduce input voltage ripple for applications sensitive to ripple on the battery voltage. All the capacitors should be surface mount for low lead inductance necessary at the 2MHz switching frequency of the FP6773 and to obtain low ESR, which improves bypassing on the input and output and improves output voltage drive by reducing output resistance. The input and output capacitors should be located as close to the V_{IN} and V_{OUT} pins as possible to obtain best bypassing, and the returns should be connected directly to the PGND pin or to the thermal pad ground located under the FP6773. The fly capacitor should be located as close to the C1 and C2 pins as possible.

The sense resistor R_{SENSE} is determined by the value needed in the Torch mode for the desired output current by the equation:

$R_{SENSE} = V_{FB} / I_{OUT}$

where V_{FB} = 50mV (Torch Mode).

Once the R_{SENSE} resistor has been selected for Torch mode, the V_{FB} voltage can be selected for Flash mode using the following equation：

$V_{FB}=I_{OUT}×R_{SENSE}$ (Flash Mode)

where I_{OUT} is for Flash

Next, the R_{SET} resistor can be selected for Flash mode using the following equation:

R_{SET} = (1.26V/ V_{FB})*11.2kΩ (Flash Mode)

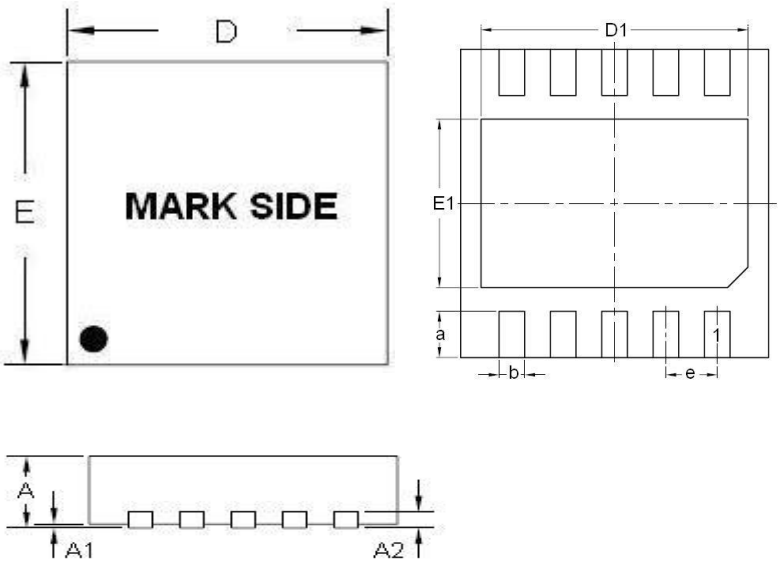
For an example of 230mA Torch mode and 700mA Flash mode, the values R_{SENSE} = 0.22Ω, V_{FB}= 150mV (Flash Mode), and R_{SET} = 95kΩ are calculated. The power obtained in the Flash mode would be:

$P_{FLASH} = V ×I = 150mV×700mA = 105mW$

The typical 0603 surface mount resistor is rated at 1/10 Watt continuous power and 1/5 Watt pulsed power, more than enough for this application.

Outline Information

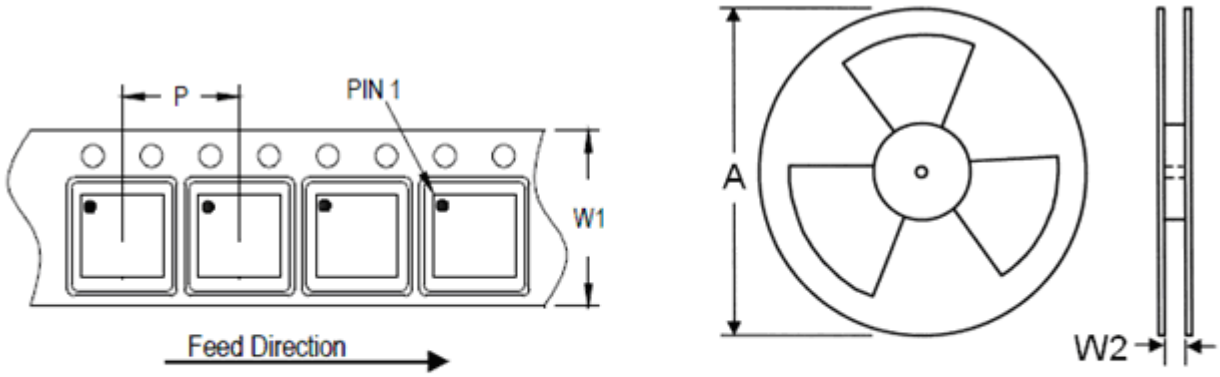
TDFN-10 Package (3mm x 3mm) (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.70	0.80
A1	0.00	0.05
A2	0.18	0.25
D	2.95	3.05
E	2.95	3.05
a	0.35	0.45
b	0.18	0.30
e	0.45	0.55
D1	2.20	2.70
E1	1.40	1.75

Note：Followed From JEDEC MO-220-J.

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	3,000

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