

## **5A 500KHz Synchronous Boost Converter**

### **❖ GENERAL DESCRIPTION**

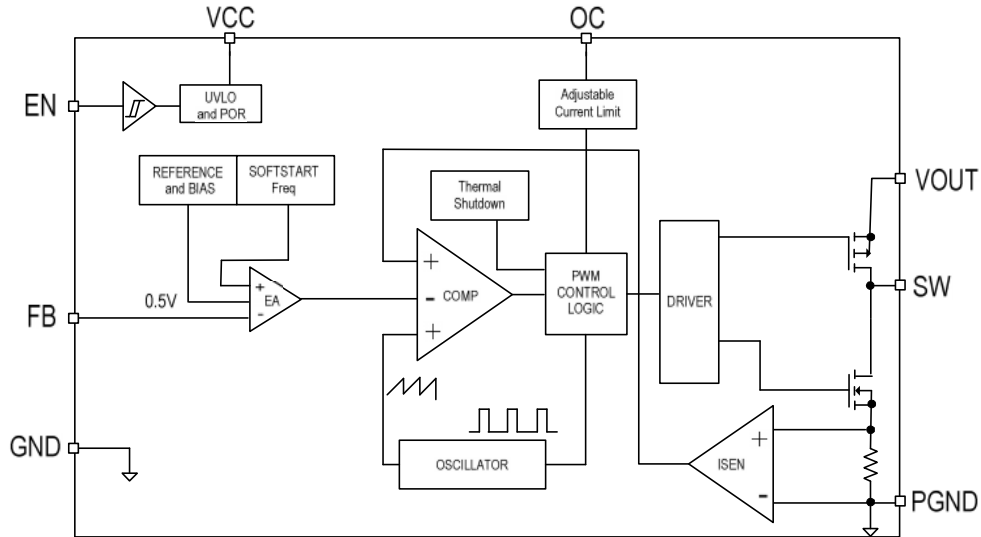
The MA2002 is a highly efficient, synchronous, fixed frequency, current-mode step-up converter, inrush current limiting and internal soft-start. It includes an error amplifier, ramp generator, comparator, N-Channel switch and P-Channel synchronous rectified switch (which greatly improves efficiency).

The 500KHz switching frequency allows for smaller external components producing a compact solution for a wide range of load currents. The MA2002 regulates the output voltage up to 5.5V and provides up to 3A output.

### **❖ FEATURES**

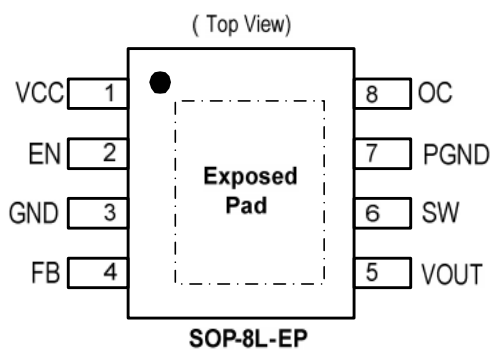
- Over 90% Efficiency
- Adjustable Output from  $V_{IN}$  to 5.5V
- 5A, Typical Switch Current Limit
- +2.8V to +5.5V Input Range
- 500KHz Fixed Switching Frequency
- 1 $\mu$ A Shutdown Current
- Programmable Soft-Start
- Thermal Shutdown
- Internal Synchronous Rectifier
- SOP-8L-EP Pb-free Package

## ❖ BLOCK DIAGRAM



## ❖ PIN ASSIGNMENT

The package of MA2002 is SOP-8L-EP; the pin assignment is given by:



Name	Description
<b>VCC</b>	VCC Input Pin
<b>EN</b>	Chip Enable pin. Active high. Internal pull high for auto start up.
<b>GND</b>	Ground Pin.
<b>FB</b>	Feedback Pin.
<b>VOUT</b>	Output Pin
<b>SW</b>	Switching Pin
<b>PGND</b>	Power Ground Pin.
<b>OC</b>	Adjustable Current limit

## ❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
<p><b>MA2002 XXX</b></p> <p>Package Type: ES: SOP-8L-EP</p> <p>Packing: A: Taping</p>	<p>Logo ← <b>MA2002</b> → Part number</p> <p>          <b>XXXXX</b> → ID code: internal</p> <p>                    → WW: 01~52</p> <p>                    → Year: 14=2014</p>

**❖ ABSOLUTE MAXIMUM RATINGS** (at  $T_A=25^{\circ}\text{C}$ )

Characteristics	Symbol	Rating	Unit
All pin voltage	$V_{IN}$	-0.3 to 6.0	V
EN,OC,FB pin voltage		-0.3 to $V_{IN}+0.3$	V
SW pin voltage	$V_{SW}$	-0.3 to 6.5	V
Continuous Power Dissipation	PD	$(T_J-T_A) / \theta_{JA}$	mW
Operating Junction Temperature	Top	-40 to 125	$^{\circ}\text{C}$
Storage Temperature Range		-65 to 150	$^{\circ}\text{C}$
Thermal Resistance from Junction to case	$\theta_{JC}$	15	$^{\circ}\text{C}/\text{W}$
Thermal Resistance from Junction to ambient	$\theta_{JA}$	40	$^{\circ}\text{C}/\text{W}$

Note:  $\theta_{JA}$  is measured with the PCB copper are (need connect to exposed pad) of approximately 1 in<sup>2</sup> (Multi-layer).

**❖ ELECTRICAL CHARACTERISTICS**

( $V_{IN} = 3.6\text{V}$ ,  $V_{EN} = 3.6\text{V}$ ,  $V_{OUT} = 5\text{V}$ ,  $T_A = 25^{\circ}\text{C}$ )

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range	$V_{IN}$		2.8	-	5.5	V
Input UVLO	UVLO		2	2.3	2.6	V
Quiescent Current	$I_{CCQ}$	$V_{FB} = 0.6\text{V}$	-	360	500	$\mu\text{A}$
Shutdown Current	$I_{SD}$	$V_{EN} = 0\text{V}$	-	1	3	$\mu\text{A}$
FB Pin Voltage	$V_{FB}$		0.490	0.5	0.510	V
VOUT Fix Voltage	$V_{FB}$	$V_{FB} \leq 0.2\text{V}$	-	5.125	-	V
Load Regulation		$0\text{A} < I_{OUT} < 3\text{A}$	-	0.2	-	%
Line Regulation		$2.8\text{V} < V_{IN} < 5.5\text{V}$	-	0.5	-	%
EN Pin Voltage High	$V_{ENH}$		1.4	-	-	V
EN Pin Voltage Low	$V_{ENL}$		-	-	0.6	V
EN Pin Leakage Current		$V_{EN} = 3\text{V}$	-	0.1	1	$\mu\text{A}$
Switching Frequency	$F_{OSC}$		-	500	-	KHz
Short-Circuit Frequency	$F_{OSC1}$	$V_{OUT} \leq 2.8\text{V}$	-	1/4	-	$F_{OSC}$
Programmable Current Limit	$C_L$	Roc=5k	-	5.0	-	A
Switching Maximum Duty	Dmax		-	65	-	%
Minimum Duty	Dmin		0	-	-	%

P-Switch $R_{DS(ON)}$ (Note1)	$R_{DS(ON)-I}$	-	75	-	m $\Omega$
N-Switch $R_{DS(ON)}$ (Note1)	$R_{DS(ON)-N}$	-	65	-	m $\Omega$
Thermal Shutdown	$T_{SD}$	-	150	-	$^{\circ}C$
Thermal Shutdown Protection hysteresis	$T_{SH}$	-	30	-	$^{\circ}C$

Note1: Guaranteed by design.

