UNIVERSAL PARTS SEMICONDUCTOR

up8008

1.5MHz, 1A, Synchronous Step Down DC/DC Converter

■DESCRIPTION

The UP8008 is a high-efficiency, DC-to-DC step-down switching regulators, capable of delivering up to 1A of output current. The device operates from an input voltage range of 2.5V to 6.0V and provides an output voltage from 0.6V to VIN, making the UP8008 ideal for low voltage power conversions. Running at a fixed frequency of 1.5MHz allows the use of small external components, such as ceramic input and output caps, as well as small inductors, while still providing low output ripples. This low noise output along with its excellent efficiency achieved by the internal synchronous rectifier, making UP8008 an ideal green replacement for large power consuming linear regulators. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal-overload protection improves design reliability.
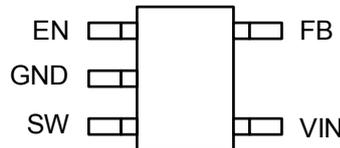
■FEATURE

Duty Cycle 0~100%
1A Output Current
High Efficiency Up To 96%
2.6V to 5.5V Input Voltage Range
Fixed 1.5MHz Frequency
Logic Control Shutdown IQ<1µA
Thermal Shutdown
Output Adjustable from 0.6V to Input Voltage

■APPLICATIONS

Digital Framer
PDA and Pocket PC
Cellular Phone and Smart Phone
Wireless Devices
Battery Powered Widgets
Portable Media Players
Electronic Scales

■PIN CONFIGURATION

EN
GND
SW

FB
VIN

TOP VIEW
SOT23-5L

■PART MARKING INFORMATION

UP8008XX-XX X

Lead Plating Code
Handling Code
Package Code

Lead Plating Code
G : Lead-free product.
This product is RoHS compliant

Handling Code
TR : Tape&Reel   TB : Tape&Box

Package Code
S5 : SOT23-5L

up8008

■ORDERING INFORMATION

Part Number	Package Code	Package	Voltage Code	Shipping
UP8008S5-TRG	S5	SOT23-5L	ADJ	3000/Tape&Reel

Note:
※"VV"stands for output voltages.
※ G : Lead-free product. This product is RoHS compliant

■ABSOLUTE MAXIMUM RATINGS (T$_A$ = 25℃ Unless otherwise noted)

Parameter	Symbol	Maximum	Unit
Thermal Resistance (Junction to Ambient)	θ$_{JA}$	250	°C/W
Thermal Resistance (Junction to Case)	θ$_{JC}$	90	°C/W
Input Voltage	V$_{IN}$	-0.3 ~ +6.5	V
EN, FB, SW Pin Voltage	V$_{OUT}$	-0.3 ~ V$_{IN}$	V
Operating Junction Temperature	T$_J$	-4 ~ +85	℃
Storage Temperature Range	T$_{STG}$	-65 ~ +150	℃

Note: Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are
   positive into, negative out of the specified terminal.

■ELECTRICAL CHARACTERISTICS(T$_A$ = 25℃ Unless otherwise noted)

T =25°C , V =3.6V unless otherwise noted.

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
Input Voltage Range	V$_{IN}$	-40°C ~ +85°C		2.5	-	6.0	V
Feedback Voltage	V$_{FB}$	TA=25°C		0.588	0.6	0.612	V
		TA=-40~85		0.585	0.6	0.615	V
EN Threshold High	V$_{EH}$	-40°C ~ +85°C		1.5	-	-	V
EN Threshold Low	V$_{EL}$	-40°C ~ +85°C		-	-	0.4	V
Peak Inductor Current	I$_{PK}$	V$_{FB}$=0.5V		-	1.5	-	A
EN Input Current	I$_{EN}$	-		-	±0.01	1	µA
Reference Voltage Line Regulation	ΔV$_{FB}$	V$_{IN}$=2.7V ~ 5.5V		-	0.04	-	%/V
Quiescent Current	I$_Q$	V$_{FB}$=0.78V		-	30	-	µA
Shutdown Current	I$_{SD}$	V$_{EN}$ = 0V		-	-	1	µA
Oscillator Frequency	f$_{OSC}$	V$_{FB}$ = 0.6V, -40°C ~ +85°C		-	1.5	-	MHz
Drain-Source On-State Resistance	R$_{DS(ON)}$	I$_{DS}$=200mA	PMOSFET	-	0.22	-	Ω
			NMOSFET	-	0.30	-	Ω
SW Leakage Current	I$_{LSW}$	V$_{OUT}$=5.5V, V$_{SW}$=0 or 5.5V, EN=0V		-	-	10	µA

