

## 300mA Low Noise High PSRR LDO with Shutdown

### Description

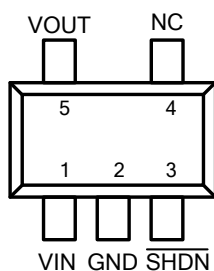
The FP6146 is a low dropout, low noise, high PSRR, very low quiescent current positive linear regulator. The FP6146 can supply 200mA output current with low dropout voltage at about 300mV that optimized for battery-powered systems or portable wireless devices such as mobile phones. The shutdown function can provide remote control for the external signal to decide the on/off state of FP6146 that consumes less than 0.1 $\mu$ A during shutdown mode.

The FP6146 regulator is able to operate with output capacitors as small as 1 $\mu$ F for stability. Other than the current limit protection, FP6146 also offers the on chip thermal shutdown feature providing protection against overload or any condition when the ambient temperature exceeds the maximum junction temperature.

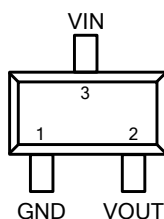
The FP6146 offers high precision output voltage of  $\pm 2\%$ . It is housed in low-profile, space-saving SOT-23-3, SOT-23-5, TSOT-23-5, TDFN-6 (1.6mm $\times$ 1.6mm), SC-82-4 and SC-70-5 packages.

### Pin Assignments

#### S5 Package (SOT-23-5)



#### S3 Package (SOT-23-3)



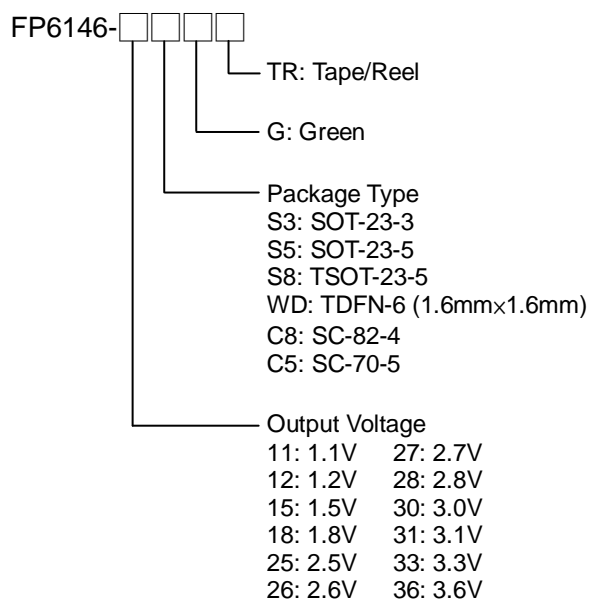
### Features

- Low Dropout Voltage of 300mV at 200mA
- Low 30 $\mu$ Vrms Output Noise
- Guaranteed 300mA Output Current
- High Power Supply Rejection Ratio of 70dB at 10kHz
- Very Low Quiescent Current at 35 $\mu$ A
- Max.  $\pm 2\%$  Output Voltage Accuracy
- Needs Only 1 $\mu$ F Capacitor for Stability
- Fast Response in Line/Load Transient
- Thermal Shutdown Protection
- Current Limit Protection
- Low-ESR Ceramic Capacitor for Output Stability
- Miniature Packages:  
SOT-23-3, SOT-23-5, TSOT-23-5, TDFN-6 (1.6mm $\times$ 1.6mm), SC-82-4 and SC-70-5
- RoHS Compliant

### Applications

- Mobile Phones
- Notebook, Sub-Notebook and Tablet Computers
- DSC
- Portable Information Appliances
- Battery Power Systems

### Ordering Information



Note 1: Please consult Fitipower sales office or authorized distributors for availability of special output voltages.

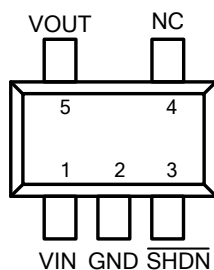
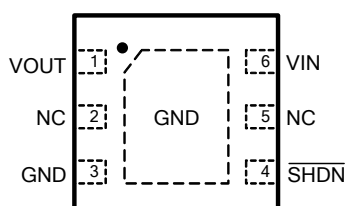
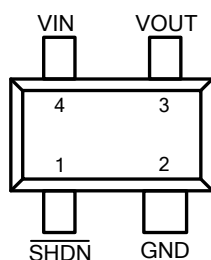
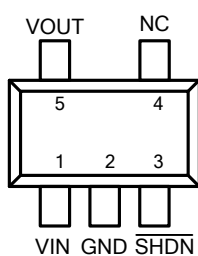
**S8 Package (TSOT-23-5)**

**WD Package TDFN-6 (1.6mm×1.6mm)**

**C8 Package (SC-82-4)**

**C5 Package (SC-70-5)**


Figure 1. Pin Assignment of FP6146

**SOT-23-3 Marking**

Part Number	Product Code	Part Number	Product Code
FP6146-12S3G	FB8		

**SOT-23-5 Marking**

Part Number	Product Code	Part Number	Product Code
FP6146-11S5G	FH9	FP6146-27S5G	B6G
FP6146-12S5G	H2=	FP6146-28S5G	H6=
FP6146-15S5G	H3=	FP6146-30S5G	H7=
FP6146-18S5G	H4=	FP6146-31S5G	t3G
FP6146-25S5G	H5=	FP6146-33S5G	H8=
FP6146-26S5G	r5=	FP6146-36S5G	a2G

**TSOT-23-5 Marking**

Part Number	Product Code	Part Number	Product Code
FP6146-12S8G	H9=	FP6146-28S8G	K3=
FP6146-15S8G	H0=	FP6146-30S8G	K4=
FP6146-18S8G	K1=	FP6146-31S8G	t4G
FP6146-25S8G	K2=	FP6146-33S8G	K5=
FP6146-26S8G	r6=	FP6146-36S8G	a3G

**TDFN-6 (1.6mm×1.6mm) Marking**

Part Number	Product Code	Part Number	Product Code
FP6146-12WDG	f	FP6146-28WDG	m
FP6146-15WDG	h	FP6146-30WDG	n
FP6146-18WDG	i	FP6146-31WDG	g
FP6146-25WDG	k	FP6146-33WDG	r
FP6146-26WDG	B-	FP6146-36WDG	s

**SC-82-4 Marking**

Part Number	Product Code	Part Number	Product Code
FP6146-12C8G	T1=	FP6146-28C8G	T5=
FP6146-15C8G	T2=	FP6146-30C8G	T6=
FP6146-18C8G	T3=	FP6146-31C8G	t5G
FP6146-25C8G	T4=	FP6146-33C8G	T7=
FP6146-26C8G	r4=	FP6146-36C8G	a1G

