300mA, Low Noise High PSRR LDO Regulator

Description

The FP6187 is a low dropout, low noise, high PSRR, low quiescent current positive linear regulator. The FP6187 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 FP6187 that consumes less than 0.1μA during shutdown mode.

The FP6187 regulator is able to operate with output capacitors as small as 1μF for stability. The FP6187 fault protection includes the current limit protection and current foldback protection.

The FP6187 offers high precision output voltage of ±1%. The FP6187 is available in UTDFN-4L (1mm×1mm) and SOT-23-5L packages which features small size.

Features

- Low V_{IN} and Wide V_{IN} Range: 1.75V to 5.5V
- Output Current 300mA*1
- ±1% Output Voltage Accuracy
- Output Noise 65μVrms from 10Hz to 100kHz
- V_{OUT} Fixed 1.0V to 3.3V
- Low Dropout Voltage of 160mV at 2.8V/300mA
- Ripple Rejection 65dB at 1kHz
- Low Quiescent Current at 2μA
- Needs Only 1μF Capacitor for Stability
- Thermal Shutdown Protection
- Current Limit Protection
- Current Foldback Protection
- Output Discharge Function
- UTDFN-4L (1mm×1mm) and SOT-23-5L Packages
- RoHS Compliant

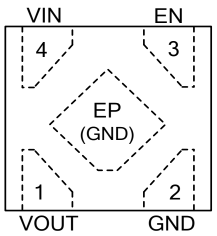
*1 Attention should be paid to the power dissipation of the package when the output current is large.

Applications

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

Pin Assignment

X6 Package: UTDFN-4L (1mmx1mm) (Top view)



S5 Package: SOT-23-5L

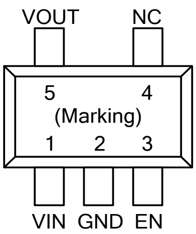


Figure 1. Pin Assignment of FP6187

Ordering Information

FP6187-□□

Package Type
X6: UTDFN-4L (1mmx1mm)
S5: SOT-23-5L

Output Voltage

10: 1.0V	1J:1.05V
11: 1.1V	12: 1.2V
15: 1.5V	18: 1.8V
22: 2.2V	25: 2.5V
28: 2.8V	30: 3.0V
33: 3.3V	

Marking Information

Part Number	Product Code
FP6187-10X6	**YJ**
FP6187-1JX6	**YK**
FP6187-11X6	**YL**
FP6187-12X6	**YM**
FP6187-15X6	**YN**
FP6187-18X6	**YP**
FP6187-22X6	**YR**
FP6187-25X6	**YS**
FP6187-28X6	**YT**
FP6187-30X6	**YU**
FP6187-33X6	**YV**
FP6187-10S5	**GA9**
FP6187-12S5	**GA2**
FP6187-18S5	**GB0**
FP6187-25S5	**GD1**
FP6187-28S5	**GB1**
FP6187-30S5	**GB2**
FP6187-33S5	**GB3**

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

Typical Application Circuit

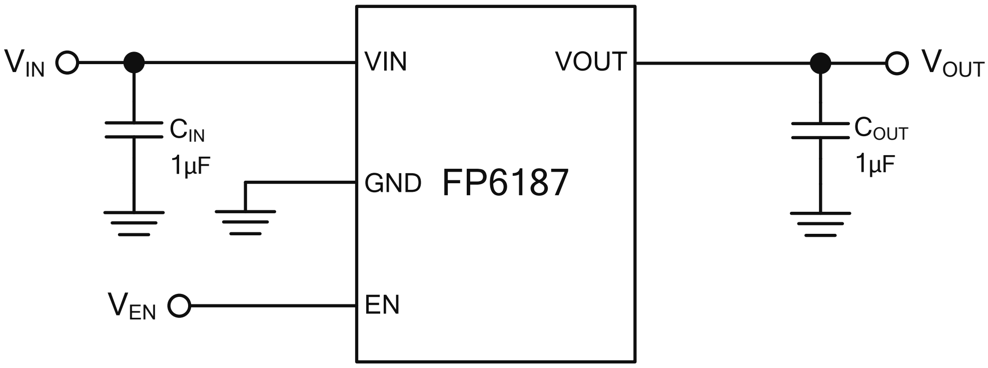


Figure 2. Typical Application Circuit of FP6187

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 FP6187 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

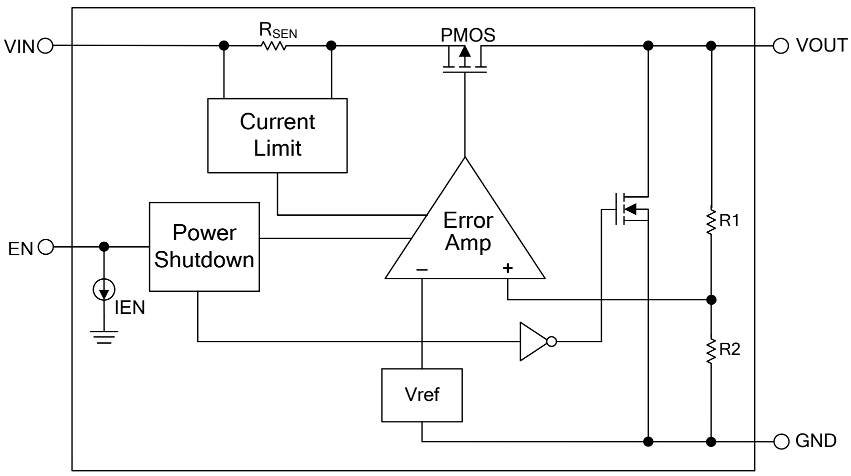


Figure 3. Block Diagram of FP6187

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°C & T_J=125°C (P_D)

