600mA Low Noise LDO with Adjustable Output Function

Description

The FP6186A is a family of CMOS low dropout (LDO) regulators with a low dropout voltage of 400mV at 600mA designed for noise-sensitive portable device, RF and wireless applications. Quiescent current of FP6186A is as low as 60μA and it works with low-ESR ceramic capacitors, which makes it very suitable for space sensitive handheld applications. The soft-start function will eliminate current surges during start-up and the output discharge function will dissipate the residue output voltage in the capacitor during shut-down.

Other features include current limit, thermal protection, high output accuracy, and low noise output etc..

The FP6186A is available in a SOT-23-5 package.

Features

- Low VIN and Wide VIN Range: 1.7V to 5.5V
- Adjustable Output Voltage Range is from 0.8V to 5V, VOUT Accuracy ±1.25%
- 600mA Output Current
- Ripple Rejection 75dB at 1kHz
- Low Output Noise, 50μVrms from 10Hz to 100kHz
- Quiescent Current as Low as 60μA
- Current Limit Protection
- Thermal Shutdown Protection
- 1μF Output Capacitor Required for Stability
- RoHS Compliant

Applications

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

Pin Assignments

S5 Package: SOT-23-5

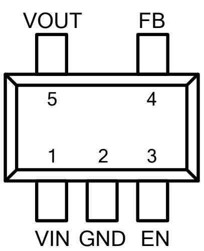


Figure 1. Pin Assignments of FP6186A

Ordering Information

FP6186A□

Package Type
S5: SOT-23-5

SOT-23-5 Marking

Part Number	Product Code
FP6186AS5	**GA8**

Typical Application Circuit

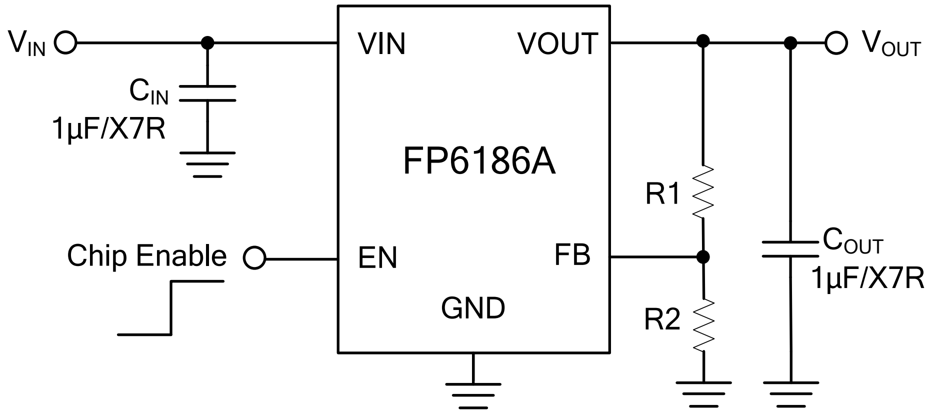


Figure 2. Typical Application Circuit for FP6186A Adjustable Voltage

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.	Pin Function
VIN	**1**	Supply voltage.
GND	**2**	Ground.
EN	**3**	Chip enable control input. Pull the pin high to enable IC, and pull low or keep it floating to disable the device.
FB	**4**	Feedback voltage pin.
VOUT	**5**	LDO output.

