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

DESCRIPTION

The STD1807 is a high-efficiency, DC-to-DC step-down switching regulators, capable of delivering up to 1.5A 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 STD1807 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 STD1807 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.

PART NUMBER INFORMATION

STD 1807 S5 - TR G
a b c d e

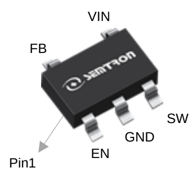
a : Company name
b : Product Serial number
c : Package code S5: SOT-23-5L
d : Handling code TR: Tape&Reel
e : Green produce code G: *RoHS Compliant*

FEATURES

- Duty Cycle 0~100%
- 1.5A Output Current
- High Efficiency Up To 96%
- 2.5V to 6.0V Input Voltage Range
- Fixed 1.5MHz Frequency
- Logic Control Shutdown I_Q<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
- DC/DC Converter



SOT-23-5L

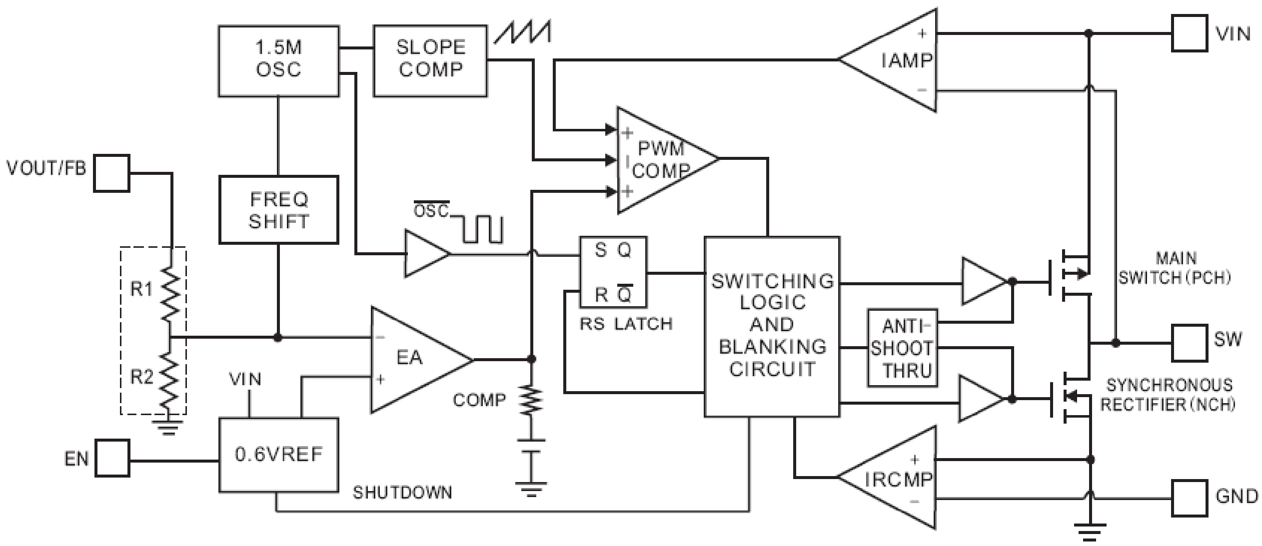
ABSOLUTE MAXIMUM RATINGS *(T_A=25°C Unless otherwise noted)*

Symbol	Parameter	Typical	Units
θ_{JA}	Thermal Resistance (Junction to Ambient)	250	°C/W
θ_{JC}	Thermal Resistance (Junction to Case)	90	°C/W
V_{IN}	Input Voltage	-0.3 ~ +6.5	V
V_{OUT}	EN, FB, SW Pin Voltage	-0.3 ~ V_{IN}	V
T_J	Operating Junction Temperature	-40 ~ +85	°C
T_{STG}	Storage Temperature Range	-65 ~ +150	°C

ELECTRICAL CHARACTERISTICS(T_A=25°C, V_{IN}=3.6V Unless otherwise noted)