  UTDFN-4L (1mmx1mm) -- 0.5W

  SOT-23-5L -- 0.4W
- Package Thermal Resistance (θ_{JA}) (Note 3)

  UTDFN-4L (1mmx1mm) -- 195°C/W

  SOT-23-5L -- 250°C/W
- Package Thermal Resistance (θ_{JC})

  UTDFN-4L (1mmx1mm) -- 65°C/W

  SOT-23-5L -- 130°C/W
- Lead Temperature (Soldering, 10sec.) -- +260°C
- Junction Temperature (T_J) -- -40°C to +150°C
- Storage Temperature (T_{STG}) --- -65°C to +150°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°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} -- +1.75V to +5.5V
- Output Current I_{OUT} --- 300mA
- Operating Ambient Temperature Range -- -40°C to +85°C
- Operating Junction Temperature Range -- -40°C to +125°C

Electrical Characteristics

(V_{IN}=V_{OUT}+1V, EN pin connected to V_{IN}, C_{IN}=1µF, C_{OUT}=1µF, T_A=25ºC, unless otherwise specified.)

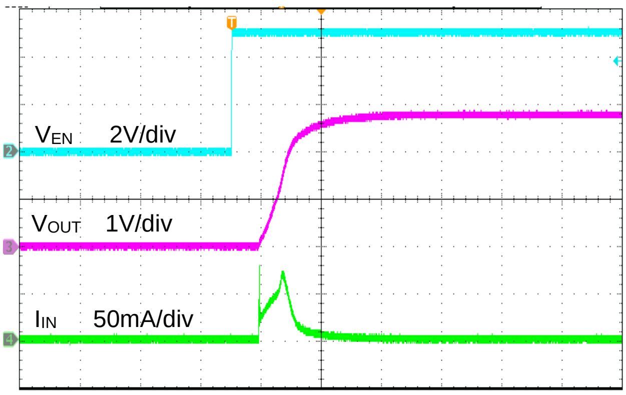
Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input Voltage Range	V_{IN}			1.75		5.5	V
Quiescent Current (Note 4)	I_Q	I_{OUT}=0A			2	4	µA
Standby Current	I_{STBY}	EN Pin Connected to GND			0.1	1	µA
Output Voltage Accuracy	ΔV_{OUT}	I_{OUT}=1mA		-1		+1	%
Dropout Voltage (Note 5)	V_{DROP}	I_{OUT}=300mA	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}=0A to 300mA			6	30	mV
Ripple Rejection (Note 7)	PSRR	V_{IN}=V_{OUT}+1V_{DC}+0.2$V_{P-P(AC)}$, f_{RIPPLE}=1KHz,V_{OUT}=1.2V, I_{OUT}=30mA			65		dB
Output Noise Voltage (Note 7)	V_{NOISE}	C_{OUT}=1µF, I_{OUT}=30mA BW=10Hz ~ 100KHz			65		µV_{RMS}
Current Limit	I_{LIMIT}			320			mA
Current Foldback	I_{CFB}	R_{Load}=1Ω			100		mA
Output Discharge Resistance	R_{DIS}	V_{EN}=0V			60		Ω
Thermal Shutdown Threshold (Note 7)	T_{SD}				160		ºC
Thermal Shutdown Threshold Hysteresis (Note 7)	ΔT_{SD}				30		ºC
EN Pin Current	I_{EN}	V_{EN}=2.5V			0.3		uA
EN Pin Threshold	$V_{EN(ON)}$	Start-up		1.0			V
	$V_{EN(OFF)}$	Shutdown				0.4	V

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}, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $T_A=25^oC$, unless otherwise specified.