**SC-70-5 Marking**

Part Number	Product Code	Part Number	Product Code
FP6146-12C5G	a5G	FP6146-28C5G	A1G
FP6146-15C5G	a6G	FP6146-30C5G	A2G
FP6146-18C5G	a7G	FP6146-31C5G	A3G
FP6146-25C5G	a8G	FP6146-33C5G	A4G
FP6146-26C5G	a9G	FP6146-36C5G	A5G

## Typical Application Circuit

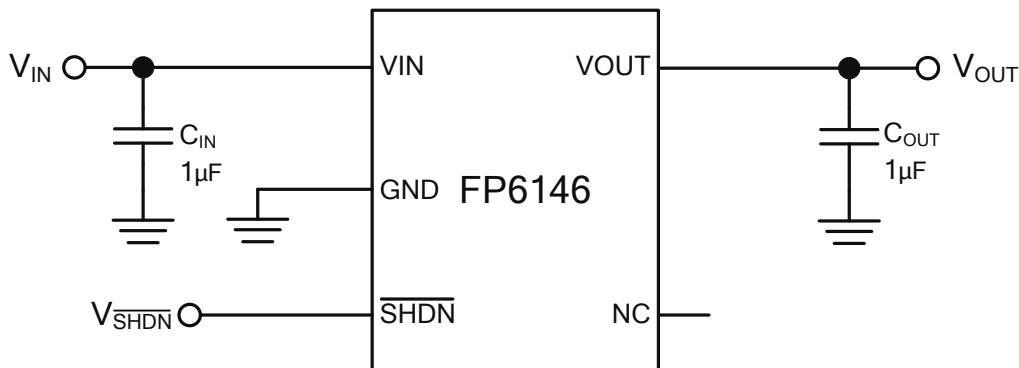


Figure 2. Typical Application Circuit of FP6146

Note 2: 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 Function
<b>VIN</b>	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.
<b>VOUT</b>	The output supplies power to loads. The output capacitor is required to prevent output voltage from oscillation. The FP6146 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.
<b>NC</b>	No connection
<b>GND</b>	Common ground pin
<b>SHDN</b>	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.

**Block Diagram**

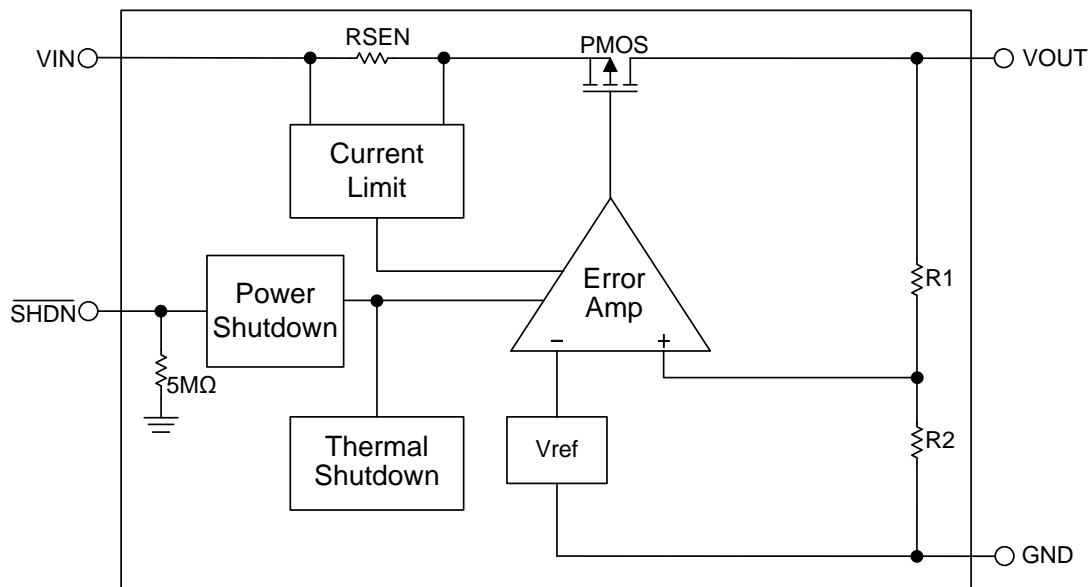


Figure 3. Block Diagram of FP6146

## Absolute Maximum Ratings

- VIN,  $\overline{\text{SHDN}}$  to GND ----- +6V
- Power Dissipation @ $T_A=25^\circ\text{C}$ , ( $P_D$ )
  - SOT-23-3 ----- +0.4W
  - SOT-23-5 ----- +0.4W
  - TSOT-23-5 ----- +0.4W
  - TDFN-6 (1.6mm×1.6mm) ----- +0.63W
  - SC-82-4 ----- +0.2W
  - SC-70-5 ----- +0.3W
- Package Thermal Resistance, ( $\theta_{JA}$ )
  - SOT-23-3 ----- +250°C/W
  - SOT-23-5 ----- +250°C/W
  - TSOT-23-5 ----- +250°C/W
  - TDFN-6 (1.6mm×1.6mm) ----- +160°C/W
  - SC-82-4 ----- +500°C/W
  - SC-70-5 ----- +330°C/W
- Maximum Junction Temperature ( $T_J$ ) ----- +150°C
- Storage Temperature Range ( $T_{STG}$ ) ----- -65°C to +150°C
- Lead Temperature (Soldering, 10 sec.) ( $T_{LEAD}$ ) ----- +260°C

Note 3 : Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

## Recommended Operating Conditions

- Input Voltage ( $V_{IN}$ ) ----- +2.0V to +5.5V
- Operating Temperature Range ( $T_{OPR}$ ) ----- -40°C to +85°C

