23V, 2A, 600KHz Asynchronous Step-Down DC/DC Converter

Description

The FR97063A is a monolithic step-down switch mode converter with a built-in power MOSFET. It achieves 2A output current over a wide input supply range with excellent load and line regulation. Current mode operation provides fast transient response and eases loop stabilization. Fault condition protection includes cycle-by-cycle current limit and thermal shutdown.

The FR97063A is available in SOP-8 and MSOP-10 (exposed pad) packages, which provides a very compact system solution and good thermal conductance.

Features

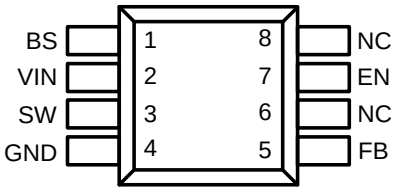
- 2A Output Current
- 180mΩ Internal Power MOSFET Switch
- Stable with Low ESR Output Ceramic Capacitors
- Up to 92% Efficiency
- Fixed 600KHz Frequency
- Current Mode Operation
- Thermal Shutdown
- Cycle-by-Cycle Over Current Protection
- Wide 4.5V to 23V Operating Input Range
- Output Adjustable from 0.805V to 15V
- 10μA Shutdown Current
- Available in SOP-8 and MSOP-10 (Exposed Pad) Packages

Applications

- Distributed Power System
- Battery Charger
- OLPC, Netbook
- Pre-Regulator for Linear Regulator
- WLED Driver

Pin Assignments

SO Package (SOP-8)



MP Package (MSOP-10 Exposed Pad)

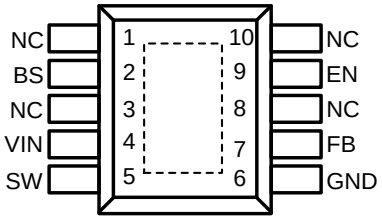
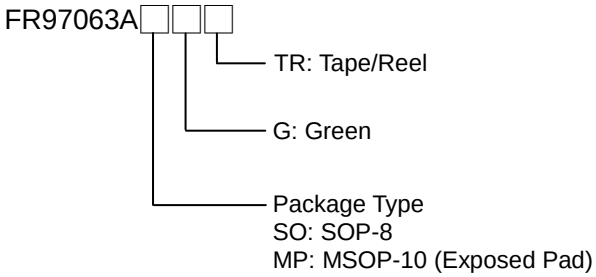


Figure 1. Pin Assignment of FR97063A

Ordering Information



Typical Application Circuit

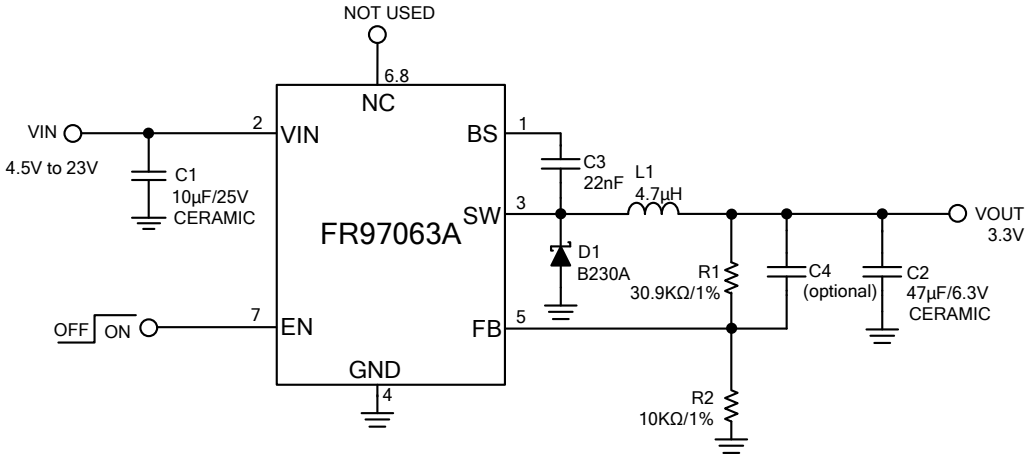


Figure 2. Typical Application Circuit of FR97063A (SOP-8 package)