■FUNCTION BLOCK DIAGRAM
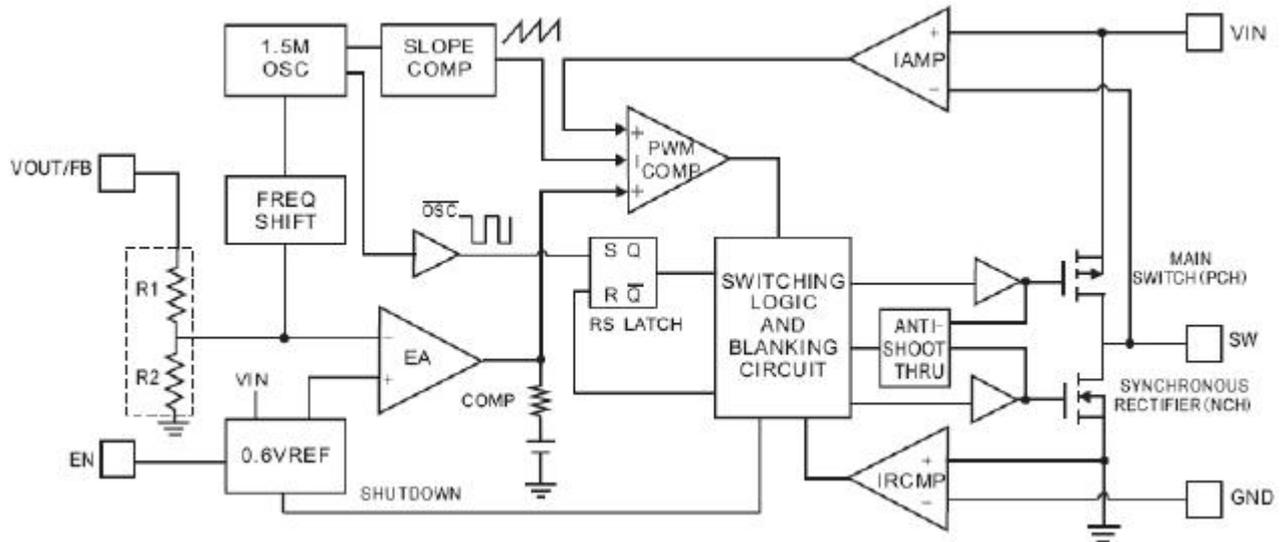
■TYPICAL APPLICATION