## Electrical Characteristics

( $V_{IN}=V_{OUT}+1V$ ,  $\overline{SHDN}$  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	
Current Limit	$I_{LIMIT}$	$R_{Load}=1\Omega$	300			mA	
Quiescent Current	$I_Q$	$I_{OUT}=0mA$		35	60	$\mu A$	
Standby Current	$I_{STBY}$	$\overline{SHDN}$ Pin Connected to GND		0.1	1	$\mu A$	
Output Voltage Accuracy	$\Delta V_{OUT}$	$I_{OUT}=1mA$	-2		+2	%	
Dropout Voltage (Note4)	$V_{DROP}$	$I_{OUT}=150mA$	$V_{OUT}=1.2V$		1100	1300	mV
			$V_{OUT}=1.5V$		910	1100	
			$V_{OUT}=1.8V$		750	900	
			$V_{OUT}=2.5V$		500	600	
			$V_{OUT}=3.0V$		270	330	
			$V_{OUT}=3.3V$		230	270	
		$I_{OUT}=300mA$	$V_{OUT}=1.2V$		1950	2300	
			$V_{OUT}=1.5V$		1600	1920	
			$V_{OUT}=1.8V$		1450	1750	
			$V_{OUT}=2.5V$		980	1170	
			$V_{OUT}=3.0V$		510	610	
			$V_{OUT}=3.3V$		400	480	
Line Regulation	$\Delta V_{LINE}$	$I_{OUT}=1mA$ , $V_{IN}=V_{OUT}+1V$ to 5V		1	8	mV	
Load Regulation (Note5)	$\Delta V_{LOAD}$	$I_{OUT}=0mA$ to 150mA		6	30	mV	
Ripple Rejection (Note6)	PSRR	$V_{IN}=V_{OUT}+1V$ , $f_{RIPPLE} = 10kHz$		70		dB	
Output Noise Voltage (Note6)	$V_{NOISE}$	$C_{OUT}=1\mu F$ , $I_{OUT}=0mA$		30		$\mu V_{RMS}$	
Temperature Coefficient (Note6)	TC	$I_{OUT}=1mA$ , $V_{IN}=5V$		100		ppm/ $^\circ C$	
Thermal Shutdown Threshold (Note6)	$T_{SD}$			145		$^\circ C$	
	$\Delta T_{SD}$	Hysteresis		25		$^\circ C$	
$\overline{SHDN}$ Pull-Low Resistance	$R_{\overline{SHDN}}$			5		$M\Omega$	
$\overline{SHDN}$ Pin Threshold	$V_{\overline{SHDN}(ON)}$	Start-up	1.0			V	
	$V_{\overline{SHDN}(OFF)}$	Shutdown			0.4	V	

Note 4: 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 5: Load regulation and dropout voltage are measured at a constant junction temperature by using a 40ms low duty cycle current pulse.

Note 6: Guarantee by design.