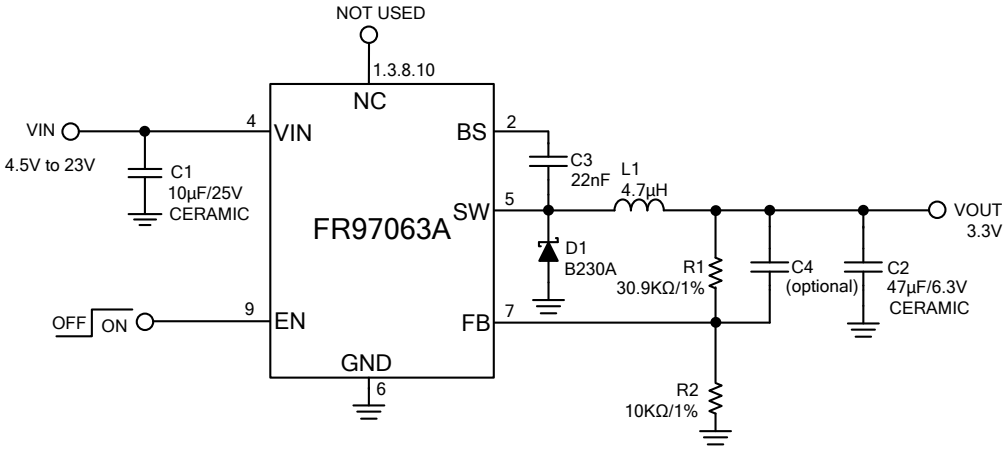


Figure 3. Typical Application Circuit of FR97063A (MSOP-10 exposed pad package)

Functional Pin Description

Pin Name	Pin Function
BS	Bootstrap. A 22nF capacitor is connected between SW and BS pins to drive the power switch's gate above the supply voltage.
VIN	Power Supply Input. Drive 4.5V to 23V voltage to this pin to power on this chip. Connect a 10μF ceramic bypass capacitor between VIN and GND to eliminate noise.
SW	Switch Output. Connect this pin to the switch end of the inductor.
GND	Ground. This pin is the voltage reference for the regulated output voltage. For this reason, care must be taken in its layout.
FB	Feedback. An external resistor divider from the output to GND, tapped to the FB pin sets the output voltage.
NC	No Connection.
EN	On/Off Control Input. Pull EN above 1.2V to turn the device on.

