150KHz, 3A PWM Buck DC/DC Converter

Description

The FP6346 series of regulators are monolithic integrated circuits capable of driving 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V, and an adjustable output version.
These regulators require a minimum number of external components and are simpler to use by internal frequency compensation and a fixed frequency oscillator.
Other features include a guaranteed ±4% tolerance on output voltage under specified input voltage and output load conditions, and ±15% on the oscillator frequency. Self protection features include current limit for the output switch and an over temperature shutdown for complete protection under fault conditions. The packages are available in a standard 5-lead TO-220, and 5-lead TO-263.

Features

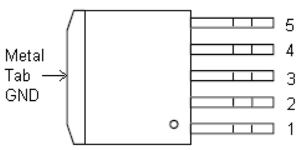
- 3.3V, 5V, 12V and adjustable output version
- Adjustable version output voltage range, 1.23V to 18V±4%
- 150kHz±15% fixed switching frequency
- Voltage mode non-synchronous PWM control
- Thermal-shutdown and current-limit protection
- ON /OFF shutdown control input
- Operating voltage can be up to 22V
- Output load current: 3A
- Low power standby mode
- Built-in switching transistor on chip
- TO-220-5L and TO-263-5L packages

Applications

- LCD monitor/TV
- External HDD
- Networking equipments

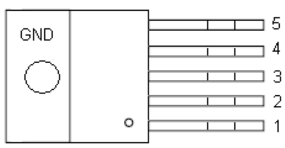
Pin Assignments

T6 Package (TO-263-5L)



TOP VIEW
1.VIN
2.OUT
3.GND
4.FB
5.SD

T1 Package (TO-220-5L)



TOP VIEW
1.VIN
2.OUT
3.GND
4.FB
5.SD

Figure 1. Pin Assignment of FP6346 (Top View)

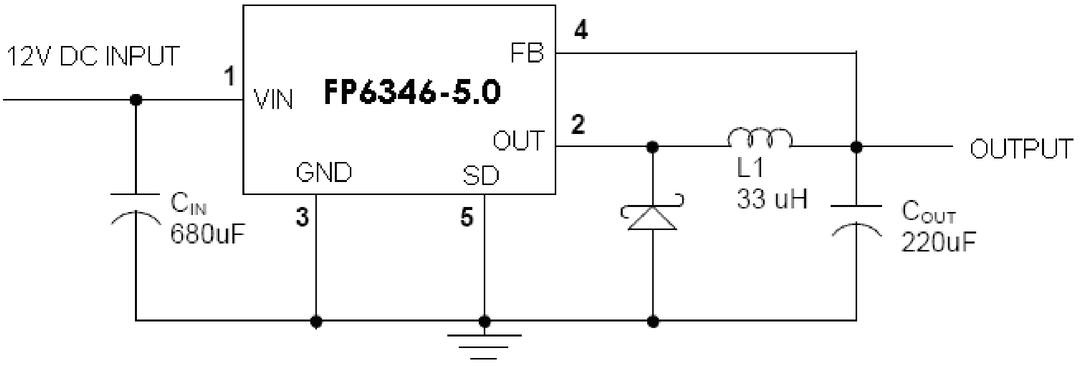
Ordering Information

FP6346-□□□□

- TR: Tape / Reel
- P: Green
  G: Green
- Package Type
  T1: TO-220-5L
  T6: TO-263-5L
- Output Voltage
  Blank: Adjustable
  33: Fixed output 3.3V
  50: Fixed output 5.0V
  12: Fixed output 12V

