3A, 23V, 340kHz Synchronous Step-Down Converter

General Description

The RT8253A is a high efficiency, monolithic synchronous step-down DC/DC converter that can deliver up to 3A output current from a 4.5V to 23V input supply. The RT8253A's current mode architecture and external compensation allow the transient response to be optimized over a wide range of loads and output capacitors. Cycle by cycle current limit provides protection against shorted outputs and soft-start eliminates input current surge during start up. Fault conditions also include output under voltage protection and thermal shutdown. The low current (<3μA) shutdown mode provides output disconnect, enabling easy power management in battery powered systems. The RT8253A is available in a SOP-8 (Exposed Pad) package.

Ordering Information

RT8253A □□□

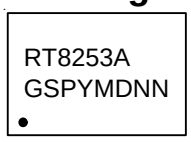
- Package Type
  SP : SOP-8 (Exposed Pad-Option 1)
- Lead Plating System
  G : Green (Halogen Free and Pb Free)
- H : UVP Hiccup
  L : UVP Latch-Off

Note :

Richtek products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

Marking Information



RT8253AGSP : Product Number

YMDNN : Date Code

Features

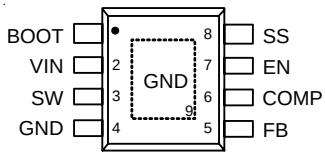
- **±1.5% High Accuracy Feedback Voltage**
- **4.5V to 23V Input Voltage Range**
- **3A Output Current**
- **Integrated N-MOSFET Switches**
- **Current Mode Control**
- **Fixed Frequency Operation : 340kHz**
- **Output Adjustable from 0.8V to 20V**
- **Up to 95% Efficiency**
- **Programmable Soft-Start**
- **Stable with Low ESR Ceramic Output Capacitors**
- **Cycle by Cycle Over Current Protection**
- **Input Under Voltage Lockout**
- **Output Under Voltage Protection**
- **Thermal Shutdown Protection**
- **RoHS Compliant and Halogen Free**

Applications

- Industrial and Commercial Low Power Systems
- Set Top Box
- LCD Monitors and TVs
- Green Electronics/Appliances
- Point of Load Regulation of High Performance DSPs
- Wireless AP/Router

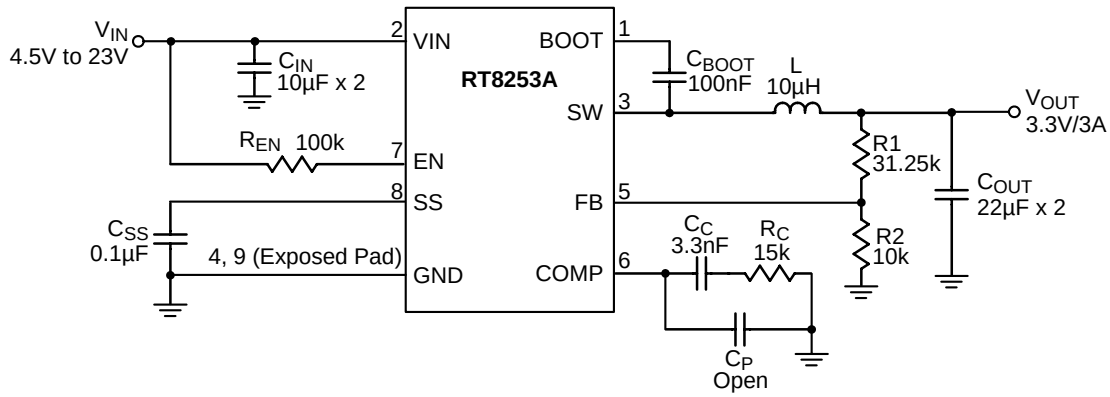
Pin Configurations

(TOP VIEW)



SOP-8 (Exposed Pad)