**Typical Performance Curves**

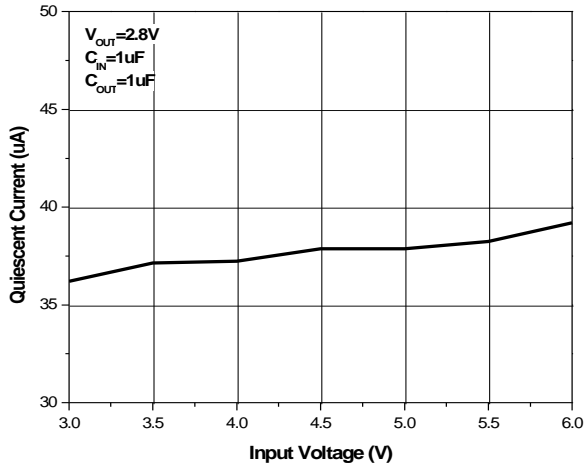


Figure 4. Quiescent Current vs. Input Voltage

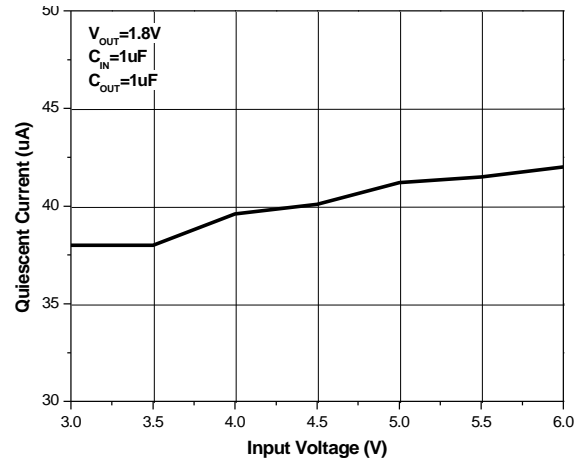


Figure 5. Quiescent Current vs. Input Voltage

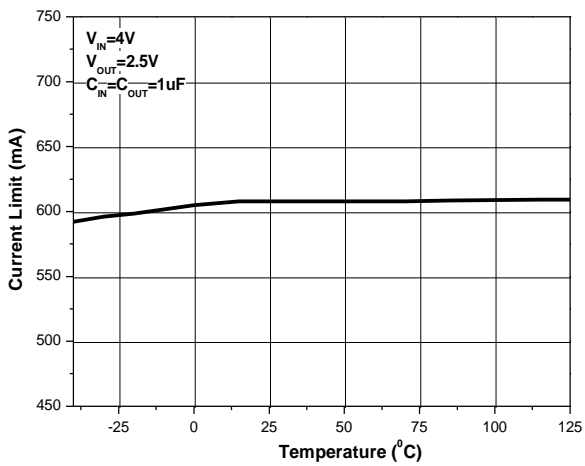


Figure 6. Current Limit vs. Temperature

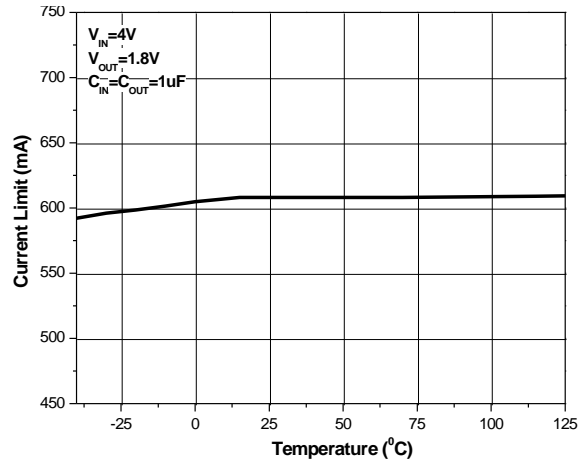


Figure 7. Current Limit vs. Temperature

**V<sub>IN</sub>=2.8V, V<sub>OUT</sub>=1.8V, I<sub>OUT</sub>=1mA to 100mA**

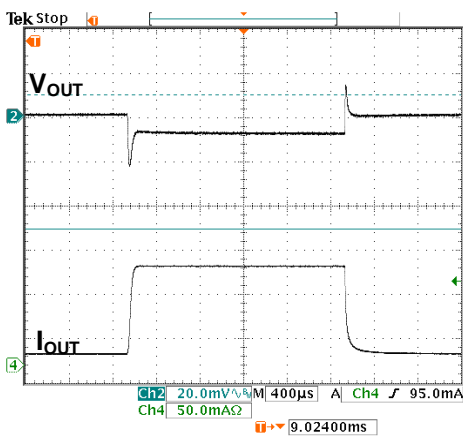


Figure 8. Load Transition Response

**V<sub>IN</sub>=3.8V, V<sub>OUT</sub>=2.8V, I<sub>OUT</sub>=1mA to 100mA**

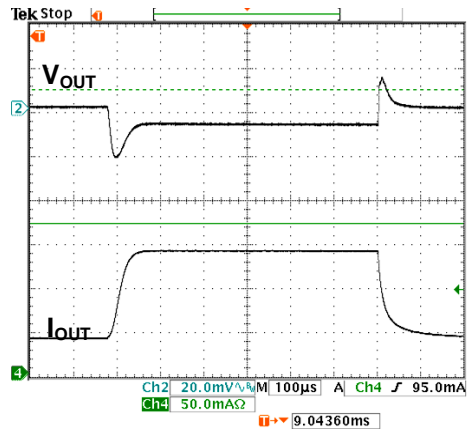


Figure 9. Load Transition Response

**Typical Performance Curves (Continued)**

$V_{IN}=4.3V, V_{OUT}=3.3V, I_{OUT}=1mA \text{ to } 100mA$

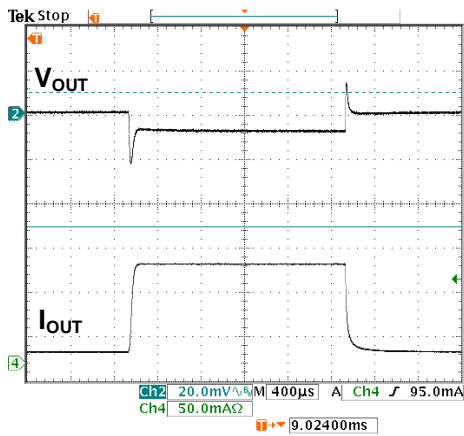


Figure 10. Load Transition Response

$V_{IN}=3.5V, V_{OUT}=2.5V, I_{OUT}=1mA \text{ to } 100mA$

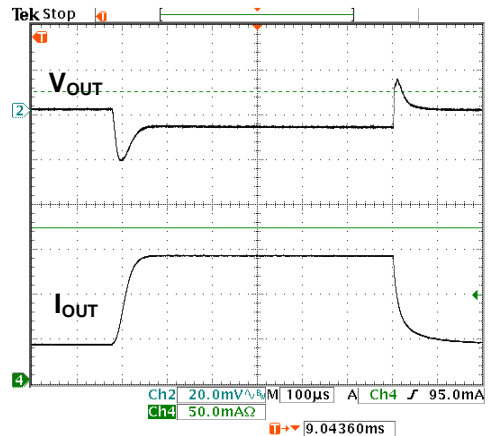


Figure 11. Load Transition Response

$V_{IN}=3.8V, V_{OUT}=2.8V, I_{OUT}=1mA \text{ to } 150mA$

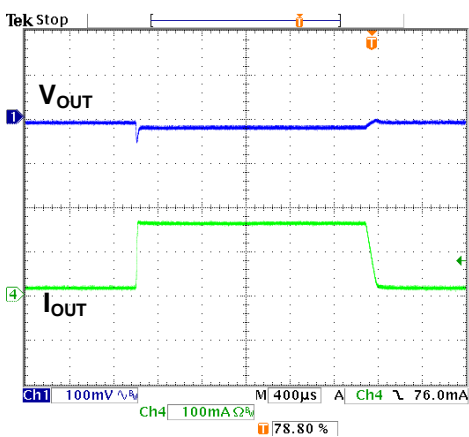


Figure 12. Load Transition Response

$V_{IN}=3.8V, V_{OUT}=2.8V, I_{OUT}=0mA \text{ to } 150mA$

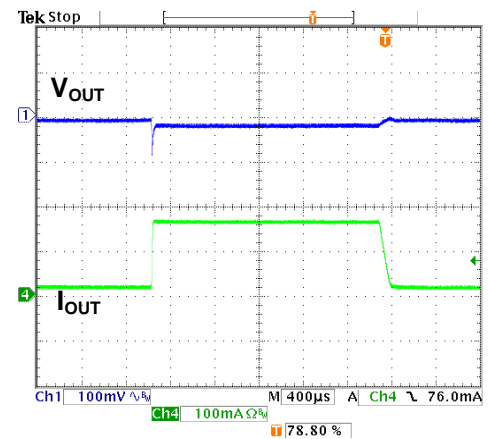


Figure 13. Load Transition Response

$V_{IN}=4V, V_{OUT}=2.8V, I_{OUT}=100mA$

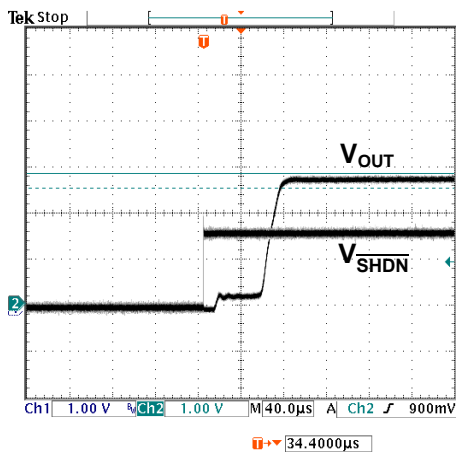