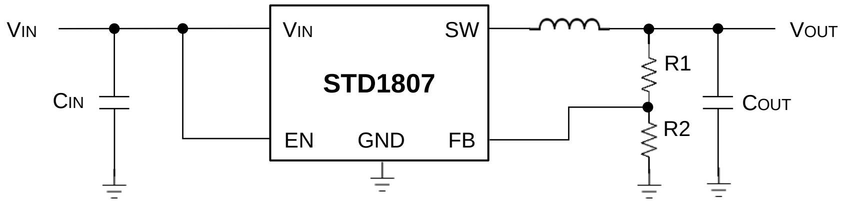
Symbol	Parameter	Test Condition		Min	Typ	Max	Unit
V_{IN}	Input Voltage Range	-40°C~+85°C		2.5		6	V
V_{FB}	Feedback Voltage	T_A=25°C		0.588	0.6	0.612	V
I_{FB}	Feedback Input Current	-40°C~+85°C			0.01		μA
V_{EH}	EN Threshold High	-40°C~+85°C		1.5			V
V_{EL}	EN Threshold Low	-40°C~+85°C				0.4	V
I_{EN}	EN Input Current	-				1	μA
I_{PK}	Peak Inductor Current	V_{FB}=0.5V			1.5		A
ΔV_{FB}	Reference Voltage Line Regulation	V_{IN}=2.7V~5.5V			0.04		%/V
I_Q	Quiescent Current	V_{FB}=0.78V			30	-	μA
I_{SD}	Shutdown Current	V_{EN}=0V				1	μA
f_{OSC}	Oscillator Frequency	V_{FB}=0.6V, -40°C~+85°C			1.5		MHz
$R_{DS(ON)}$	Drain-Source On-State Resistance	I_{DS}=200mA	PMOSFET		0.22		Ω
			NMOSFET		0.30		Ω
I_{LSW}	SW Leakage Current	V_{OUT}=5.5V, V_{SW}=0 or 5.5V, EN=0V				10	μA

FUNCTION BLOCK DIAGRAM



FUNCTION BLOCK DIAGRAM

◆Adjustable Output Voltage



VIN=2.5V~6.0V
VOUT=1.8V
R1=240KΩ
R2=120KΩ
CIN=10μF
COUT=10μF
L=2.2 μH

$$Vout=0.6*(1+\frac{R1}{R2})$$

DETAIL DESCRIPTION

The STD1807 high-efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1.5A 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 STD1807 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

STD1807 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. STD1807 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

STD1807 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 2.5V, 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 0.6V.

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 / (2π x fOSC x COUT)]

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

VRIPPLE(ESR) = IL(PEAK) x 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

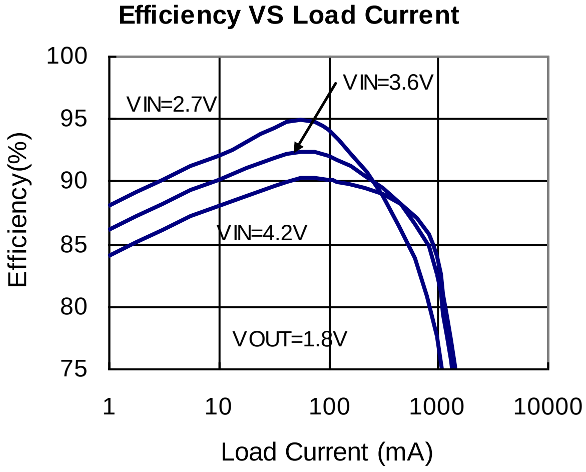
If much smaller values are used, inductor current rises, and a larger output capacitance may be required to suppress output ripple. Larger values than LIDEAL can be used to obtain higher output current, but typically with larger inductor size.

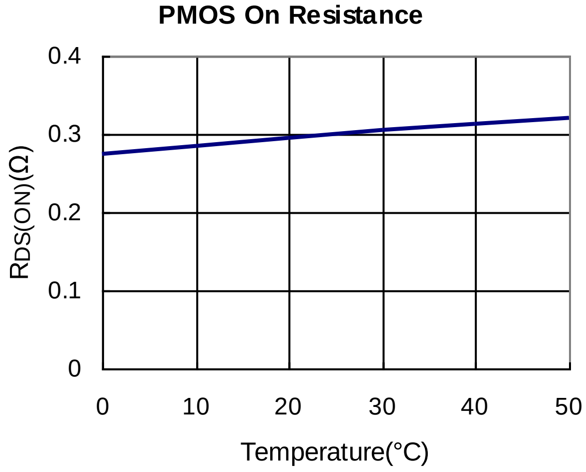
■APPLICAITION INFORMATION

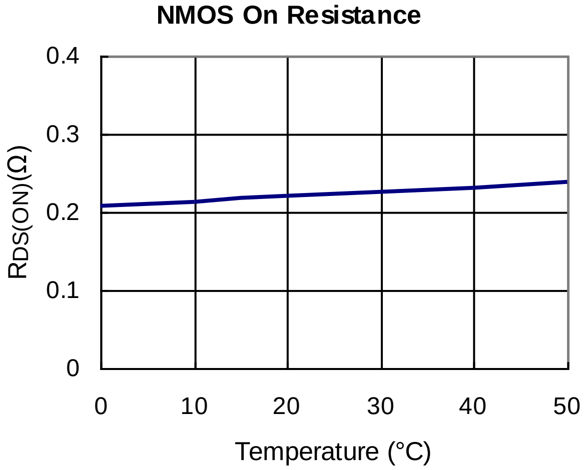
Layout is critical to achieve clean and stable operation. The switching power stage requires particular attention. Follow these guidelines for good PC board layout:

