6A HV Asynchronous 500kHz Boost Converter

General Description

The EMH7090 is a monolithic asynchronous boost DC-DC converter. Its PWM circuitry with built-in 6A 60mΩ power MOSFET make this regulator highly power efficient.

The EMH7090 has wide input voltage range from 2.9V~12V to support applications with single-cell or two-cell lithium batteries. The device could have 6A switching current capacity to provide an output voltage up to 14V.

The EMH7090 uses current mode PWM control topology to regulate the output voltage. That works into power saving mode to get better efficiency for battery in light load condition. In heavy load condition, the EMH7090 works into PWM operating mode.

The EMH7090 non-inverting input of error amplifier connects to 0.6V precision reference voltage and internal soft-start function can reduce the inrush current. In addition, overvoltage protection, cycle by cycle over current protection, and thermal shutdown protection are designed into this chip.

The EMH7090 is available in E-SOP-8L package and provides space-saving PCB for the application fields.

Features

- Input Voltage Range 2.9V~12V
- Adjustable Output Voltage Range 5V~14V
- Internal Fixed PWM frequency: 500kHz
- Precision Feedback Reference Voltage: 0.6V
- Internal 60mΩ, 6A, 16V Power MOSFET
- Internal Soft-start
- Over Temperature Protection
- Over Voltage Protection
- Cycle by Cycle Over Current Protection
- Package: E-SOP-8L

Applications

- Chargers
- LCD Displays
- LED Application
- Bluetooth Speaker
- Power Bank
- Handheld or Portable Devices

Typical Application

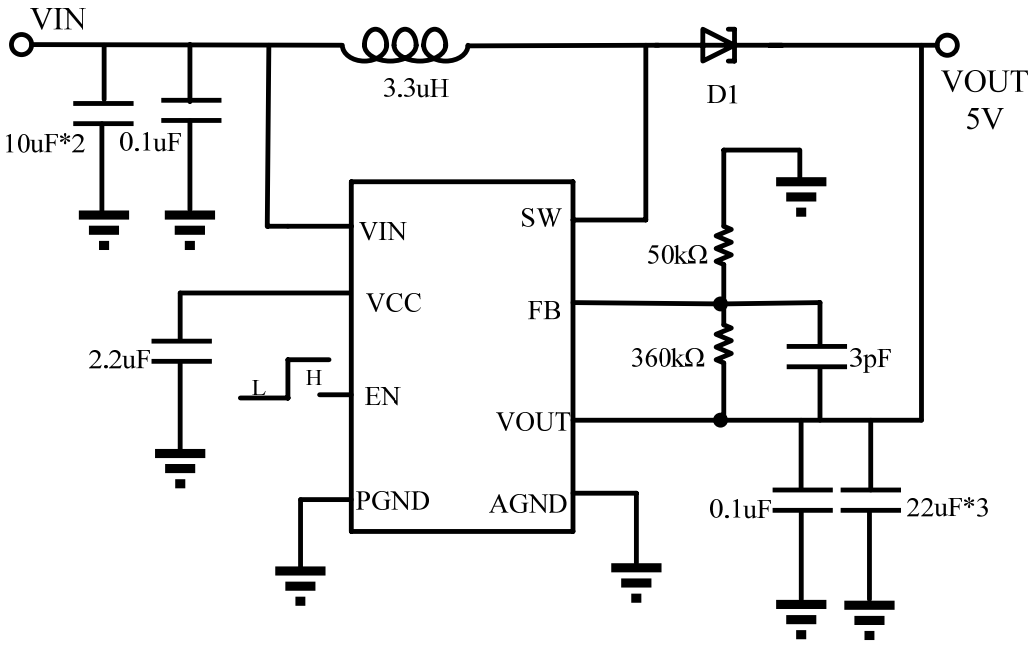
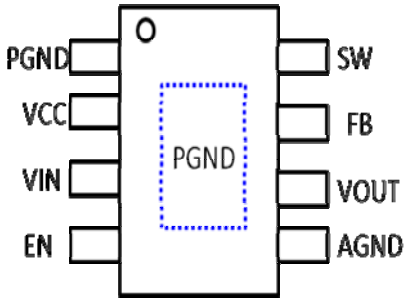


Fig. 1 EMH7090 application circuit

Package Configuration

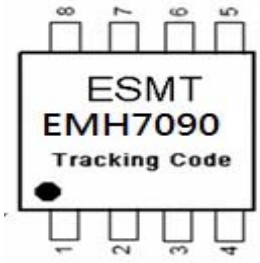


E-SOP-8L (Top View)

EMH7090-00SG08NRR

00	Adjustable Output
SG08	E-SOP-8L Package
NRR	RoHS & Halogen free package Commercial Grade Temperature Rating: -40 to 85°C Package in Tape & Reel

Order, Mark & Packing information

Package	Vout(V)	Product ID	Marking	Packing
E-SOP-8L	Adjustable	EMH7090-00SG08NRR		Tape & Reel 3K units