Typical Application Circuit

(1) Fixed Type Circuit



(2) Adjustable Type Circuit

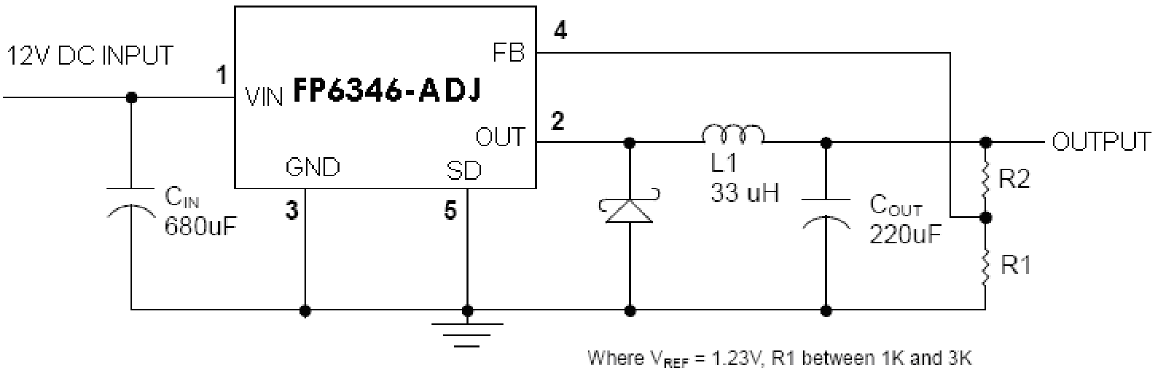


Figure 2. Typical Application Circuit of FP6346

Functional Pin Description

Pin Name	Pin Function
VIN	Operating voltage input
OUT	Switching output
GND	Ground
FB	Output voltage feedback control
SD	ON/OFF Shutdown

Absolute Maximum Ratings

- VIN to GND -- +24V
- SD to GND -- -0.3V to 18V
- FB to GND -- -0.3V to 18V
- OUT to GND -- -1V
- Junction Temperature -- +150°C
- Operating Temperature Range -- -40°C to 125°C
- Storage Temperature Range -- -65°C to 150°C
- Lead Temperature (Soldering, 10sec.) --- 260°C
- ESD (Human Body Mode) -- 2000V

Note1：Stresses beyond those listed under “Absolute Maximum Ratings" may cause permanent damage to the device.

Block Diagram

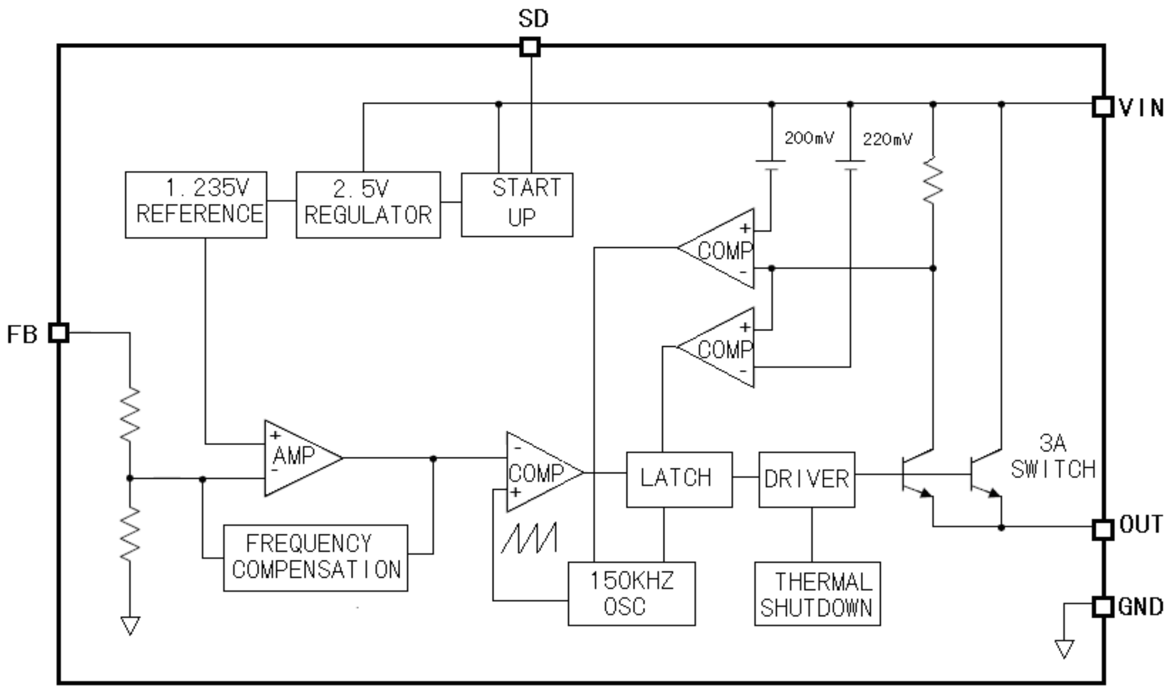


Figure 3. Block Diagram of FP6346

Electrical Characteristics (All Output Voltage Versions)

(Unless otherwise specified, V_{IN}=12V for 3.3V, 5V, adjustable version and V_{IN}=18V for the 12V version, load=0.5A, T_J = 25°C.)