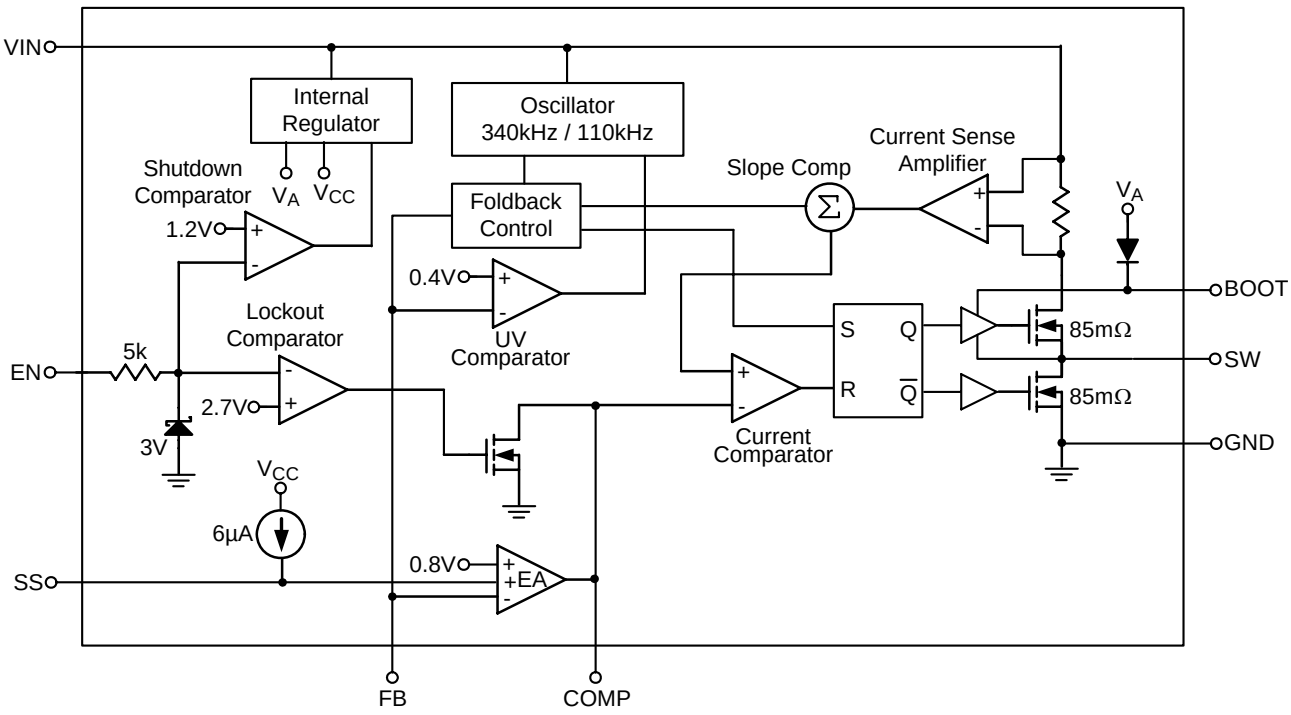
Typical Application Circuit



Functional Pin Description

Pin No.	Pin Name	Pin Function
1	BOOT	Bootstrap for High Side Gate Driver. Connect 0.1µF or greater ceramic capacitor from BOOT to SW pins.
2	VIN	Input Supply Voltage. Must bypass with a suitably large ceramic capacitor.
3	SW	Phase Node Connect to external L-C filter.
4, 9 (Exposed Pad)	GND	Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.
5	FB	Feedback Input Pin. This pin is connected to the converter output. It is used to set the output of the converter to regulate to the desired value via an internal resistive divider. For an adjustable output, an external resistive divider is connected to this pin.
6	COMP	Compensation Node. COMP is used to compensate the regulation control loop. Connect a series RC network from COMP to GND. In some cases, an additional capacitor from COMP to GND is required.
7	EN	Enable Input Pin. A logic high enables the converter; a logic low forces the RT8253A into shutdown mode reducing the supply current to less than 3µA. Attach this pin to VIN with a 100kΩ pull up resistor for automatic startup.
8	SS	Soft-Start Control Input. SS controls the soft-start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1µF capacitor sets the soft-start period to 13.5ms.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- V_{IN} ---------- –0.3V to 25V
- SW ---------- –0.3V to (V_{IN} + 0.3V)
- BOOT ---------- (SW–0.3V) to (SW + 6V)
- All Other Voltages ---------- –0.3V to 6V
- BOOT – SW ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  SOP-8 (Exposed Pad) ---------- 1.333W
- Package Thermal Resistance (Note 2)
  SOP-8 (Exposed Pad), θ_{JA} ---------- 75°C/W
  SOP-8 (Exposed Pad), θ_{JC} ---------- 15°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 4)

- Supply Voltage, V_{IN} ---------- 4.5V to 23V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = 12V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Shutdown Supply Current		V_{EN} = 0V	--	0.5	3	μA
Supply Current		V_{EN} = 3 V, V_{FB} = 0.9V	--	0.8	1.2	mA
Feedback Reference Voltage	V_{FB}	4.5V ≤ V_{IN} ≤ 23V	0.788	0.8	0.812	V
Error Amplifier Transconductance	g_{EA}	ΔI_C = ± 10μA	--	940	--	μA/V
High Side Switch On Resistance	$R_{DS(ON)1}$		--	85	--	mΩ
Low Side Switch On Resistance	$R_{DS(ON)2}$		--	85	--	mΩ
High Side Switch Leakage Current		V_{EN} = 0V, V_{SW} = 0V	--	0	10	μA
Upper Switch Current Limit		Min. Duty Cycle, V_{BOOT} – V_{SW} = 4.8V	--	5.8	--	A
COMP to Current Sense Transconductance	g_{CS}		--	5.6	--	A/V
Oscillation Frequency	f_{OSC1}		300	340	380	kHz
Short Circuit Oscillation Frequency	f_{OSC2}	V_{FB} = 0V	--	110	--	kHz
Maximum Duty Cycle	D_{MAX}	V_{FB} = 0.7V	--	93	--	%
Minimum On Time	t_{ON}		--	100	--	ns

To be continued

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Under Voltage Lockout Threshold			V_{IN} Rising	3.8	4.2	4.5	V
Input Under Voltage Lockout Threshold Hysteresis				--	320	--	mV
EN Threshold Voltage	Logic-High	V_{IH}		2.7	--	5.5	V
	Logic-Low	V_{IL}		--	--	0.4	
Soft-Start Current		I_{SS}	V_{SS} = 0V	--	6	--	μA
Soft-Start Period		t_{SS}	C_{SS} = 0.1μF	--	13.5	--	ms
Thermal Shutdown		T_{SD}		--	150	--	°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

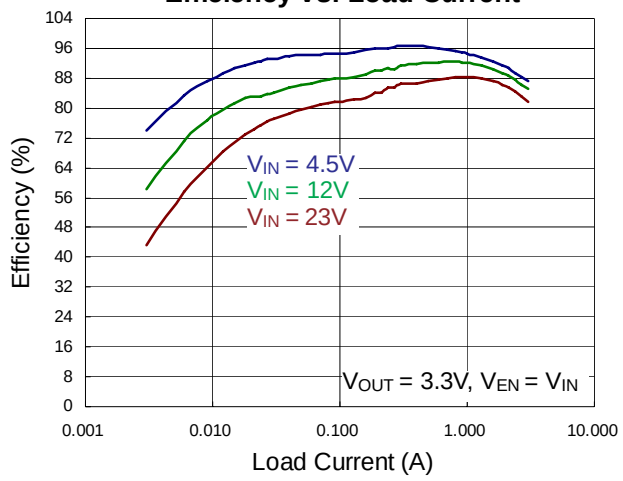
Note 2. θ_{JA} is measured in natural convection at T_A = 25°C on a high effective thermal conductivity four-layer test board of JEDEC 51-7 thermal measurement standard. The measurement case positions of θ_{JC} are on the lead of the SOP package and the expose pad for the SOP(Exposed Pad) package.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

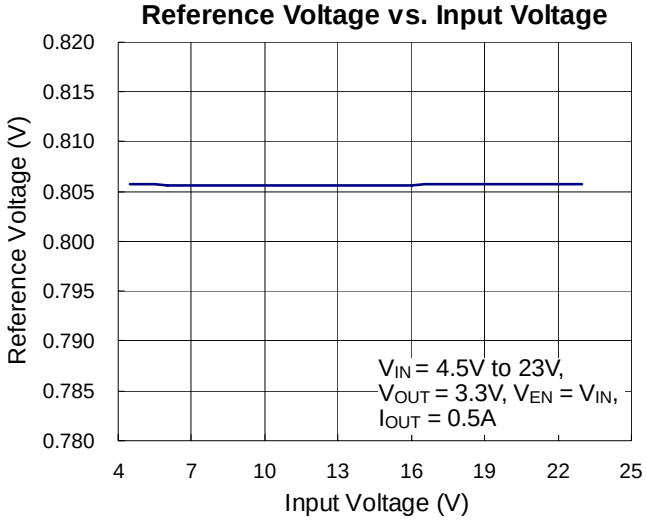
Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

