

300mA, Low Noise High PSRR LDO Regulator

Description

The FP6170 is a low dropout, low noise, high PSRR, low quiescent current positive linear regulator. The FP6170 can supply 300mA output current with low dropout voltage at about 160mV that optimized for battery-powered systems or portable wireless devices such as mobile phones. The shutdown function can provide remote control for the external signal to decide the on/off state of FP6170 that consumes less than 0.1 μ A during shutdown mode.

The FP6170 regulator is able to operate with output capacitors as small as 1 μ F for stability. The FP6170 fault protection includes the current limit protection and short current protection.

The FP6170 offers high precision output voltage of $\pm 1\%$. The FP6170 is available in UTDFN-4L (1mm $\times$ 1mm) and SOT-23-5L Packages package which features small size.

Features

- Low V_{IN} and Wide V_{IN} Range: 1.9V to 5.5V
- Output Current 300mA^{*1}
- $\pm 1\%$ Output Voltage Accuracy
- Output Noise 15 μ Vrms from 10Hz to 100kHz
- V_{OUT} Fixed 1.0V to 3.3V
- Low Dropout Voltage of 160mV at 2.8V/300mA
- Ripple Rejection 85dB at 1kHz
- Low Quiescent Current at 6.5 μ A
- Needs Only 1 μ F Capacitor for Stability
- Inrush Current Limit
- Thermal Shutdown Protection
- Current Limit Protection
- Short Current Protection
- Output Discharge Function
- UTDFN-4L (1mm $\times$ 1mm) and SOT-23-5L Packages
- RoHS Compliant

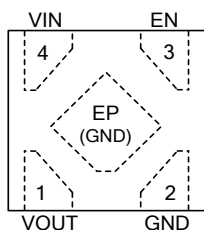
*1 Attention should be paid to the power dissipation of the package when the output current is large.

Applications

- PDAs, Mobile phones, GPS, Smartphones
- Wireless Handsets, Wireless LAN, Bluetooth®, Zigbee®
- Portable Medical Equipment
- Other Battery Powered Applications

Pin Assignment

X7 Package: UTDFN-4L (1mmx1mm) (Top view)



S5 Package: SOT-23-5L

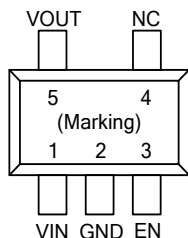


Figure1. Pin Assignment of FP6170

Ordering Information

FP6170-		
	Package Type	
	X7: UTDFN-4L (1mmx1mm)	
	S5: SOT-23-5L	
	Output Voltage	
	10: 1.0V	1J: 1.05V
	12: 1.2V	15: 1.5V
	22: 2.2V	25: 2.5V
	30: 3.0V	33: 3.3V

Marking Information

Part Number	Product Code
FP6170-10X7	iF
FP6170-1JX7	iG
FP6170-11X7	iH
FP6170-12X7	iC
FP6170-15X7	iJ
FP6170-18X7	iK
FP6170-22X7	iL
FP6170-25X7	iM
FP6170-28X7	iB
FP6170-30X7	iM
FP6170-33X7	iN
FP6170-10S5	Ha4
FP6170-1JS5	Ha5
FP6170-11S5	Ha6
FP6170-12S5	Ha7
FP6170-15S5	Hb0
FP6170-18S5	Hb1
FP6170-22S5	Hb2
FP6170-25S5	Hb3
FP6170-28S5	Hb4
FP6170-30S5	Hb5
FP6170-33S5	Hb6

Note: Please consult Fitipower sales office or authorized distributors for availability of special output voltages.