Block Diagram

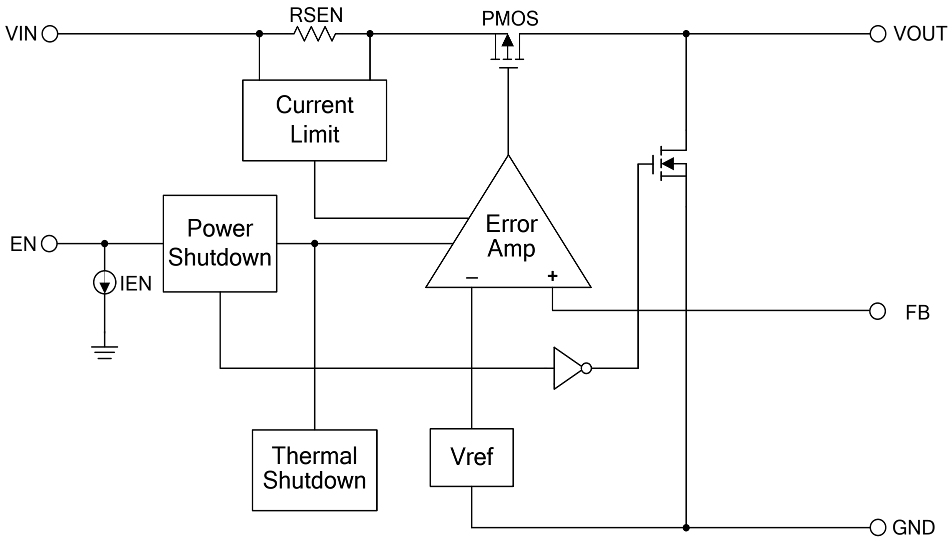


Figure 3. Block Diagram of FP6186A

Absolute Maximum Ratings (Note 2)

- VIN, EN, FB to GND -- -0.3V to +6V
- VOUT Voltage -- -0.3V to VIN+0.3V
- Power Dissipation @25°C, (P_D) --- 0.4W
- Package Thermal Resistance, (θ_{JA}) --- 250°C/W
- Package Thermal Resistance, (θ_{JC}) --- 130°C/W
- Junction Temperature --- -40°C to +150°C
- Storage Temperature Range (T_{STG}) --- -65°C to +150°C
- Lead Temperature (Soldering, 10sec) --- +260°C

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

Recommended Operating Conditions

- Supply Voltage (V_{IN}) -- +1.7V to +5.5V
- Output Current (I_{OUT}) --- 600mA
- Operating Temperature Range -- -40°C to +85°C

Electrical Characteristics

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input Voltage Range	V_{IN}		1.7		5.5	V
Output Voltage Accuracy	ΔV_{OUT}	I_{OUT} = 10mA	-1.25		+1.25	%
Quiescent Current	I_Q	V_{EN}=5V, I_{OUT}=0A		60		µA
Standby Current	I_{STBY}	V_{EN}=0V		0.1	1	µA
Feedback Reference	V_{FB}	I_{OUT} = 10mA	0.79	0.8	0.81	V
Current Limit	I_{LIM}	R_{LOAD}=0Ω, 2.2V≦VIN≦5.5V	0.8			A
Dropout Voltage (Note 3)	V_{DROP}	I_{OUT}=600mA, V_{OUT} =0.9V		1000	1100	mV
		V_{OUT} =1.2V		900	1000	
		V_{OUT} =1.5V		800	900	
		V_{OUT} =1.8V		580	760	
		V_{OUT} =2.5V		520	680	
		V_{OUT} =2.7V		480	620	
		V_{OUT} =3.0V		440	580	
		V_{OUT} =3.3V		400	520	
Line Regulation	ΔV_{LINE}	I_{OUT}=1mA, V_{IN}=V_{OUT} +1V to 5V		1	8	mV
Load Regulation (Note 4)	ΔV_{LOAD}	I_{OUT} =0 ~ 600mA		6	30	mV
EN Threshold	$V_{EN(ON)}$	Start-up	1			V
	$V_{EN(OFF)}$	Shutdown			0.4	
Enable Pin Current	I_{EN}			0.3		µA
Output Noise Voltage (Note 5)	V_{ON}	C_{OUT}=1µF, I_{OUT}=0A		50		μV_{RMS}
Output Discharge Resistance	R_{DIS}	V_{EN}=0V		60		Ω
Ripple Rejection (Note 5)	PSRR	V_{IN}=V_{OUT}+1V_{DC}+0.2$V_{P-P(AC)}$, f_{RIPPLE}=1KHz,V_{OUT}=1.2V, I_{OUT}=30mA		75		dB

Electrical Characteristics (Continued)

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Thermal Shutdown Threshold (Note 5)	T_{SD}			145		°C
	ΔT_{SD}	Hysteresis		25		

Note 3: 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.

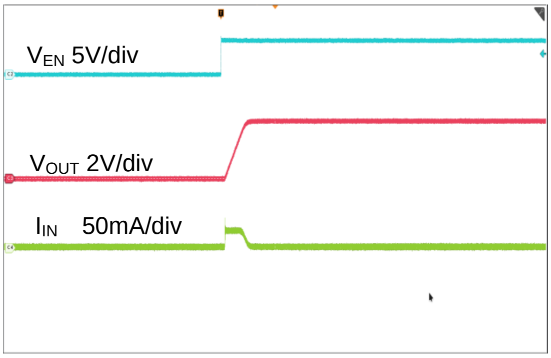
Note 4: Load regulation and dropout voltage are measured at a constant junction temperature by using a 40ms low duty cycle current pulse.

