SemTron Microtech Corporation

SMC1822SQ

28V,2A 1MHz Synchronous Step Down DC/DC Converter

DESCRIPTION

The SMC1822SQ is a high-efficiency, DC-to-DC step-down switching regulators, capable of delivering up to 2A of output current. The device operates from an input voltage range of 4.2V to 28V and provides an output voltage from 0.8V to V_{IN}, making the SMC1822SQ ideal for low voltage power conversions. Running at a fixed frequency of 1MHz 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 SMC1822SQ 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.

FEATURES

- ◆Duty Cycle 0~99%
- ◆2A Output Current
- ◆4.2V to 28V Input Voltage Range
- ◆Fixed 1MHz Frequency
- ◆Thermal Shutdown
- ◆Output Adjustable from 0.8V to Input Voltage
- ◆ESD protected

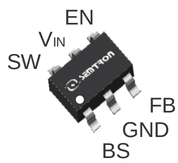
APPLICATIONS

- ◆Portable Equipment
- ◆Set Top Box
- ◆Surveillance Camera
- ◆LCD TV

PART NUMBER INFORMATION

<u>SMC</u> <u>1822</u> <u>SQ</u> - <u>TR</u> <u>G</u>
a b c d e

a : Company name.
b : Product Serial number.
c : Package code SQ:SOT-23-6L
d : Handling code TR:Tape&Reel
e : Green produce code G:*RoHS Compliant*



SOT-23-6L

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

Symbol	Parameter	Rating	Units
V_{IN}	Input, EN Voltage	-0.3 ~ 30	V
V_{OUT}	FB, SW Voltage	-0.3 ~ V_{IN}	V
V_{BS}	BS Voltage	-0.3 ~ SW+6V	°C
T_J	Operating Junction Temperature	-40 ~ 85	°C
T_{STG}	Storage Temperature Range	-55 ~ 150	°C/W
θ_{JA}	Thermal Resistance Junction to Ambient [AC]	180	°C/W
θ_{JC}	Thermal Resistance Junction to Case	90	°C/W
ESD	HBM (Human Body Mode)	2	KV

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.