Typical Application Circuit

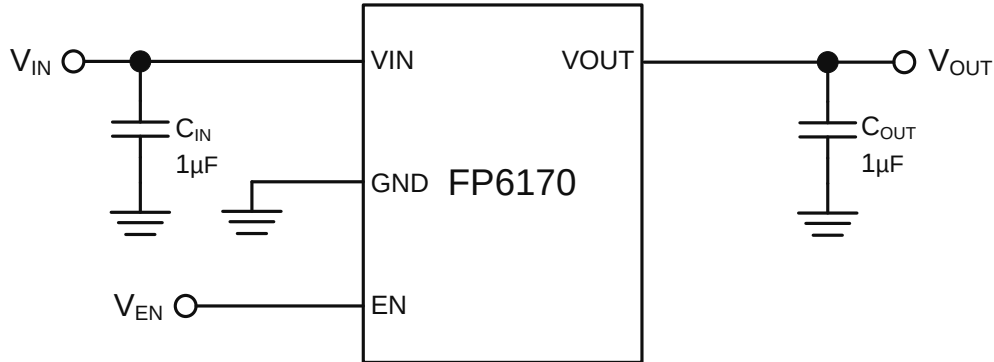


Figure 2. Typical Application Circuit of FP6170

Note 1: To prevent oscillation, it is recommended to use minimum 1μF X7R or X5R dielectric capacitors if ceramics are used as input/output capacitors.

Functional Pin Description

Pin Name	Pin No. (SOT-23-5L)	Pin No. (UTDFN-4L)	Pin Function
VIN	1	4	Power is supplied to this device from this pin which is required an input filter capacitor. In general, the input capacitor in the range of 1μF to 10μF is sufficient.
GND	2	2	Common ground pin.
EN	3	3	Pull this pin high to enable IC, pull this pin low to shutdown IC. Floating this pin will be shutdown due to the built-in pull-low resistor.
NC	4	-	NC.
VOUT	5	1	The FP6170 is stable with an output capacitor 1μF or greater. The larger output capacitor will be required for application with larger load transients. The large output capacitor could reduce output noise, improve stability and PSRR.
Exposed pad	-	EP	The exposed pad must be soldered to a large PCB area and connected to GND for maximum power dissipation.

Block Diagram

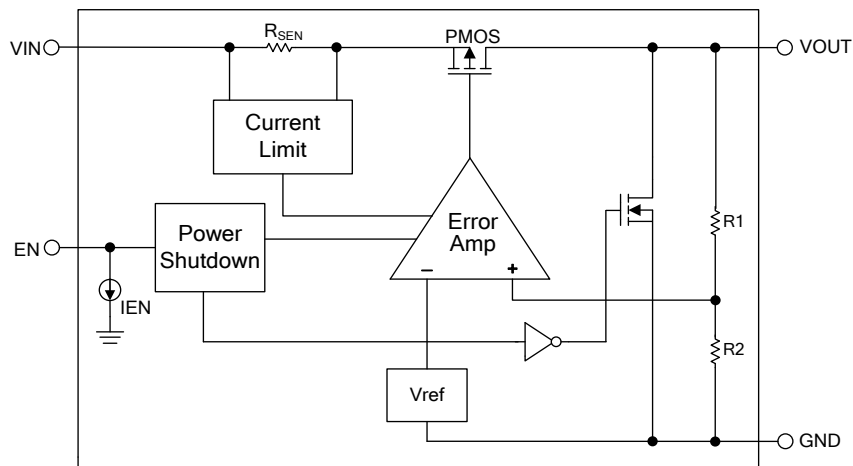


Figure 3. Block Diagram of FP6170

Absolute Maximum Ratings (Note 2)

- Supply Voltage V_{IN} ----- -0.3V to +6.5V
- Output Voltage V_{OUT} ----- -0.3V to +6.5V
- EN Voltage V_{EN} ----- -0.3V to $V_{IN} + 0.3V$
- Power Dissipation @ $T_A=25^{\circ}C$ & $T_J=125^{\circ}C$ (P_D)
 - UTDFN-4L (1mmx1mm) ----- 0.5W
 - SOT-23-5L ----- 0.4W
- Package Thermal Resistance (θ_{JA}) (Note 3)
 - UTDFN-4L (1mmx1mm) ----- $195^{\circ}C/W$
 - SOT-23-5L ----- $250^{\circ}C/W$
- Package Thermal Resistance (θ_{JC})
 - UTDFN-4L (1mmx1mm) ----- $65^{\circ}C/W$
 - SOT-23-5L ----- $130^{\circ}C/W$
- Lead Temperature (Soldering, 10sec.) ----- $+260^{\circ}C$
- Junction Temperature (T_J) ----- $-40^{\circ}C$ to $+150^{\circ}C$
- Storage Temperature (T_{STG}) ----- $-65^{\circ}C$ to $+150^{\circ}C$

Note 2: Stresses beyond this listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

Note 3: θ_{JA} is measured at $25^{\circ}C$ ambient with the component mounted on a high effective thermal conductivity 4-layer board of JEDEC-51-7. The thermal resistance greatly varies with layout, copper thickness, number of layers and PCB size.