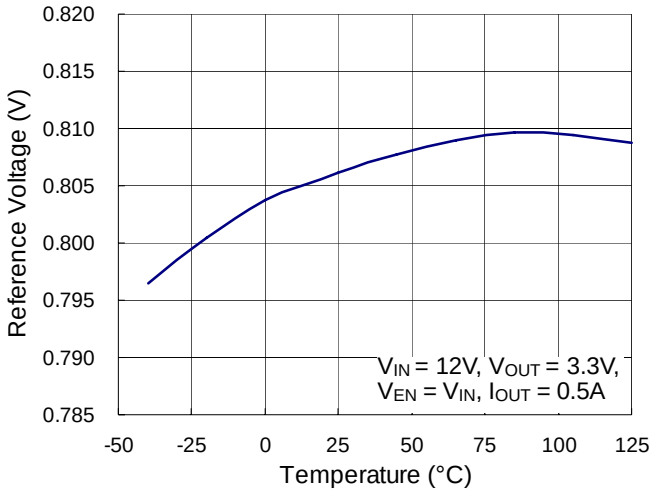
Efficiency vs. Load Current



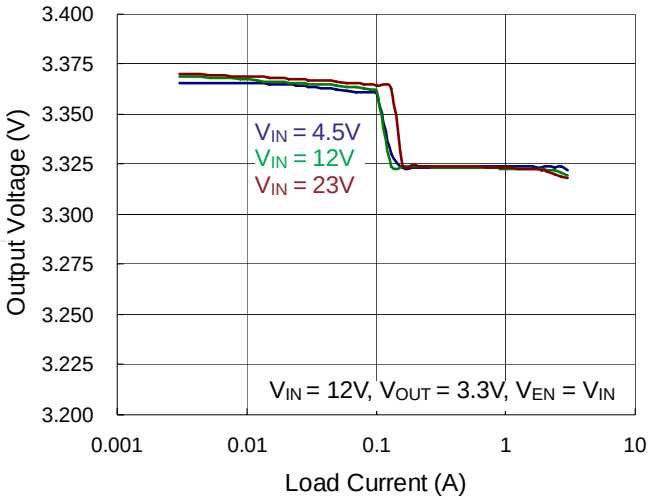
Reference Voltage vs. Input Voltage



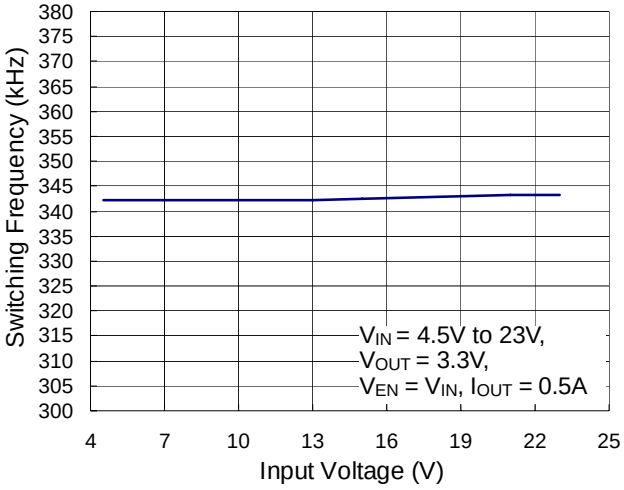
Reference Voltage vs. Temperature



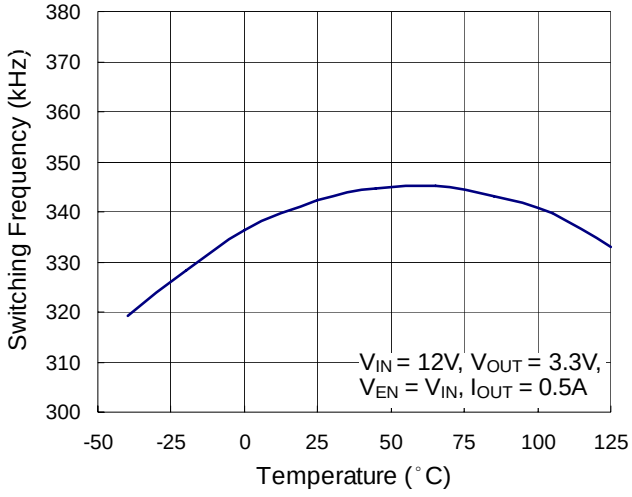
Output Voltage vs. Load Current



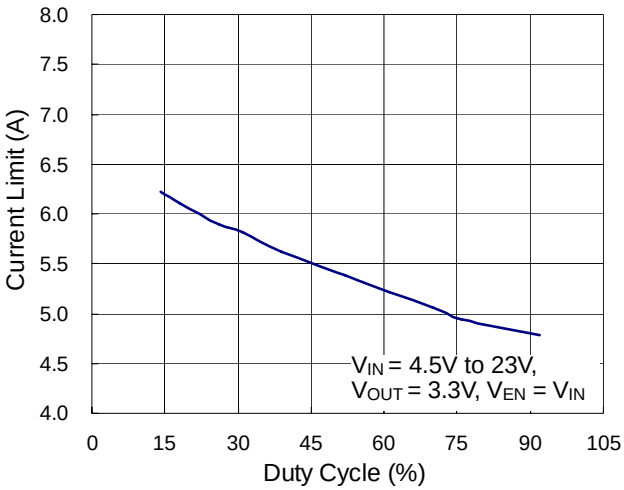
Switching Ferquency vs. Input Voltage



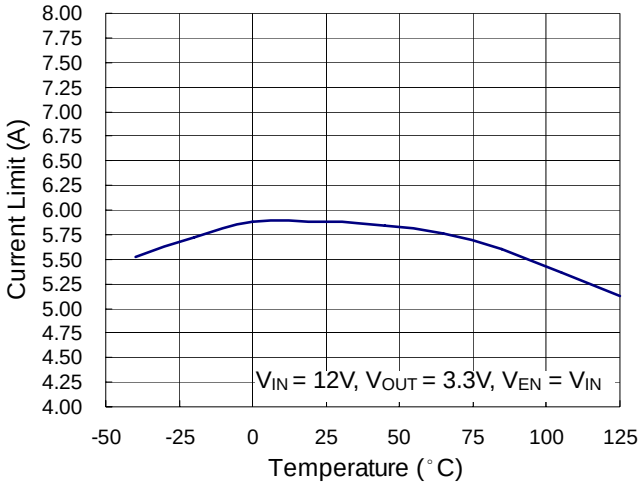
Switching Frequency vs. Temperature



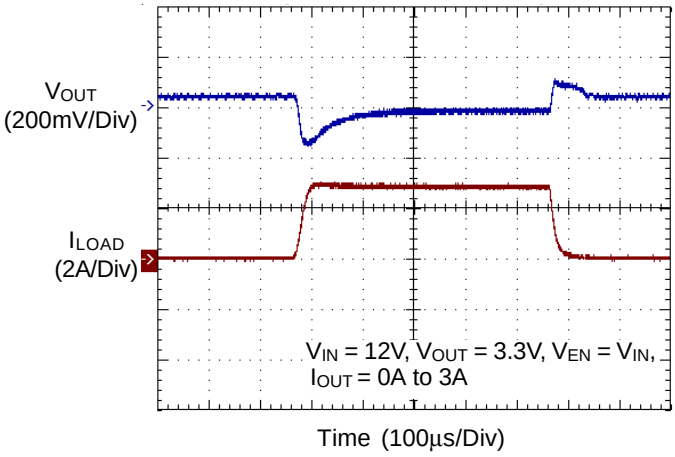
Current Limit vs. Duty Cycle



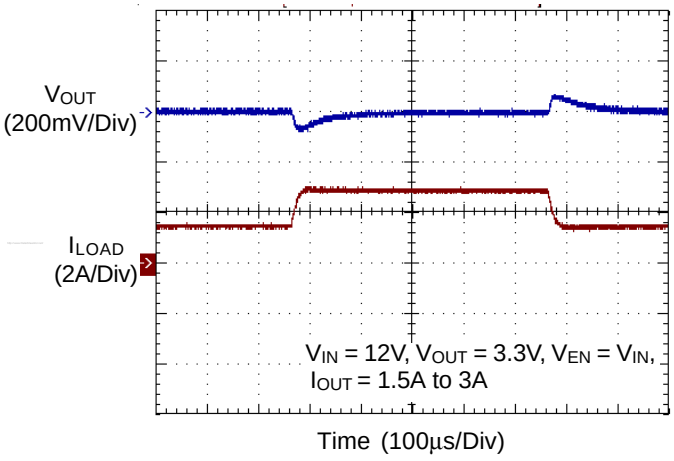
Current Limit vs. Temperature



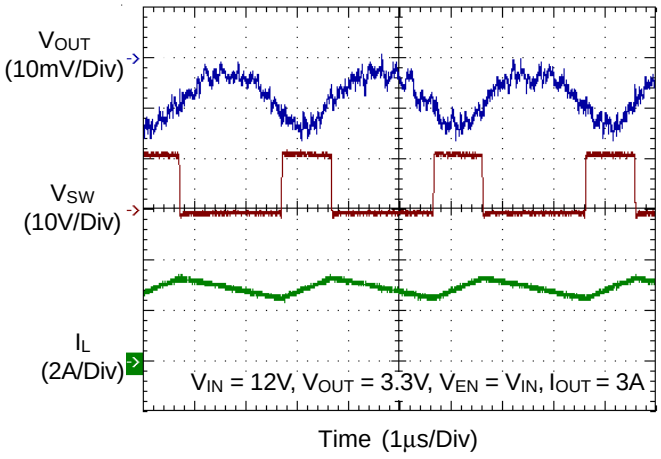
Load Transient Response



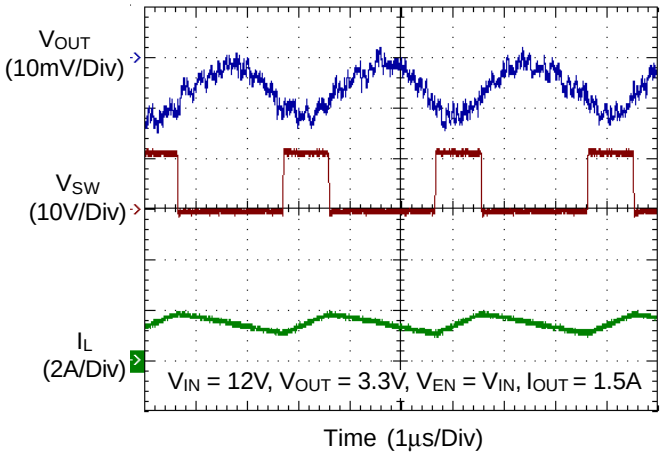
Load Transient Response



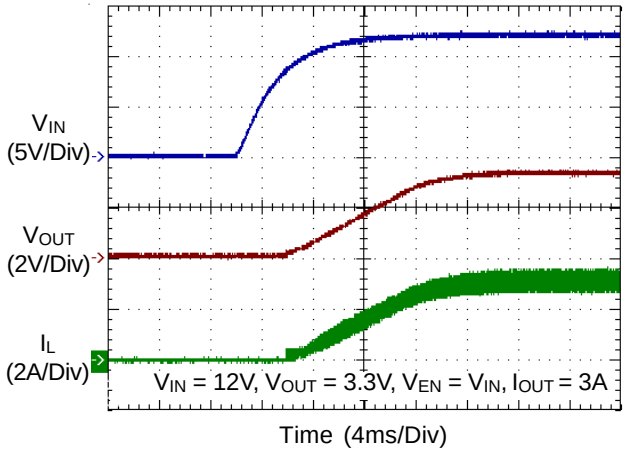
Switching Waveform



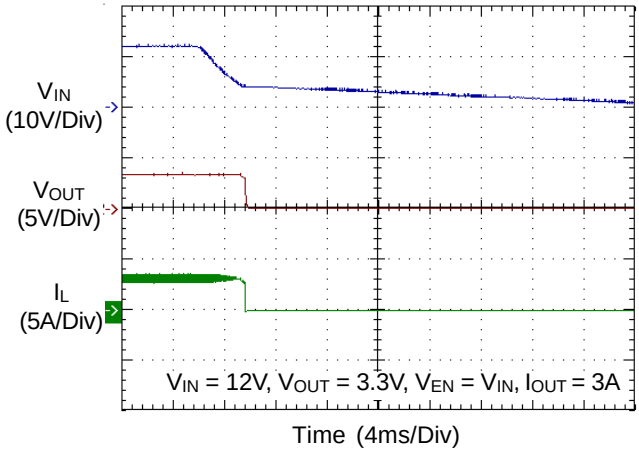
Switching Waveform



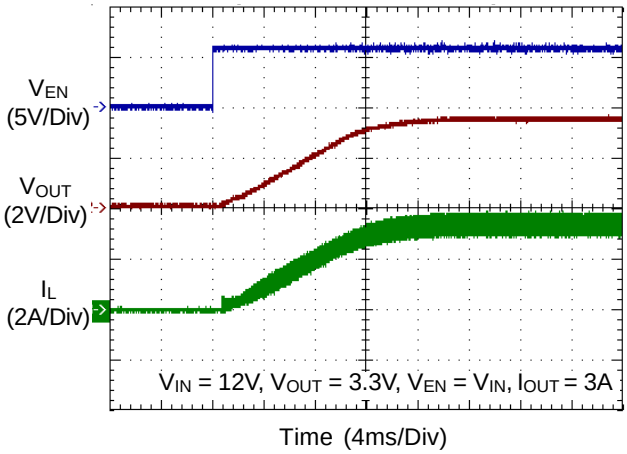
Power On From V_{IN}



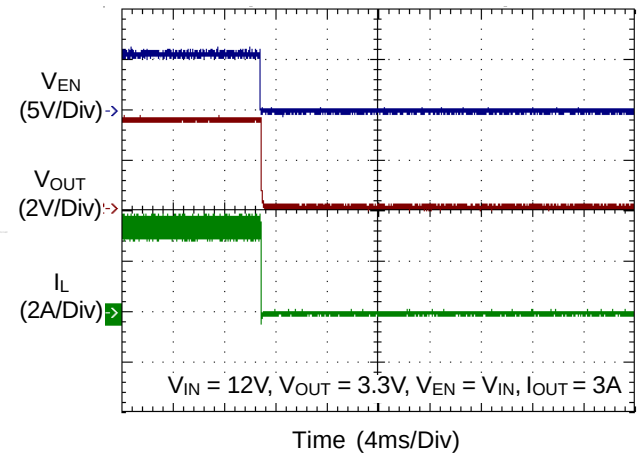
Power Off From V_{IN}



Power On From EN



Power Off From EN



Application Information

The RT8253A is a single phase buck PWM converter with internal N-MOSFET switches. It provides single feedback loop, current mode control with fast transient response. An internal 0.8V reference allows the output voltage to be precisely regulated for low output voltage applications. A fixed switching frequency (340kHz) oscillator is integrated to eliminate external component count. The RT8253A also supports programmable soft start function by an external capacitor. Protection features include over current protection, under voltage protection and input Under Voltage Lockout (UVLO).

PWM Operation

The RT8253A utilizes DEM control to improve light load efficiency. Depending on the load current, the controller automatically operates in Diode Emulation Mode (DEM) or in Continuous Conduction Mode (CCM) with fixed frequency PWM.