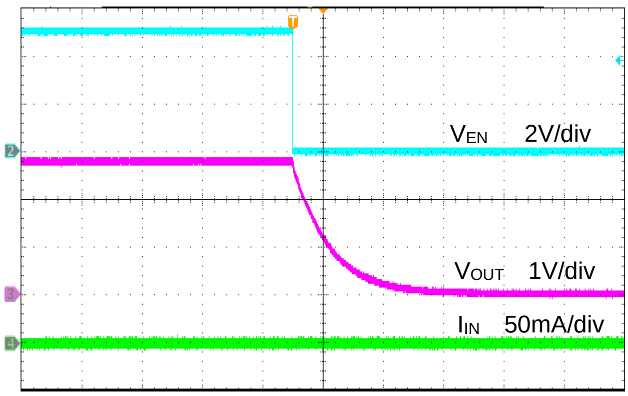
$V_{OUT}=2.8V$, $I_{OUT}=0mA$



200us/div

Figure 4. Turn ON Waveform

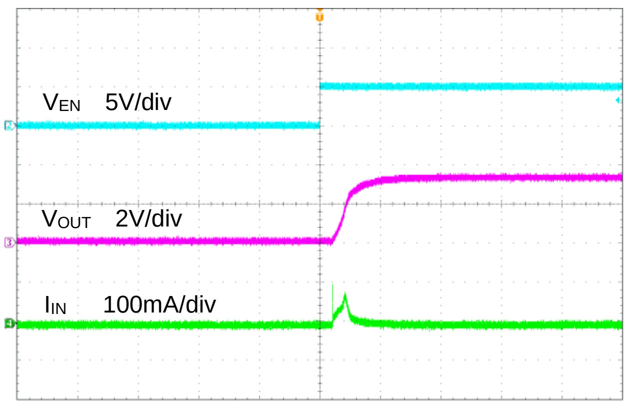
$V_{OUT}=2.8V$, $I_{OUT}=0mA$



400us/div

Figure 5. Turn OFF Waveform

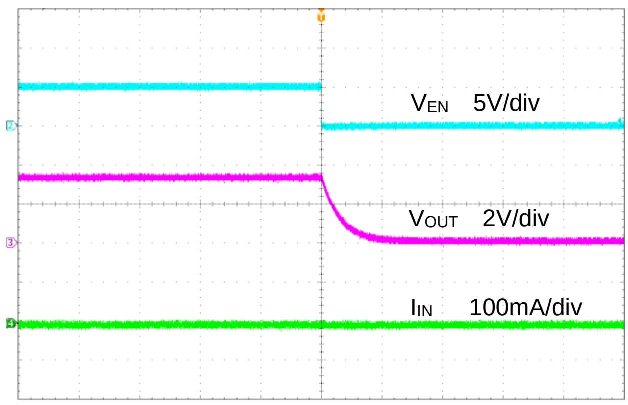
$V_{OUT}=3.3V$, $I_{OUT}=0mA$



400us/div

Figure 6. Turn ON Waveform

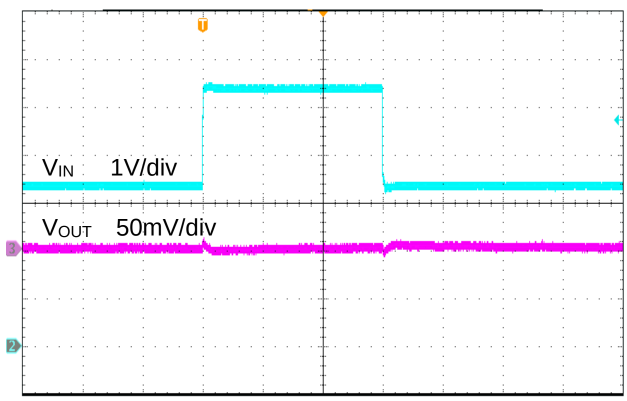
$V_{OUT}=3.3V$, $I_{OUT}=0mA$



100us/div

Figure 7. Turn OFF Waveform

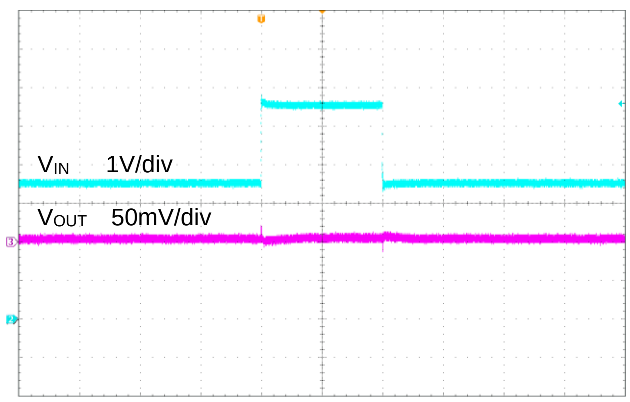
$2.8V_{OUT}/V_{IN}=3.2V\rightarrow5.5V\rightarrow3.2V$ $I_{OUT}=10mA$, C_{IN}=none



100us/div

Figure 8. Line Transient Response

$3.3V_{OUT}/V_{IN}=3.6V\rightarrow5.5V\rightarrow3.6V$ $I_{OUT}=10mA$, C_{IN}=none



400us/div

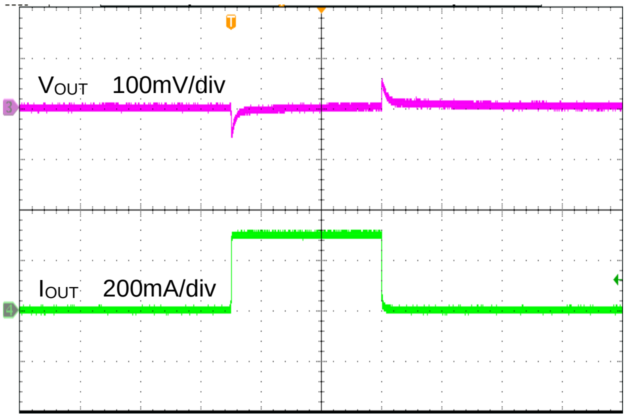
Figure 9. Line Transient Response

Typical Performance Curves (Continued)