Note 5: Guarantee by design.

Typical Performance Curves

$V_{IN}=V_{OUT}+1$, EN Pin connected to V_{IN}, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, TA=+25°C, unless otherwise specified.

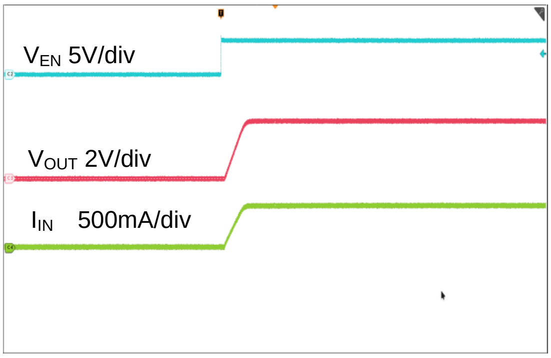
$V_{IN}=4.3V$, $V_{OUT}=3.3V$, $I_{OUT}=0mA$



400us/div

Figure 4. Turn ON Waveform

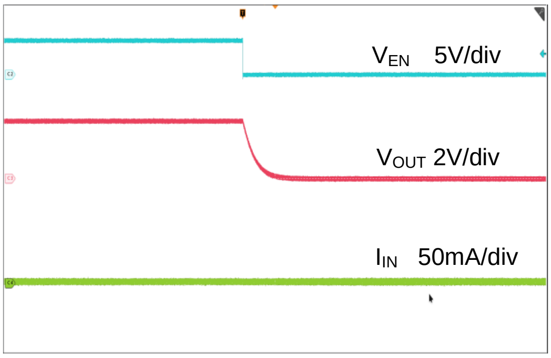
$V_{IN}=4.3V$, $V_{OUT}=3.3V$, $I_{OUT}=600mA$



400us/div

Figure 5. Turn ON Waveform

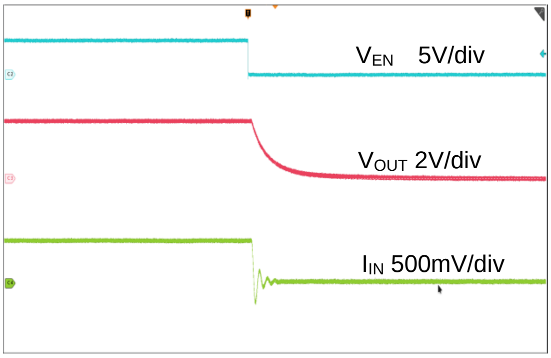
$V_{IN}=4.3V$, $V_{OUT}=3.3V$, $I_{OUT}=0mA$



400us/div

Figure 6. Turn OFF Waveform

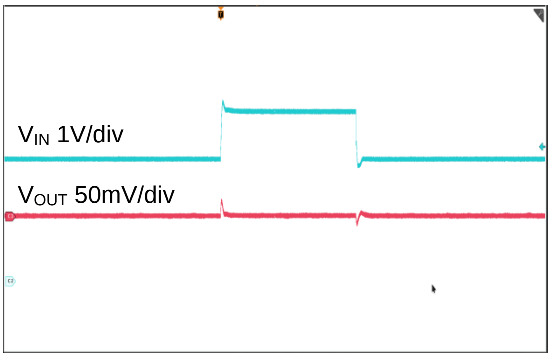
$V_{IN}=4.3V$, $V_{OUT}=3.3V$, $I_{OUT}=600mA$



20us/div

Figure 7. Turn OFF Waveform

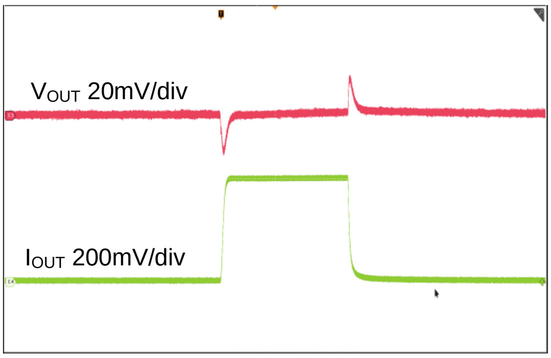
$V_{IN}=3.5V \rightarrow 5.0V \rightarrow 3.5V$, $V_{OUT}=3.3V/10mA$, C_{IN}=none



100us /div

Figure 8. Line Transient Response

$V_{IN}=4.3V$, $V_{OUT}=3.3V$, $I_{OUT}=0mA \rightarrow 600mA \rightarrow 0mA$



200us /div

Figure 9. Load Transient Response

Typical Performance Curves (Continued)

V_{IN}=V_{OUT}+1, EN Pin connected to V_{IN}, C_{IN}=1μF, C_{OUT}=1μF, TA=+25°C, unless otherwise specified.