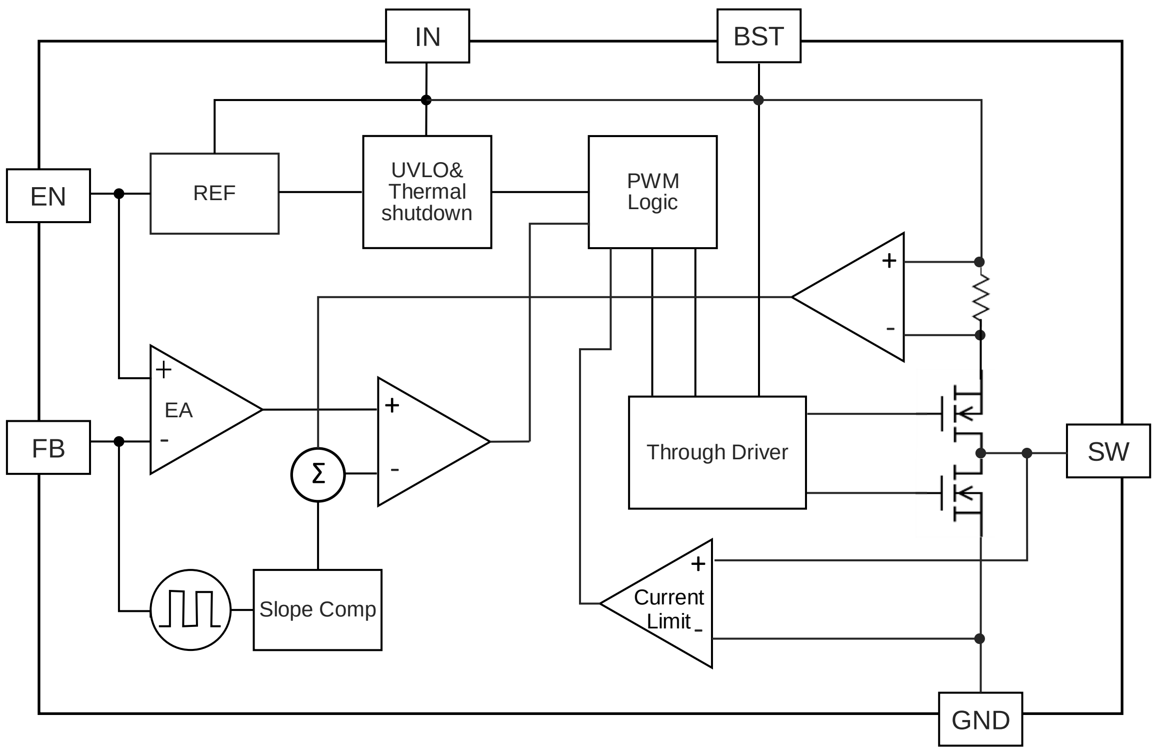
PIN DESCRIPTION

Pin	Name	Desciption
1	BS	Bootstrap pin. Connect a 10nF capacitor from this pin to SW
2	GND	Ground
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V_{OUT}
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable.
5	V_{IN}	Supply Voltage. Bypass with a 4.7μF ceramic capacitor to GND
6	SW	Inductor Connection. Connect two 22uF capacitors from this pin to GND

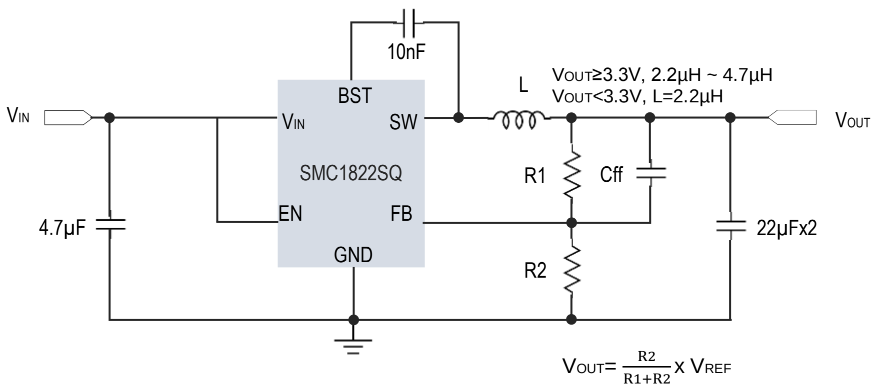
ELECTRICAL CHARACTERISTICS *(T_A=25°C, V_{IN}=12V, V_{OUT}=3.3V, Unless otherwise noted)*

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range	-40°C ~ +85°C	4.2		28	V
V_{UVLO}	Input UVLO	Rising, Hysteresis=0.34V		4.2	-	V
I_{IN}	Input Supply Current	V_{IN}=12V, I_{OUT}=0, V_{FB}=0.85V			0.75	mA
V_{FB}	Feedback Voltage	T_A=25°C	0.784	0.8	0.816	V
I_{FB}	Feedback Input Current	-40°C ~ +85°C		0	1	μA
V_{EH}	EN Threshold High	-40°C ~ +85°C	1.48	1.58	1.68	V
V_{EL}	EN Threshold Low	-40°C ~ +85°C	1.315	1.4	1.485	V
I_{EN}	EN Input Current	V_{EN}=2V		1		μA
$R_{DS(ON)}$	High Side On Resistance			0.16		Ω
	Low Side On Resistance			0.095		Ω
I_{PK}	Peak Inductor Current			3.5		A
t_{ON}	Circuit Hiccup On Time			2		mS
t_{OFF}	Circuit Hiccup Off Time			6		mS
$V_{FB(TH)}$	Feedback Threshold			0.2		V
I_{SD}	Shutdown Current			7	14	μA
f_{OSC}	Oscillator Frequency	V_{FB}=0.8V, -40°C ~ +85°C		1		MHz
I_{LSW}	SW Leakage Current	V_{IN}=V_{SW}=12V			20	μA
T_{SD}	Thermal Shutdown	Rising, Hysteresis=10°C		150		°C