◆Adjustable Output Voltage
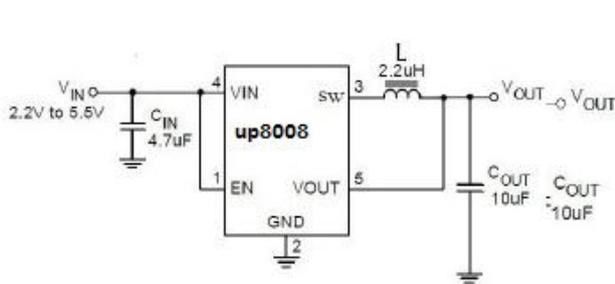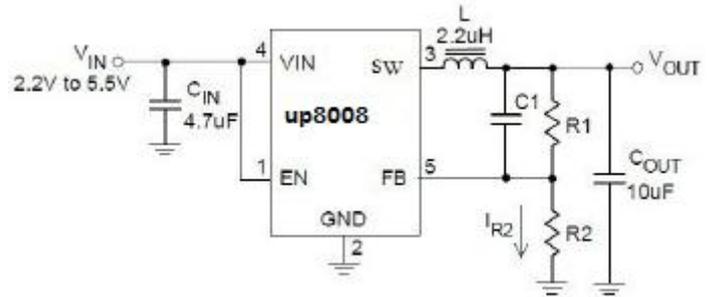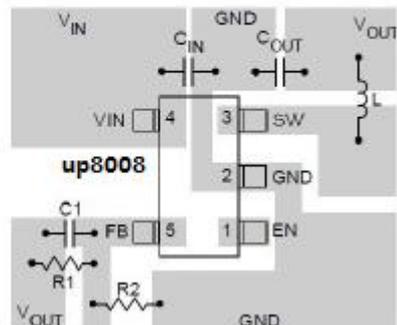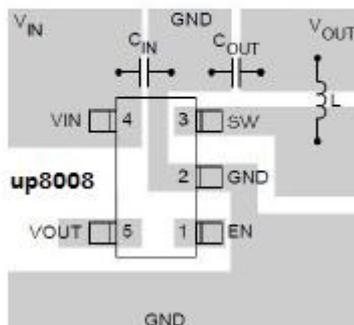

Figure 1. Fixed Voltage Regulator

and (R1 x C1) should be in the range between 3×10^{-6} and 6×10^{-6} for component selection.

Figure 2. Adjustable Voltage Regulator

Layout Guide

■DETAIL DESCRIPTION

The UP8008 high-efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1A of output current. The device operates in pulse-width modulation (PWM) at 1.5MHz from a 2.5V to 6.0V input voltage and provides an output voltage from 0.6V to VIN, making the UP8008 ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

◆Loop Operation

UP8008 uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp. At each rising edge of the internal clock, the internal high-side MOSFET turns on until the PWM comparator terminates the on cycle. During this on-time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor. The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal. During the off cycle, the internal high-side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

◆Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

◆Current Limit

There is a cycle-by-cycle current limit on the high-side MOSFET of 1.5A(typ). When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. UP8008 utilizes a frequency fold-back mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 200mV, limiting the current to 1.5A (typ) and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

◆Soft Start

UP8008 has a internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal-overload event, the I soft-start circuitry slowly ramps up current available at SW.

◆UVLO And Thermal Shutdown

If IN drops below 2.5V, the UVLO circuit inhibits switching. Once IN rises above 2.6V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device. When the junction temperature exceeds TJ= +160°C, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 15°C, resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

■DESIGN PROCEDURE

◆Setting Output Voltage

Output voltages are set by external resistors. The FB hreshold is 0.8V.

$$RTOP = RBOTTOM[(VOUT / 0.6) - 1]$$

◆Input Capacitor Selection

The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source. The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

$$VRIPPLE = IL(PEAK)[1 / (2\pi \times fOSC \times COUT)]$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$$VRIPPLE(ESR) = IL(PEAK) \times ESR$$

◆Output Capacitor and Inductor Selection

Follow the below table for Inductor and Output cap selection:

VOUT	1.2V	1.5V	1.8V	2.5V	3.3V
COUT	33µF	33µF	10~22µF	10~22µF	10µF
L	1.5µH	1.5µH	2.2µH	3.3µH	4.7µH

If much smaller values are used, inductor current rises, and a larger output capacitance may be required to suppress output ripple. Larger values than LIDEAL can be used to obtain higher output current, but typically with larger inductor size.

■APPLICAITION INFORMATION

Layout is critical to achieve clean and stable operation. The switching power stage requires particular attention. Follow these guidelines for good PC board layout:

1) Place decoupling capacitors as close to the IC as possible. Keep power ground plane (connected to PGND) and signal ground plane (connected to GND) separate.