Functional Block Diagram

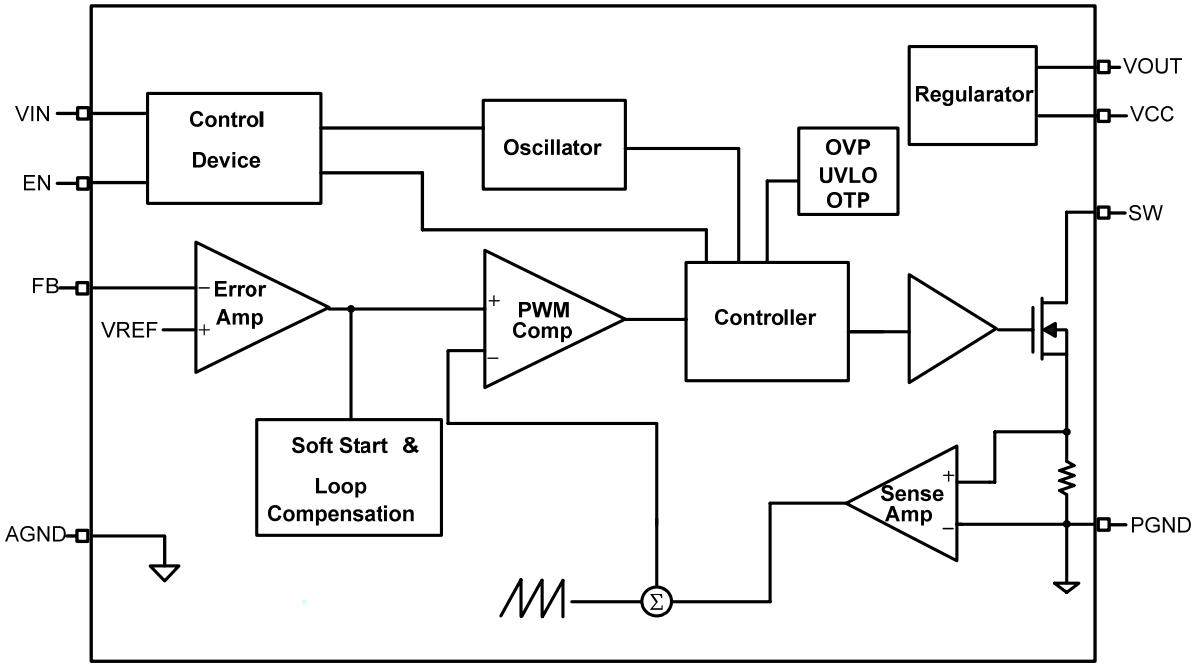


Fig. 2

Pin Functions

Pin Name	E-SOP-8L	Function
PGND	1	**Power Ground Pin.** Connect exposed pad to GND plane for optimal thermal performance.
VCC	2	**Output of the internal regulator.** A ceramic capacitor of more than 2.2uF requirement between this pin and GND.
VIN	3	**Supply Voltage.** Must be closely decoupled to GND pin with 10uF*2 or greater ceramic capacitor.
EN	4	**Enable Pin.** High: Enable; Low: Disable.
AGND	5	**Analog Ground Pin.** Signal ground of the IC.
VOUT	6	**Input of the internal regulator.** Boost converter output for internal regulator.
FB	7	**Feedback Pin.** Receives the feedback voltage from an external resistive divider across the output.
SW	8	**Switch Out.** Must be connected an Inductor from VIN pin to SW pin.
PGND	9	**Power Ground Pin/Thermal Pad.** This pin must be connected to ground. The thermal pad with large thermal land area on the PCB will be helpful chip power dissipation.

Absolute Maximum Ratings

Devices are subjected to fail if they stay above absolute maximum ratings.

Supply Voltage (VIN,VOUT) ---------- – 0.3V to 16V
EN, FB ,Vcc Voltages ---------- – 0.3V to 6V
SW Voltage ---------- – 0.3V to (16V + 0.3V)
Lead Temperature (Soldering, 10 sec)---------- 260°C

Operating Temperature Range ----- –40°C to 85°C
Junction Temperature (Note 1) ---------- 150°C
Storage Temperature Range -------- – 65°C to 150°C
ESD Susceptiblity HBM ---------- 2KV
MM ---------- 200V

Recommended Operating Conditions

Input Voltage (VIN) ---------- +2.9V to +12V
Output Voltage (VOUT) ---------- +5V to +14V

Junction Operating Temperature --- -40°C to 125°C

Thermal data

Package	Thermal resistance	Parameter	Value
E-SOP-8L	θ_{JA} (Note 2)	Junction-ambient	50°C/W
	$\theta_{JC(top)}$ (Note 3)	Junction-case (top)	39°C/W
	$\theta_{JC(bottom)}$ (Note 4)	Junction-case (bottom)	10°C/W

Note 1: T_J is a function of the ambient temperature T_A and power dissipation P_D ($T_J = T_A + (P_D * \theta_{JA})$).

Note 2: θ_{JA} is simulated in the natural convection at T_A=25℃ on a highly effective thermal conductivity (thermal land area completed with >3x3cm² area) board (2 layers , 2S0P) according to the JEDEC 51-7 thermal measurement standard.

Note 3: $\theta_{JC(top)}$ represents the heat resistance between the chip junction and the top surface of package.

Note 4: $\theta_{JC(bottom)}$ represents the heat resistance between the chip junction and the center of the exposed pad on the underside of the package.

Electrical Characteristics

VIN=3.6V, T_A=+25°C, unless otherwise specified.

