300mA, Low Noise High PSRR LDO Regulator

Description

The FP6168 is a low dropout, low noise, high PSRR, low quiescent current positive linear regulator. The FP6168 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 FP6168 that consumes less than 0.1µA during shutdown mode.

The FP6168 regulator is able to operate with output capacitors as small as 1µF for stability. The FP6168 fault protection includes the current limit protection and short current protection.

The FP6168 offers high precision output voltage of ±1%. The FP6168 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: 1.9V 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 80dB at 1kHz
- Low Quiescent Current at 10µA
- Needs Only 1µF Capacitor for Stability
- Inrush current protection
- Thermal Shutdown Protection
- Current Limit Protection
- Short Current Protection
- Output Discharge Function
- UTDFN-4L (1mm×1mm) and SOT-23-5L Packages
- RoHS Compliant

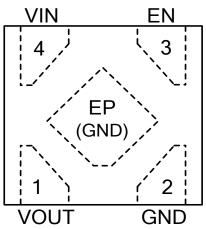
*1 Attention should be paid to the power dissipation of the package when the output current is large.

Applications

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

Pin Assignment

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



S5 Package: SOT-23-5L

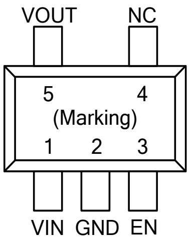


Figure1. Pin Assignment of FP6168

Ordering Information

FP6168-□□

Package Type
X7: 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
FP6168-10X7	**bL**
FP6168-1JX7	**bM**
FP6168-11X7	**bN**
FP6168-12X7	**bP**
FP6168-15X7	**bR**
FP6168-18X7	**bS**
FP6168-22X7	**bT**
FP6168-25X7	**bU**
FP6168-28X7	**dA**
FP6168-30X7	**dB**
FP6168-33X7	**dC**
FP6168-10S5	**CH7**
FP6168-1JS5	**CH8**
FP6168-11S5	**CH9**
FP6168-12S5	**CN0**
FP6168-15S5	**CN1**
FP6168-18S5	**CN2**
FP6168-22S5	**CN3**
FP6168-25S5	**CN4**
FP6168-28S5	**CN5**
FP6168-30S5	**CN6**
FP6168-33S5	**CN7**

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

Typical Application Circuit

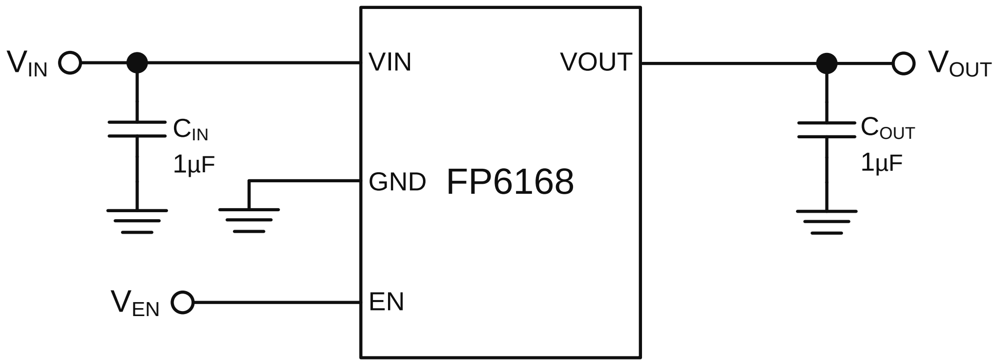


Figure 2. Typical Application Circuit of FP6168

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 current.
NC	**4**	**-**	NC.
VOUT	**5**	**1**	The FP6168 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