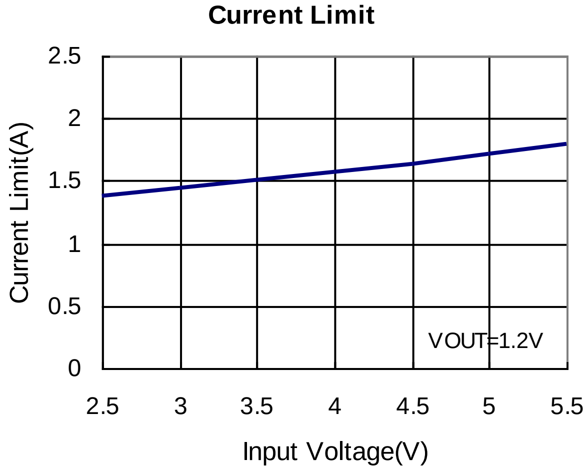
1) Place decoupling capacitors as close to the IC as possible. Keep power ground plane (connected to PGND) and signal ground plane (connected to GND) separate.
2) Connect input and output capacitors to the power ground plane; connect all other capacitors to the signal ground plane.
3) Keep the high-current 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 VIN, 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.

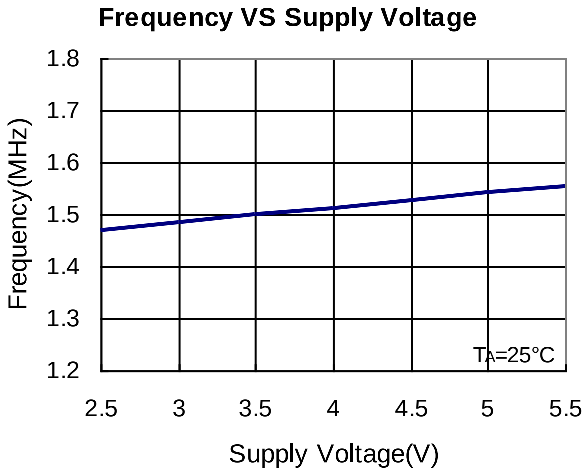
TYPICAL OPERATING CHARACTERISTICS(T_A=25°C, V_{IN}=3.6V Unless otherwise noted)