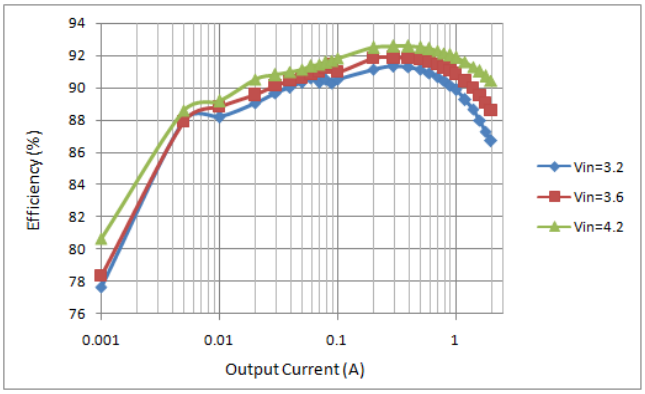
Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{FB}	Feedback Voltage	2.9V≦V_{IN}≦12V		0.6		V
$R_{DS(ON)}$	Switch on Resistance	V_{IN}=3.6V, V_{OUT}=5V		60		mΩ
I_{SW}	Switch Leakage	V_{IN}=6V, V_{OUT}=6V, V_{EN}=1.2V, V_{SW}=15V			5	μA
I_{LIM}	Current Limit	V_{IN}=6V, V_{OUT}=6V, V_{EN}=1.2V		6		A
V_{IN_UVLO}	VIN UVLO Threshold	V_{IN} rising		2.7		V
	VIN UVLO Threshold	V_{IN} falling		2.5		V
	VCC Regulation	V_{IN}=8V, V_{OUT}=8V, V_{EN}=1.2V		5		V
F_{OSC}	Oscillation Frequency	V_{FB}=0.4V		500		kHz
D_{max}	Max Duty cycle			90		%
	Shutdown Supply Current	V_{EN}=0		5		μA
	Quiescent Supply Current (No Switching)	V_{EN}=1.2V,V_{FB}=1V		150		uA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Quiescent Supply Current (Switching)	V_{EN}=1.2V,V_{FB}=0.4V		1.5		mA
T_{SD}	Thermal Shutdown			160		℃
	Thermal Shutdown Hysteresis			30		℃
	EN Input Low Voltage				0.4	V
	EN Input High Voltage		1.2			V
	EN Pull down resistor			800		kΩ

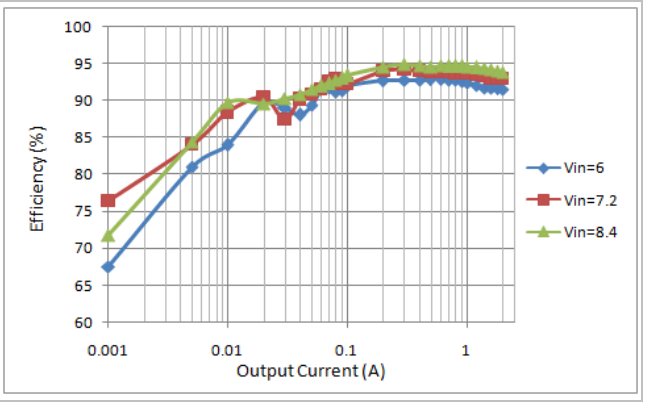
Typical Performance Characteristics

V_{IN}=3.6V, V_{OUT}=5.0V, T_A=25℃, L=3.3uH, C_{IN}=10uF*2, C_{OUT}=22uF*3, unless otherwise specified

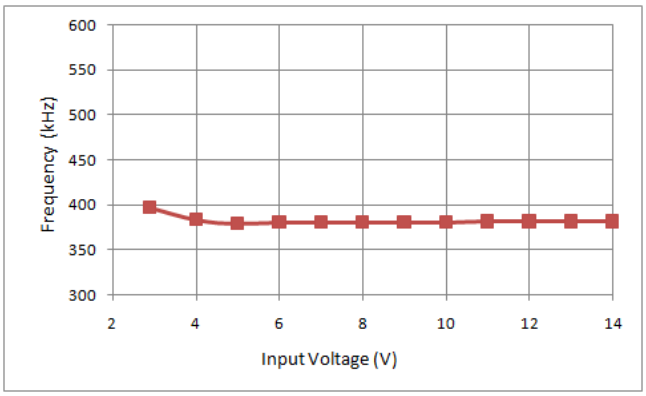
Efficiency (V_{OUT}=5V) (Fig. 3)



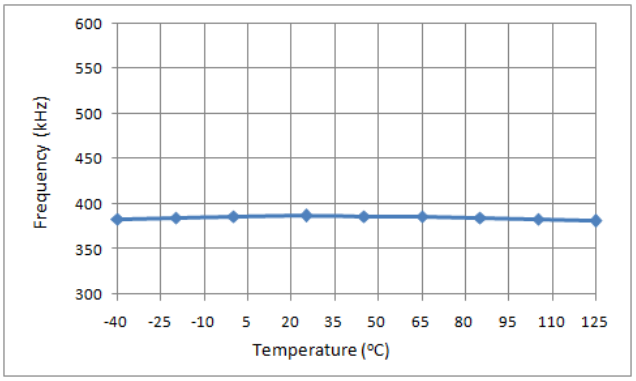
Efficiency (V_{OUT}=12V) (Fig. 4)



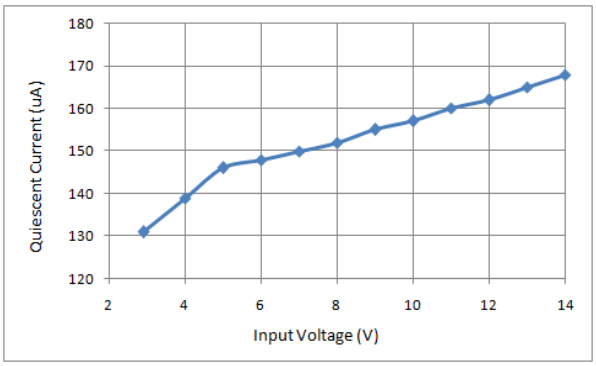
Operation Frequency vs. Input Voltage (Fig. 5)