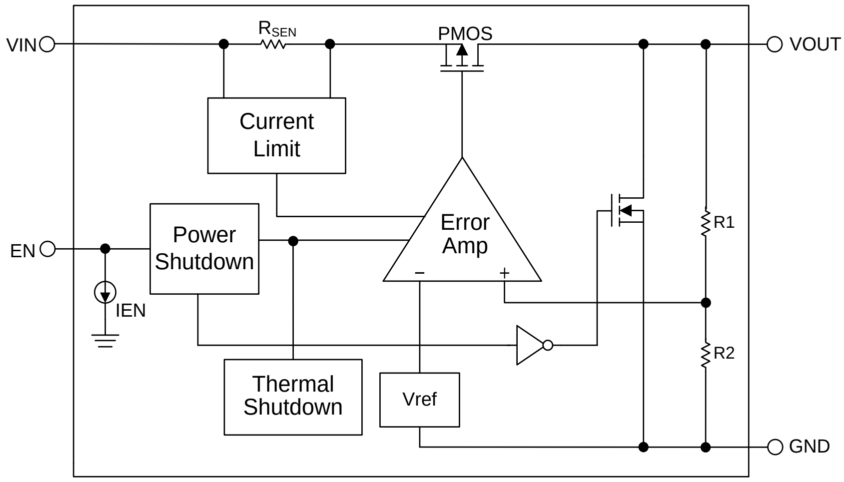


Figure 3. Block Diagram of FP6168

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}-- +1.9V to +5.5V
- Output Current I_{OUT}-- 0mA to 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.)

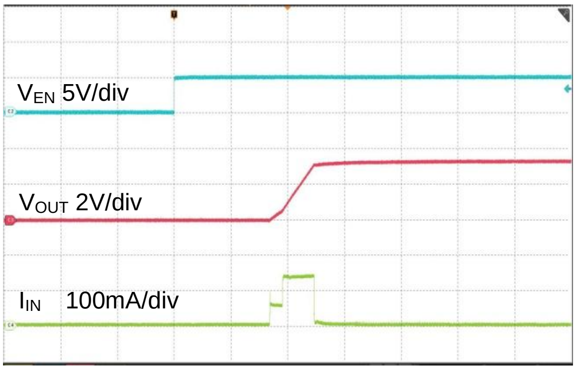
Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input Voltage Range	V_{IN}			1.9		5.5	V
Quiescent Current (Note 4)	I_Q	I_{OUT}=0A		6	10	25	µA
Standby Current	I_{STBY}	EN Pin Connected to GND			0.1	1	µA
Output Voltage Accuracy	ΔV_{OUT}	I_{OUT}=1mA		-1		+1	%
Dropout Voltage (Note 5)	V_{DROP}	I_{OUT}=300mA	V_{OUT}=1.0V	450	650	850	mV
			V_{OUT}=1.05V	410	590	770	
			V_{OUT}=1.1V	370	530	690	
			V_{OUT}=1.2V	310	440	570	
			V_{OUT}=1.5V	240	350	460	
			V_{OUT}=1.8V	160	230	300	
			V_{OUT}=2.2V	150	215	280	
			V_{OUT}=2.5V	130	180	230	
			V_{OUT}=2.8V	110	160	210	
			V_{OUT}=3.0V	100	150	200	
			V_{OUT}=3.3V	90	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}+0.2$V_{P-P(AC)}$, f_{RIPPLE}=1KHz,I_{OUT}=20mA			80		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
Inrush Current Limit (Note 7)	I_{RUSH}	V_{OUT}> V_{OUT}*15%,C_{OUT}=22uF			130		mA
Short Current Limit	I_{CFB}	R_{Load}=1Ω		48	60	72	mA
Output Discharge Resistance	R_{DIS}	V_{EN}=0V		35	60	90	Ω
EN Pin Current	I_{EN}	V_{EN}=2.5V		0.09	0.3	1.11	uA
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		ºC
Thermal Shutdown Threshold Hysteresis (Note 7)	ΔT_{SD}				30		ºC

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}=1µF, C_{OUT}=1µF, T_A=25ºC, unless otherwise specified.