Recommended Operating Conditions

- Supply Voltage V_{IN} ----- +1.9V to +5.5V
- Output Current I_{OUT} ----- 0mA to 300mA
- Operating Ambient Temperature Range ----- $-40^{\circ}C$ to $+85^{\circ}C$
- Operating Junction Temperature Range ----- $-40^{\circ}C$ to $+125^{\circ}C$

Electrical Characteristics

($V_{IN}=V_{OUT}+1V$, EN pin connected to V_{IN} , $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $T_A=25^{\circ}C$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		1.9		5.5	V
Quiescent Current (Note 4)	I_Q	$I_{OUT}=0A$		6.5	8.5	μA
Standby Current	I_{STBY}	EN Pin Connected to GND		0.1	1	μA
Output Voltage Accuracy	ΔV_{OUT}	$I_{OUT}=1mA$	-1		+1	%
Dropout Voltage (Note 5)	V_{DROP}	$I_{OUT}=300mA$	$V_{OUT}=1.0V$	650	850	mV
			$V_{OUT}=1.05V$	590	770	
			$V_{OUT}=1.1V$	530	690	
			$V_{OUT}=1.2V$	440	570	
			$V_{OUT}=1.5V$	350	460	
			$V_{OUT}=1.8V$	230	300	
			$V_{OUT}=2.2V$	215	280	
			$V_{OUT}=2.5V$	180	230	
			$V_{OUT}=2.8V$	160	210	
			$V_{OUT}=3.0V$	150	200	
			$V_{OUT}=3.3V$	135	180	
Line Regulation	ΔV_{LINE}	$I_{OUT}=1mA$, $V_{IN}=V_{OUT}+1V$ to 5V		1	8	mV
Load Regulation (Note 6)	ΔV_{LOAD}	$I_{OUT}=1mA$ to 300mA		6	30	mV
Ripple Rejection (Note 7)	PSRR	$V_{IN}=V_{OUT}+1V_{DC}+0.2V_{P-P(AC)}$, $f_{RIPPLE}=1KHz$, $I_{OUT}=20mA$		85		dB
Output Noise Voltage (Note 7)	V_{NOISE}	$C_{OUT}=1\mu F$, $I_{OUT}=30mA$ $BW=10Hz \sim 100KHz$		15		μV_{RMS}
Current Limit	I_{LIMIT}	$V_{OUT}=2.8V$	320	650		mA
Current Foldback	I_{CFB}	$V_{OUT} < V_{OUT} \times 15\%$		60		mA
Inrush current Limit	I_{RUSH}	$V_{OUT} < V_{OUT} \times 15\%$	48	60	72	mA
		$V_{OUT} > V_{OUT} \times 15\%$, Time=0.7ms		130		
		$V_{OUT} > V_{OUT} \times 15\%$, Time Over 0.7ms		250		
Output Discharge Resistance	R_{DIS}	$V_{EN}=0V$		60		Ω
EN Pin Current	I_{EN}	$V_{EN}=2.5V$		0.3		μA
EN Pin Threshold	$V_{EN(ON)}$	Start-up	1.0			V
	$V_{EN(OFF)}$	Shutdown			0.4	V
Thermal Shutdown Threshold (Note 7)	T_{SD}			160		$^{\circ}C$
Thermal Shutdown Threshold Hysteresis (Note 7)	ΔT_{SD}			30		$^{\circ}C$

Note 4: Except EN pull down current (I_{EN}).

Note 5: The dropout voltage is defined as $V_{IN}-V_{OUT}$, which is measured when V_{OUT} drops 2% of its normal value with the specified output current.

Note 6: Load regulation and dropout voltage are measured at a constant junction temperature by using a 40ms low duty cycle current pulse.

Note 7: Guarantee by design.

Typical Performance Curves

$V_{IN}=V_{OUT}+1V$, EN pin connected to V_{IN} , $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $T_A=25^\circ C$, unless otherwise specified.