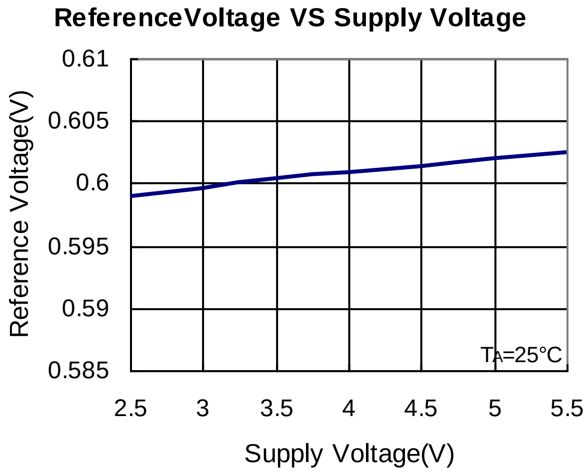




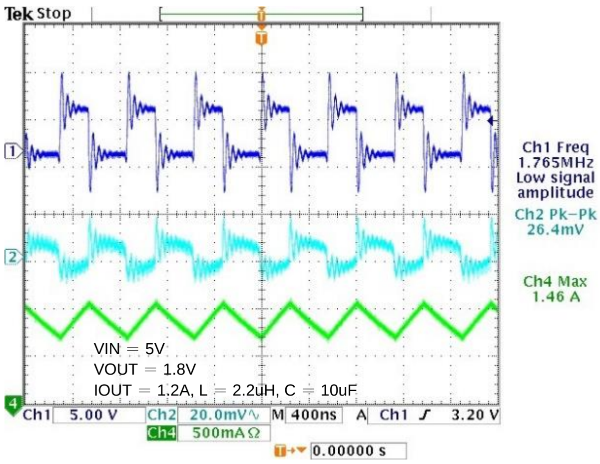




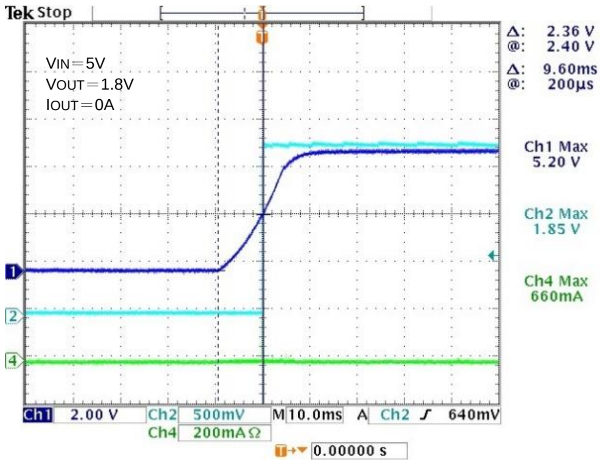




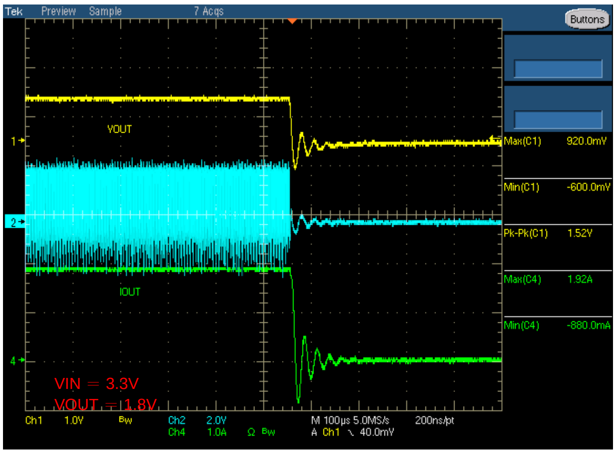
OPERATING WAVEFORMS



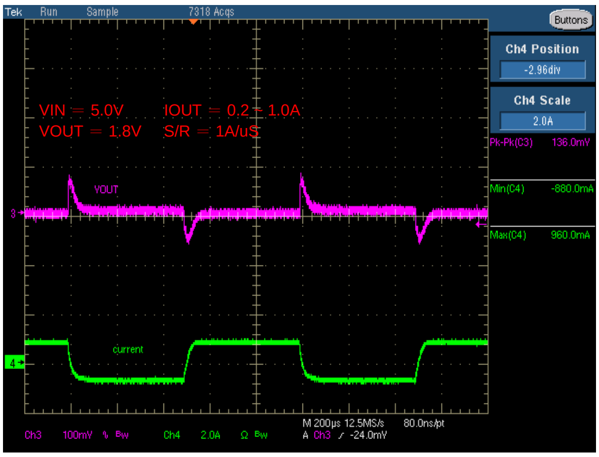
Switch & Ripple Waveform



Transient waveform

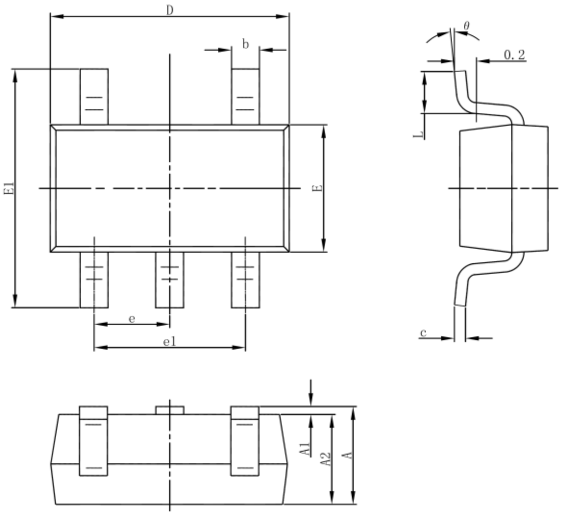


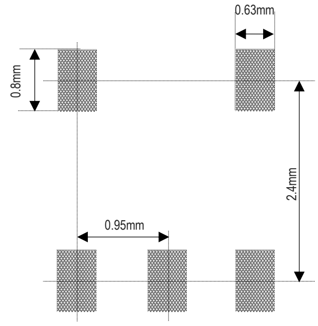
Over Current Protect Waveform



Soft Start Waveform

SOT-23-5L PACKAGE DIMENSIONS





Recommended Land Pattern

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	0.500	0.012	0.020
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	0.950 BSC		0.037 BSC	
e1	1.800	2.000	0.710	0.790
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°