Block Diagram

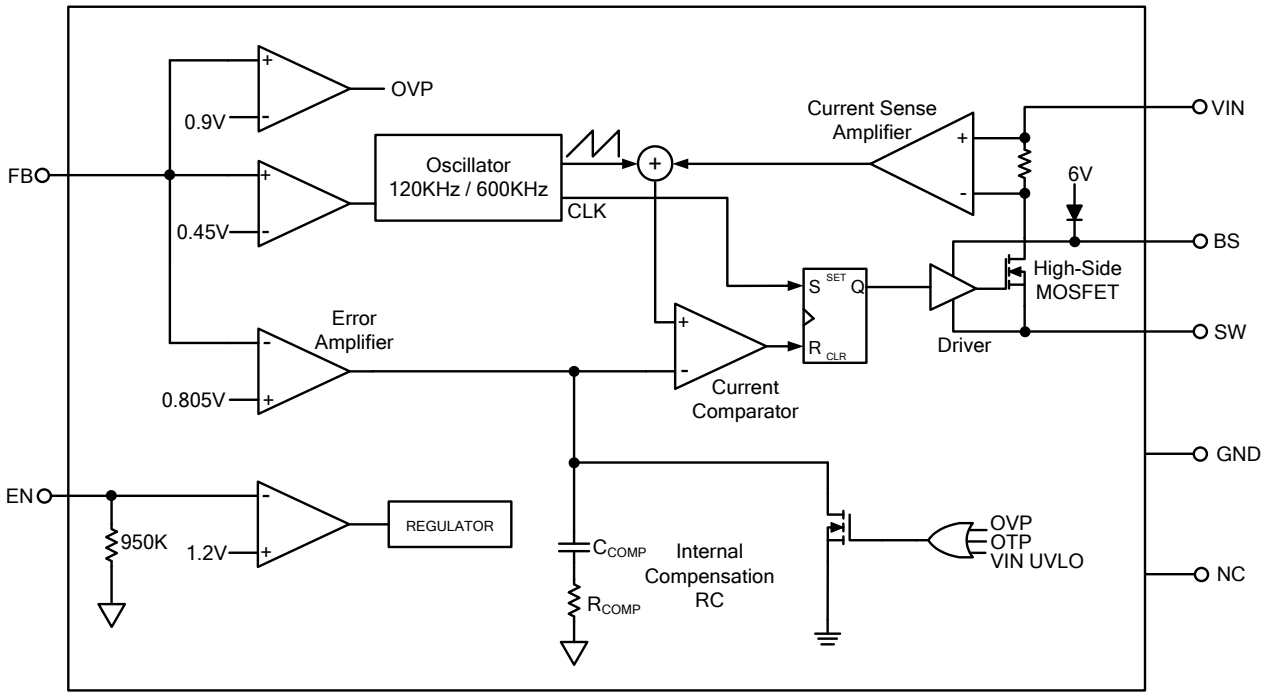


Figure 4. Block Diagram of FR97063A

Absolute Maximum Ratings

- Supply Voltage V_{IN} ---------- +25V
- V_{SW} ---------- -3V to V_{IN} +0.3V
- V_{BS} ---------- V_{sw} +6V
- All Other Pins Voltage ---------- -0.3V to +6V
- Maximum Junction Temperature (T_J) ---------- +150°C
- Storage Temperature (T_S) ---------- -65°C to +150°C
- Lead Temperature (Soldering, 10sec.) ---------- +260°C
- Power Dissipation @T_A=25°C, (P_D)
  - SOP-8 ---------- 0.63W
  - MSOP-10 (Exposed Pad) ---------- 0.91W
- Package Thermal Resistance, (θ_{JA})
  - SOP-8 ---------- 160°C/W
  - MSOP-10 (Exposed Pad) ---------- 160°C/W

Note 1：Stresses beyond those listed under “Absolute Maximum Ratings" may cause permanent damage to the device.

Recommended Operating Conditions

- Supply Voltage (V_{IN}) ---------- +4.5V to +23V
- Output Voltage (V_{OUT}) ---------- +0.805V to +15V
- Operation Temperature Range ---------- -40°C to +85°C

Note 2：If out of its operation conditions, the device is not guaranteed to function.

Electrical Characteristics

(V_{IN}=12V, T_A=25℃, unless otherwise specified.)

Parameter	Conditions	Min	Typ	Max	Unit
Feedback Voltage	4.5V ≤ V_{IN} ≤ 23V	0.785	0.805	0.825	V
Switch-On Resistance (*)			180		mΩ
Switch Leakage	V_{EN} = 0V, V_{SW} = 0V			10	μA
Current Limit (*)			3		A
Oscillator Frequency		480	600	720	KHz
Fold-back Frequency	V_{FB} = 0V		120		KHz
Maximum Duty Cycle			85		%
Minimum On-Time (*)			100		ns
Under Voltage Lockout Threshold Rising		4.1	4.4	4.7	V
Under Voltage Lockout Threshold Hysteresis			250		mV
EN Input Low Voltage				0.4	V
EN Input High Voltage		1.2			V
EN Input Current	V_{EN} = 2V		2.0		μA
	V_{EN} = 0V		0.1		
Supply Current (Shutdown)	V_{EN} = 0V		10		μA
Supply Current (Quiescent)	V_{EN} = 2V, V_{FB} = 1V		1.8		mA
Thermal Shutdown (*)			150		°C

*: Guaranteed by design

Note 3：V_{IN} = 5V, V_{OUT} = 3.3V, maximum load current is about 1.4A.

Typical Performance Curves

V_{IN} = 12V, V_{OUT} = 3.3V, C1 = 10µF, C2 = 47µF, L1 = 4.7µH, TA = +25°C, unless otherwise noted.