At light load condition, the RT8253A automatically operates in diode emulation mode to reduce switching frequency to improve efficiency. As the output current decreases from heavy load condition, the inductor current decreases, and eventually the inductor valley current decreases to zero, which is the boundary between continuous conduction mode and discontinuous conduction mode. By emulating the behavior of diodes, the low side MOSFET allows only partial negative current to flow when the inductor freewheeling current becomes negative. As the load current further decreases, it takes longer and longer to discharge the output capacitor to the level that allows the next UGATE on-time to begin. When the output current increases from light load to heavy load, the switching frequency increases to the CCM value as the inductor current reaches the continuous conduction condition. The controller will then operate in continuous conduction mode with 340kHz fixed PWM switching frequency.

Output Voltage Setting

Connect a resistive voltage divider at the FB pin between V_{OUT} and GND to adjust the respective output voltage between 0.8V and 20V (Figure 1). Choose R2 to be approximately 10kΩ, and solve for R1 using the equation :

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

where V_{FB} is 0.8V (typ.).

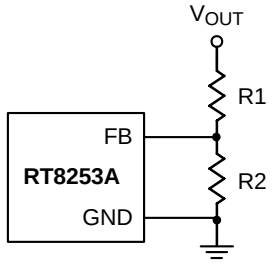


Figure 1. Setting V_{OUT} with a Resistive Voltage Divider

External Bootstrap Diode & Capacitor

The bootstrap capacitor must be 0.1μF and located between the BOOT pin and SW pin. This capacitor provides the gate driver voltage for the high side MOSFET and should be a high quality ceramic type with X7R or X5R grade dielectric for temperature stability.