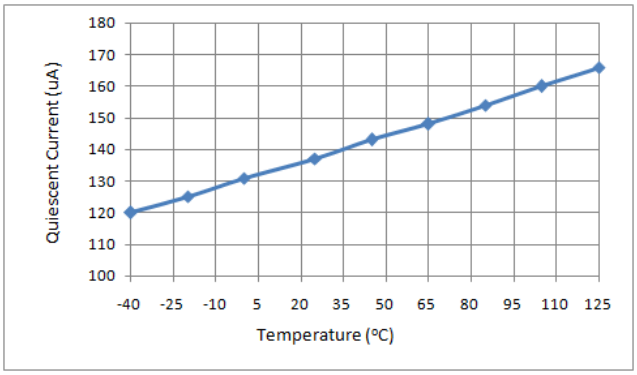
Operation Frequency vs. Temperature (Fig. 6)



Quiescent Current vs. Input Voltage (Fig. 7)



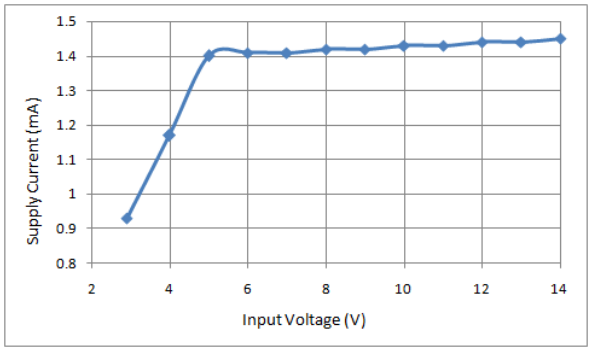
Quiescent Current vs. Temperature (Fig. 8)



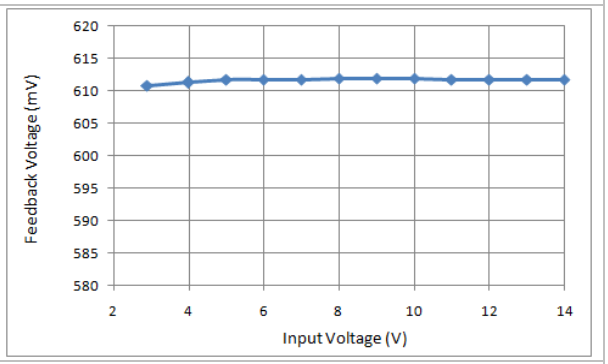
Typical Performance Characteristics (cont.)

V_{IN}=3.6V, V_{OUT}=5.0V, T_A=25℃, L=3.3uH, C_{IN}=10uF*2, C_{OUT}=22uF*3, unless otherwise specified

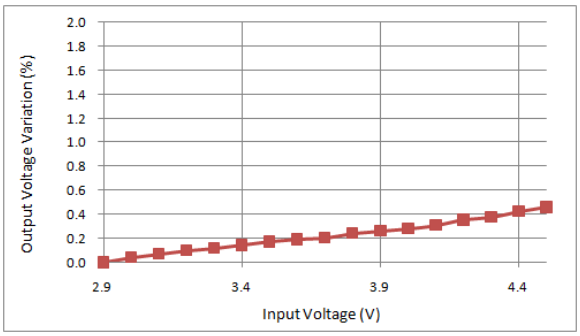
Supply Current vs. Input Voltage (Fig. 9)



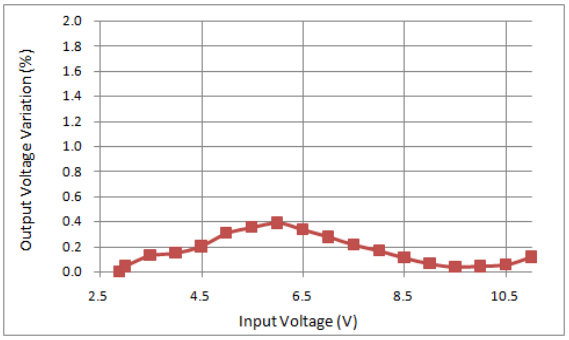
Feedback Voltage vs. Input Voltage (Fig. 10)



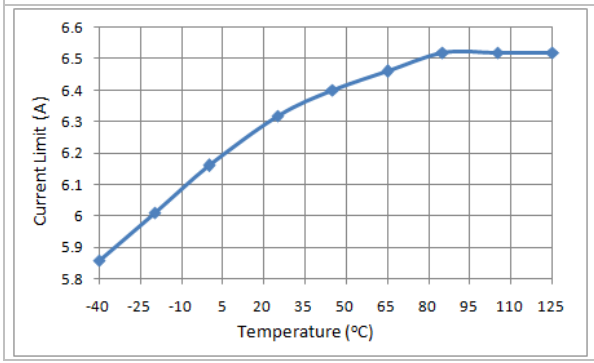
Output Voltage Variation vs. Input Voltage (V_{OUT}=5V) (Fig. 11)



Output Voltage Variation vs. Input Voltage (V_{OUT}=12V) (Fig. 12)



Current Limit vs. Temperature (Fig. 12-1)

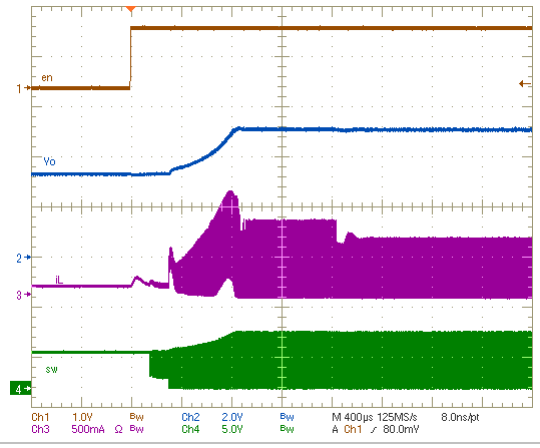


Typical Performance Characteristics (cont.)