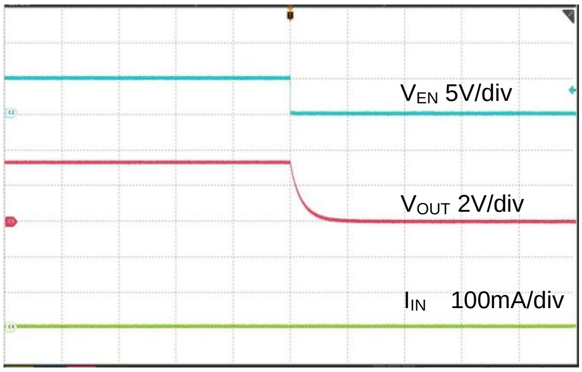
V_{OUT}=3.3V, I_{OUT}=0mA



40us/div

Figure 4. Turn ON Waveform

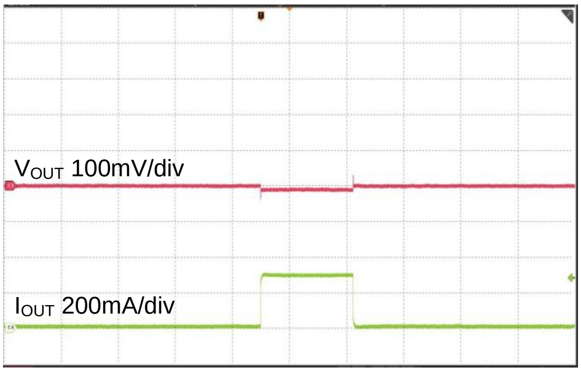
V_{OUT}=3.3V, I_{OUT}=0mA



400us/div

Figure 5. Turn OFF Waveform

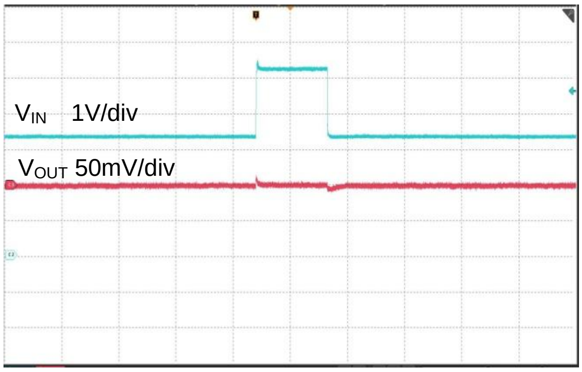
3.3V_{OUT}/ I_{OUT}=1mA→300mA→1mA



200u s/div

Figure 6. Load Transient Response

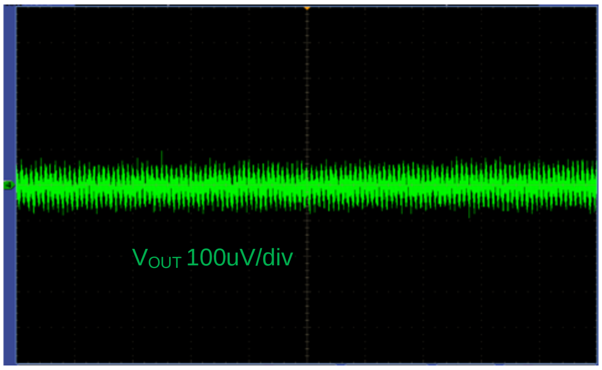
3.3V_{OUT}/V_{IN}=3.6V→5.5V→3.6V I_{OUT}=10mA, C_{IN}=none



400us/div

Figure 7. Line Transient Response

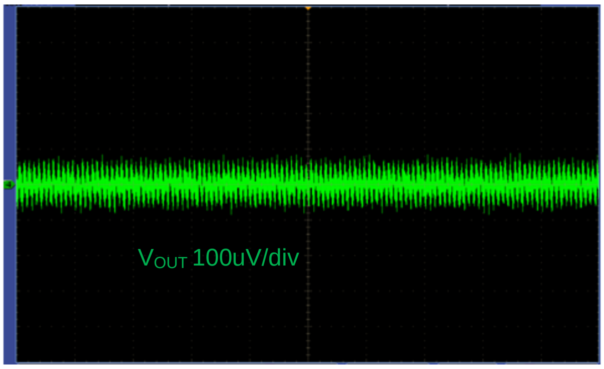
V_{IN}= Li-ion Battery 3.0V, V_{OUT}=1.2V, I_{OUT}=1mA



200ms/div

Figure 8. Output Noise Voltage

V_{IN}= Li-ion Battery 3.8V, V_{OUT}=2.8V, I_{OUT}=1mA



200ms/div

Figure 9. Output Noise 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.