An external bootstrap diode may enhance the efficiency of the regulator and it is recommended to add one between an external 5V source and the BOOT pin (Figure 2). The applicable conditions of the external bootstrap diode are as follows :

- Input voltage is lower than 5.5V; and
- Duty cycle is high: $D = \frac{V_{OUT}}{V_{IN}} > 65\%$

In these cases, the external 5V source can be a fixed 5V from the system or the output of the RT8253A. Note that the external boot voltage must be lower than 5.5V.

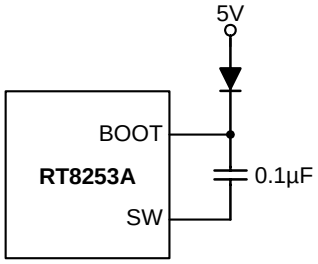


Figure 2. External Bootstrap Diode & Capacitor

Chip Enable and Disable

The EN pin is the RT8253A enable input. Drive EN below the precise input falling edge trip level to place the RT8253A in its low power shutdown state. The RT8253A quiescent current drops to lower than 3μA while in shutdown. When

shutdown mode is activated, the RT8253A will stop switching. The accurate 0.4V falling edge threshold on the EN pin can be used to detect a specific analog voltage level and to shutdown the device. Once in shutdown, the 2.7V rising edge threshold must be triggered to reactivate the power up sequence. For external timing control (e.g. RC), the EN pin can also be externally pulled high by adding a R_{EN}* resistor and C_{EN}* capacitor from the VIN pin. For general applications, the EN pin is externally pulled high by adding a 100kΩ from the VIN pin (see Figure 3).

UVLO Protection

The RT8253A has an input under voltage lockout protection (UVLO). If the input voltage exceeds the UVLO rising threshold voltage (4.2V typ.), the converter will reset and prepare the PWM for operation. If the input voltage falls below the UVLO falling threshold voltage during normal operation, the device will stop switching. The UVLO rising and falling threshold voltage has a hysteresis to prevent noise caused reset.