V_{IN}=3.6V, V_{OUT}=5.0V, T_A=25℃, L=3.3uH, C_{IN}=10uF*2, C_{OUT}=22uF*3, unless otherwise specified

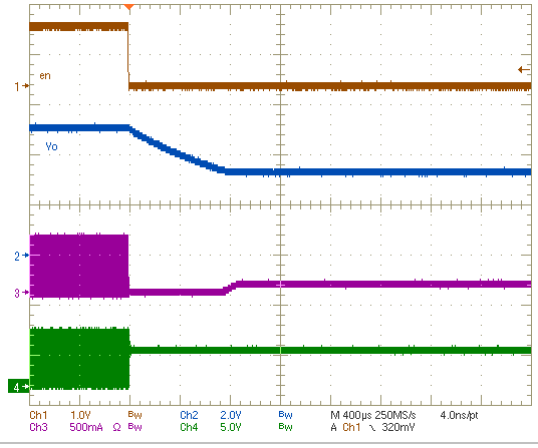
Power On from EN (Fig. 13)

V_{IN}=3.6V, V_{OUT}=5V



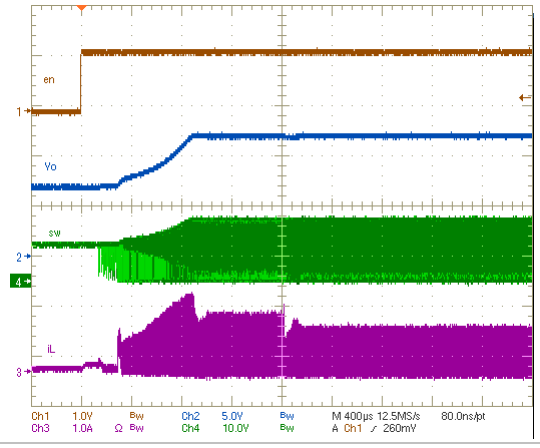
Power Off from EN (Fig. 14)

V_{IN}=3.6V, V_{OUT}=5V



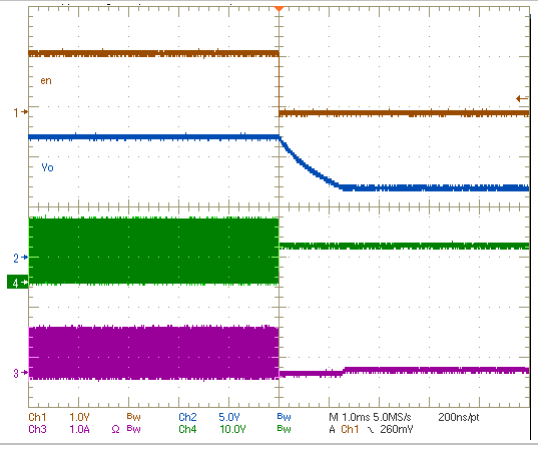
Power On from EN (Fig. 15)

V_{IN}=7.2V, V_{OUT}=12V



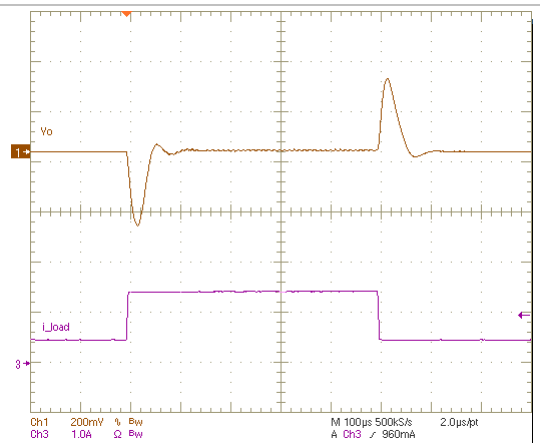
Power Off from EN (Fig. 16)

V_{IN}=7.2V, V_{OUT}=12V



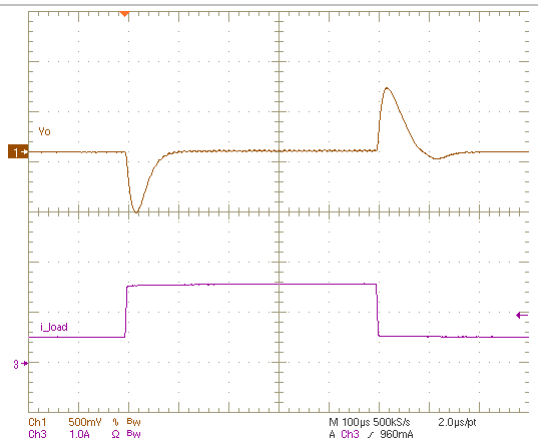
Load Transient Response (Fig. 17)

V_{IN}=3.6V, V_{OUT}=5V, I_{OUT}=0.5A->1.5A



Load Transient Response (Fig. 18)

V_{IN}=7.2V, V_{OUT}=12V, I_{OUT}=0.5A->1.5A

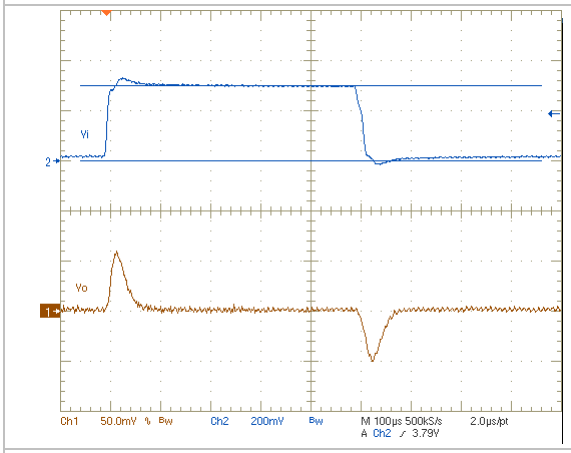


Typical Performance Characteristics (cont.)