Figure 14. Shutdown/Enable Test

$V_{IN}=4V, V_{OUT}=2.8V, I_{OUT}=100mA$

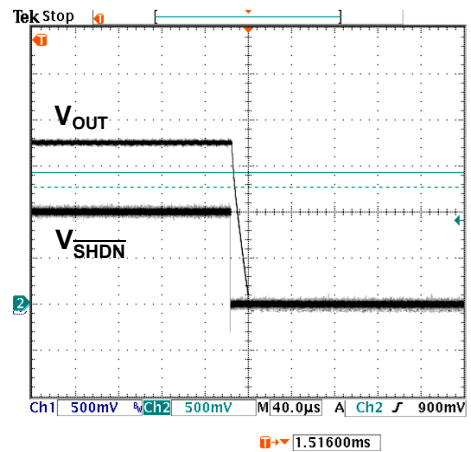


Figure 15. Shutdown/Enable Test



**Typical Performance Curves (Continued)**

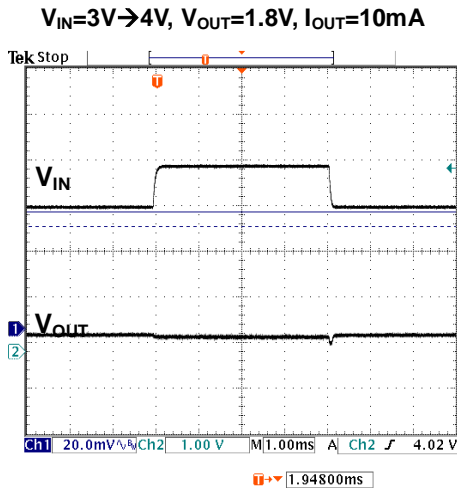


Figure 16. Line Transition Response

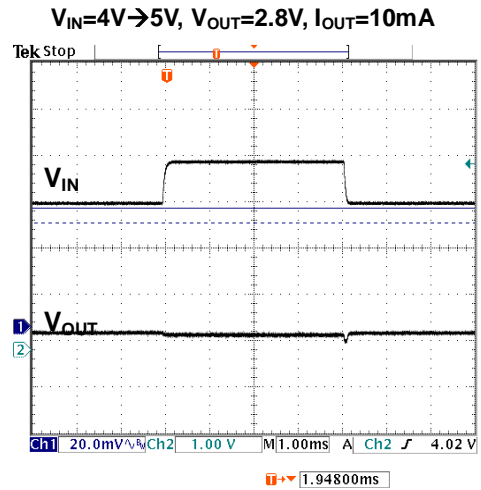


Figure 17. Line Transition Response

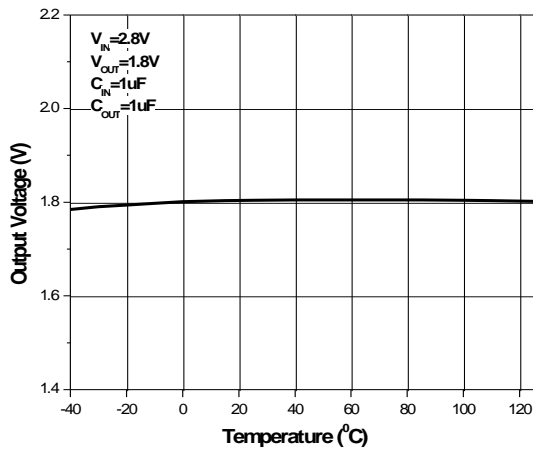


Figure 18. Output Voltage vs. Temperature

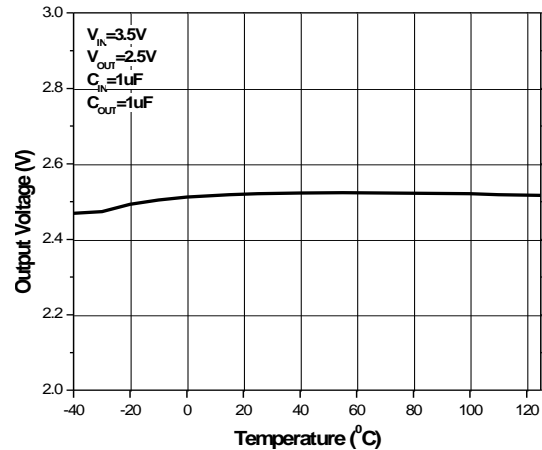


Figure 19. Output Voltage vs. Temperature

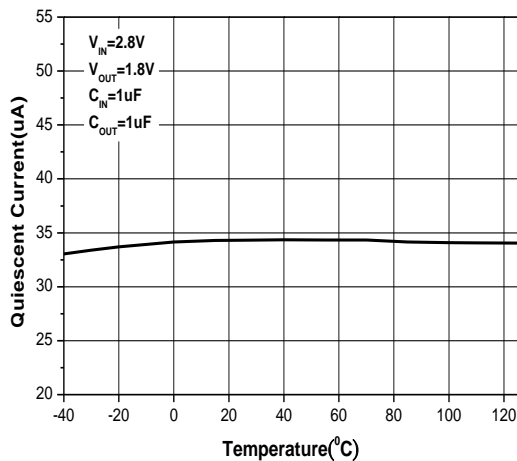


Figure 20. Quiescent Current vs. Temperature

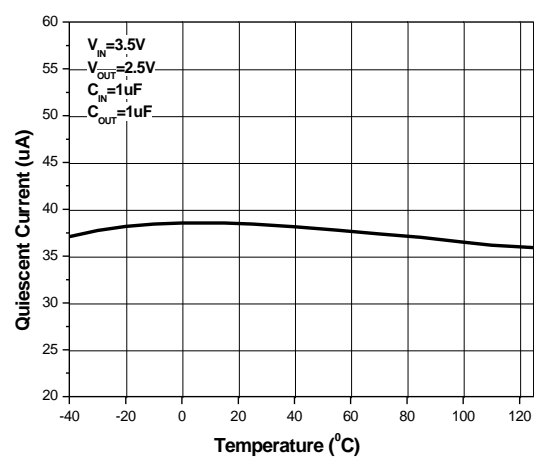


Figure 21. Quiescent Current vs. Temperature

**Typical Performance Curves (Continued)**

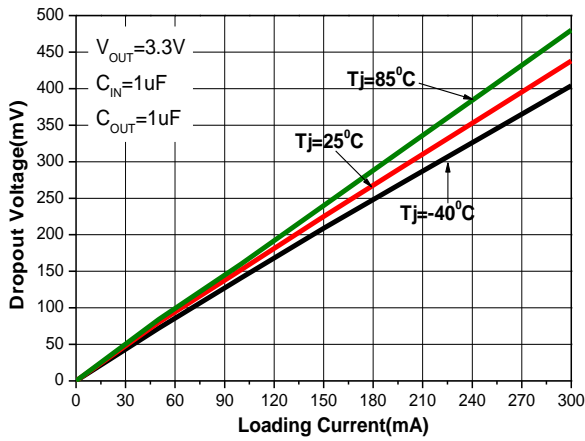


Figure 22.  $V_{OUT}=3.3V$  Dropout vs. Temperature

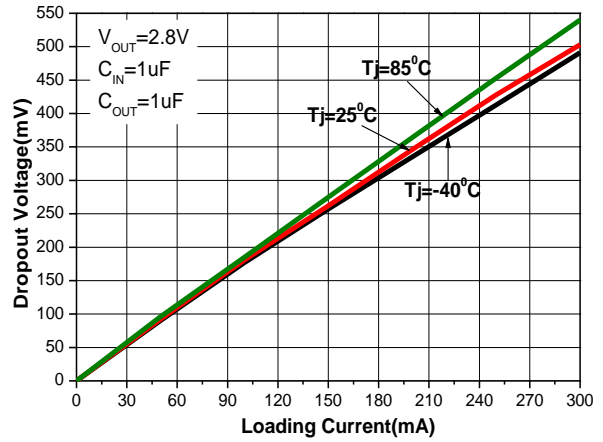


Figure 23.  $V_{OUT}=2.8V$  Dropout vs. Temperature

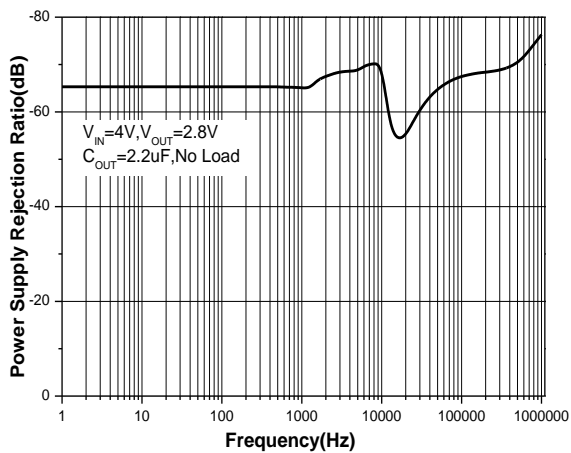


Figure 24. Power Supply Rejection Ratio vs. Frequency

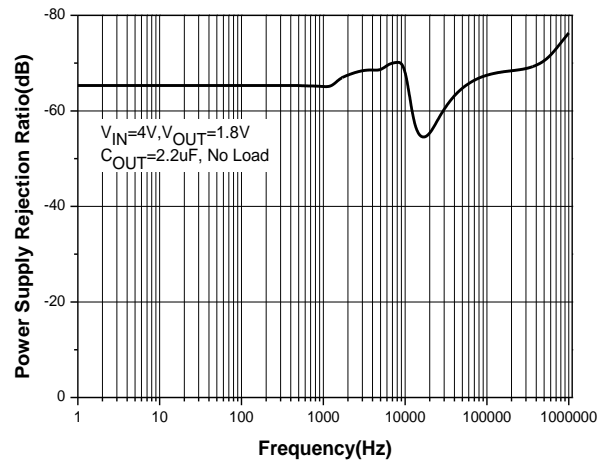


Figure 25. Power Supply Rejection Ratio vs. Frequency

## Application Information

The FP6146 is a low dropout linear regulator that could provide 200mA output current at dropout voltage about 300mV. Current limit and on chip thermal shutdown features provide protection against any combination of overload or ambient temperature that could exceed maximum junction temperature.