Parameter		Conditions	Symbol	Min	Typ	Max	Unit
Operating Voltage			V_{IN}	4.5		22	V
Output Feedback	FP6346-ADJ	5V ≤V_{IN} ≤ 22V 0.2A ≤load ≤ 3A Vo programmed for 3V	V_{FB}	1.193	1.23	1.267	V
Efficiency (Note2)	FP6346-ADJ	V_{IN} = 12V, load =3A	η		75		%
Output Voltage	FP6346-3.3V	5.5V ≤V_{IN} ≤ 22V 0.2A ≤load ≤ 3A	V_O	3.168	3.3	3.4327	V
Efficiency (Note2)	FP6346-3.3V	V_{IN} = 12V, load =3A	η		76		%
Output Voltage	FP6346-5.0V	8V ≤V_{IN}≤ 22V 0.2A ≤load ≤ 3A	V_O	4.8	5	5.2	V
Efficiency (Note2)	FP6346-5.0V	V_{IN} = 12V, load =3A	η		81		%
Output Voltage	FP6346-12V	15V ≤V_{IN} ≤ 22V 0.2A ≤load ≤ 3A	V_O	11.52	12	12.48	V
Efficiency (Note2)	FP6346-12V	V_{FB} =16V, load =3A	η		89		%
Feedback Bias Current		V_{FB}=1.3V (Adjustable version only)	I_{FB}		-10	-50	nA
Oscillator Frequency			F_{OSC}	127	150	173	kHz
Oscillator Frequency of Short Circuit Protect		When current limit occurred and V_{FB} < 0.5V, T_A=25ºC	F_{SCP}	10	50	80	kHz
Saturation Voltage		I_{OUT}=3A No outside circuit V_{FB} = 0V force driver on	V_{SAT}		1.2	1.6	V
Max. Duty Cycle (ON)		V_{FB} = 0V force driver on	DC		100		%
Max. Duty Cycle (OFF)		V_{FB} = 12V force driver off	DC	0			%
OUT= 0V	Output Leakage Current	No outside circuit VFB=12V force driver off	I_L			-200	uA
OUT= -1V	Output Leakage Current	V_{IN} =22V	I_L	-4			mA
Current Limit (Note2)		Peak current No outside circuit V_{FB} =0V force driver on	I_{CL}	3.6	4.5	5.5	A
Quiescent Current		V_{FB} =12V force driver off	I_Q		3.5	10	mA
Standby Quiescent Current		V_{SD}=5V V_{IN} =22V	I_{STBY}		80	150	uA
ON/OFF Pin Logic Input Threshold Voltage		Low (regulator ON)	V_{IL}	-	1.3	0.6	V
ON/OFF Pin Logic Input Threshold Voltage		High (regulator OFF)	V_{IH}	2.0			V
ON/OFF Pin Logic Input Current		V_{LOGIC} =2.5V (OFF)	I_H			-0.01	uA
ON/OFF Pin Logic Input Current		V_{LOGIC} =0.5V (ON)	I_L		-0.1	-1	uA
Thermal Resistance Junction to Case (Note2)		TO-220-5	θ_{JC}		2.5		ºC/W
Thermal Resistance Junction to Case (Note2)		TO-263-5	θ_{JC}	3			ºC/W
Thermal Resistance Junction to Ambient (Note2)		TO-220-5, With copper area of approximately 3 in^2	θ_{JA}		28		ºC/W
Thermal Resistance Junction to Ambient (Note2)		TO-263-5, With copper area of approximately 3 in^2	θ_{JA}	30			ºC/W

Note2：The specification is guaranteed by design, not production tested.