$V_{OUT}=1.2V$, $I_{OUT}=20mA$

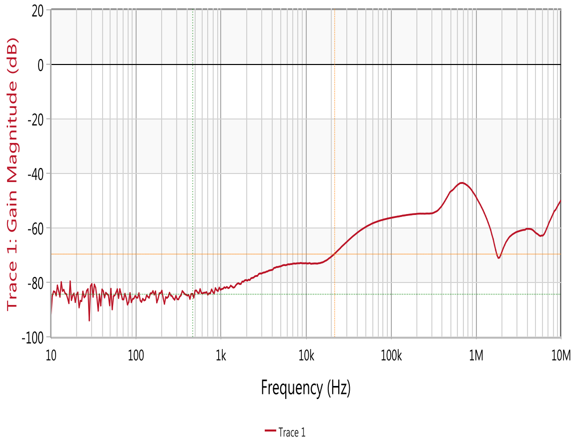


Figure 10. PSRR vs. Frequency

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

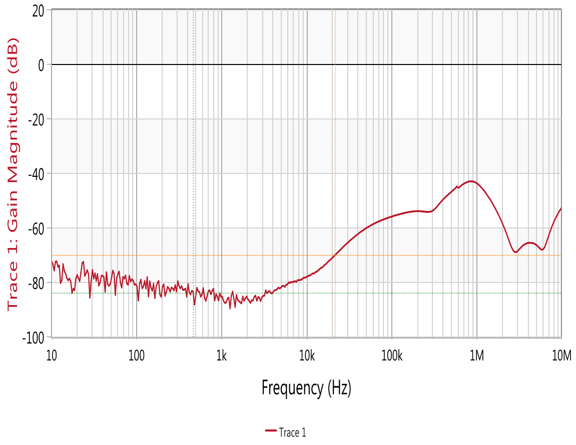


Figure 11. PSRR vs. Frequency

$V_{OUT}=3.3V$, $I_{OUT}=20mA$

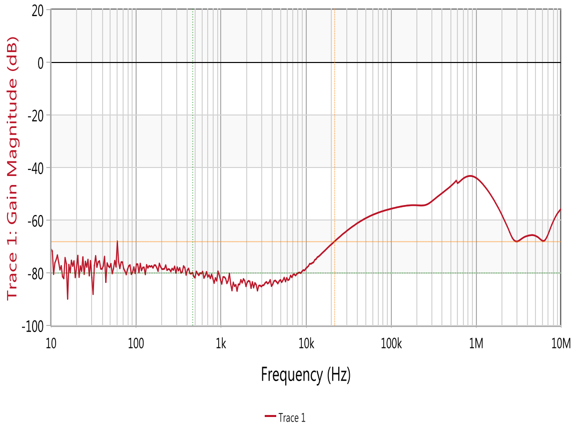


Figure 12. PSRR vs. Frequency

$V_{OUT}=1.2V$, $I_{OUT}=0mA$

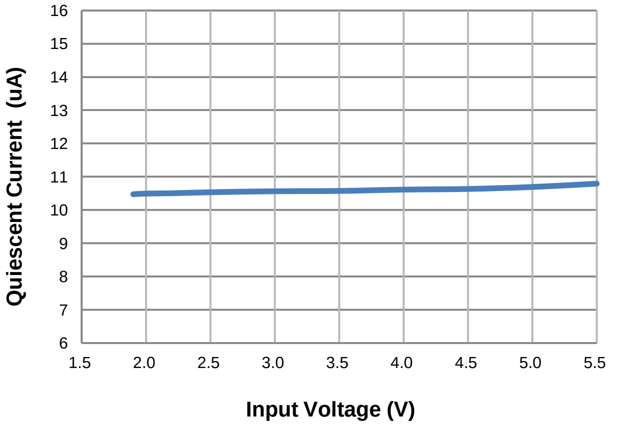


Figure 13. Quiescent Current vs. Input Voltage

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

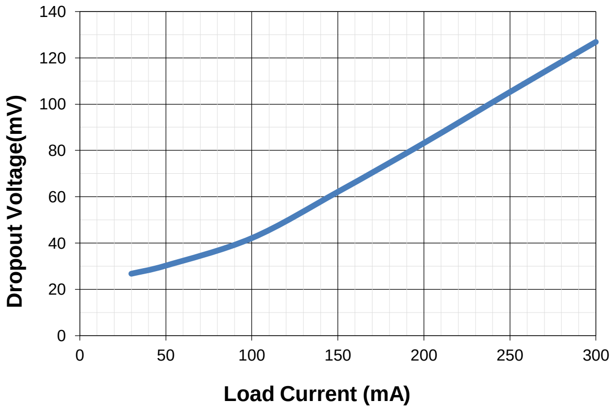


Figure 14. Dropout Voltage vs. Output Current

$V_{IN}=4.3V$, $V_{OUT}=3.3V$

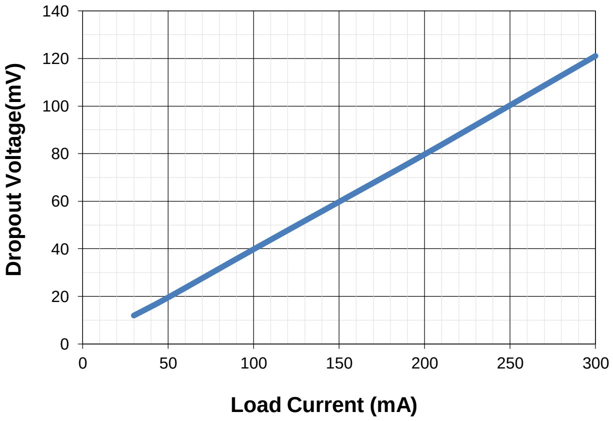


Figure 15. Dropout Voltage vs. Output Current

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_{IN}=2.2V, V_{OUT}=1.2V

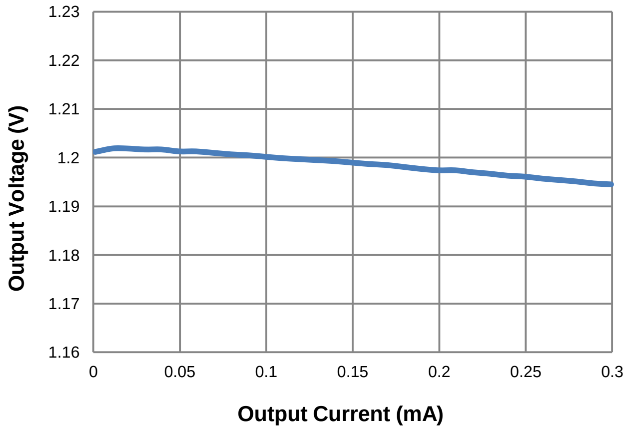


Figure 16. Output Voltage vs. Output Current

V_{IN}=4.3V, V_{OUT}=3.3V

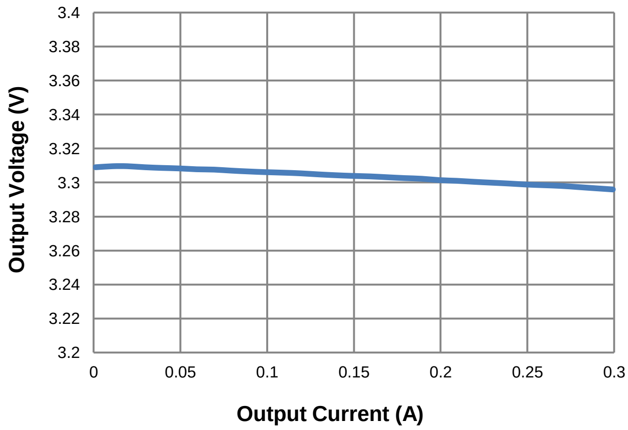