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

2.8V

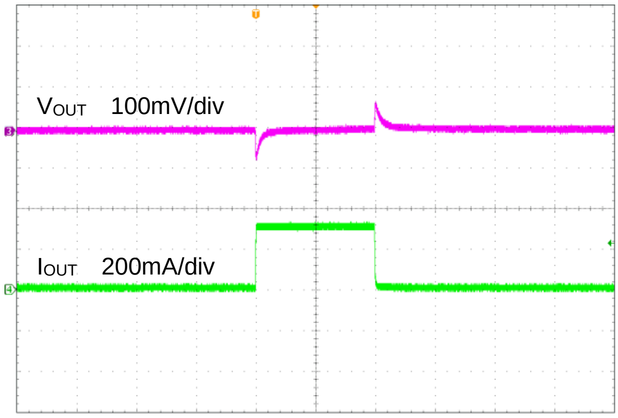
$2.8V_{OUT}/I_{OUT}=1mA\rightarrow300mA\rightarrow1mA$



2ms/div

Figure 10. Load Transient Response

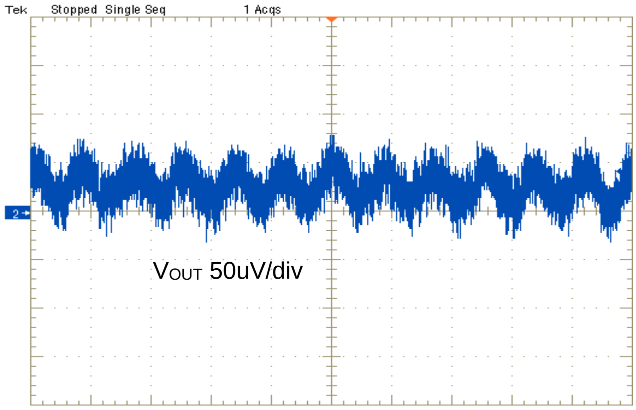
$3.3V_{OUT}/ I_{OUT}=1mA\rightarrow300mA\rightarrow1mA$



2ms/div

Figure 11. Load Transient Response

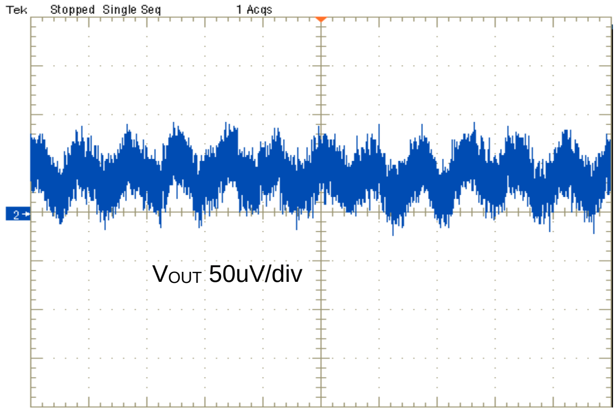
V_{IN}= Li-ion Battery 3.6V, V_{OUT}=1.8V, I_{OUT}=0mA



20ms/div

Figure 12. Output Noise Voltage

V_{IN}= Li-ion Battery 3.6V, V_{OUT}=1.8V, I_{OUT}=1mA



20ms/div

Figure 13. Output Noise Voltage

Typical Performance Curves (Continued)

V_{IN}=V_{OUT}+1V, EN pin connected to V_{IN}, C_{IN}=1µF, C_{OUT}=1µF, T_A=25ºC, unless otherwise specified.