$V_{OUT}=2.8V$, $I_{OUT}=0mA$

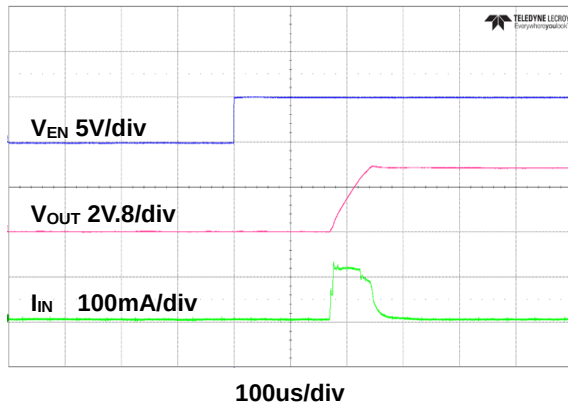


Figure 4. Turn ON Waveform

$V_{OUT}=2.8V$, $I_{OUT}=0mA$

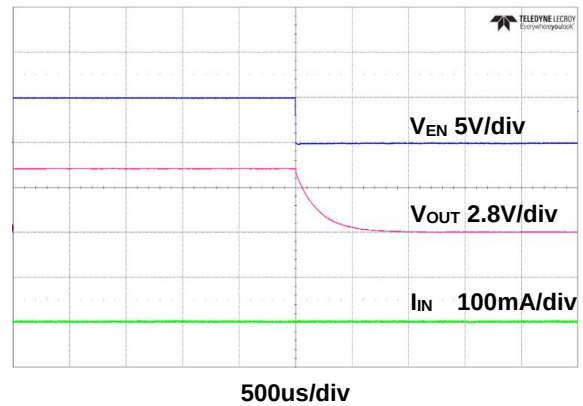


Figure 5. Turn OFF Waveform

$V_{OUT}=2.8V$ / $I_{OUT}=1mA \rightarrow 300mA \rightarrow 1mA$

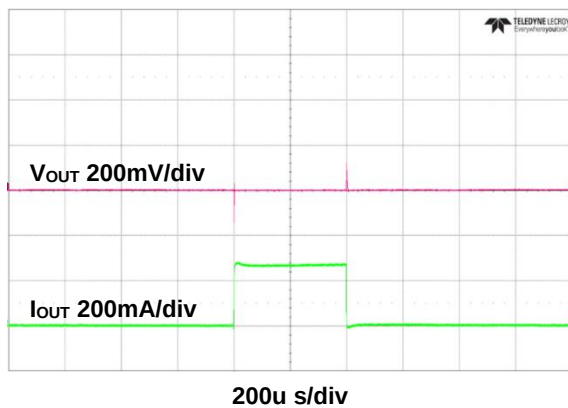


Figure 6. Load Transient Response

V_{IN} = Li-ion Battery 3.8V, $V_{OUT}=2.8V$, $I_{OUT}=30mA$

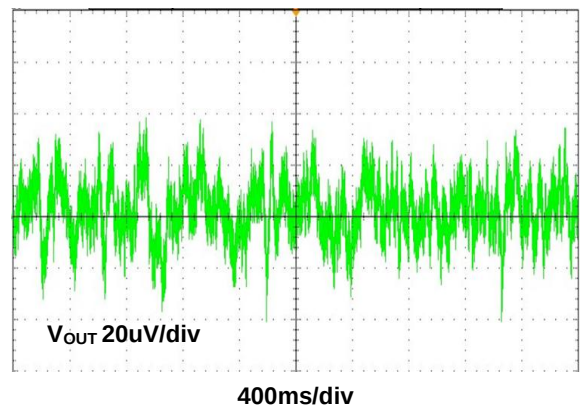


Figure 7. Output Noise Voltage

$V_{OUT}=2.8V$, $I_{OUT}=20mA$

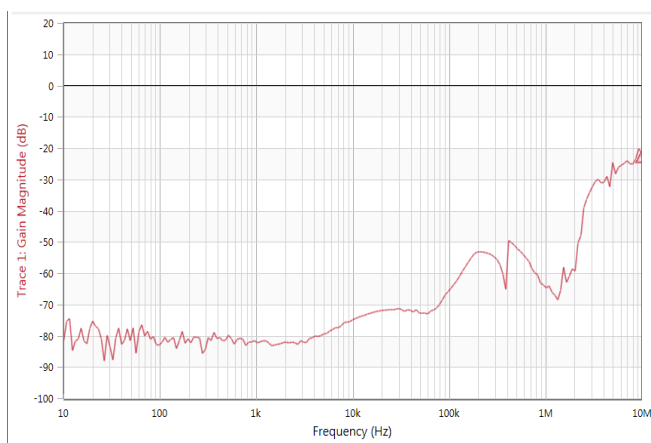


Figure 8. PSRR vs. Frequency

$V_{OUT}=2.8V$, $I_{OUT}=0mA$

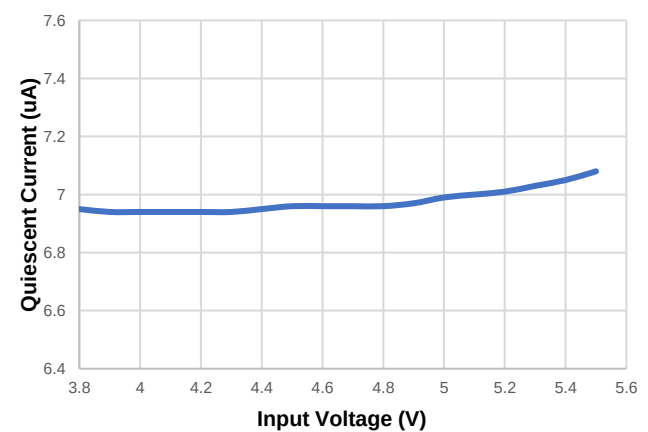


Figure 9. Quiescent Current vs. Input Voltage

Typical Performance Curves (Continued)

$V_{IN}=V_{OUT}+1V$, EN pin connected to V_{IN} , $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $T_A=25^\circ C$, unless otherwise specified.