Figure 17. Output Voltage vs. Output Current

V_{OUT}=1.2V, I_{OUT}=1mA

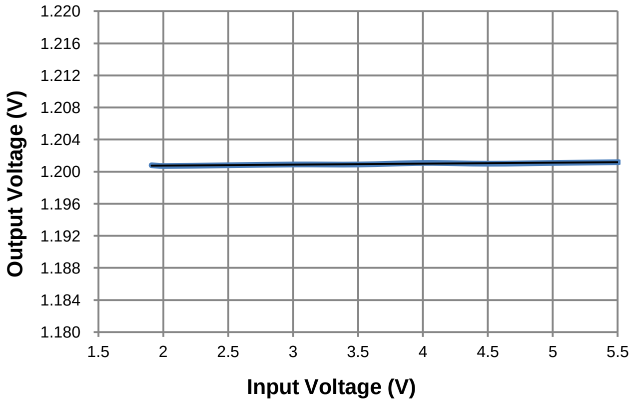


Figure 18. Output Voltage vs. Input Voltage

V_{OUT}=3.3V, I_{OUT}=1mA

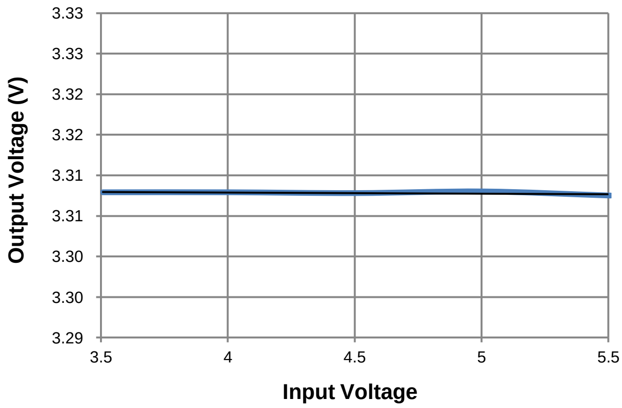


Figure 19. Output Voltage vs. Input Voltage

V_{OUT}=1.2V

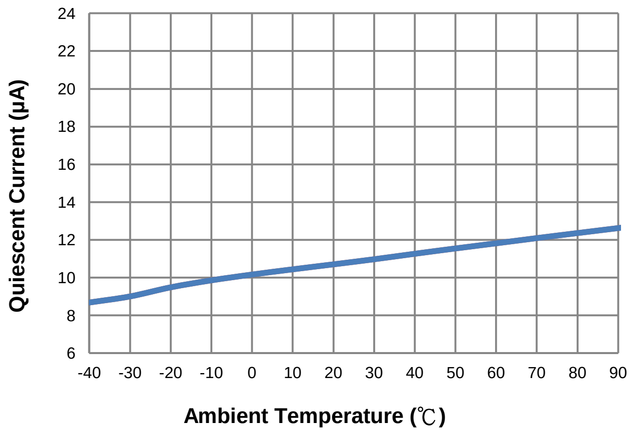


Figure 20. Quiescent Current vs. Ambient Temperature

V_{OUT}=1.2V

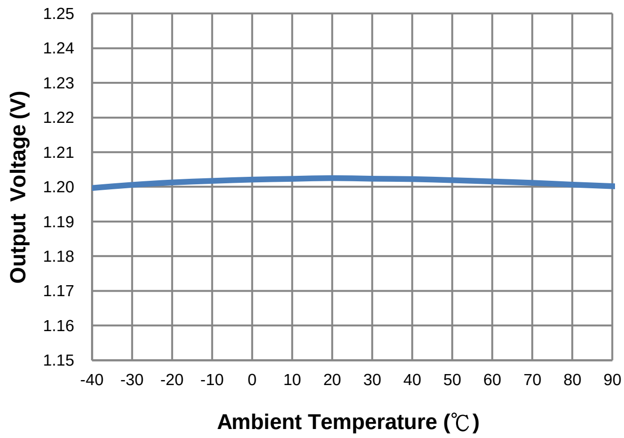


Figure 21. Output Voltage vs. Ambient Temperature

Application Information

The FP6168 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 FP6168 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 22μF X5R or X7R dielectric ceramic capacitors with 30mΩ to 50mΩ ESR range between device outputs and ground for stability. The FP6168 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. Inrush Current Protection

The inrush current limit value at start-up increases in proportion to the capacitance of C_{OUT}. When the FP6168 is power on, the inrush current is limited to 60mA until output voltage is exceeds 15% of V_{OUT} voltage. Then the inrush current limit is increased to about 130mA.

If the capacitance value of C_{OUT} is too large, the start-up time becomes longer , the inrush current increases, after that, all what limits the inrush current is the current limit protection value of the FP6168.Finally, output voltage reaches default value, and the output current decreases down to the value of continuous current required by the output load.

3. Protection Features

In order to prevent overloading condition from damaging the device, FP6168 has current limiting function designed to protect the device.

4. 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.

5. Shutdown Operation

The FP6168 is shutdown by pulling the EN input low, and turned on by driving the EN high. If EN pin floating, the FP6168 will shut down because EN pin has built-in a pull low current (refer to Block Diagram).