V_{OUT}=1.2V, I_{OUT}=30mA

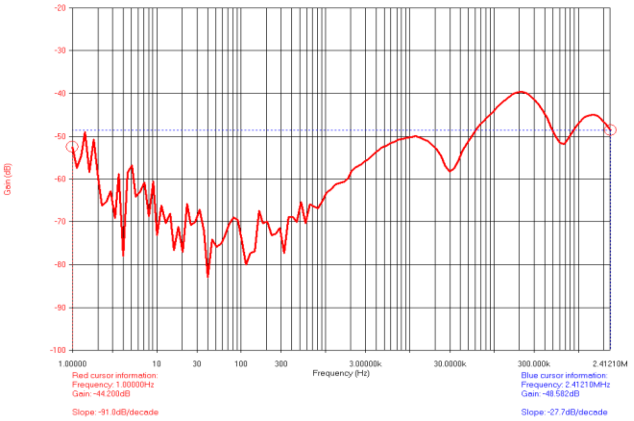


Figure 14. PSRR vs. Frequency

V_{OUT}=2.8V, I_{OUT}=30mA

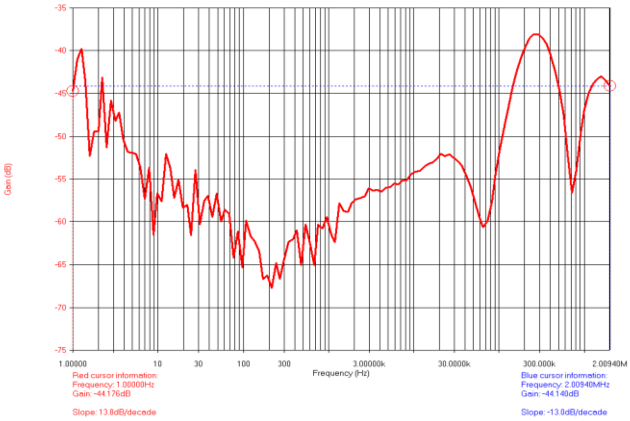


Figure 15. PSRR vs. Frequency

V_{OUT}=3.3V, I_{OUT}=30mA

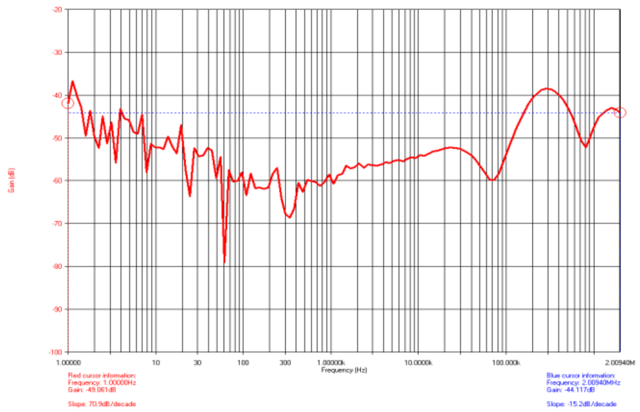


Figure 16. PSRR vs. Frequency

V_{IN}=3.8V, V_{OUT}=2.8V

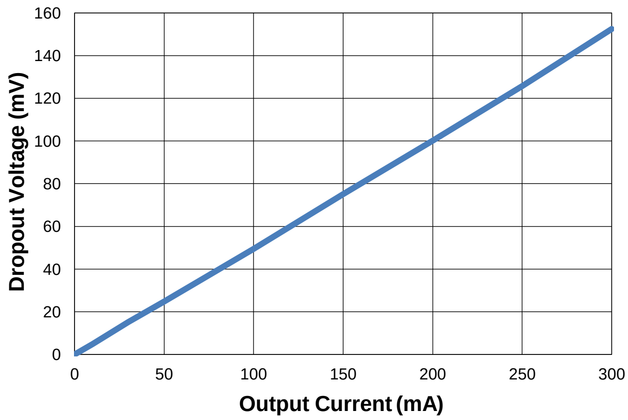


Figure 17. Dropout Voltage vs. Output Current

V_{IN}=3.8V, V_{OUT}=2.8V

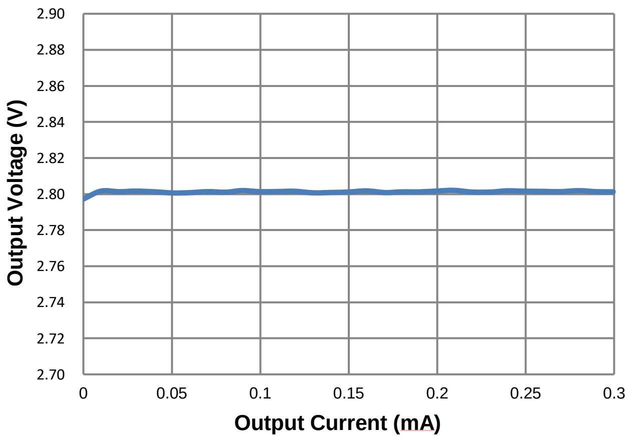


Figure 18. Output Voltage vs. Output Current

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

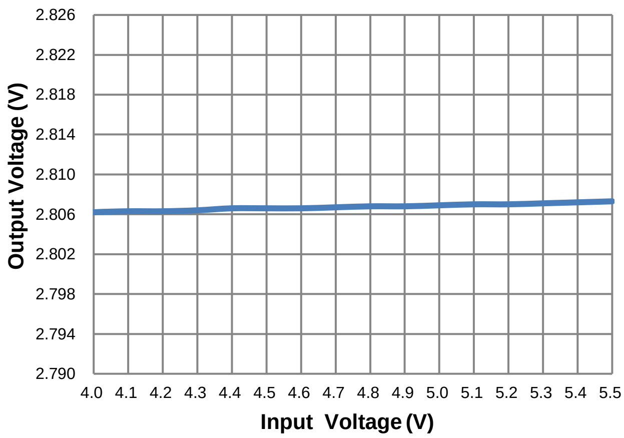


Figure 19. Output Voltage vs. Input Voltage

Typical Performance Curves (Continued)