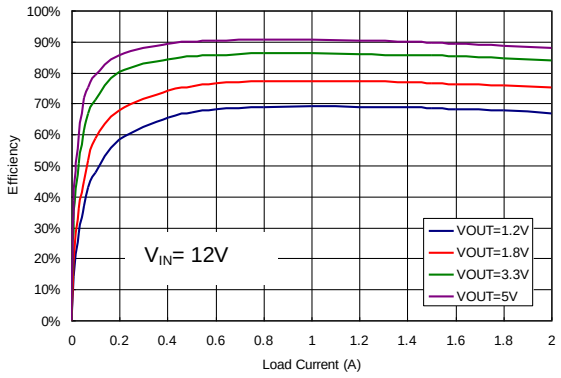


Figure 5. Efficiency vs. Loading

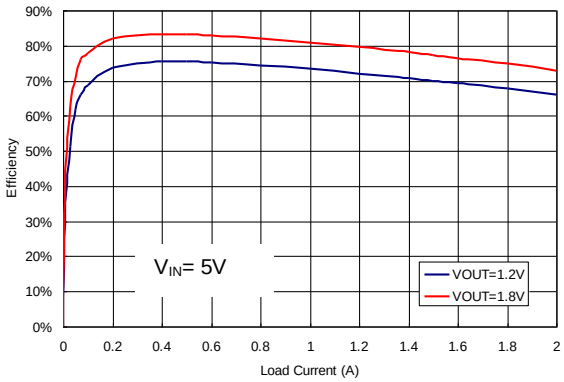


Figure 6. Efficiency vs. Loading

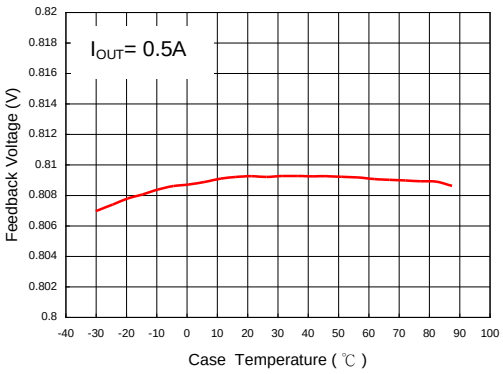


Figure 7. Feedback Voltage vs. Case Temperature

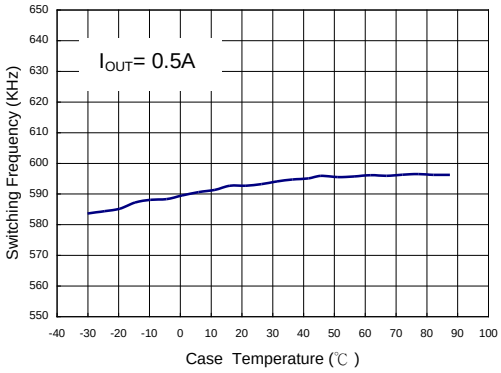


Figure 8. Switching Frequency vs. Case Temperature

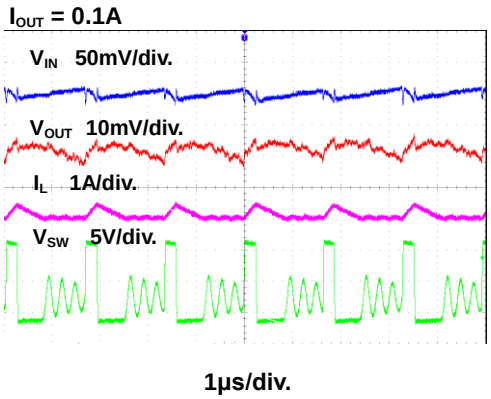


Figure 9. DC Ripple Waveform

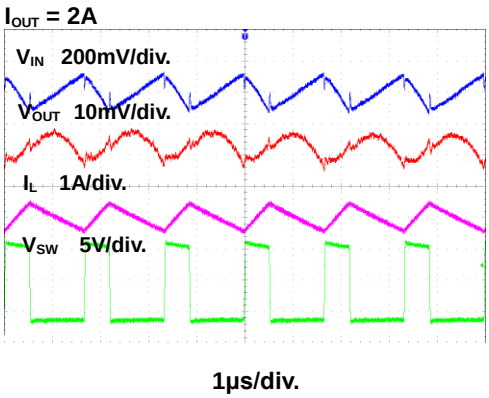


Figure 10. DC Ripple Waveform

Typical Performance Curves (Continued)

V_{IN} = 12V, V_{OUT} = 3.3V, C1 = 10µF, C2 = 47µF, L1 = 4.7µH, TA = +25°C, unless otherwise noted.