Typical Performance Curves

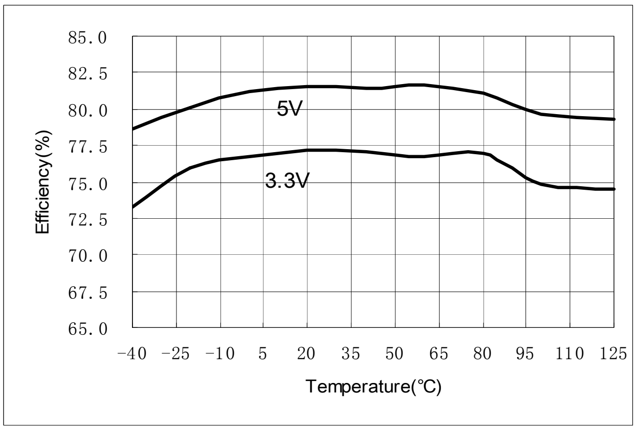


Figure 4. Efficiency vs. Temperature.
V_{IN}=12V, V_O=3.3V, 5.0V, load=3A

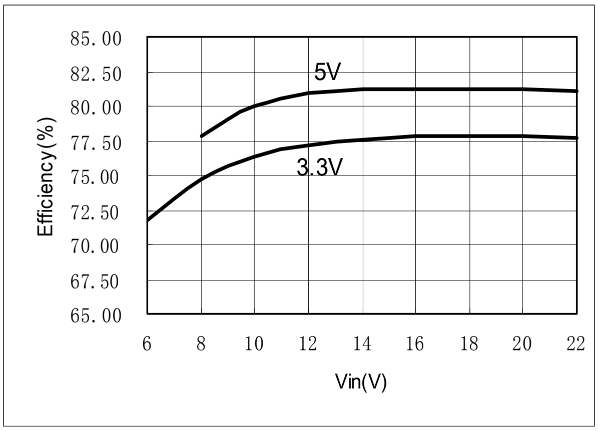


Figure 5. Efficiency vs. V_{IN}
V_O=3.3V, 5.0V, load=3A

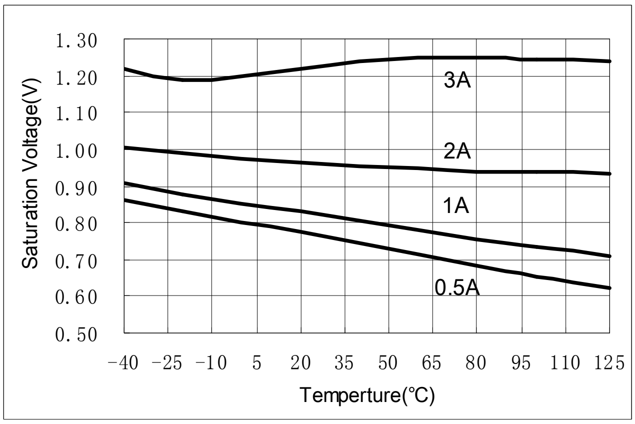


Figure 6. Saturation Voltage vs. Temperature
V_{IN}=12V

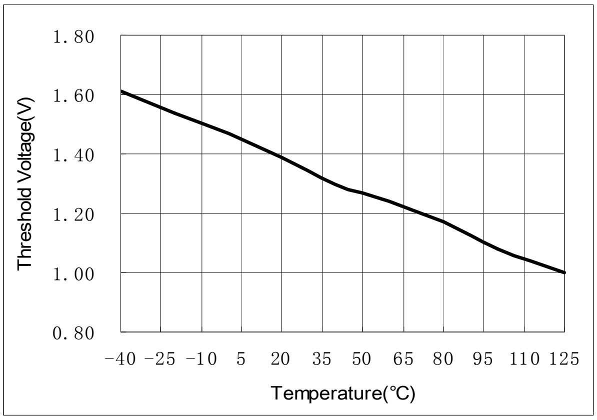


Figure 7. ON/OFF Threshold Voltage vs. Temperature
V_{IN}=12V, load=0.5A

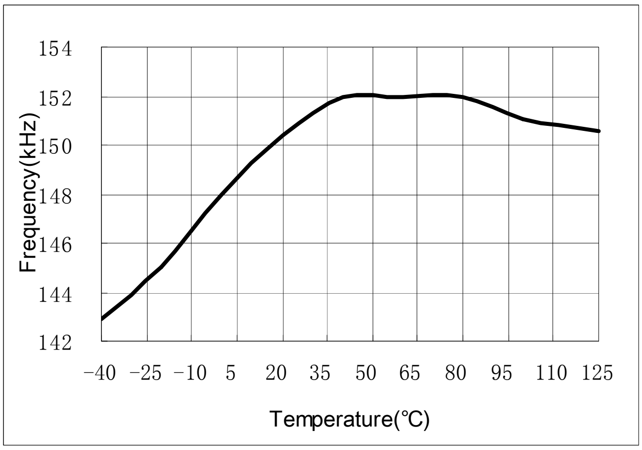


Figure 8. Frequency vs. Temperature.
V_{IN}=12V,Vo=5V,load=0.5A

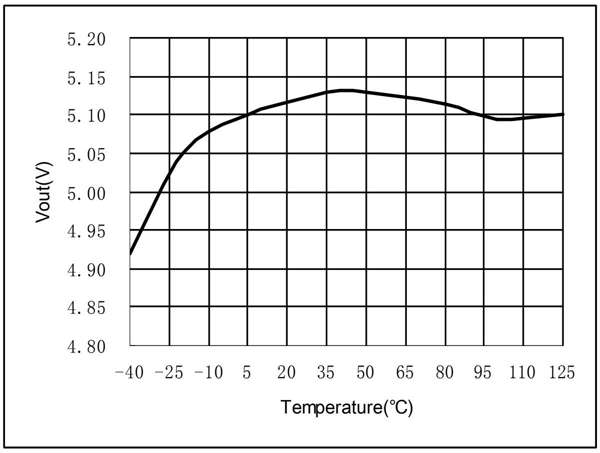


Figure 9. Vo vs. Temperature.
V_{IN}=12V, load=3A

Typical Performance Curves (Continued)

