Wide-Input Range CC/CV Step-Down Synchronous DC/DC Converter

FEATURES

- 36V Input Voltage Surge
- Wide input voltage:8~30V
- Up to 2.4A Output Current at 5V Output
- 130k~500kHz Adjustable Frequency
- ±4% CC Accuracy
- Internal Compensation
- 32V Input OVP Protection
- HICCUP Mode
- Output OVP Protection
- Efficiency up to 93% at 2.4A
- 0.2~2V Output Line Drop Compensation
- 2% Feedback Voltage Accuracy
- Integrated Soft Start
- Thermal Shutdown
- Secondary Cycle-by-Cycle Current Limit
- EMI Consideration
- ESOP8 Package

GENERAL DESCRIPTION

HM1683A is a wide input voltage, high efficiency Active CC step-down DC/DC converter that operates in either CV(Constant Output Voltage) mode or CC(Constant Output Current) mode. HM1683A provides up to total 2.4A output current at 5V output. Switching frequency can be set by external resistor. Maximum 93% efficient be obtained at 2.4A and 5V output. One current sensor CSpin ensurethe channel CC control. HM1683A internal Integrate 80mΩ high side power MOSFETand 60mΩ low side power MOSFET.Advanced production features include UVLO, Thermal Shutdown, Soft Start, OVP.

APPLICATIONS

- Car Charger/ Adaptor
- Rechargeable Portable Devices
- General-Purpose CC/CV Supply

TYPICAL APPILCATION

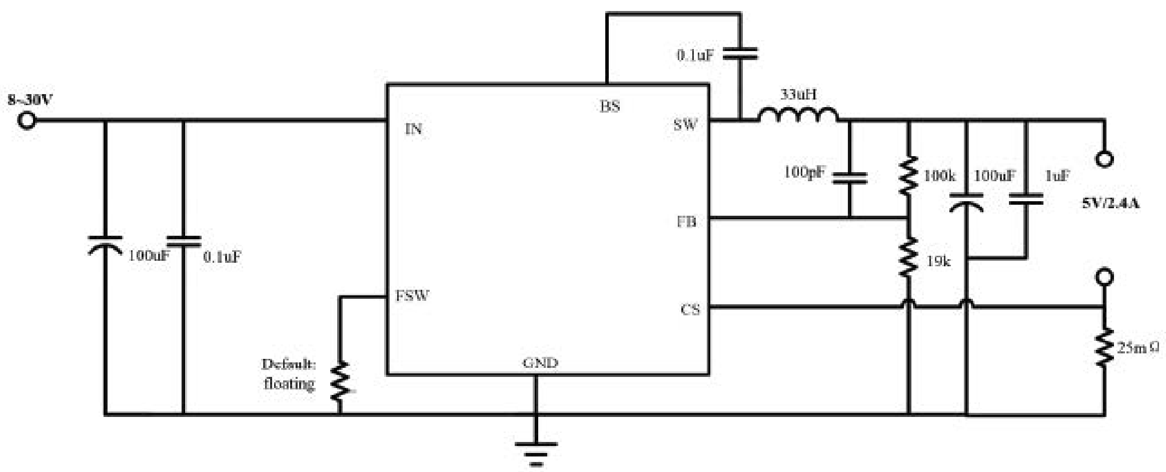
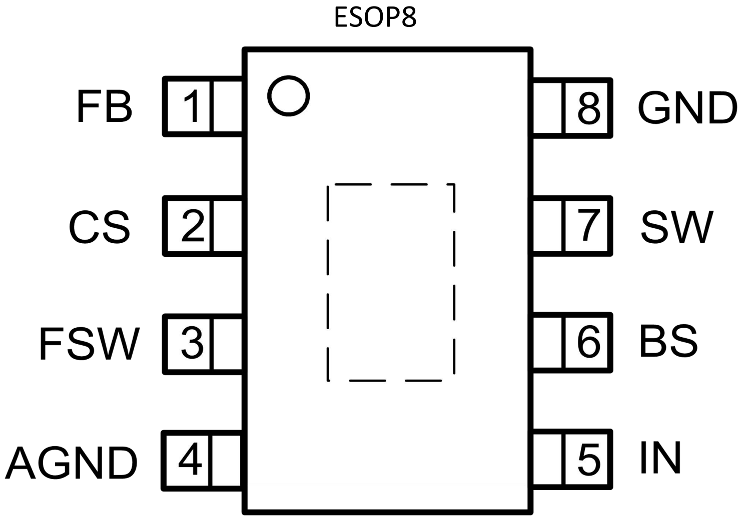