External Soft-Start (SS)

It is highly recommended to program the soft start time externally because it is not included internally. The RT8253A effectively uses the lower voltage of the internal voltage reference or the SS pin voltage as the power supply's reference voltage which is fed into the error amplifier and regulate accordingly. A capacitor (C_{SS}) between the SS pin and ground implements a soft start time. The RT8253A has an internal pull up current source of 6μA that charges the external soft start capacitor. The equation for the soft start time is shown below :

$$t_{SS} = \frac{C_{SS} \times V_{REF}}{I_{SS}}$$

where V_{REF} is 0.8V and I_{SS} current is 6μA.

Generally, a 0.1μF capacitor is used and the soft start time will be 13.5ms (typ.)

Under Voltage Protection

Hiccup Mode

For the RT8253AH, Hiccup Mode Under Voltage Protection (UVP) function is provided. When the FB voltage drops below half of the feedback voltage, V_{FB}, the UVP function will be triggered and the RT8253AH will shut down for a period of time and then recover automatically. The Hiccup Mode UVP can reduce input current in short circuit conditions.

Latch Off Mode

For the RT8253AL, Latch Off Mode Under Voltage Protection (UVP) function is provided. When the FB voltage drops below half of the feedback voltage, V_{FB}, the UVP function will be triggered and the RT8253AL will shut down in Latch Off Mode. In shutdown condition, the RT8253AL can only be reset through EN or power input V_{IN}.

Input Inrush Current

To calculate the input inrush current, the following equation can be used :

$$I_{INRUSH} = \frac{C_{OUT} \times V_{OUT}}{t_{SS}}$$

where I_{INRUSH} is the input current during start up, C_{OUT} is the total output capacitance, V_{OUT} is the desired output voltage, and t_{SS} is the soft start time. If the inrush current is higher than the current limit level, current limit will be triggered.

Inductor Selection

The switching frequency (on-time) and operating point (% ripple or LIR) determine the inductor value as shown below :

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{f_{SW} \times LIR \times I_{LOAD(MAX)} \times V_{IN}}$$

where LIR is the ratio of the peak to peak ripple current to the average inductor current.

Find a low loss inductor having the lowest possible DC resistance that fits in the allotted dimensions. Ferrite cores are often the best choice, although powdered iron is inexpensive and can work well at 200kHz. The core must be large enough not to saturate at the peak inductor current (I_{PEAK}) :

$$I_{PEAK} = I_{LOAD(MAX)} + \left[(LIR/2) \times I_{LOAD(MAX)} \right]$$

The calculation above shall serve as a general reference. To further improve transient response, the output inductor can be reduced further. This needs to be considered along with the selection of the output capacitor.

Input Capacitor Selection

Voltage rating and current rating are the key parameters in selecting the input capacitor. Generally, the input capacitor should have a voltage rating 1.5 times greater than the maximum input voltage to be considered a conservatively safe design.

The input capacitor is used to supply the input RMS current, which can be approximately calculated using the following equation :

$$I_{IN\_RMS} = I_{LOAD} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

The next step is to select a proper capacitor for RMS current rating. For a good design use more than one capacitor with low Equivalent Series Resistance (ESR) in parallel to form a capacitor bank.

Output Capacitor Selection

The output capacitor and inductor form a low pass filter in the buck topology. In steady state condition, the ripple current flowing into/out of the capacitor results in ripple voltage. The output voltage ripple (V_{p-p}) can be calculated by the following equation.

$$V_{P-P} = LIR \times I_{LOAD(MAX)} \times \left(ESR + \frac{1}{8 \times C_{OUT} \times f_{SW}}\right)$$

When load transient occurs, the output capacitor supplies the load current before the controller can respond. Therefore, the ESR will dominate the output voltage sag during load transient. The output voltage undershoot (V_{SAG}) can be calculated by the following equation :

$$V_{SAG} = \Delta I_{LOAD} \times ESR$$

For a given output voltage sag specification, the ESR value can be determined.

Another parameter that has influence on the output voltage sag is the equivalent series inductance (ESL). The rapid change in load current results in di/dt during transient. Therefore ESL contributes to part of the voltage sag. Use a capacitor that has low ESL to obtain better transient performance. Generally, using several capacitors connected in parallel will have better transient performance than using one single capacitor for the same total ESR.

Unlike the electrolytic capacitor, the ceramic capacitor has relatively low ESR and can reduce the voltage deviation during load transient. However, the ceramic capacitor can only provide low capacitance value. Therefore, using a mixed combination of electrolytic capacitor and ceramic capacitor can also have better transient performance.

EMI Consideration

Since parasitic inductance and capacitance effects in PCB circuitry would cause a spike voltage on the SW pin when high side MOSFET is turned on/off, this spike voltage on SW may impact EMI performance in the system. In order to enhance EMI performance, there are two methods to suppress the spike voltage. One method is to place an R-C snubber between SW and GND and locate them as close as possible to the SW pin (see Figure 3). Another way is adding a resistor in series with the bootstrap capacitor, C_{BOOT}, but this will decrease the driving capability to the high side MOSFET. It is strongly recommended to reserve the R-C snubber during PCB layout for EMI improvement. Moreover, reducing the SW trace area and keeping the main power in a small loop will be helpful for EMI performance. For detailed PCB layout guideline, please refer to the section on Layout Consideration.

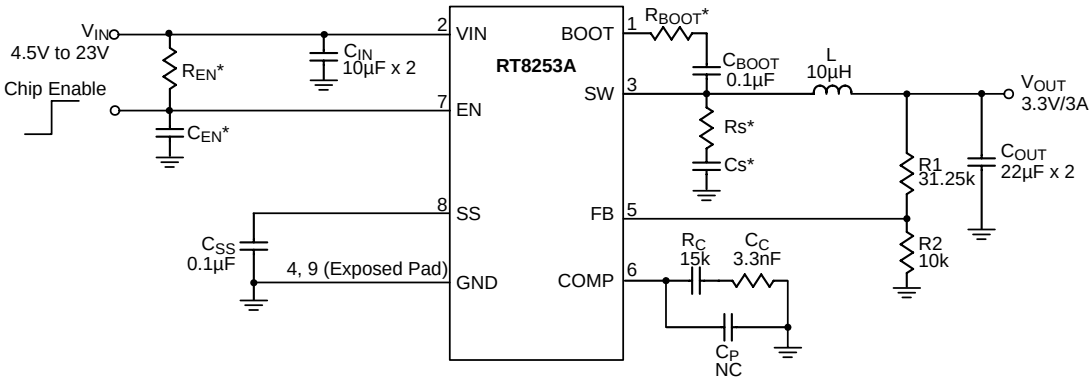


Figure 3. Reference Circuit with Snubber and Enable Timing Control

Thermal Shutdown

The device implements an internal thermal shutdown function to protect itself when the junction temperature exceeds 150°C. The thermal shutdown forces the device to stop switching when the junction temperature exceeds the thermal shutdown threshold. Once the die temperature decreases below 150°C, the device reinstates the power up sequence.