FUNCTION BLOCK DIAGRAM



TYPICAL APPLICATION



DETAIL DESCRIPTION

The SMC1822SQ high-efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 2A of output current. The device operates in pulse-width modulation (PWM) at 1MHz from a 4.2V to 28V input voltage and provides an output voltage from 0.8V to V_{IN}, making the SMC1822SQ 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

SMC1822SQ 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 2A(typ). When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. SMC1822SQ 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 2A (typ) and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

◆Soft Start

SMC1822SQ 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 l soft-start circuitry slowly ramps up current available at SW.

◆UVLO And Thermal Shutdown

If in drops below 4.2V, the UVLO circuit inhibits switching. Once in rises above 4.2V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device. When the junction temperature exceeds T_J= +150°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 25°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 threshold is 0.8V.The output voltage is calculated using below equation.

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

Where: VREF =0.8V typically (the internal reference voltage)

Resistors R2 has to be between 1KΩ to 12KΩ and thus R1 is calculated by following equation.

$$R_1 = \left(\frac{V_{OUT}}{V_{REF}} - 1\right) \times R_2$$

◆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.

■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.

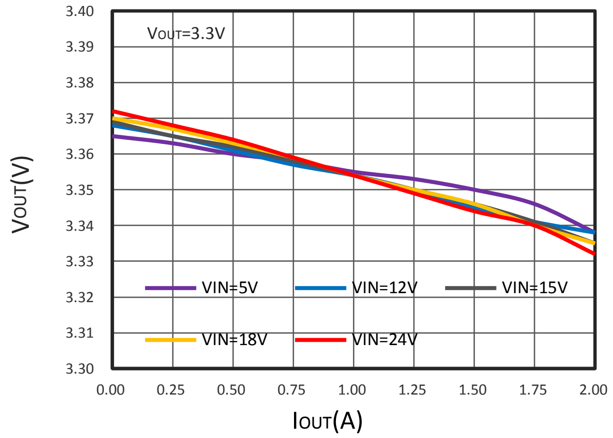
3) Keep the high-current paths as short and wide as possible. Keep the path of switching current (C1 to in and C1 to GND) short. Avoid vias in the switching paths.

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

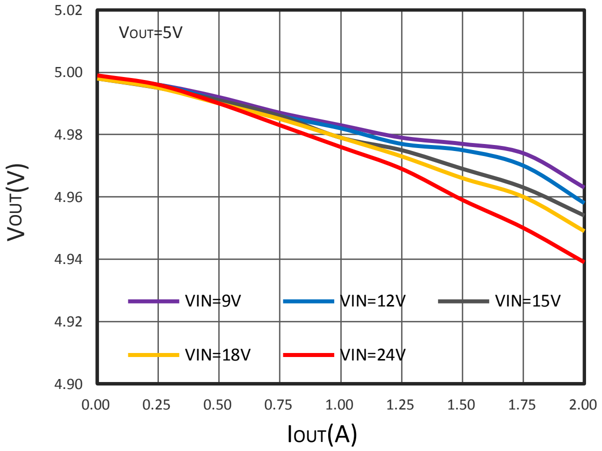
5) Ensure all feedback connections are short and direct. Place the feedback resistors as close to the IC as possible.