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

V_{OUT}=2.8V

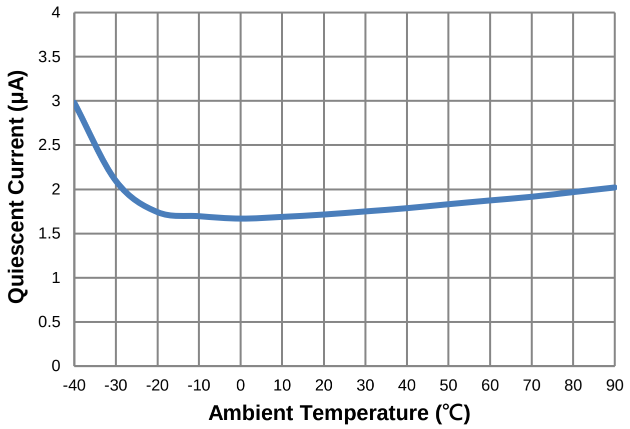


Figure 20. Quiescent Current vs. Ambient Temperature

V_{OUT}=2.8V

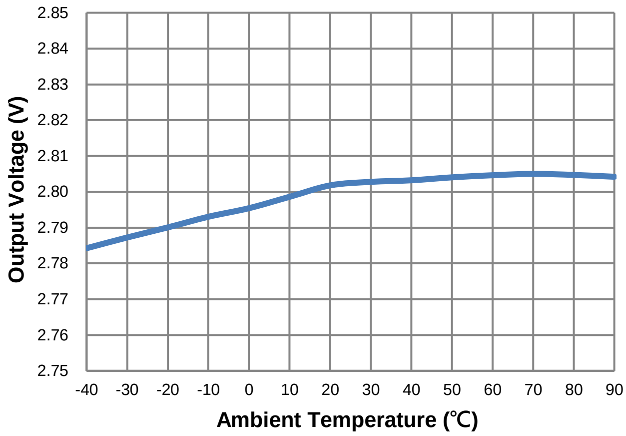


Figure 21. Output Voltage vs. Ambient Temperature

V_{OUT}=1.2V

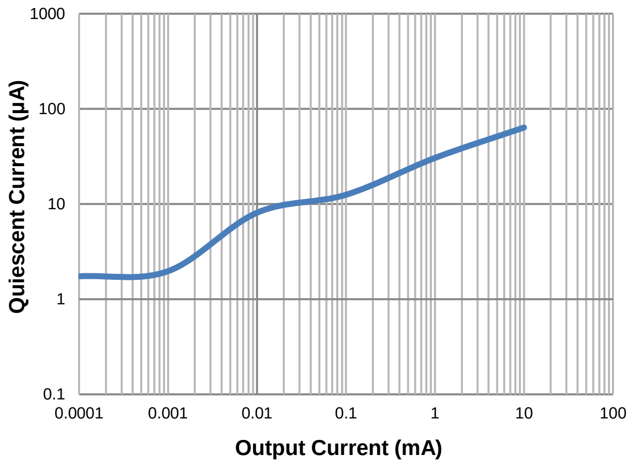


Figure 22. Quiescent Current vs. Output Current

V_{OUT}=2.5V

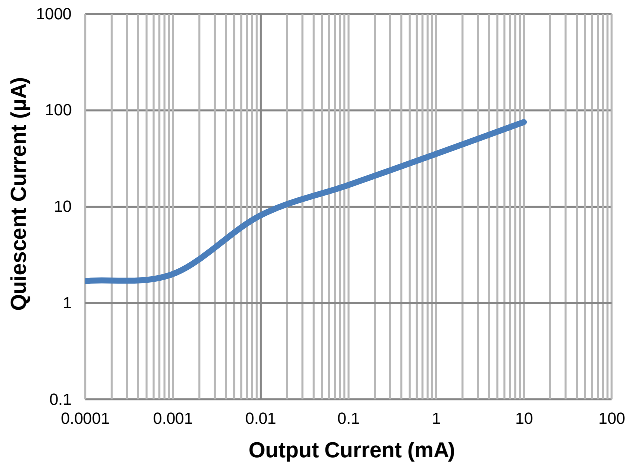


Figure 23. Quiescent Current vs. Output Current

V_{OUT}=1.2V

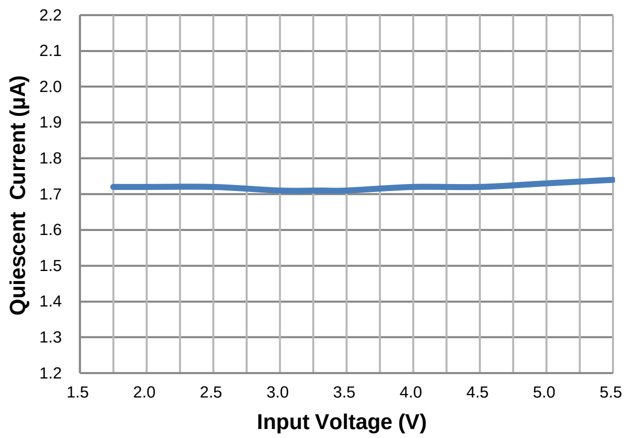


Figure 24. Quiescent Current vs. Input Voltage

V_{OUT}=2.5V

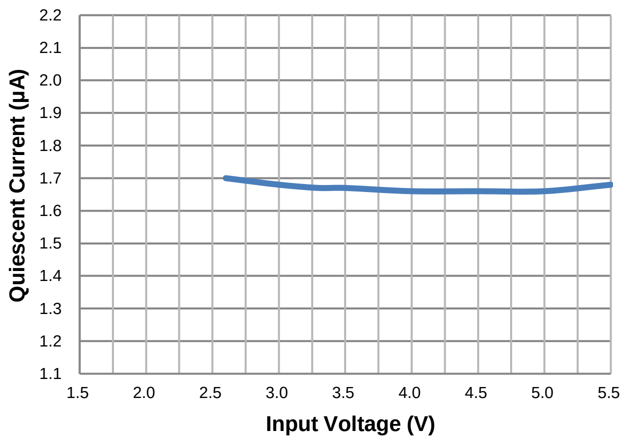


Figure 25. Quiescent Current vs. Input Voltage

Application Information

The FP6187 is a low dropout linear regulator that could provide 300mA output current at dropout voltage about 160mV (2.8V output voltage).

1. Output and Input Capacitor

The FP6187 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 1µF to 10µF X5R or X7R dielectric ceramic capacitors with 30mΩ to 50mΩ ESR range between device outputs and ground for stability. The FP6187 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.

2. Protection Features