I_{OUT} = 0.1A

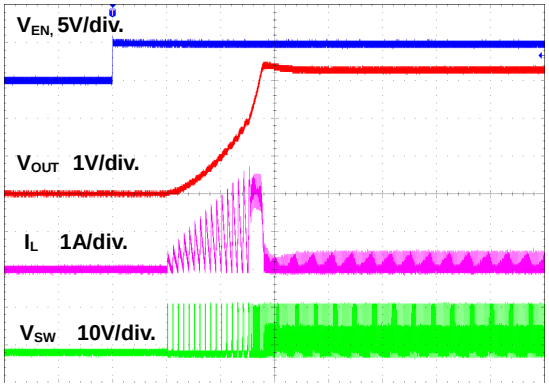


Figure 11. Startup Through Enable Waveform

I_{OUT} = 2A

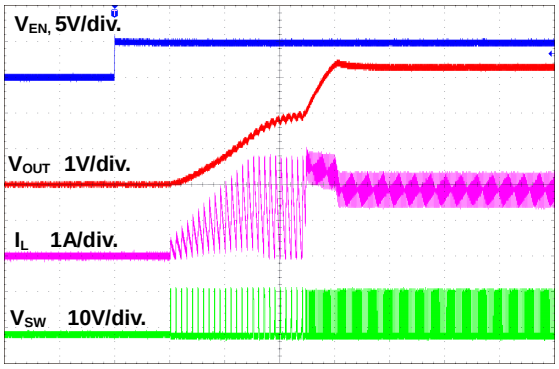


Figure 12. Startup Through Enable Waveform

I_{OUT} = 0.1A

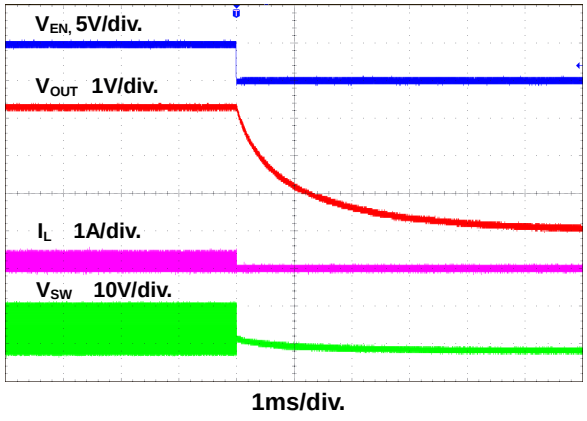


Figure 13. Shutdown Through Enable Waveform

I_{OUT} = 2A

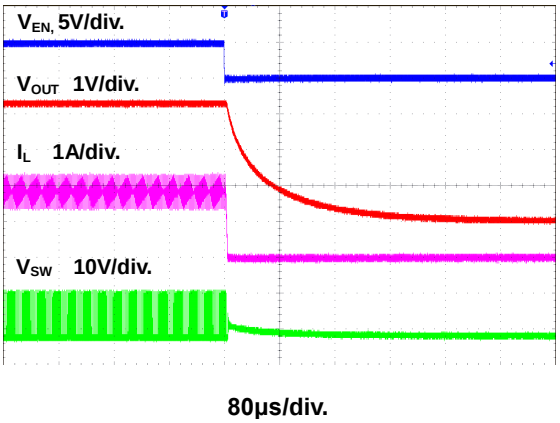


Figure 14. Shutdown Through Enable Waveform

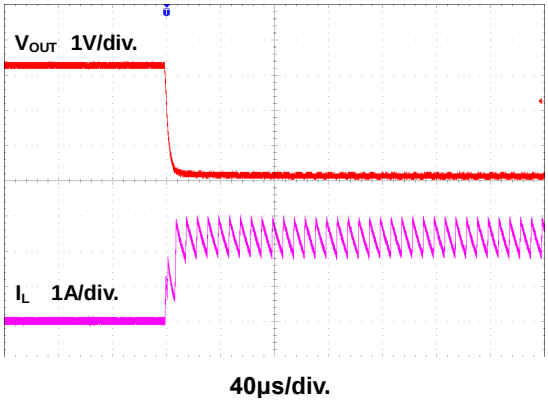


Figure 15. Short Circuit Test Waveform

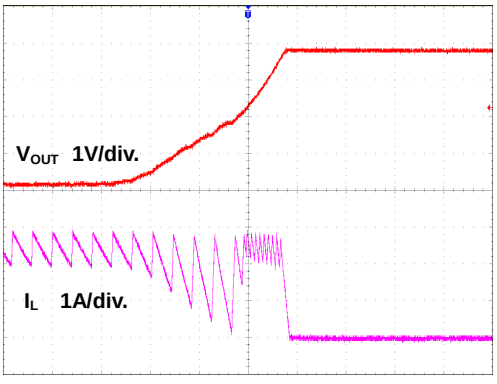


Figure 16. Short Circuit Recovery Waveform

Typical Performance Curves (Continued)

V_{IN} = 12V, V_{OUT} = 3.3V, C1 = 10µF, C2 = 47µF, L1 = 4.7µH, TA = +25°C, unless otherwise noted.