$V_{OUT}=2.8V$

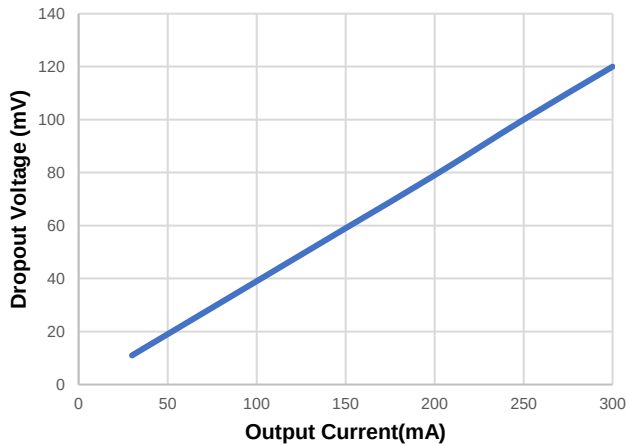


Figure 10. Dropout Voltage vs. Output Current

$V_{OUT}=2.8V$

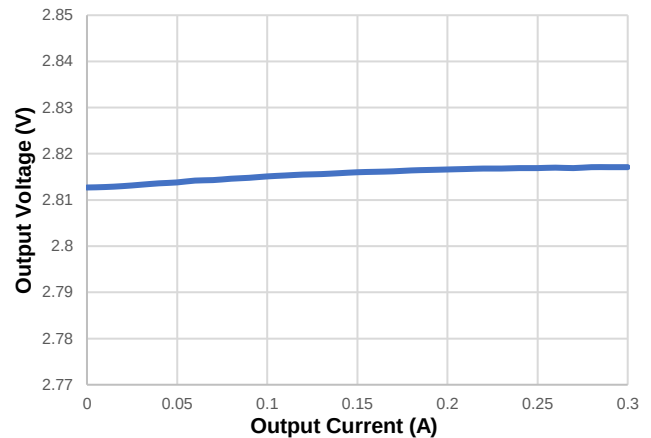


Figure 11. Output Voltage vs. Output Current

$V_{OUT}=2.8V$, $I_{OUT}=1mA$

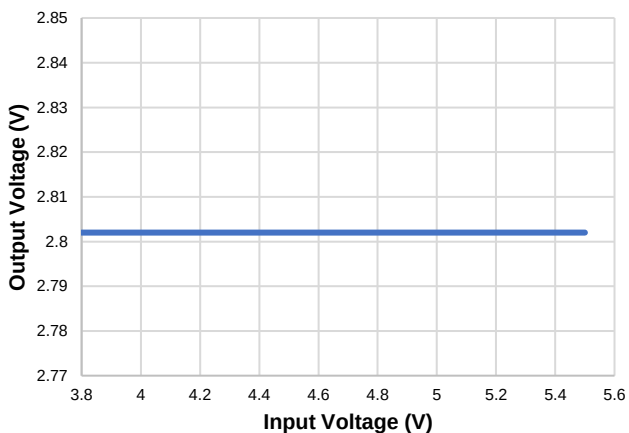


Figure 12. Output Voltage vs. Input Voltage

$V_{OUT}=2.8V$, $I_{OUT}=0mA$

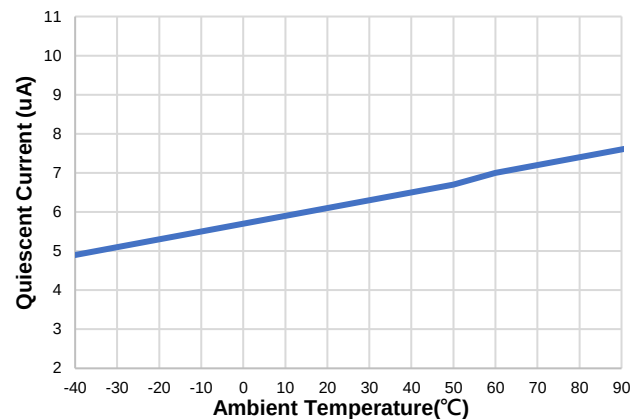


Figure 13. Quiescent Current vs. Ambient Temperature

$V_{OUT}=2.8V$

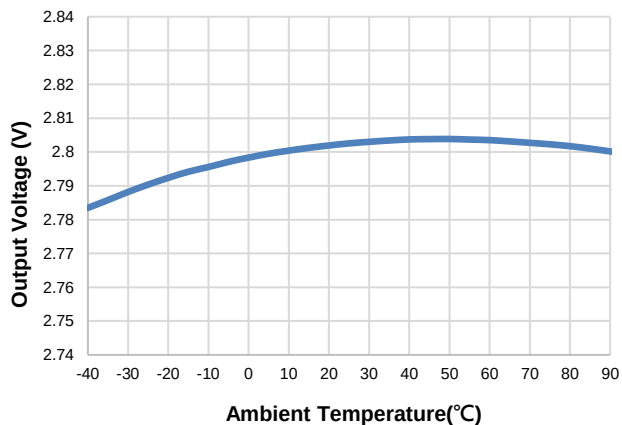


Figure 14. Output Voltage vs. Ambient Temperature

Application Information

The FP6170 is a low dropout linear regulator that could provide 300mA output current at dropout voltage about 160mV (2.8V output voltage).

Output and Input Capacitor

The FP6170 regulator is designed to be stable with a wide range of output capacitors. The ESR of the output capacitor affects stability. Larger value of the output capacitor decreases the peak deviations and improves transient response for larger current changes.

The capacitor types (aluminum, ceramic, and tantalum) have different characterizations such as temperature and voltage coefficients. All ceramic capacitors are manufactured with a variety of dielectrics, each with different behavior across temperature and applications. Common dielectrics used are X5R, X7R and Y5V. It is recommended to use 1 μ F to 22 μ F X5R or X7R dielectric ceramic capacitors with 30m Ω to 50m Ω ESR range between device outputs and ground for stability. The FP6170 is designed to be stable with low ESR ceramic capacitors and higher values of capacitors and ESR could improve output stability. The ESR of output capacitor is very important because it generates a zero to provide phase lead for loop stability.

There are no requirements for the ESR on the input capacitor, but its voltage and temperature coefficient have to be considered for device application environment.

Inrush Current Limit

The inrush current limit during the V_{OUT} ramp-up phase scales proportionally with the output capacitance (C_{OUT}) such that the inrush current is initially clamped at 60mA until V_{OUT} exceeds 15% of its default value, at which point the limit steps up to 130mA for a maximum duration of 700 μ s. If V_{OUT} fails to reach its default value within this initial 700 μ s window, the limit automatically shifts to 250mA for an additional 700 μ s, and if V_{OUT} still does not achieve its default value after this second 700 μ s window expires, the inrush current limit is entirely released, leaving the current restricted solely by the internal Current Limit Protection until V_{OUT} successfully reaches its default regulated value and the output current naturally declines to the continuous current required by the load.