### 1. Output and Input Capacitor

The FP6146 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 $\mu$ F to 10 $\mu$ F X5R or X7R dielectric ceramic capacitors with 30m $\Omega$  to 50m $\Omega$  ESR range between device outputs and ground for stability. The FP6146 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 or thermal condition from damaging the device, FP6146 has internal thermal and current limiting functions designed to protect the device. It will rapidly shut off PMOS pass element during over-temperature condition.

### 3. Thermal Consideration

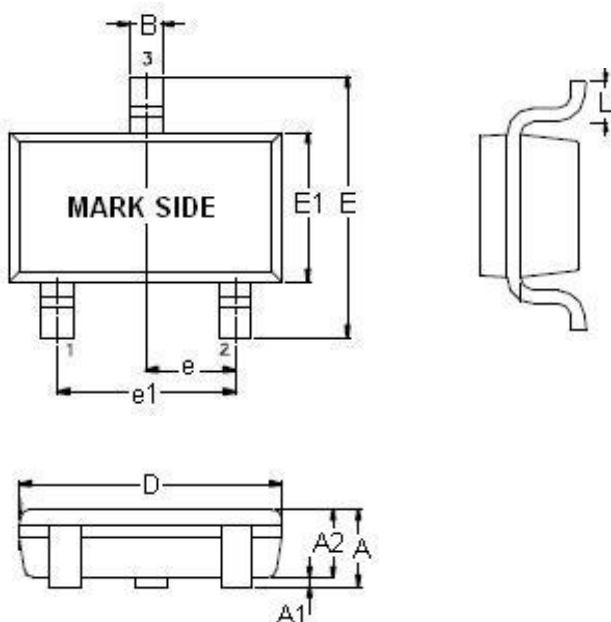
The power handling capability of the device will be limited by allowable operation junction temperature (125°C). The power dissipated by the device will be estimated by  $P_D = I_{OUT} \times (V_{IN} - V_{OUT})$ . The power dissipation should be lower than the maximum power dissipation listed in "Absolute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

### 4. Shutdown Operation

The FP6146 is shutdown by pulling the  $\overline{\text{SHDN}}$  input low, and turned on by driving the  $\overline{\text{SHDN}}$  high. If  $\overline{\text{SHDN}}$  pin floating, the FP6146 will shut down because  $\overline{\text{SHDN}}$  pin has built-in a pull low resistor (refer to Block Diagram).