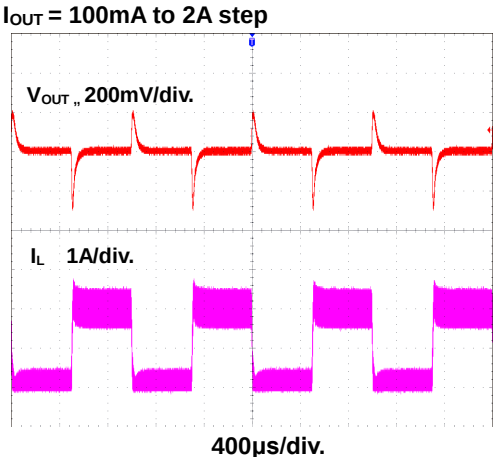
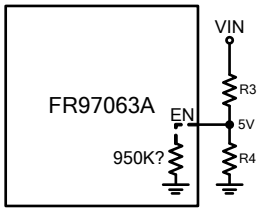


Figure 17. Load Transient Waveform

Application Information

Setting EN Automatic Startup Voltage



The external resistor divider is used to set the EN automatic startup voltage:

$$R4=\frac{V_{EN}}{\left(\frac{V_{IN}-V_{EN}}{R3}\right)}$$

For example, V_{IN}=12V, R3=100KΩ, thus R4 resistor value is:

$$R4=\frac{5V}{\left(\frac{12V-5V}{100k\Omega}\right)}\approx 71.5k\Omega$$

Table 1 shows a list of resistor selection for common input voltages:

Table 1 -- Resistor Selection for Common Input Voltages

VIN	R3	R4
5V	100kΩ	NC
12V	100kΩ	71.5kΩ
16V	100kΩ	45.3kΩ

Setting Output Voltage

The external resistor divider is used to set the output voltage. FR97063A feedback resistors are unconcerned of compensation and provide an easy way to program output voltage. Table 2 shows a list of resistor selection for common output voltages:

$$V_{OUT}=0.805\times\left(1+\frac{R1}{R2}\right)V$$

Table 2 —Resistor Selection for Common Output Voltages

V_{OUT}	R1	R2
5V	43kΩ	8.2kΩ
3.3V	30.9kΩ	10kΩ
2.5V	21kΩ	10kΩ
1.8V	12.4kΩ	10kΩ

Selecting the Inductor

A 4.7μH inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For the highest efficiency, the inductor's DC resistance should be less than 200mΩ. For most designs, the required inductance value can be derived from the following equation.

$$\Delta I=0.3\times I_{L(MAX)}$$

$$L\geq(V_{IN}-V_{OUT})\times\left(\frac{V_{OUT}}{F_{SW}\times\Delta I\times V_{IN}}\right)$$

Where ΔI is the inductor ripple current.

Choose the inductor ripple current to be 30% of the maximum load current. The maximum inductor peak current is calculated from:

$$I_{L(MAX)}=I_{LOAD}+\frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, a larger inductance is recommended for improving efficiency.

Selecting the Input Capacitor

The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent high frequency switching current from passing through the input. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. For most applications, 10μF capacitor is sufficient.

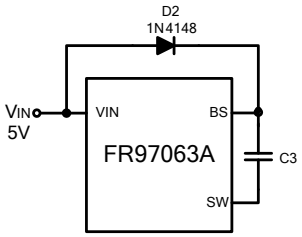
Application Information (Continued)

Selecting the Output Capacitor

The output capacitor keeps the output voltage ripple small, and a 47μF ceramic capacitor with X5R or X7R dielectrics is recommended for its low ESR characteristics.

External Bootstrap Diode

An external bootstrap diode is recommended if the input voltage is less than 5V or there is a 5V system rail available. This diode helps improving the efficiency. Low cost diodes, such as 1N4148, are suitable for this application.



Rectifier Diode

Use a Schottky diode as the rectifier to conduct current when the high-side power MOSFET is off. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating higher than the maximum input voltage.