Current Limit Protection

In order to prevent overloading condition from damaging the device, FP6170 has current limiting function designed to protect the device.

Thermal Consideration

The power handling capability of the device will be limited by allowable operation junction temperature (125°C). The power dissipated by the device will be estimated by $P_D = I_{OUT} \times (V_{IN} - V_{OUT})$. The power dissipation should be lower than the maximum power dissipation listed in "Absolute Maximum Ratings" section.

Shutdown Operation

The FP6170 is shutdown by pulling the EN input low, and turned on by driving the EN high. If EN pin floating, the FP6170 will shut down because EN pin has built-in a pull low resistor (refer to Block Diagram).

Output Discharge Function

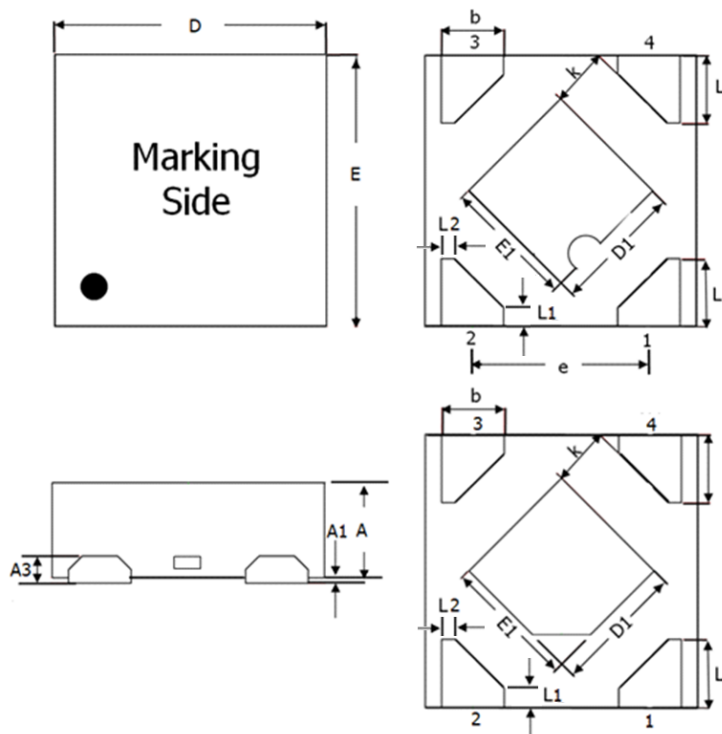
The FP6170 provides auto discharge function, an discharge MOSFET with $R_{DS(ON)}$ of 60 Ω typical is integrated between V_{OUT} and GND pins, which can discharge the charge of the output capacitors quickly when turning off FP6170 with EN pin.

PCB Layout Recommendation

Place the input capacitors and output capacitors as close to the device as possible. The traces which connect to these capacitors should be as short and wide as possible to minimize parasitic inductance and resistance.

Outline Information

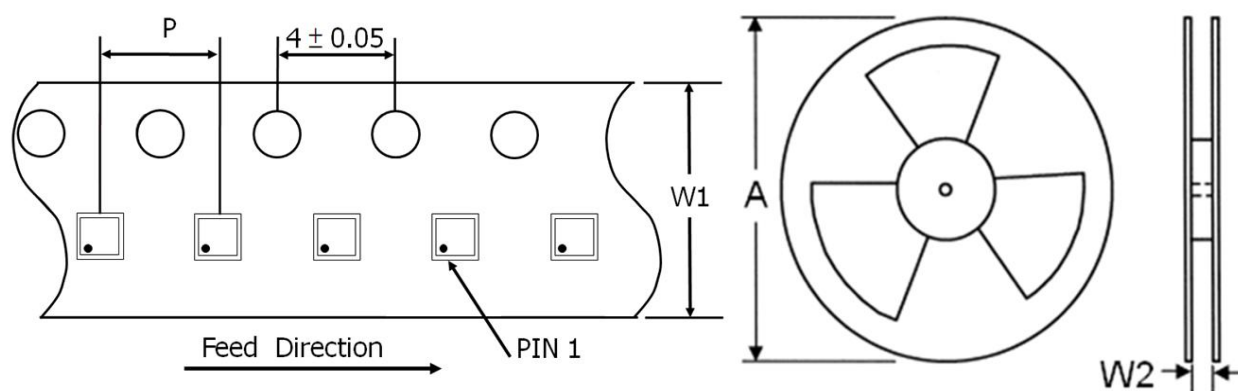
UTDFN-4L (1mmx1mm) (pitch 0.65mm) Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.320	0.450
A1	0.000	0.050
A3	0.070	0.200
D	0.950	1.050
E	0.950	1.050
D1	0.380	0.580
E1	0.380	0.580
k	0.200 REF.	
b	0.180	0.300
e	0.600	0.700
L	0.200	0.300
L1	0.076	0.086
L2	0.056	0.066

Note 8: Followed from JEDEC 664-1.