V_{IN}=3.6V, V_{OUT}=5.0V, T_A=25℃, L=3.3uH, C_{IN}=10uF*2, C_{OUT}=22uF*3, unless otherwise specified

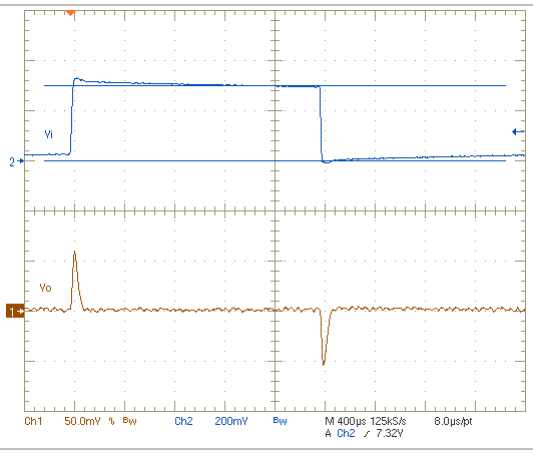
Line Transient Response (Fig. 19)

V_{IN}=3.6V->3.9V, V_{OUT}=5V, I_{OUT}=1A



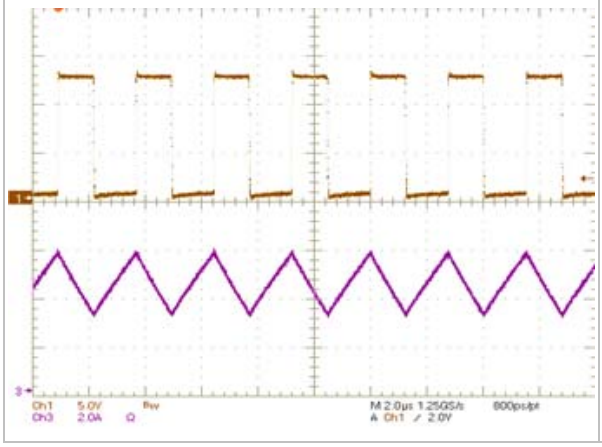
Line Transient Response (Fig. 20)

V_{IN}=7.2V->7.5V, V_{OUT}=12V, I_{OUT}=1A



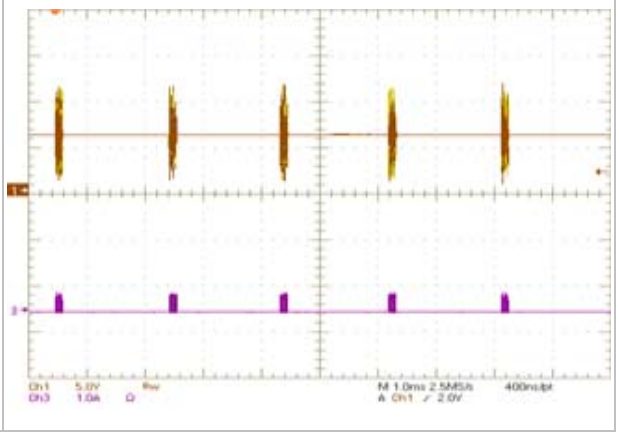
Heavy Load PWM Operation (Fig. 21)

V_{IN}=6V, V_{OUT}=12V, I_{OUT}=2A



Light Load PSM Operation (Fig. 22)

V_{IN}=6V, V_{OUT}=12V, I_{OUT}=1mA



Function Description

Detailed Description

The EMH7090 is a current mode boost converter. The constant switching frequency is 500kHz and operates with pulse width modulation (PWM). Build-in 16V/6A MOSFET provides a high output voltage. The control loop architecture is peak current mode control; therefore slope compensation circuit is added to the current signal to allow stable operation for duty cycles larger than 50%.

Soft Start

Soft start circuitry is integrated into EMH7090 to avoid inrush current during power on. After the IC is enabled, the output of error amplifier is clamped by the internal soft-start function, which causes PWM pulse width increasing slowly and thus reducing input surge current.

Over Temperature Protection

EMH7090 will turn off the power MOSFET automatically when the internal junction temperature is over 160°C. The power MOSFET wake up when the junction temperature drops 30°C under the OTP threshold temperature.

Over Voltage Protection

The EMH7090 has output over-voltage protections. The thresholds output OVP circuit minimum 118% x VOUT, respectively. Once the output voltage is higher than the threshold, the NMOS driver is turned off. When the output voltage drops lower than the threshold, the NMOS will be turned on again.

Over current Protection

The EMH7090 cycle-by-cycle limits the peak inductor current to protect NMOS driver. The NMOS driver will turn off when switching current reaches OCP level.

Application Information

Inductor Selection

Inductance value is decided based on different condition. 2.2uH or 3.3uH inductor value is recommended for general application circuit. There are three important inductor specifications, DC resistance, saturation current and core loss. Low DC resistance has better power efficiency.