6. Output Discharge Function

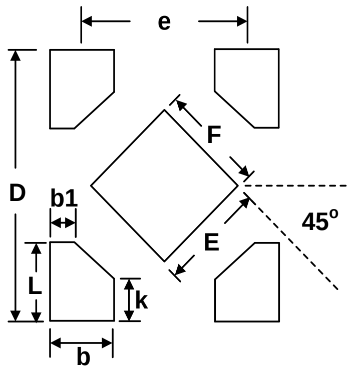
The FP6168 provides auto discharge function, an discharge MOSFET with $R_{DS(ON)}$ of 60Ω typical is integrated between V_{OUT} and GND pins, which can discharge the charge of the output capacitors quickly when turning off FP6168 with EN pin.

7. 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.

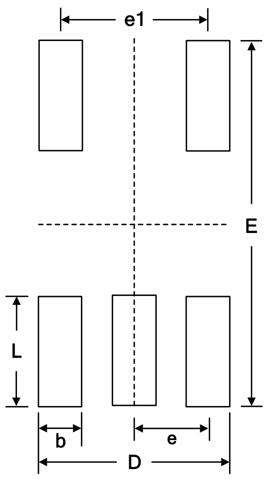
PCB Footprint

UTDFN-4L (1mm×1mm) 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

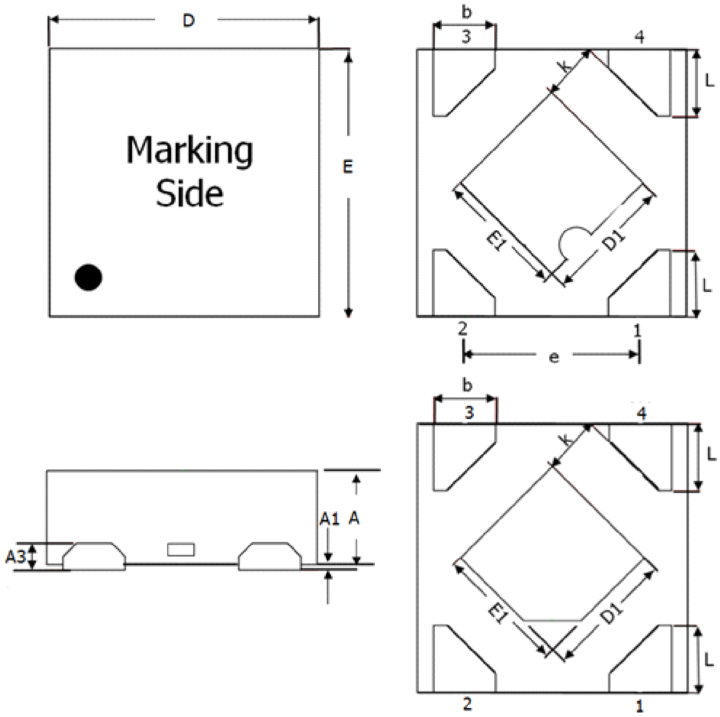
SOT-23-5L Package (Unit: mm)



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

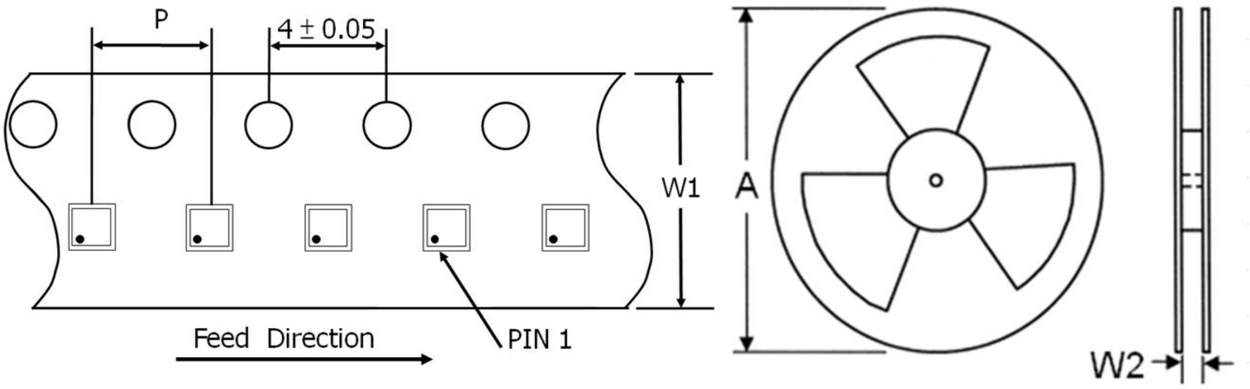
UTDFN-4L (1mmx1mm) (pitch 0.65mm) Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.32	0.45
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	0.20REF.	
b	0.18	0.30
e	0.60	0.70
L	0.20	0.30