2) Connect input and output capacitors to the power ground plane; connect all other capacitors to the signal ground plane.
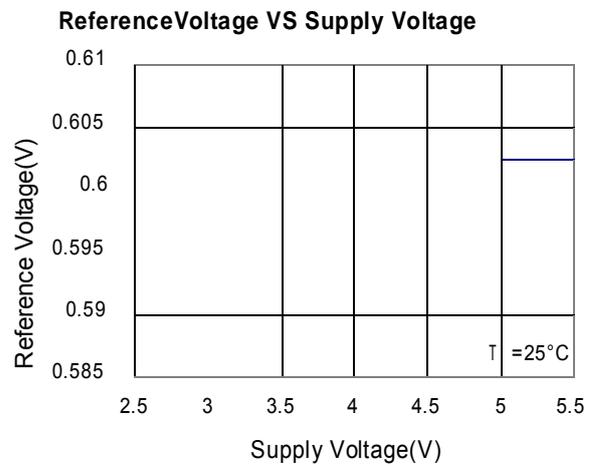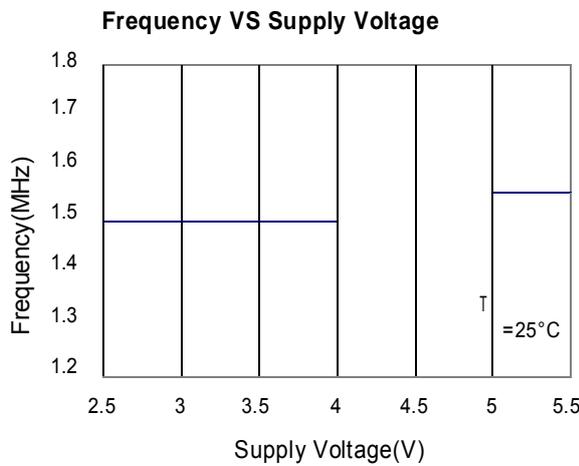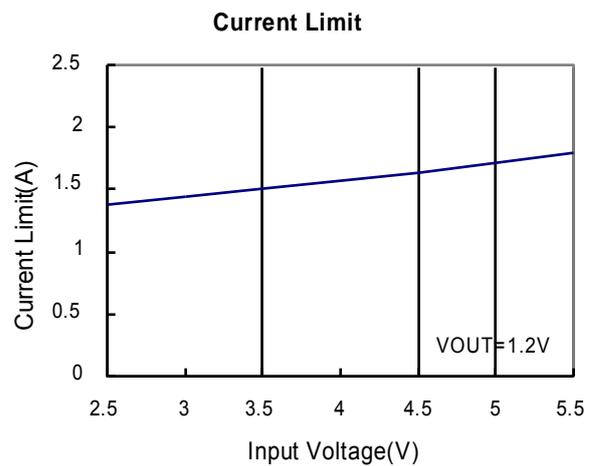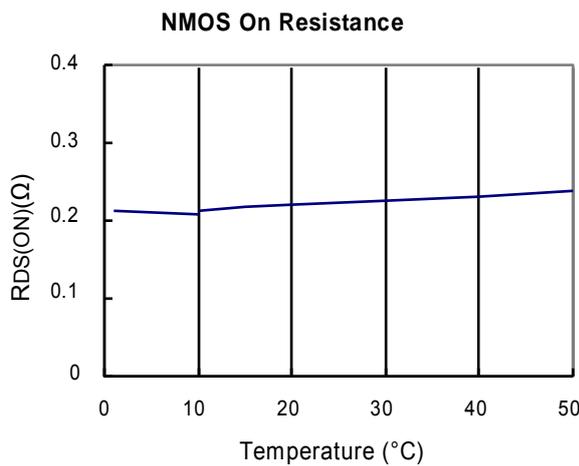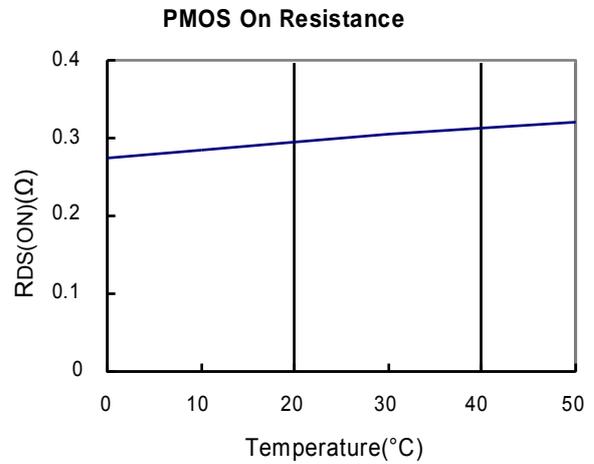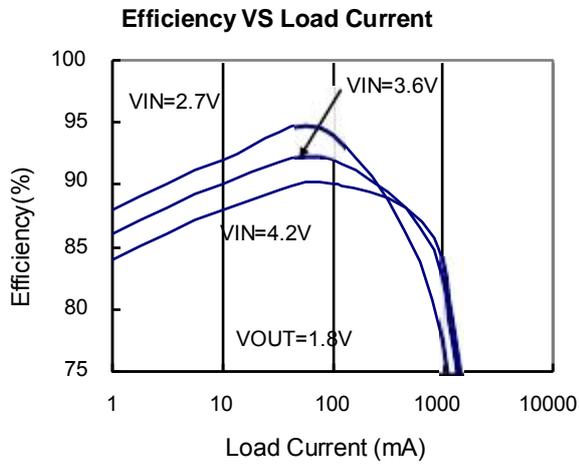
3) Keep the high-current paths as short and wide as possible. Keep the path of switching current (C1 to IN and C1 to GND) short. Avoid vias in the switching paths.