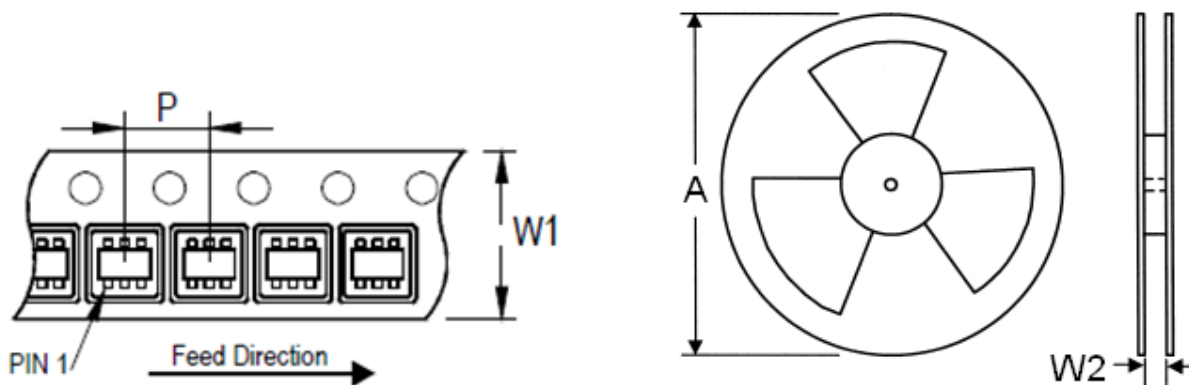
**Outline Information**

SOT-23-3 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

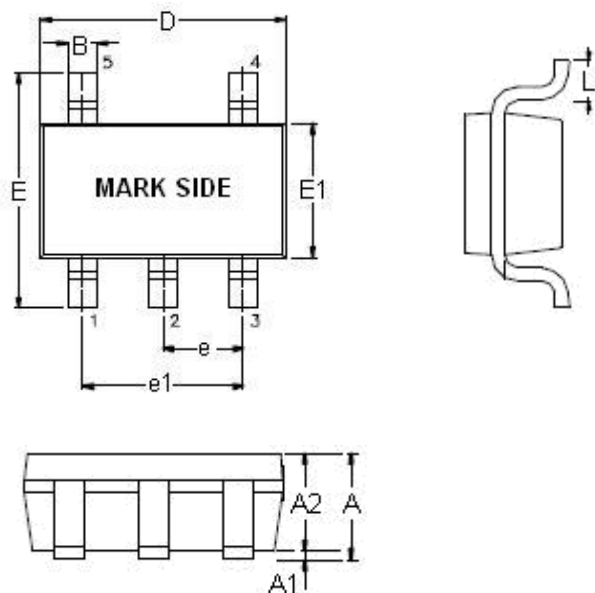
**Carrier Dimensions**



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

**Outline Information (Continued)**

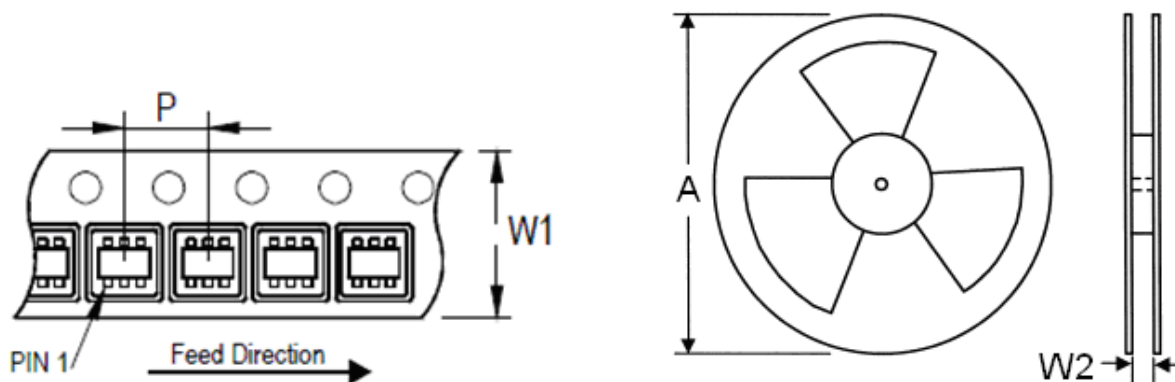
SOT-23-5 Package (Unit: mm)



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.

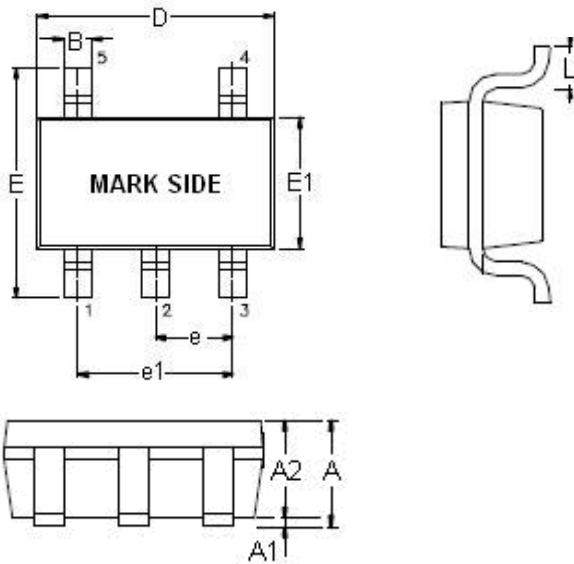
**Carrier Dimensions**



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

**Outline Information (Continued)**

TSOT-23-5 Package (Unit: mm)

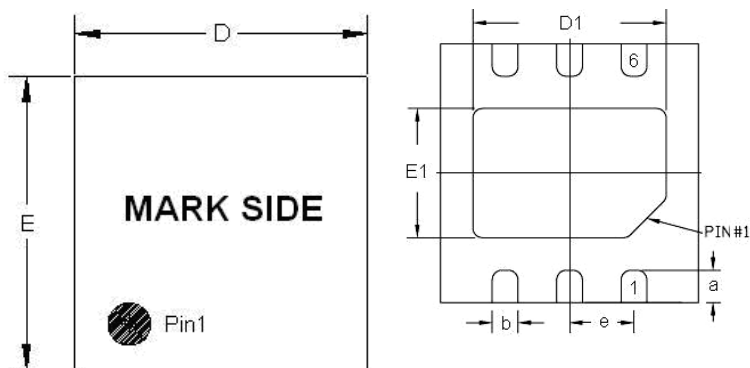


SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.70	0.90
A1	0.00	0.10
A2	0.70	1.00
B	0.30	0.50
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.90	1.00
e1	1.80	2.00
L	0.30	0.60

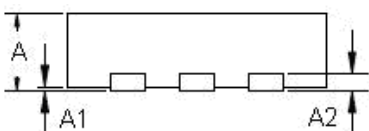
**Carrier Dimensions**

**Outline Information (Continued)**

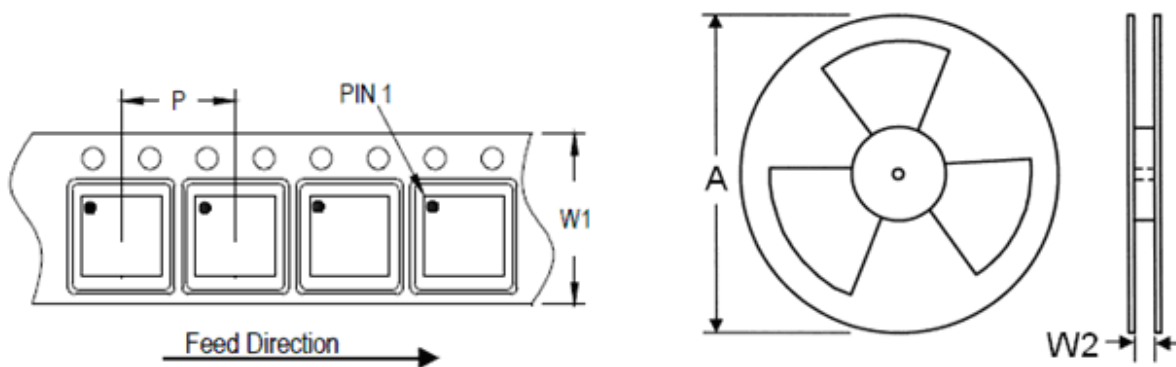
**TDFN-6 (1.6mm×1.6mm) Package (Unit: mm)**