PCB Layout Recommendation

The device's performance and stability are dramatically affected by PCB layout. It is recommended to follow these general guidelines shown as below:

1. 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.
2. Place V_{IN} bypass capacitors close to the V_{IN} pin.
3. Place feedback resistors close to the FB pin.
4. Keep the sensitive signal (FB) away from the switching signal (SW).
5. The exposed pad of the package should be soldered to an equivalent area of metal on the PCB. This area should connect to the GND plane and have multiple via connections to the back of the PCB as well as connections to intermediate PCB layers. The GND plane area which connects to the exposed pad should be maximized to improve thermal performance. (Figure 6)

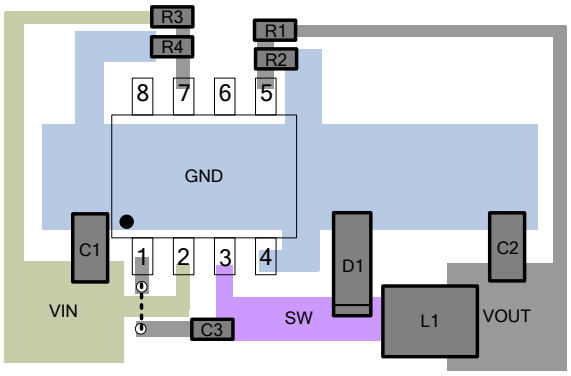


Figure 18. Recommended Layout Diagram (SOP-8 package)

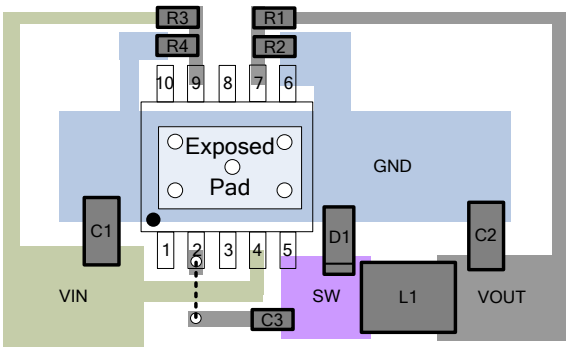
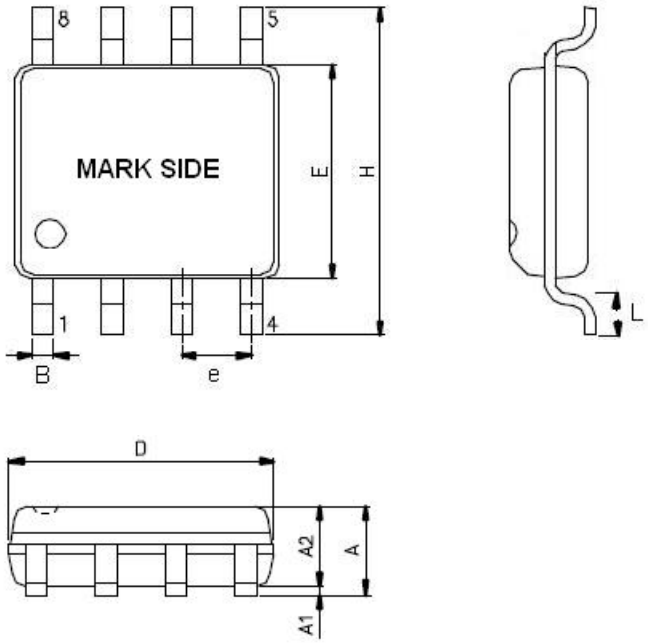


Figure 19. Recommended Layout Diagram (MSOP-10 exposed pad package)

Outline Information

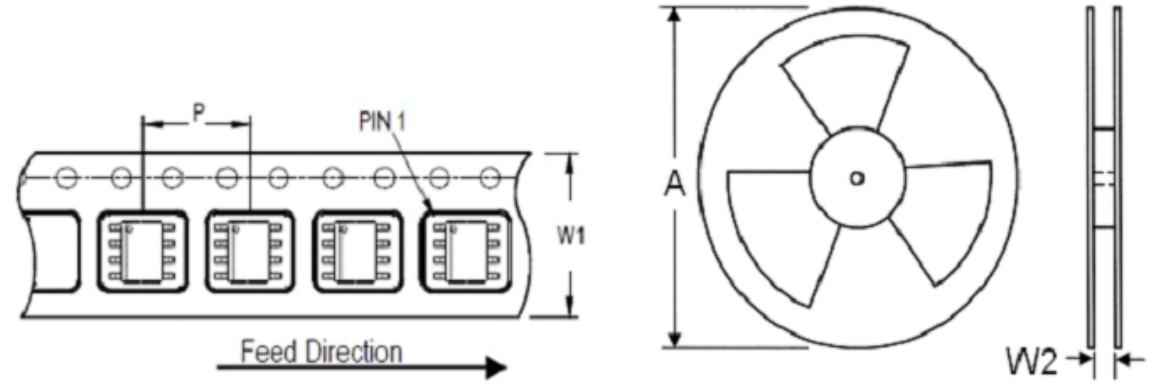
SOP-8 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
A2	1.25	1.50
B	0.31	0.51
D	4.80	5.00
E	3.80	4.00
e	1.20	1.34
H	5.80	6.20
L	0.40	1.27