4) If possible, connect IN, SW, and GND separately to a large copper area to help cool the IC to further improve efficiency and long-term reliability.

5) Ensure all feedback connections are short and direct. Place the feedback resistors as close to the IC as possible.

6) Route high-speed switching nodes away from sensitive analog areas

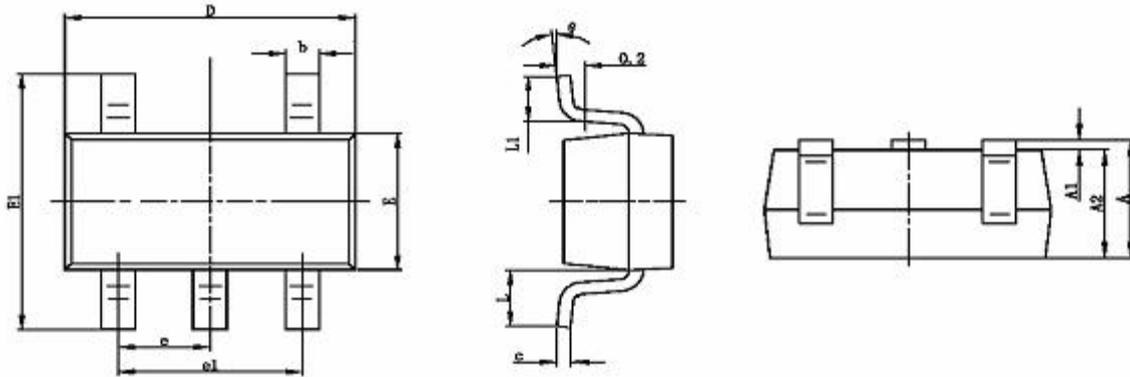■TYPICAL OPERATING CHARACTERISTICS

TA=25°C, VIN=3.6V, unless otherwise noted

Efficiency VS Load Current

PMOS On Resistance

NMOS On Resistance

Current Limit

Frequency VS Supply Voltage

ReferenceVoltage VS Supply Voltage

■SOT23-5L PACKAGE DIMENSIONS

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°