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

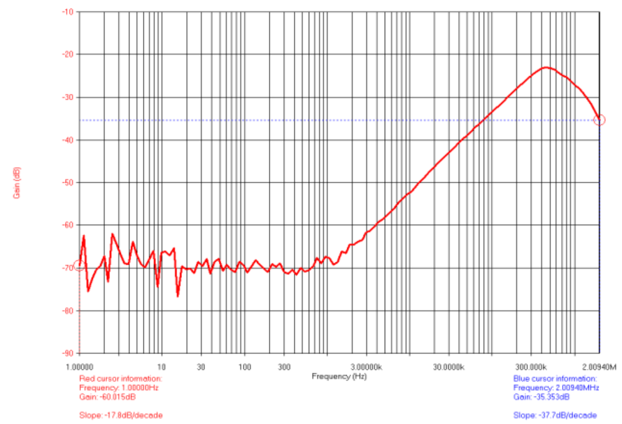


Figure 10. PSRR vs. Frequency

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

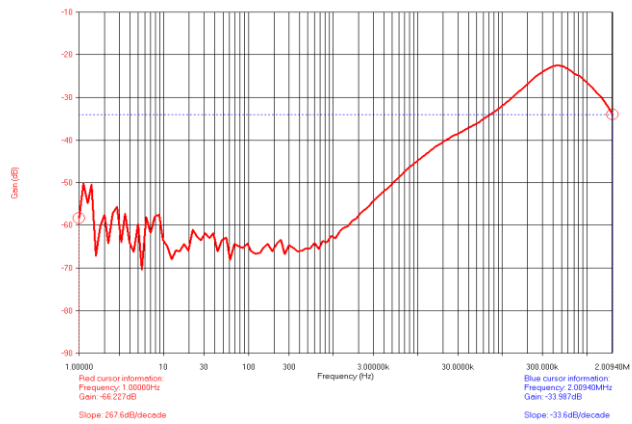


Figure 11. PSRR vs. Frequency

V_{IN}=4.3V, V_{OUT}=3.3V, I_{OUT}=600mA

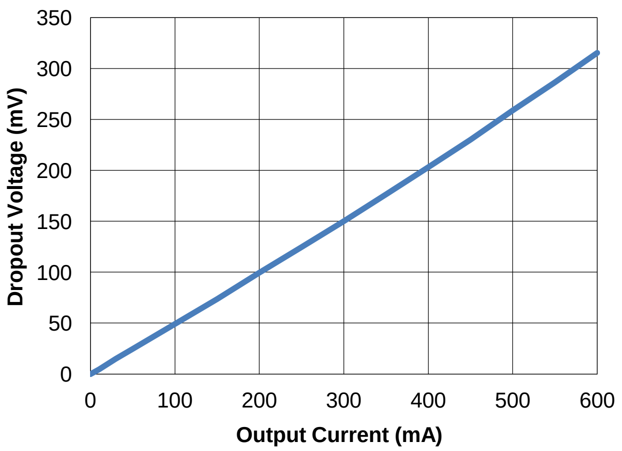


Figure 12. Dropout Voltage vs. Output Current

V_{IN}=4.3V, V_{OUT}=3.3V, I_{OUT}=600mA

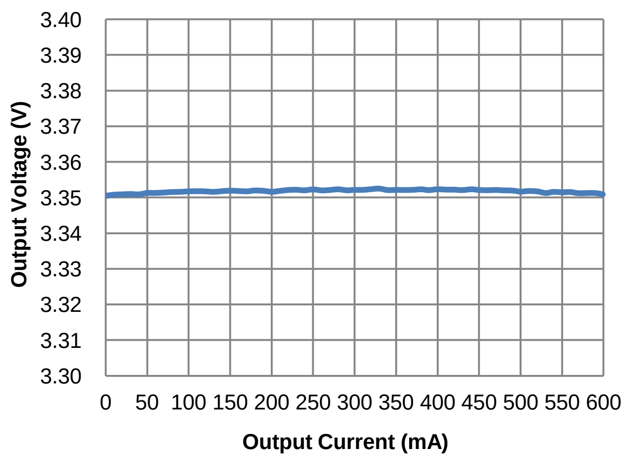


Figure 13. Output Voltage vs. Output Current

V_{IN}=4.3V, V_{OUT}=3.3V, I_{OUT}=0A

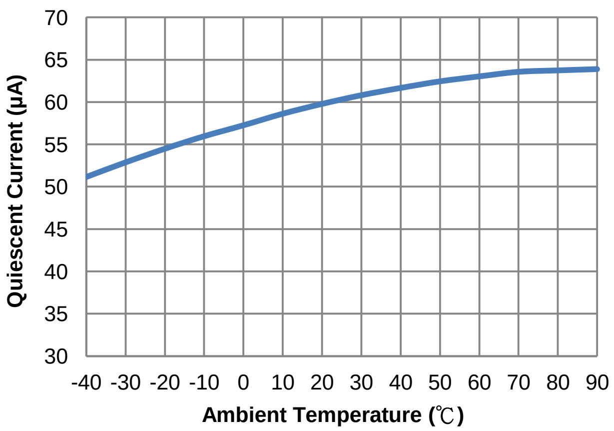


Figure 14. Quiescent Current vs. Ambient Temperature

V_{IN}=3.0V, V_{OUT}=VFB, I_{OUT}=1mA

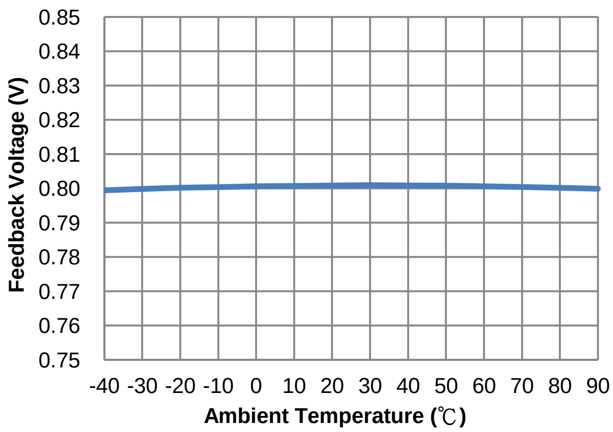


Figure 15. Feedback Voltage vs. Ambient Temperature

Applications Information

The FP6186A is a low-noise, low-dropout, low-quiescent current linear regulator designed for space-restricted applications. These devices can supply loads up to 600mA. As shown in the block diagram, the FP6186A consists of a highly accurate band gap core, noise bypass circuit, error amplifier, P-channel pass transistor, soft start, fast discharge and an internal feedback voltage divider. The band gap reference is connected to the error amplifier's inverting input. The error amplifier compares this reference with the feedback voltage and amplifies the difference. If the feedback voltage is lower than the reference voltage, the pass transistor gate will be pulled low. This allows more current to pass to the output and increases the output voltage. If the feedback voltage is too high, the pass transistor gate will be pulled high, allowing less current to pass to the output. The output voltage is feedback through an internal resistor voltage divider connected to the VOUT pin. Additional blocks include a current limit, over temperature protection and shutdown logic. Besides, current limit and on chip thermal shutdown features provide protection against any combination of over-load or ambient temperature that could cause junction temperature exceeding maximum rating.

Output and Input Capacitor

The FP6186A 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 transition response for larger current changes.

The capacitor types (aluminum, ceramic and tantalum) have different characterizations, such as temperature and voltage coefficients. All ceramic capacitors were 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 1.0µF to 4.7µF X5R or X7R dielectric ceramic capacitors with 10mΩ to 30mΩ ESR range between device outputs to ground for transient stability. The FP6186A 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 is no requirement for the ESR on the input capacitor, but its voltage and temperature coefficient have to be considered for device application environment.

Current Limit

The FP6186A includes a current limit. It monitors the output current and controls the pass transistor's gate voltage to limit the output current under 800mA. The output can be shorted to ground for an indefinite amount of time without damaging the part.

Quick Discharge

The FP6186A has built-in a quick discharge circuitry to protect system function correct operation. This discharge block discharges output capacitor quickly to avoid low output voltage level to affect system's MCU abnormal work when IC is power off or enable pin pulls down.