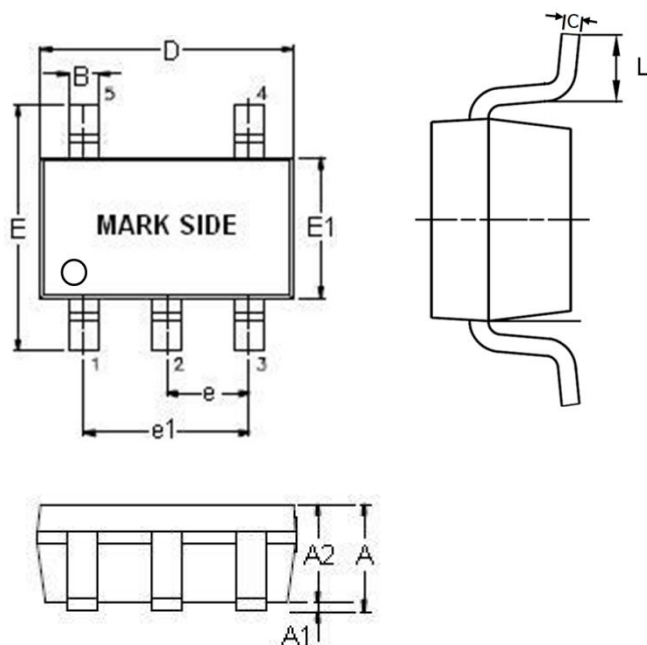
Carrier Dimensions



Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A)		Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
		in	mm			
8	4	7	180	9.5	400~1000	5000

Outline Information (Continued)

SOT-23-5L Package (Unit: mm)

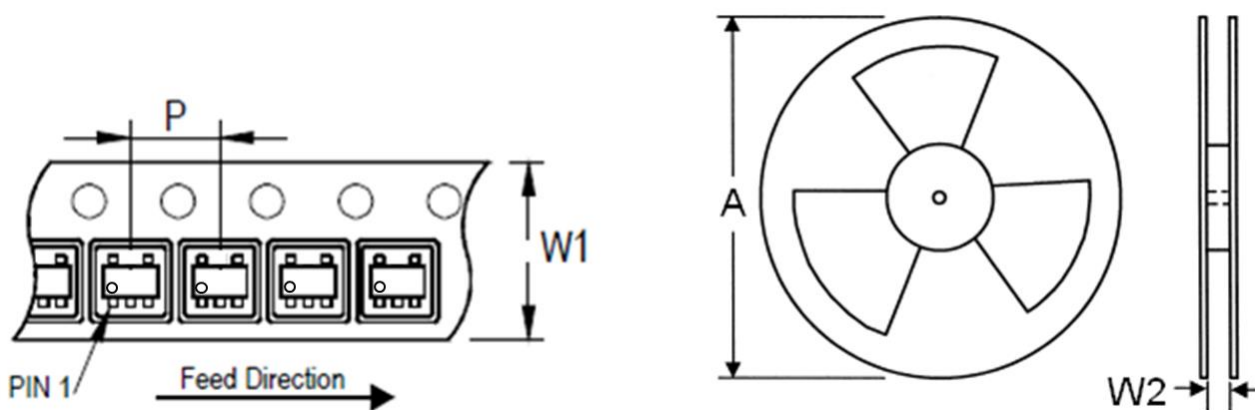


SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.90	1.30
A1	0.00	0.15
A2	0.90	1.15
B	0.28	0.50
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.90	1.00
e1	1.80	2.00
C	0.08	0.20
L	0.30	0.60

Note 9: Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.3mm.

Note 10: Followed from JEDEC MO-178-C.

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			
8	4	7	180	8.4	300~1000	3,000

Life Support Policy

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