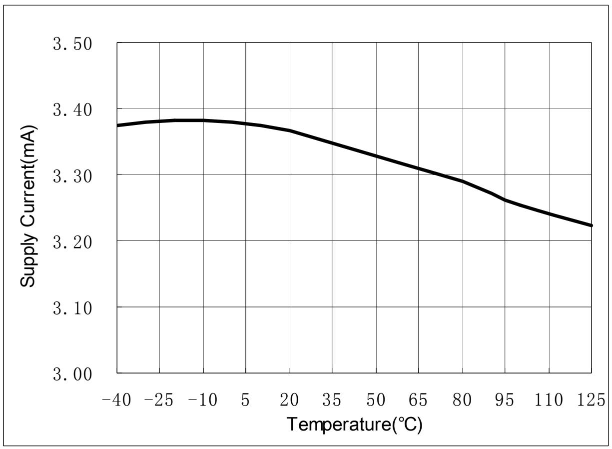


Figure 10. Supply Current vs. Temperature.
V_{IN}=12V, V_{SD}=0V,no load

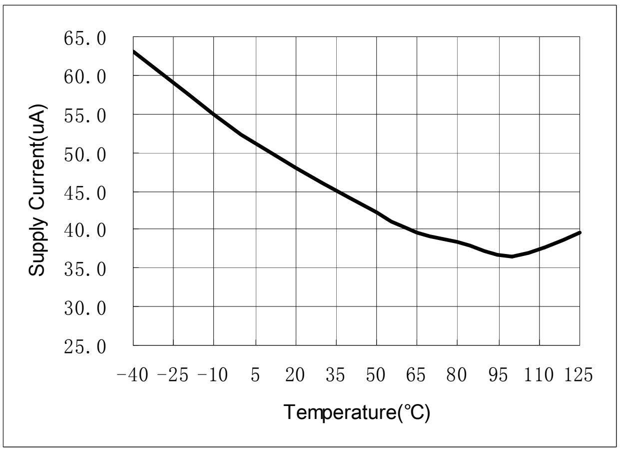


Figure11. Supply Current vs. Temperature.
V_{IN}=12V, V_{SD}=5V,no load

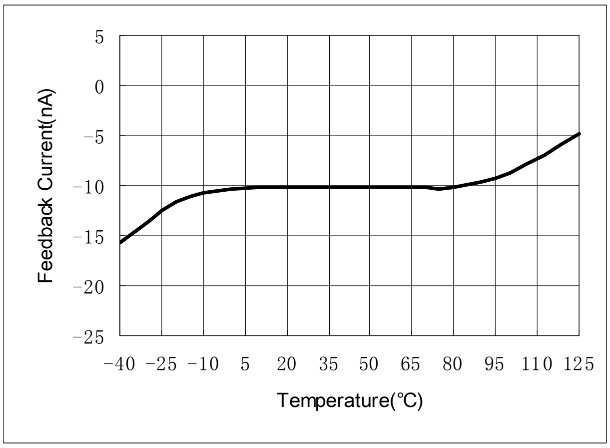


Figure12. FB pin Bias Current
V_{IN}=12V,V_{FB}=1.3V

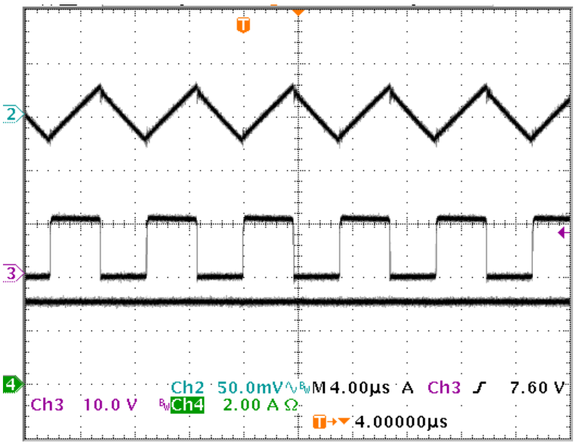


Figure13. Continuous Mode Switching Waveforms
V_{IN}=12V, Vo=5V,load=3A
CH2:Vo(ac); CH3:OUT; CH4:load current

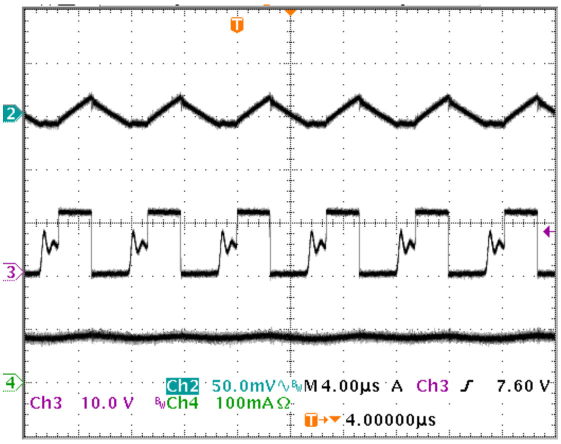


Figure14. Discontinuous Mode Switching Waveforms
V_{IN}=12V, Vo=5V,load=0.1A
CH2:Vo(ac); CH3:OUT; CH4:load current

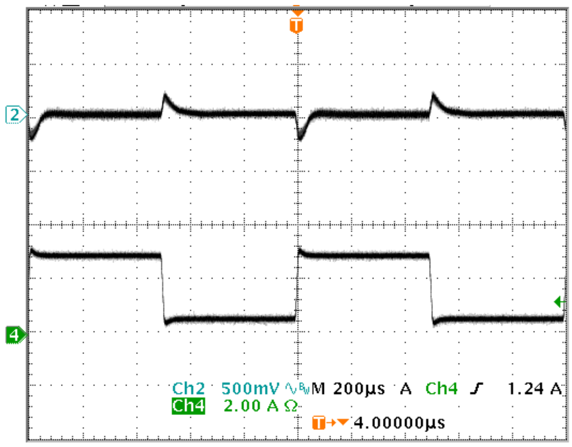


Figure15. Load Transient response
V_{IN}=12V, Vo=5V,Load=0.3Ato3A
CH2:Vo(ac); CH4:load current

Application Information

Input Capacitors (C_{IN})

It is required that V_{IN} must be bypassed with at least a 100μF electrolytic capacitor for stability. Also, it is strongly recommended the capacitor's leads must be dept short, and located near the regulator as possible. For low operating temperature range, for example, below -25° C, the input capacitor value may need to be larger. This is due to the reason that the capacitance value of electrolytic capacitors decreases and the ESR increases with lower temperatures and age. Paralleling a ceramic or solid tantalum capacitor will increase the regulator stability at cold temperatures.

Output Capacitors (C_{OUT})

An output capacitor is also required to filter the output voltage and is needed for loop stability. The capacitor should be located near the FP6346 using short PC board traces. Low ESR type capacitors are recommended for low output ripple voltage and good stability. Generally, low value or low voltage (less than 12V) electrolytic capacitors usually have higher ESR numbers. For example, the lower capacitor values (220μF–1000μF) will yield typically 50mV to 150 mV of output ripple voltage, while larger-value capacitors will reduce the ripple to approximately 20 mV to 50 mV.