In order to prevent overloading condition from damaging the device, FP6187 has current limiting function designed to protect the device.

3. Thermal Consideration

The power handling capability of the device will be limited by allowable operation junction temperature (125ºC). 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.

4. Shutdown Operation

The FP6187 is shutdown by pulling the EN input low, and turned on by driving the EN high. If EN pin floating, the FP6187 will shut down because EN pin has built-in a pull low resistor (refer to Block Diagram).

5. Output Discharge Function

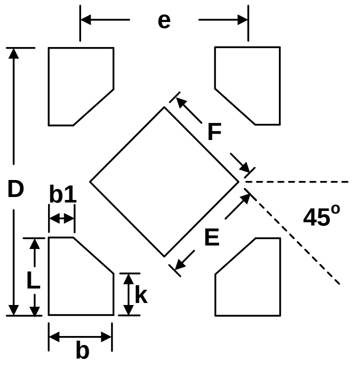
The FP6187 provides auto discharge function, an discharge MOSFET with $R_{DS(ON)}$ of 60Ω typical is integrated between VOUT and GND pins, which can discharge the charge of the output capacitors quickly when turning off FP6187 with EN pin.

6. 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.

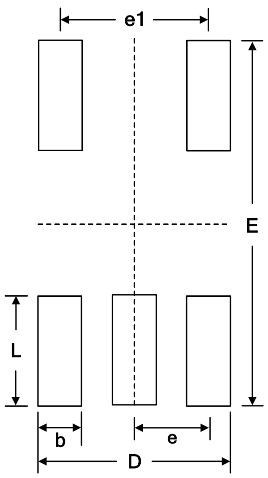
PCB Footprint

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



SYMBOLS UNIT	DIMENSION IN MILLIMETER
D	1.3
E	0.48
F	0.48
L	0.4
k	0.22
b	0.25
b1	0.12
e	0.65

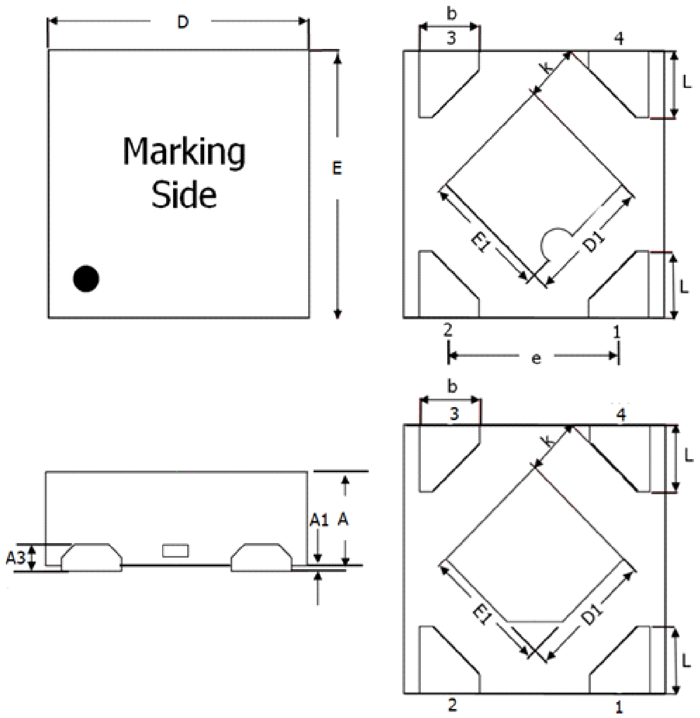
SOT-23-5L Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER
b	0.55
D	2.45
E	3.80
L	1.27
e	0.95
e1	1.90