Figure 1. Basic Application Circuit

PIN CONFIGURATION



Top Mark:HM1683A
YYXX

PIN FUNCTIONS

Pin	Name	Function
1	FB	Feedback pin
2	CS	Output current sense pin
3	FSW	Switching Frequency set pin, connect a resistor to ground, or floating: Fs=130kHz, Short to GND: 500kHz
4	AGND	Analog Ground Pin
5	IN	Power Input pin
6	BS	High side Gate Driver bias pin, Provide supply to high-side nLDMOS Gate Driver. Connect a 100nF capacitor between BS and SW
7	SW	Switch Pin, Connect to external Inductor
8	GND	PowerGround Pin
9	ThermalPad	Ground Pin(Exposed PAD)

ABSOLUTE MAXIMUM RATINGS

Items	Description	Value	Unit
Voltage Range	IN,SW	-0.3~36	V
Voltage Range	BS to SW	-0.3~6	V
Voltage Range	All other pins	-0.3~6	V
Tj	Junction Temperature	-40~150	°C
Tstg	Storage Temperature	-65~150	°C
θJA	Junction-to-ambient Thermal Resistance	60	°C/W
θJC	Junction-to-case Thermal Resistance	46	°C/W
PD	Package Dissipation	2	W
Lead Temperature	Soldering,10s	260	°C

Over operating free-air temperature range (unless otherwise noted)

ESDRATING

Items	Description	Value	Unit
V_{ESD}	Human Body Model for all pins	±2000	V

JEDEC specification JS-001

ELECTRICAL CHARACTERISTICS

(V_{IN}=12V ,V_{OUT}=5V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		8		30	V
Input Voltage Surge	V_{IN}				36	V
Under Voltage Lockout	V_{UVLO}	V_{IN} rising		7.2		V
UVLO Hysteresis	V_{UVLO_HY}			0.6		V
Quiescent Current	I_Q	no load, V_{FB}>0.83V		1		mA
Feedback Threshold Voltage	V_{FBTH}		784	800	816	mV
FB Pin input current	I_{FB}		-50		50	nA
Input OVP Voltage	V_{INOVP}		31.5			V
Output OVP Voltage	V_{OUTOVP}			10	20	%
Soft start Time	T_{SST}			4		mS
CS Current limit Voltage	V_{LIM_CS}			64		mV
SW leakage	I_{SW_LEAK}				10	uA
Maximum Duty Cycle	D_{DUTY}	F_S=130KHz			90	%
Switching Frequency	F_S	R_{FSW}=300KΩ		300		kHz
		FSW pin floating		130		kHz
		FSW short to GND		500		kHz
Switch On-Resistance (high side)	R_{ON_HS}	By design		80		mΩ
Switch On-Resistance (low side)	R_{ON_LS}	By design		60		mΩ
Thermal Shutdown Threshold	T_{SDN}			155		℃
Thermal Shutdown Hysteresis	T_{SDN_HY}			20		℃

FUNCTIONAL DESCRIPTION

HM1683A is a peak current mode pulse width modulation (PWM) converter with CC and CV control. The converter operates as follows:

A switching cycle starts when the rising edge of the Oscillator clock output causes the High-Side Power Switch to turn on and the Low-Side Power Switch to turn off. With the SW side of the inductor now connected to IN, the inductor current ramps up to store energy in the magnetic field. The inductor current level is measured by the Current Sense Amplifier and added to the Oscillator ramp signal. If the resulting summation is higher than the COMP voltage, the output of the PWM Comparator goes high. When this happens or when Oscillator clock output goes low, the High-Side Power Switch turns off.At this point, the SW side of the inductor swings to a diode voltage below ground, causing the inductor current to decrease and magnetic energy to be transferred to output. This state continues until the cycle starts again. The High-Side Power Switch is driven by logic using BS as the positive rail. This pin is charged to V_{SW} + 5V when the Low-Side Power Switch turns on. The COMP voltage is the integration of the error between FB input and the internal 0.8V reference. If FB is lower than the reference voltage, COMP tends to go higher to increase current to the output. Output current will increase until it reaches the CC limit set by the CS resistor. At this point, the device will transition from regulating output voltage to regulating output current, and the output voltage will drop with increasing load.