The amount of output ripple voltage is primarily a function of the ESR (Equivalent Series Resistance) of the output capacitor and the amplitude of the inductor ripple current (ΔI_{IND}).

Output Ripple Voltage = (ΔI_{IND}) × (ESR of C_{OUT})

Some capacitors called "high-frequency," "low-inductance," or "low-ESR." are recommended to use to further reduce the output ripple voltage to 10mV or 20mV. However, very low ESR capacitors, such as Tantalum capacitors, should be carefully evaluated.

Output Voltage Ripple and Transients

The output ripple voltage is due mainly to the inductor sawtooth ripple current multiplied by the ESR of the output capacitor.

The output voltage of a switching power supply will contain a sawtooth ripple voltage at the switcher frequency, typically about 1% of the output voltage, and may also contain short voltage spikes at the peaks of the sawtooth waveform.

Due to the fast switching action, and the parasitic inductance of the output filter capacitor, there is voltage spikes presenting at the peaks of the sawtooth waveform. Cautions must be taken for stray capacitance, wiring inductance, and even the scope probes used for transients evaluation. To minimize these voltage spikes, shortening the lead length and PCB traces is always the first thought. Further more, an additional small LC filter (3 μF & 180μF) will possibly provide a 10X reduction in output ripple voltage and transients.

Inductor Selection

The FP6346 can be used for either continuous or discontinuous modes of operation. Each mode has distinctively different operating characteristics, which can affect the regulator performance and requirements. With relatively heavy load currents, the circuit operates in the continuous mode (inductor current always flowing), but under light load conditions, the circuit will be forced to the discontinuous mode (inductor current falls to zero for a period of time). For light loads (less than approximately 300mA) it may be desirable to operate the regulator in the discontinuous mode, primarily because of the lower inductor values required for the discontinuous mode. Inductors are available in different styles such as pot core, toroid, E-frame, bobbin core, et. as well as different core materials, such as ferrites and powdered iron. The least expensive, the bobbin core type consists of wire wrapped on a ferrite rod core. This type of construction makes for an inexpensive inductor, but since the magnetic flux is not completely contained within the core, it generates more electromagnetic interference (EMI). This EMI can cause problems in sensitive circuits, or can give incorrect scope readings because of induced voltages in the scope probe.

An inductor should not be operated beyond its maximum rated current because it may saturate. When an inductor begins to saturate, the inductance decreases rapidly and the inductor begins to look mainly resistive (the DC resistance of the winding). This will cause the switch current to rise very rapidly. Different inductor types have different saturation characteristics, and this should be well considered when selecting as inductor.

Catch Diode

This diode is required to provide a return path for the inductor current when the switch is off. It should be located close to the FP6346 using short leads and short printed circuit traces as possible. To satisfy the need of fast switching speed and low forward voltage drop, Schottky diodes are widely used to provide the best efficiency, especially in low output voltage switching regulators. Besides, fast-Recovery, high-efficiency, or ultra-fast recovery diodes are also suitable. But some types

Application Information (Continued)

with an abrupt turn-off characteristic may cause instability and EMI problems. A fast-recovery diode with soft recovery characteristics is a better choice.

Feedback Connection

For fixed output voltage version, the FB (feedback) pin must be connected to V_O. For the adjustable version, it is important to place the output voltage ratio resistors near FP6346 as possible in order to minimize the noise introduction.

Enable

It is required that the ENABLE must not be left open. For normal operation, connect this pin to a "LOW" voltage. On the other hand, for standby mode, connect this pin with a "HIGH" voltage. This pin can be safely pulled up to V_{IN} without a resistor in series with it.

Grounding

To maintain output voltage stability, the power ground connections must be low-impedance. For the 5-lead TO-220 and TO-263 style package, both the tab and pin 3 are ground and either connection may be used.