Loop Compensation

The RT8253A is a current mode converter and requires external compensation to have an accurate output voltage regulation with fast transient response. The main concern of compensation deals with the position of the capacitor ESR zero and mid frequency to high frequency gain boost.

The RT8253A uses a high gain Operational Transconductance Amplifier (OTA) as the error amplifier. As Figure 4 shows, the OTA works as the voltage controlled current source. The characteristic of OTA is shown as below :

$$GM = \frac{\Delta I_{OUT}}{\Delta V_M}, \text{where } \Delta V_M = (V+) - (V-)$$

$$\text{and } \Delta V_{COMP} = \Delta I_{OUT} \times Z_{OUT}$$

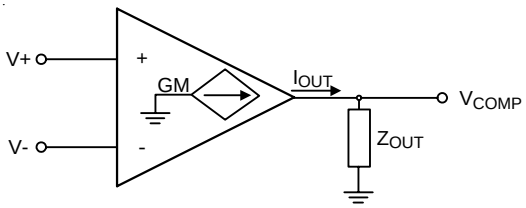


Figure 4. Operational Transconductance Amplifier, OTA

Figure 5 shows a typical buck control loop using Type-II compensator. The control loop consists of the power stage, current comparator and a compensation network. The current comparator compares V_{COMP} with the sum of current sense and slope comp to provide Pulse Width Modulated (PWM) gate driving signal with the oscillator. The PWM wave is smoothed out by the output filter, L and C_{OUT}. The output voltage (V_{OUT}) is sensed and fed to the inverting input of the error amplifier.

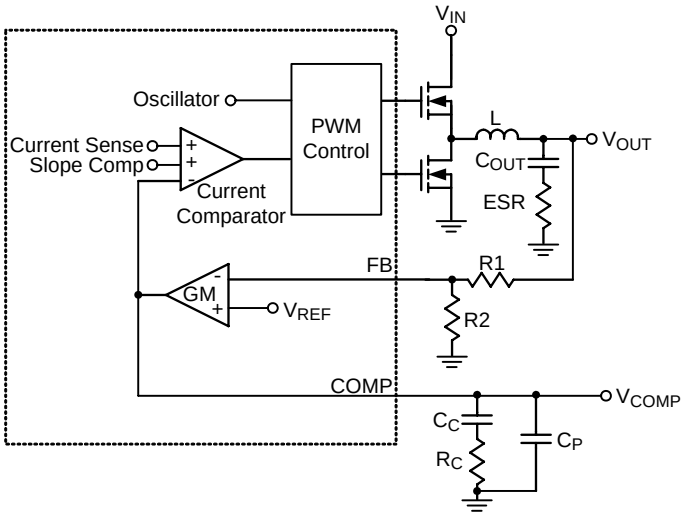


Figure 5. Typical Current Mode Buck Converter with Type-II Compensator

The modulator transfer function is the small signal transfer function of V_{OUT}/V_{COMP} (output voltage over the error amplifier output). According to the derivation of the Ridley's thesis, the transfer function is dominated by a DC gain, a double pole, a low frequency pole, and an ESR zero as shown in Figure 6.

$$\frac{V_{OUT}}{V_{COMP}} \cong R_{LOAD} \times g_{CS} \times \frac{1}{1 + \frac{R_{LOAD} \times T_S}{L} \times [m_C \times (1-D) - 0.5]} \times F_p(s) \times F_h(s)$$

where R_{LOAD} is the load resistor; g_{CS} is the current sense transconductance; m_C is the slope comp value; D is the duty cycle; T_S is the switching period. And :

$$F_p(s) = \frac{1 + sC_{OUT} \times ESR}{1 + \frac{s}{\omega_p}}$$

where

$$\omega_p = \frac{1}{C_{OUT} \times R_{LOAD}} + \frac{T_S}{L \times C_{OUT} \times [m_c \times (1-D) - 0.5]}$$

And

$$F_h(s) = \frac{1}{1 + \frac{S}{\omega_h Q_p} + \frac{S^2}{\omega_h^2}}$$

where

$$Q_p = \frac{1}{\Pi \times [m_c \times (1-D) - 0.5]}$$

$$\omega_h = \frac{\Pi}{T_S}$$

The goal of the compensation network is to provide adequate phase margin (usually greater than 45 degrees) and the highest bandwidth (0dB crossing frequency). It is also recommended to manipulate loop frequency response that its gain crosses over 0dB at a slope of -20dB/dec.

According to Figure 5, the compensation network frequency is shown as below :

$$f_{P1} = 0$$

$$f_{P2} = \frac{1}{2\Pi \times R_C \times \left(\frac{C_P \times C_C}{C_P + C_C}\right)}$$

$$fz = \frac{1}{2\Pi \times C_C \times R_C}$$

Determining the 0dB crossing frequency (f_C, control loop bandwidth) is the first step of compensator design. Usually, f_C is set to 0.1 to 0.5 times switching frequency. The second step is to calculate the open loop modulator gain and find out the gain loss at f_C. The third step is to design a compensator gain that can compensate the modulator gain loss at f_C. The final step is to design f_Z and f_{P2} to make loop have sufficient phase margin.

f_Z is designed to cancel the low frequency pole of modulator. f_{P2} is usually placed below switching frequency (typically, 0.5 to 1 times switching frequency) to eliminate high frequency noise.

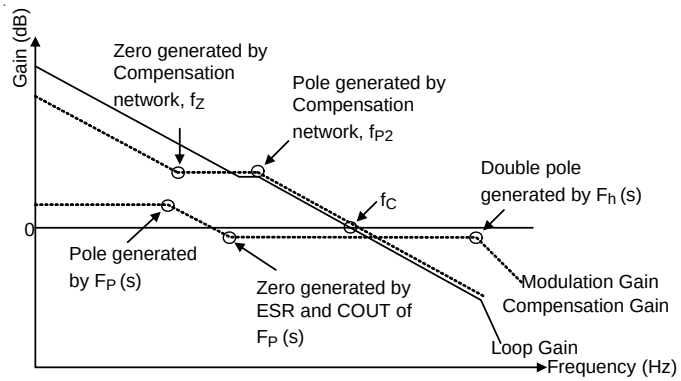


Figure 6. Typical Bode Plot of a Current Mode Buck Converter

Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by the following formula :

$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$

where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction to ambient thermal resistance.