Capacitor Selection

The output capacitor is required to maintain the DC voltage. Low ESR capacitors are preferred to reduce the output voltage ripple. Ceramic capacitor of X5R and X7R are recommended, which have low equivalent series resistance (ESR) and wider operation temperature range

Diode Selection

Schottky diodes with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the output voltage.

Output Voltage Setting

The output voltage of EMH7090 can be adjusted by a resistive divider according to the following formula:

$$V_{OUT} = V_{REF} * \left(1 + \frac{R_1}{R_2}\right) = 0.6 * \left(1 + \frac{R_1}{R_2}\right)$$

The resistive divider senses the fraction of the output voltage as shown in Fig.23 Using large feedback resistor can increase efficiency, but too large value affects the device's output accuracy because of leakage current going into device's FB pin. The recommended value for R2 is therefore in the range of 10~50KΩ.

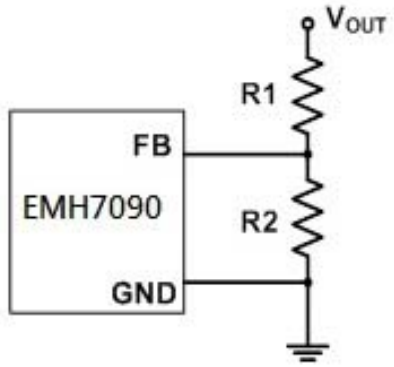


Fig. 23 Setting the Output Voltage

Applications

Typical Schematic for PCB layout

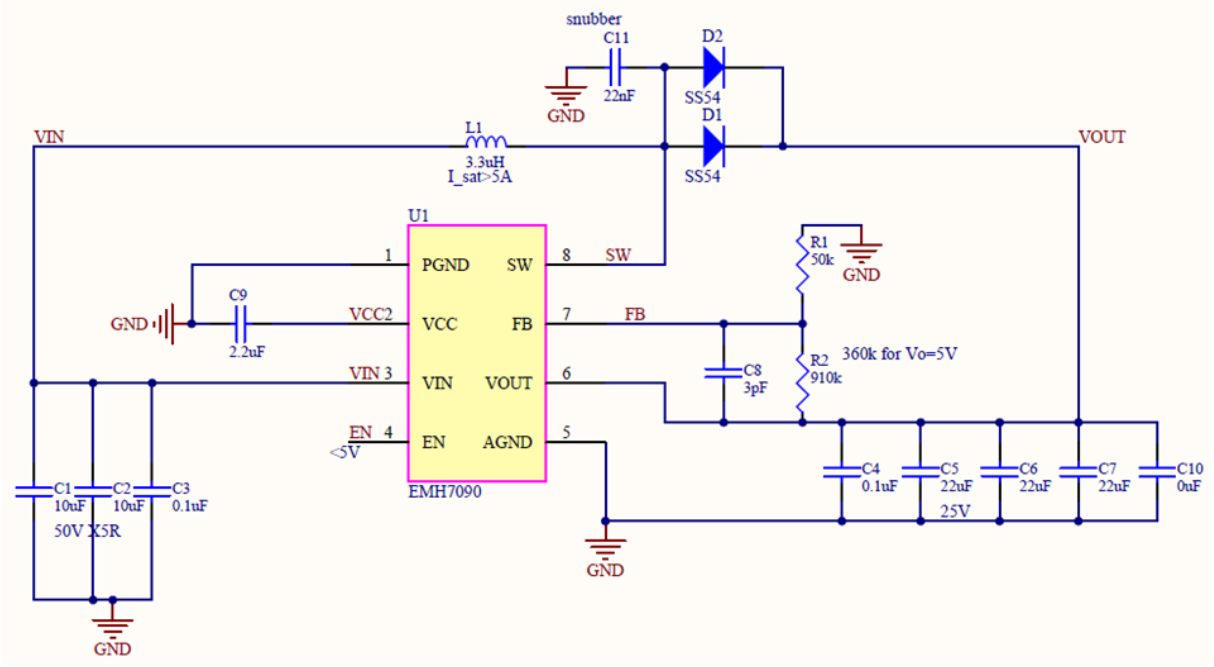


Fig. 24

PCB Layout Guidelines

When laying out the printed circuit board, the following checklist should be used to optimize the performance of EMH7090.

1. The power traces, consisting of the GND trace, the SW trace and the V_{CC} trace should be kept short, direct and wide.

2. SW、L and D switching node, wide and short trace to reduce EMI.

3. Place C_{IN} near VCC pin as closely as possible to maintain input voltage steady and filter out the pulsing input current.

4. The resistive divider R1and R2 must be connected to FB pin directly as closely as possible.

5. FB is a sensitive node. Please keep it away from switching node, SW

6. The GND of the IC, C_{IN} and C_{OUT} should be connected close together directly to a ground plane.

Typical Schematic for PCB layout (cont.)