Heat Sink and Thermal Consideration

Although the FP6346 requires only a small heat sink for most cases, the following thermal consideration is important for all operation. With the package thermal resistances θ_{JA} and θ_{JC}, total power dissipation can be estimated
as follows:

$$P_D = (V_{IN} \times I_Q)+(V_{OUT} / V_{IN})(I_{LOAD} \times V_{SAT});$$

When no heat sink is used, the junction temperature rise can be determined by the following:
$\Delta T_J = P_D \times \theta_{JA}$;
With the ambient temperature, the actual junction temperature will be:

$$T_J = \Delta T_J + T_A ;$$

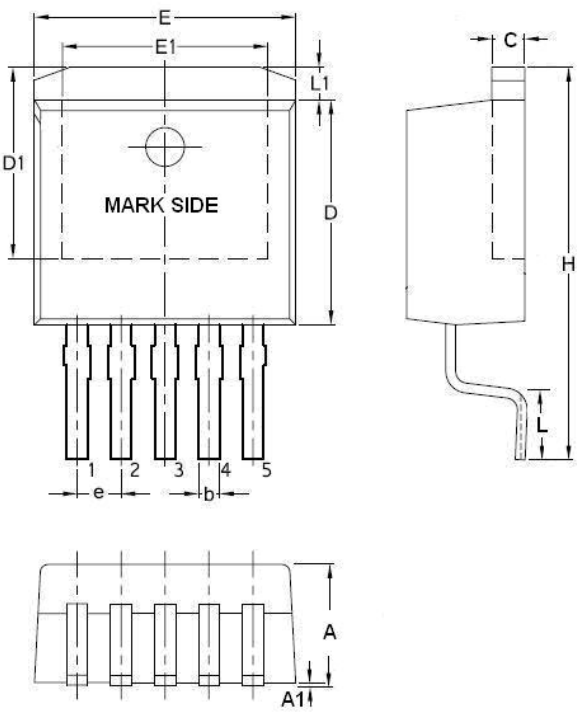
If the actual operating junction temperature is out of the safe operating junction temperature (typically 125°C), then a heat sink is required. When using a heat sink, the junction temperature rise will be reduced by the following:

$$\Delta T_J = P_D \times (\theta_{JC} + \theta_{interface} + \theta_{Heat\ sink});$$

As one can see from the above, it is important to choose a heat sink with adequate size and thermal resistance, such that to maintain the regulator's junction temperature below the maximum operating temperature.

Outline Information

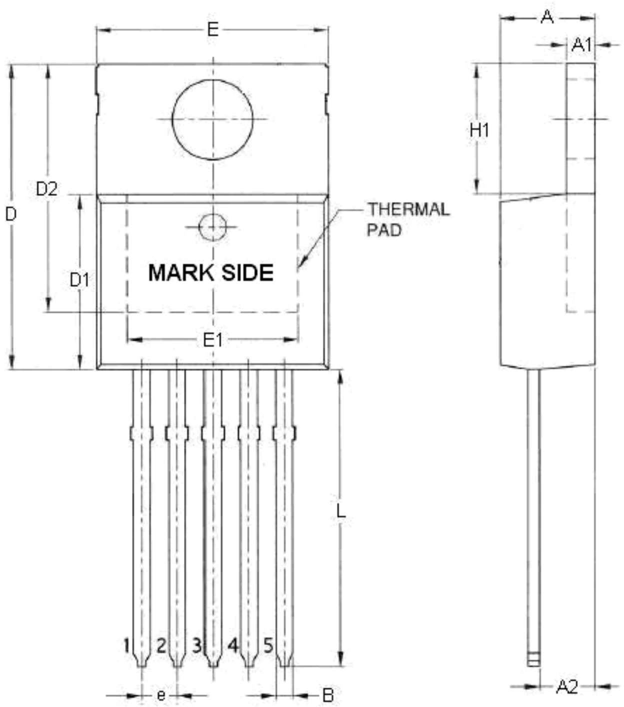
TO-263-5 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A 4.064		4.826
A1 0.005		0.254
b 0.508		0.991
C 1.143		1.651
D 8.382		9.652
D1 6.858		7.858
E 9.652		10.668
E1 6.223		7.225
L 1.778		2.800
L1 1.146		1.676
e 1.600		1.800
H 14.605		15.875

Note：Followed From JEDEC TO-263-E

TO-220- 5 Package (Unit: mm)



SYMBOL	DIMENSIONS IN MILLIMETER	
	Min	Max
A 3.560		4.830
A1 0.508		1.397
A2 2.030		2.920
H1 5.840		6.860
B 0.380		1.020
D 14.220		16.510
E 9.650		10.670
D1 8.380		9.060
D2 12.190		12.880
E1 6.858		8.890
e 1.650		1.750
L 12.700		14.730

Note：Followed From JEDEC TO-220.

Life Support Policy

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