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

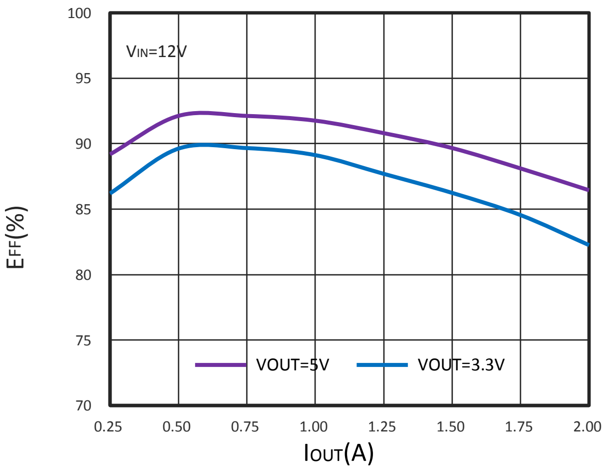
TYPICAL OPERATING CHARACTERISTICS*(TA=25°C Unless otherwise noted)*



VOUT VS IOUT

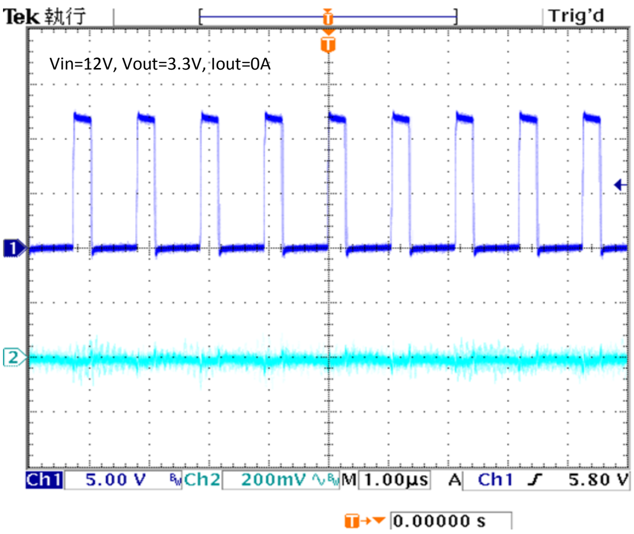


VOUT VS IOUT

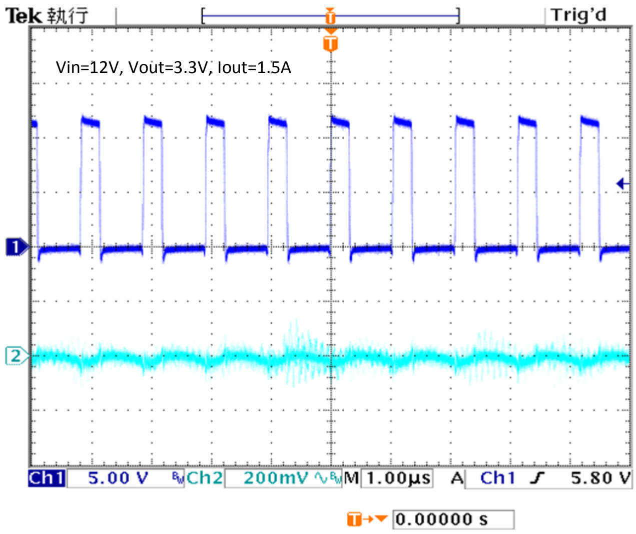


Eff VS IOUT

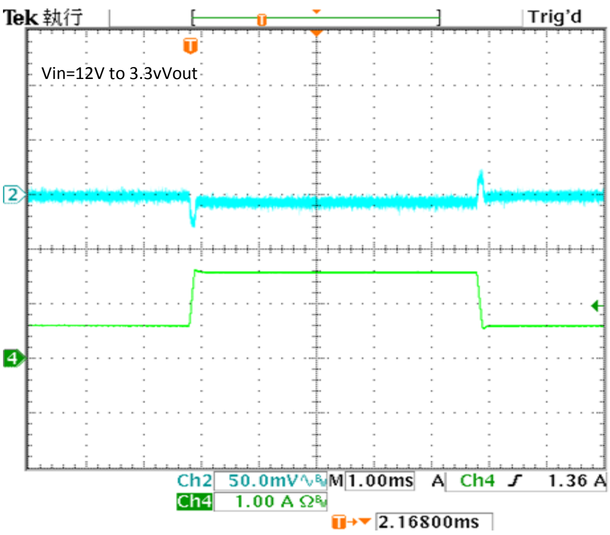
TYPICAL OPERATING CHARACTERISTICS(T_A=25°C Unless otherwise noted)