Dropout Voltage

The minimum dropout voltage of LDO determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. Because the FP6186A uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on resistance (R_{DS-ON}) multiplied by the load current.

Over Temperature Protection

Over temperature protection limits total power dissipation in the FP6186A. When the junction temperature exceeds 145°C, the thermal sensor will signal the shutdown logic and turn off the pass transistor. The thermal sensor will turn the pass transistor on again after the IC's junction temperature drops 25°C, resulting in a pulsed output during continuous thermal-overload conditions.

Thermal Consideration

The power handling capability of the device will be limited by maximum 125°C operation junction temperature. 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.

Applications Information (Continued)

Output Voltage Setting

The output voltage of regulator is determined by connecting external resistor dividers. The external resistor divider connects with FB pin. The output voltage is determined by the following equation:

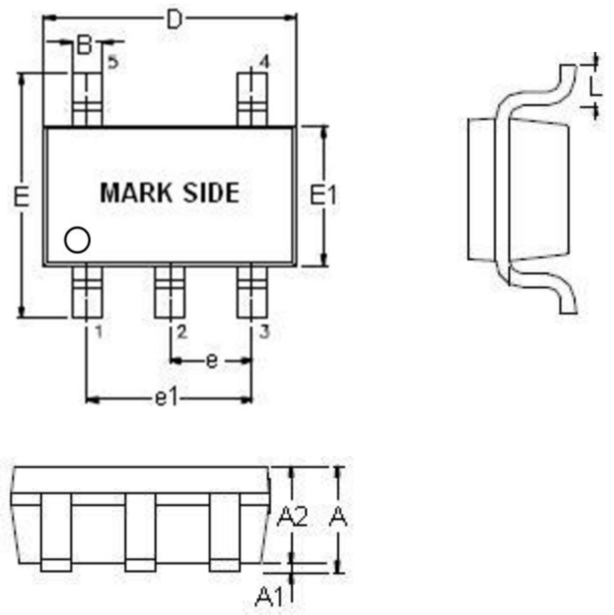
$$V_{OUT}=\frac{R1+R2}{R2}\times V_{FB}=\left(1+\frac{R1}{R2}\right)\times 0.8$$

Active/Shutdown Input Operation

The FP6186A is turned off by pulling the EN pin low and turned on by pulling it high. The enable input is TTL/CMOS compatible threshold for simple logic interfacing. If this feature is not used, the EN pin should be connected to VIN to keep the regulator output operating normally. It will become shutdown with this pin floating because EN pin has built-in a pull down resistor (refer to Block Diagram).

Outline Information

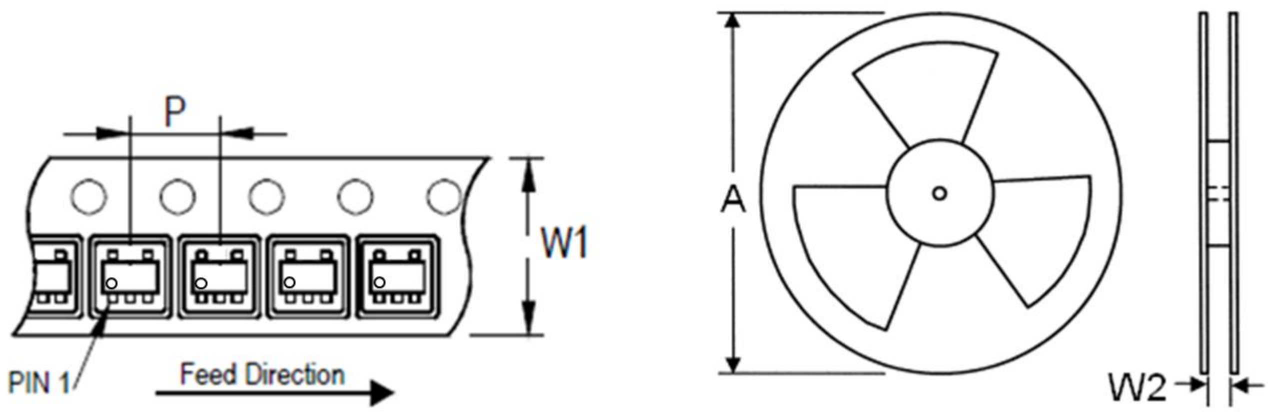
SOT-23-5 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
B	0.30	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
L	0.30	0.60

Note: 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