Outline Information

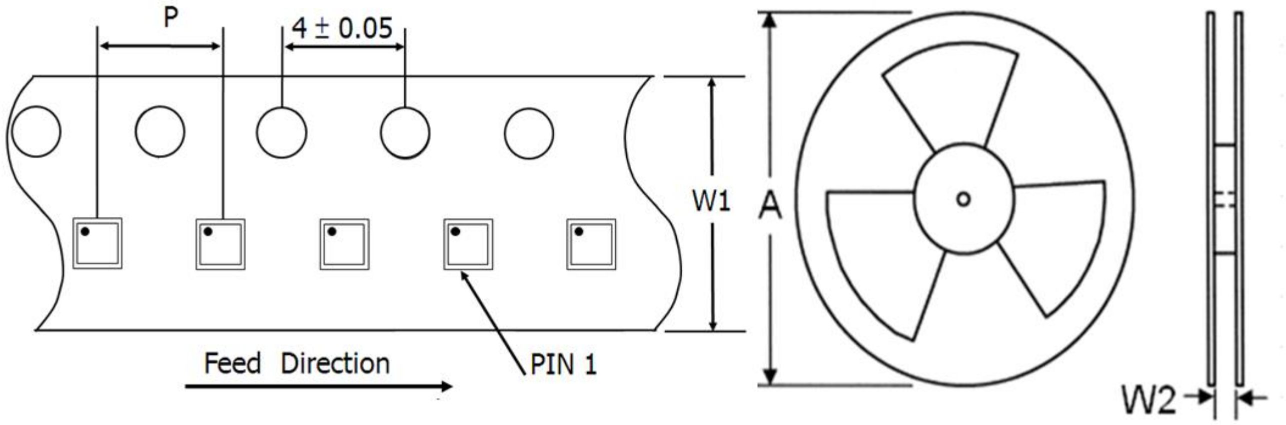
UTDFN-4L (1mmx1mm) (pitch 0.65 mm) Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.32	0.60
A1	0.00	0.05
A3	0.07	0.20
D	0.95	1.05
E	0.95	1.05
D1	0.38	0.58
E1	0.38	0.58
k	0.20 REF.	
b	0.18	0.30
e	0.60	0.70
L	0.20	0.30

Note 8: Followed From JEDEC 664-1.

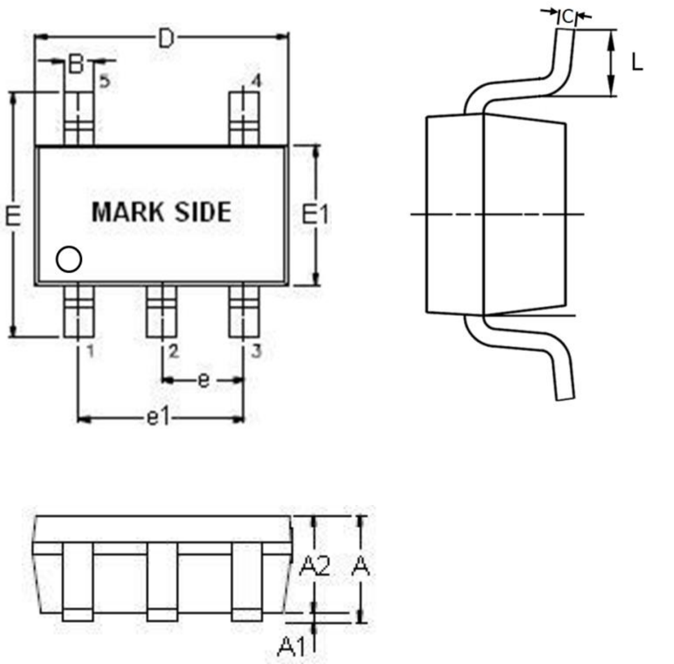
Carrier Dimensions



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)

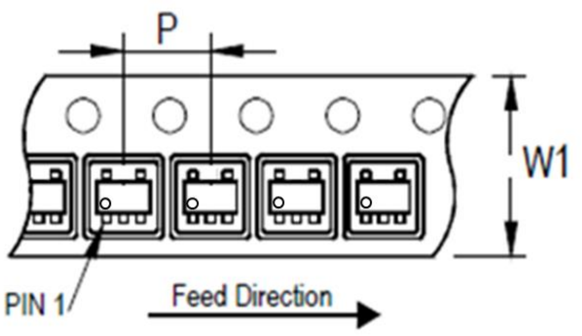
SOT-23-5L Package (Unit: mm)

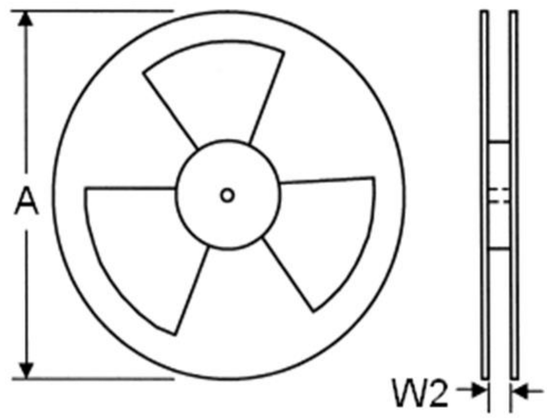


SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.90	1.30
A1	0.00	0.15
A2	0.90	1.15
B	0.28	0.50
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.90	1.00
e1	1.80	2.00
C	0.08	0.20
L	0.30	0.60

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.