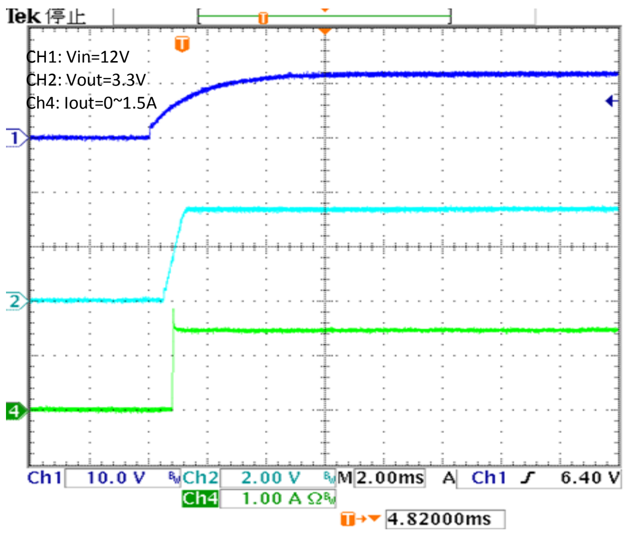
RIPPLE TEST



RIPPLE TEST

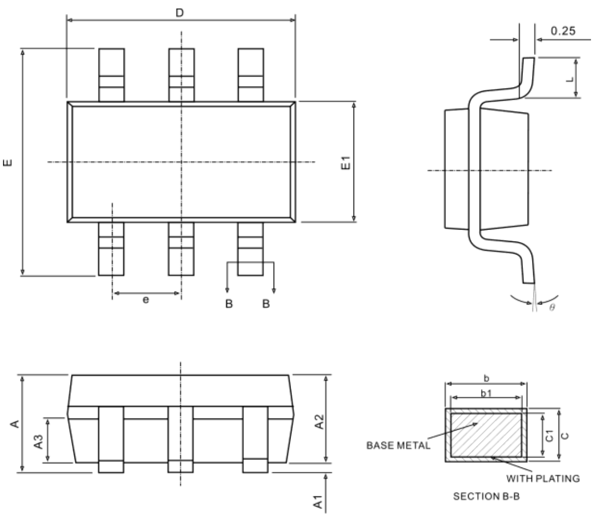


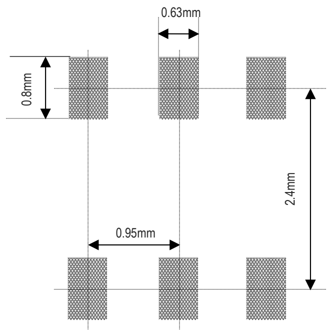
LOAD TRANSIENT



POWER ON

SOT-23-6L PACKAGE DIMENSIONS





Recommended Land Pattern

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	-	1.250	-	0.049
A1	0.040	0.100	0.002	0.004
A2	1.000	1.200	0.039	0.047
A3	0.550	0.750	0.022	0.030
b	0.380	0.480	0.015	0.019
b1	0.370	0.430	0.015	0.017
c	0.110	0.210	0.004	0.008
c1	0.100	0.160	0.004	0.006
D	2.720	3.120	0.107	0.123
E	2.600	3.000	0.102	0.118
E1	1.400	1.800	0.055	0.071
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°