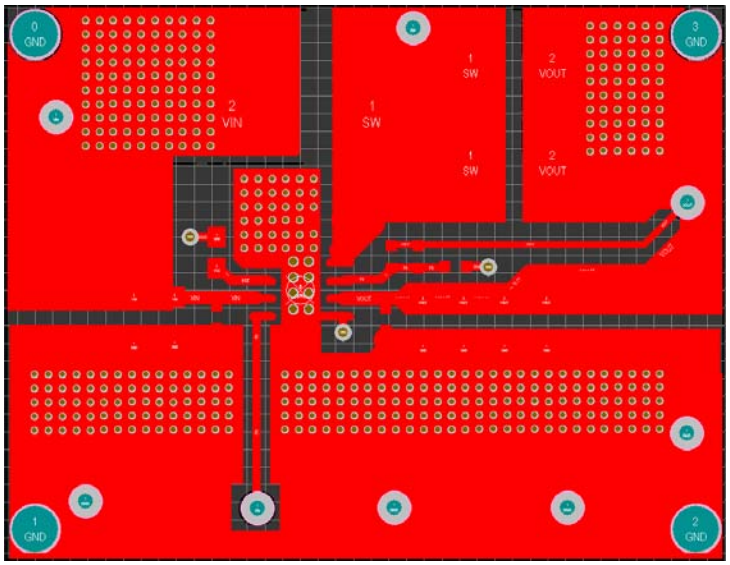


Fig. 25 Top Layer of PCB layout

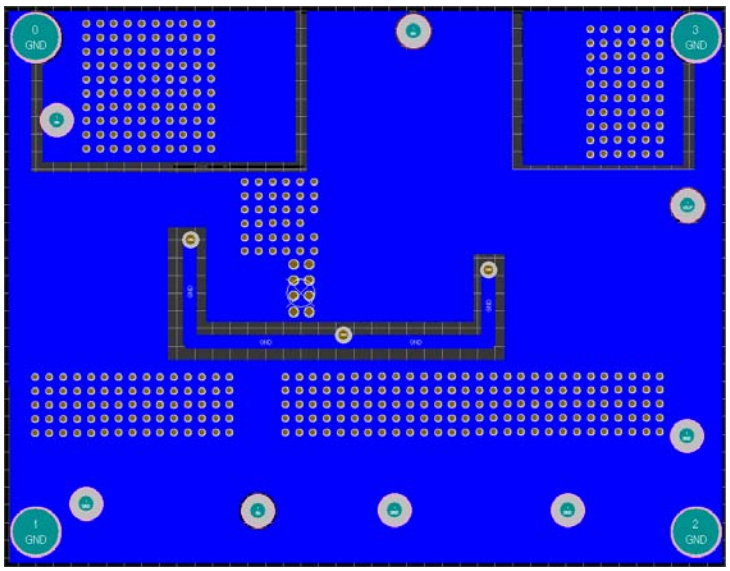
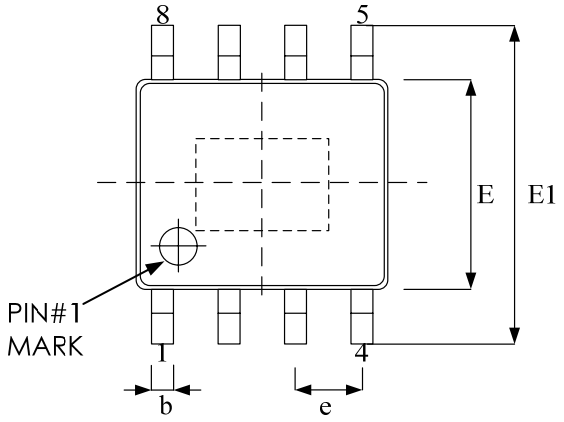
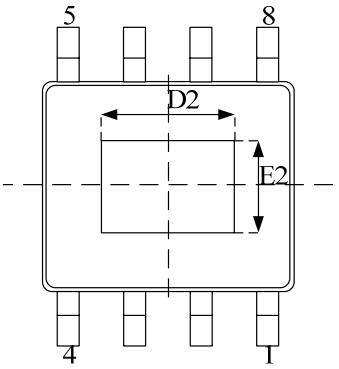


Fig. 26 Bottom Layer of PCB layout

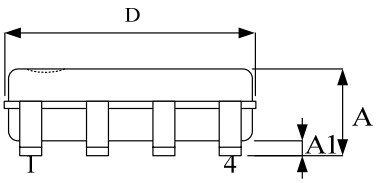
Package Outline Drawing
E-SOP-8L (150 mil)



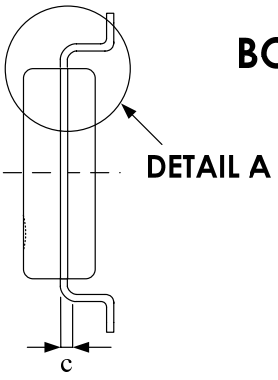
TOP VIEW

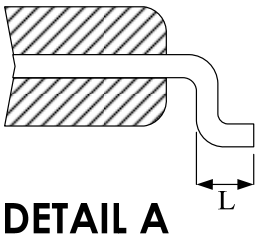


BOTTOM VIEW



SIDE VIEW





DETAIL A

Symbol	Dimension in mm	
	Min	Max
A	1.35	1.75
A1	0.00	0.25
b	0.33	0.51
c	0.17	0.25
D	4.80	5.00
E	3.81	4.00
E1	5.79	6.20
e	1.27 BSC	
L	0.41	1.27

Exposed pad

	Dimension in mm	
	Min	Max
D2	1.93	2.39
E2	1.93	2.39

Revision History

Revision	Date	Description
0.1	2016.11.09	Initial version.

Important Notice

The contents contained in this document are believed to be accurate at the time of publication. ESMT assumes no responsibility for any error in this document, and reserves the right to change the products or specification in this document without notice.

The information contained herein is presented only as a guide or examples for the application of our products. No responsibility is assumed by ESMT for any infringement of patents, copyrights, or other intellectual property rights of third parties which may result from its use. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of ESMT or others.

Any semiconductor devices may have inherently a certain rate of failure. To minimize risks associated with customer's application, adequate design and operating safeguards against injury, damage, or loss from such failure, should be provided by the customer when making application designs.

ESMT's products are not authorized for use in critical applications such as, but not limited to, life support devices or system, where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. If products described here are to be used for such kinds of application, purchaser must do its own quality assurance testing appropriate to such applications.