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.70	0.80
A1	0.00	0.05
A2	0.18	0.25
D	1.55	1.65
E	1.55	1.65
a	0.18	0.30
b	0.18	0.30
e	0.45	0.55
D1	0.95	1.05
E1	0.55	0.65



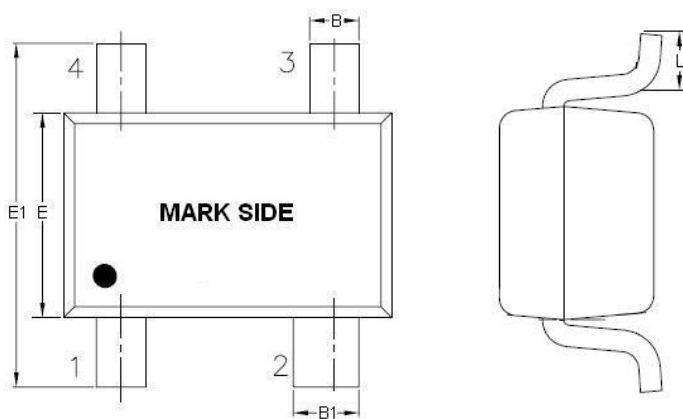
**Carrier Dimensions**



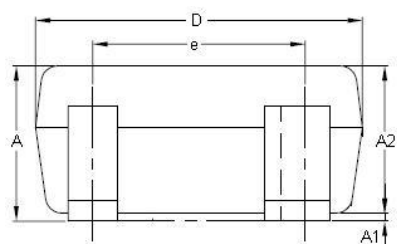
Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A)		Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
		in	mm			
8	4	7	180	8.4	400~1000	3,000

**Outline Information (Continued)**

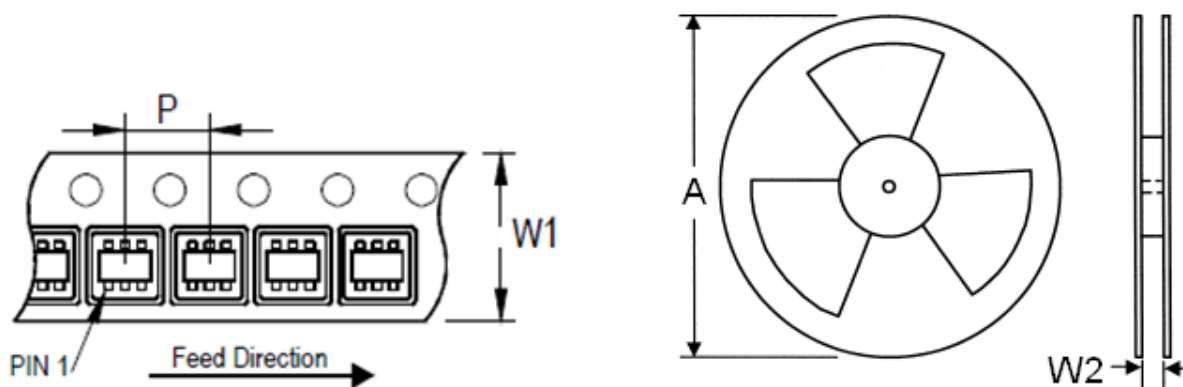
SC-82-4 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.80	1.10
A1	0.00	0.10
A2	0.80	1.00
B	0.15	0.40
B1	0.35	0.55
D	1.80	2.20
E	1.15	1.35
E1	1.80	2.40
e	1.20	1.40
L	0.25	0.45



**Carrier Dimensions**

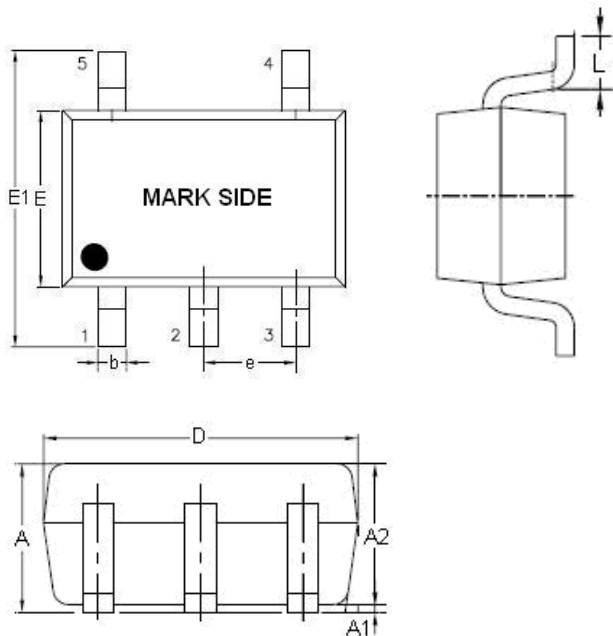


Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A)		Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
		in	mm			
8	4	7	180	8.4	300~1000	3,000



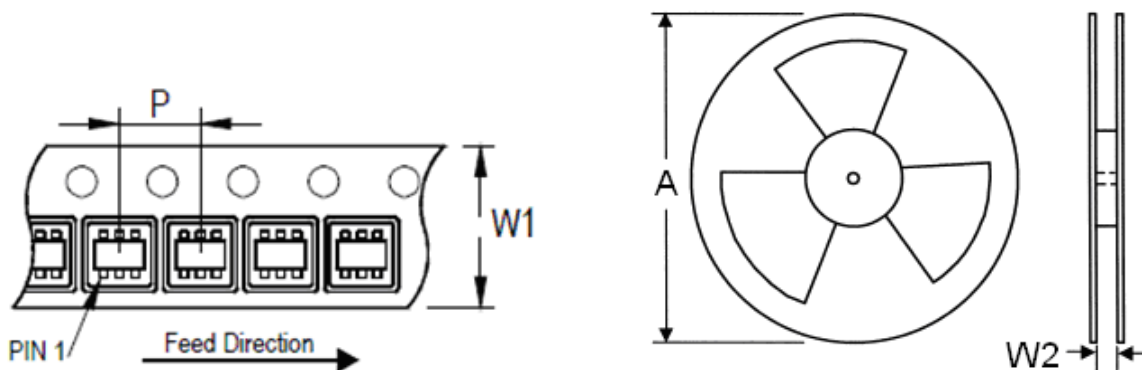
**Outline Information (Continued)**

SC-70-5 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.90	1.10
A1	0.00	0.10
A2	0.90	1.00
b	0.15	0.35
D	1.80	2.20
E1	1.80	2.40
E	1.15	1.35
e	0.55	0.75
L	0.26	0.46

**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.