Note：Followed From JEDEC MO-012-E

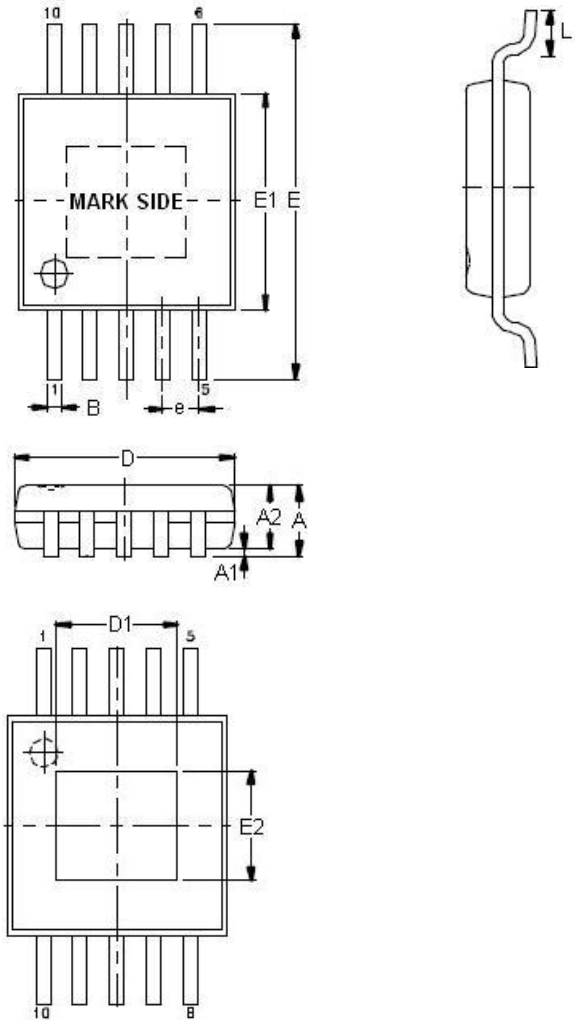
Carrier Dimensions



Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A)		Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
		in	mm			
12	8	13	330	12.4	400~1000	2,500

Outline Information (Continued)

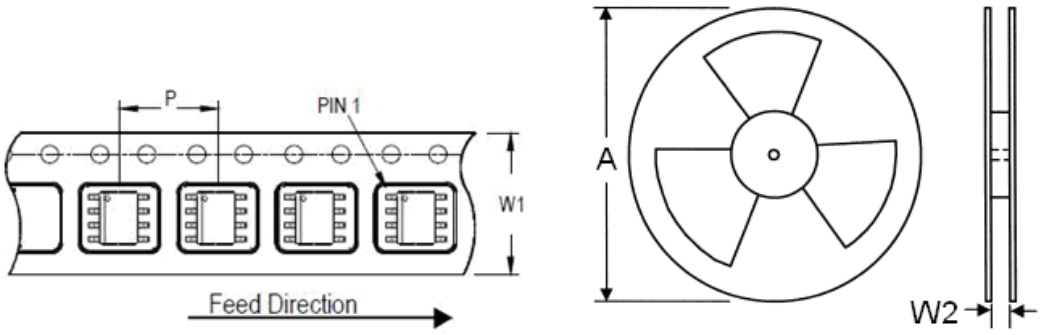
MSOP-10 (Exposed Pad) Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	0.75	1.10
A1	0.00	0.15
A2	0.75	0.95
B	0.17	0.30
D	2.90	3.10
E	4.80	5.00
E1	2.90	3.10
e	0.40	0.60
L	0.40	0.80
D1	0.75	2.50
E2	0.75	2.50

Note：Followed From JEDEC MO-187-E.

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			
12	8	13	330	12.4	400~1000	3,000

Life Support Policy

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