Note 8: Followed From JEDEC 664-1.

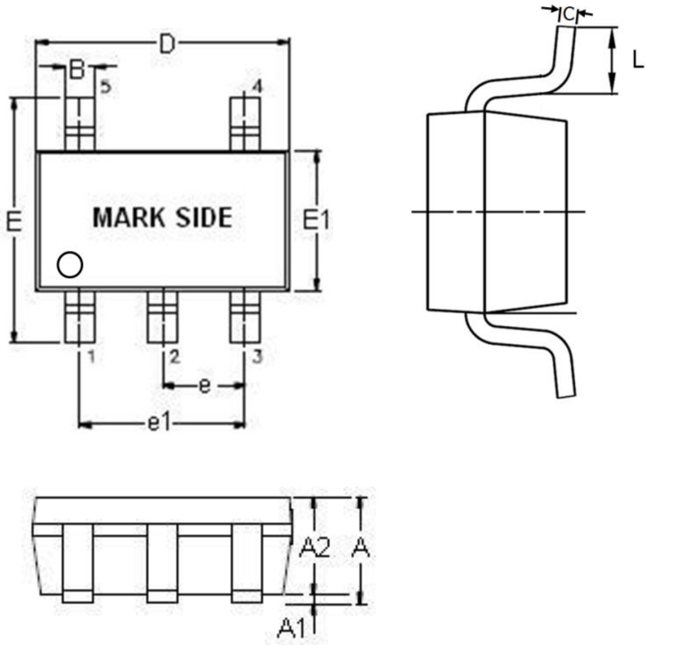
Carrier Dimensions



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)

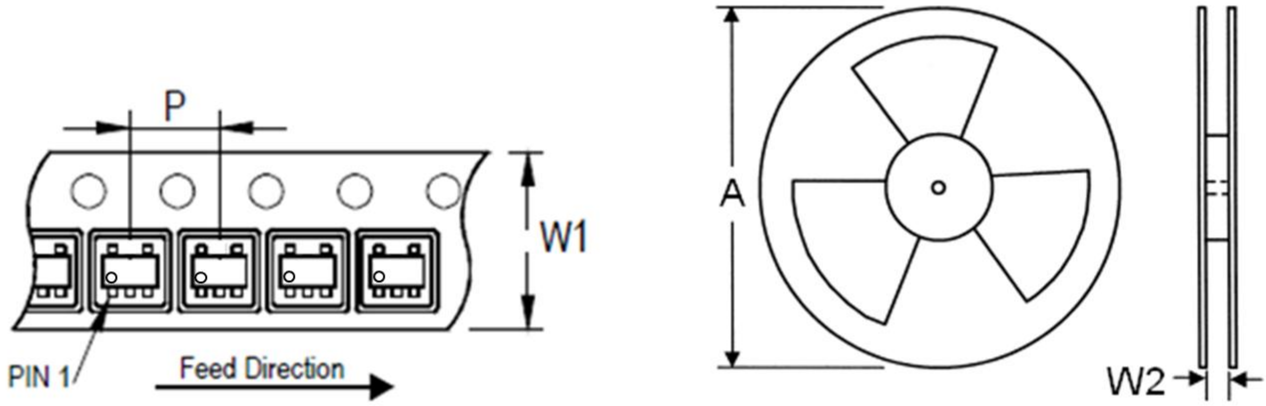


SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.90	1.30
A1	0.00	0.15
A2	0.90	1.15
B	0.28	0.50
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.90	1.00
e1	1.80	2.00
C	0.08	0.20
L	0.30	0.60

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.