For recommended operating condition specifications of the RT8253A, the maximum junction temperature is 125°C and T_A is the ambient temperature. The junction to ambient thermal resistance, θ_{JA}, is layout dependent. For SOP-8 (Exposed Pad) packages, the thermal resistance, θ_{JA}, is 75°C/W on a standard JEDEC 51-7 single layer thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by the following formula :

$P_{D(MAX)}$ = (125°C – 25°C) / (75°C/W) = 1.333W for SOP-8 (Exposed Pad) package

The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, θ_{JA}. For the RT8253A package, the derating curve in Figure 7 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

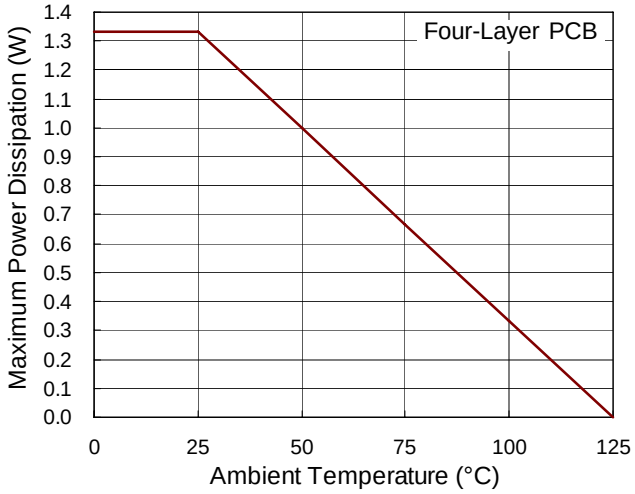


Figure 7. Derating Curve for RT8253A Package

Layout Considerations

Layout is very important in high frequency switching converter design. PCB could radiate excessive noise and contribute to the converter instability with improper layout. Certain points must be considered before starting a layout using the RT8253A (Figure 8).

- Keep the traces of the main current paths as short and wide as possible.
- Put the input capacitor as close as possible to the device pins (VIN and GND).
- SW node is with high frequency voltage swing and should be kept at small area. Keep sensitive components away from SW node to prevent stray capacitive noise pick up.
- Ensure all feedback network connections are short and direct. Place the feedback network and compensation components are close to the chip as possible.
- The GND pin and Exposed Pad should be connected to a strong ground plane for heat sinking and noise protection.
- An example of PCB layout guide is shown in Figure 8 for reference.

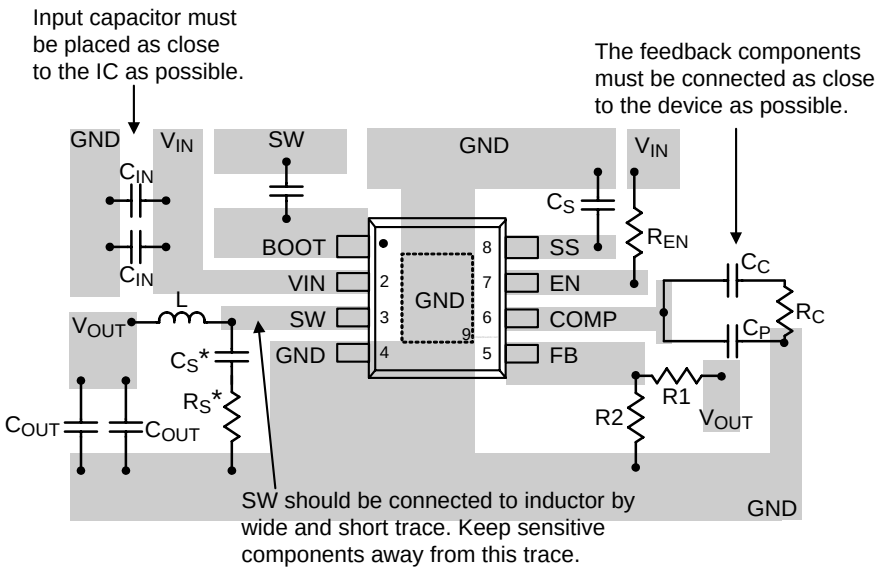
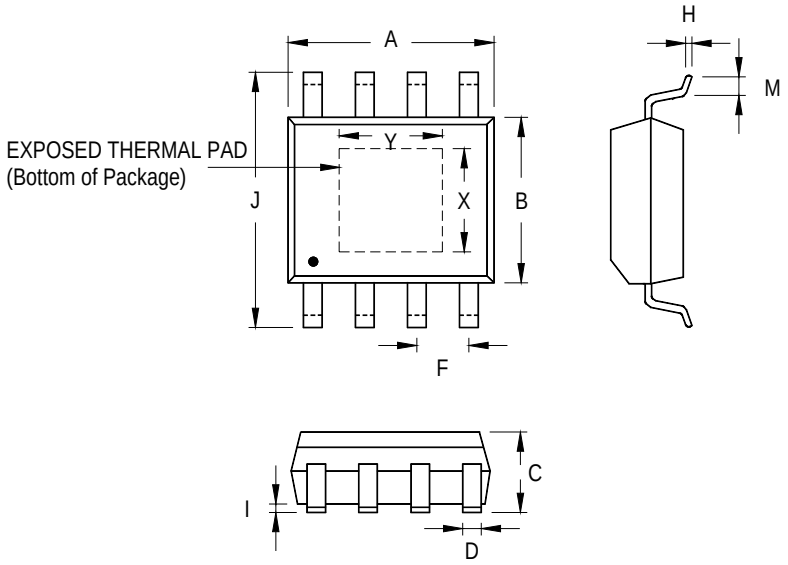


Figure 8. PCB Layout Guide

Outline Dimension



Symbol		Dimensions In Millimeters		Dimensions In Inches	
		Min	Max	Min	Max
A		4.801	5.004	0.189	0.197
B		3.810	4.000	0.150	0.157
C		1.346	1.753	0.053	0.069
D		0.330	0.510	0.013	0.020
F		1.194	1.346	0.047	0.053
H		0.170	0.254	0.007	0.010
I		0.000	0.152	0.000	0.006
J		5.791	6.200	0.228	0.244
M		0.406	1.270	0.016	0.050
Option 1	X	2.000	2.300	0.079	0.091
	Y	2.000	2.300	0.079	0.091
Option 2	X	2.100	2.500	0.083	0.098
	Y	3.000	3.500	0.118	0.138

8-Lead SOP (Exposed Pad) Plastic Package

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