FUNCTIONAL DESCRIPTION

❖ Output Voltage Setting

Figure 2: Output Voltage Setting

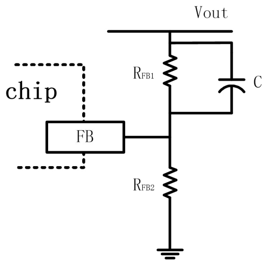


Figure 2 shows the connections for setting the output voltage. Select the proper ratio of the two feedback resistors R_{FB1} and R_{FB2} based on the output voltage. Adding a capacitor in parallel with R_{FB1} helps the system stability. Typically, use R_{FB2} ≈10kΩ and determine R_{FB1} from the following equation:

$$R_{FB1} = R_{FB2}\left(\frac{V_{OUT}}{0.8V} - 1\right)$$

❖ Limit Current Setting

HM1683A constant current value is set by a resistor connected between the CS pin and GND. The CC output current is calculated by ILIM= 64mV/Rcs

❖ Over Voltage Protection

The thresholds of input OVP circuit include are minimum 31.5V.Once the input voltage is higher than the threshold, the high-side MOSFET is turned off. When the input voltage drops lower than the threshold, the high-side MOSFET will be enabled again.

❖ HICCUP Mode

The operation of hiccup is as follows. When the VOUT voltage is short to GND or lower than 3V, the controllershuts off the power supply for a given time and then tries to start up the power supply again. If the short condition has been removed, the power supply will start up and operate normally.

❖ Thermal Shutdown

The HM1683A disables switching when its junction temperature exceeds 155°C and resumes when the temperature has dropped by 20°C.

❖ Setting the Switching Frequency

The Oscillator normally switches at 130k~500kHz, which is set by FSW resistance as Table 1

FSW pin floating	RFSW=300KΩ	RFSW= 200KΩ	FSW short to GND
130kHz	300kHz	400kHz	500kHz

❖ Setting the Cable Compensation

HM1683A provides programmable cable voltage drop compensation using the impedance at the FB pinto compensate voltage drop across the charger's outputcable. The cable compensation voltage can be expressed as:

$$Vcomp=R_{FB1}xI_{load}x10^{-6}$$

By adjust the value of R_{FB1}, the cable compensationvoltage can be programmed.

❖ EMI Consideration

Since parasitic inductance and capacitance effects in PCB circuitry would cause a spike voltage on SW node when high-side MOSFET is turned on/off, this spike voltage on SW may impact on EMI performance in the system. In order to enhance EMI performance, there are two methods to suppress the spike voltage. One is to place an RC snubber between SW and GND and make them as close as possible to the high-side MOSFET's source and low-side MOSFET's drain. Another method is to add a resistor in series with the boostrap capacitor C_{BS}. But this method will decrease the driving capability to the high-side MOSFET. It is strongly recommended to reserve the RC snubber during PCB layout for EMI improvement. Moreover, reducing the PHASE trace area and keeping the main power in a small loop will be helpful on EMI performance.

❖ PC Board Layout Guidance

When laying out the printed circuit board, theFollowing checklist should be used to ensure proper operation of the IC.

1) Arrange the power components to reduce the AC loop size consisting of C_{IN}, IN pin, SW pin and the ICPowerGNDpin.

2) Place input decoupling ceramic capacitor C_{IN} as close to IN pin as possible. C_{IN} is connected power GND with vias or short and wide path.

3) Return FB to signal GND pin, and connect the signal GND to power GND at a single point for best noise immunity. Connect Exposed Pad to power ground copper area with copper and vias.

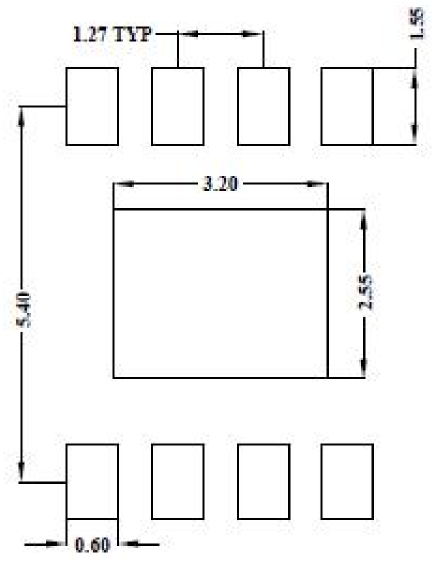
4) Use copper plane for power GND for best heat dissipation and noise immunity.

5) Place feedback resistor close to FB pin.

6) Use short trace connecting BS-C_{BS}-SW loop

PACKAGE INFORMATION

ESOP8



Recommended Pad Layout