## ❖ APPLICATION CIRCUIT

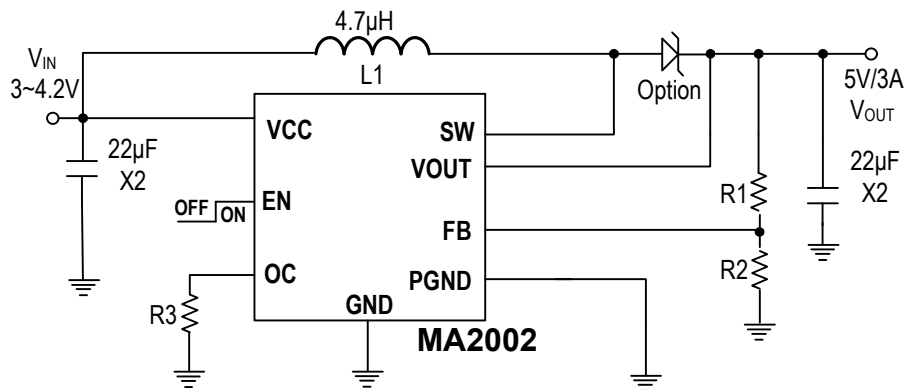


Figure 3. Typical Application Circuit

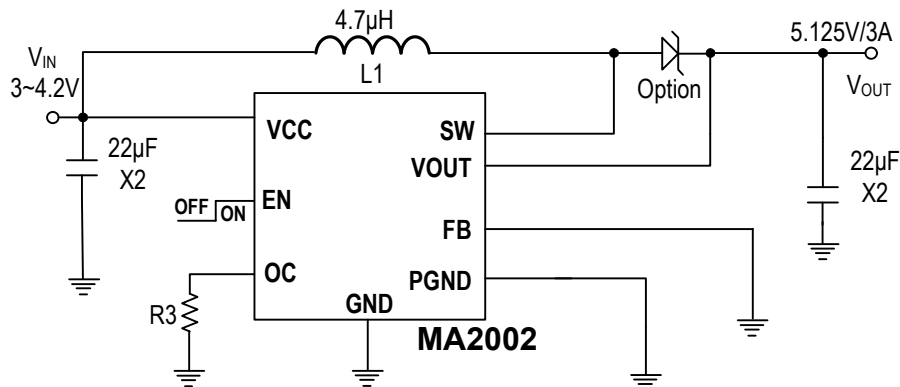


Figure 4. Fix output Typical Application Circuit

The MA2002 uses a 500KHz fixed-frequency, current-mode regulation architecture to regulate the output voltage. The MA2002 measures the output voltage through an external resistive voltage divider and compares that to the internal 0.5V reference to generate the error voltage. The current-mode regulator compares the error voltage to the inductor current to regulate the output voltage. The use of current-mode regulation improves transient response and control loop stability.

When the MA2002 is disabled (EN = Low), both power switches are off. The body of the P-Channel MOSFET connects to SW and there is no current path from SW to OUT. Therefore, the output voltage discharges to ground. When the MA2002 is enabled (EN = High), the body of the P-Channel MOSFET connects to OUT and forms a forward diode from SW to OUT. Thus the output voltage rises up toward the input voltage. When output voltage crosses 2.8V the MA2002 starts the controller and regulates the output voltage to the target value.

At the beginning of each cycle, the N-Channel MOSFET switch is turned on, forcing the inductor current to rise. The current at the source of the switch is internally measured and converted to a voltage by the current sense amplifier. That voltage is compared to the error voltage. When the inductor current rises sufficiently, the PWM comparator turns off the switch, forcing the inductor current to the output capacitor through the internal P-Channel MOSFET rectifier, which forces the inductor current to decrease. The peak inductor current is controlled by the error voltage, which in turn is controlled by the output voltage. Thus the output voltage controls the inductor current to satisfy the load.

### **Soft-Start**

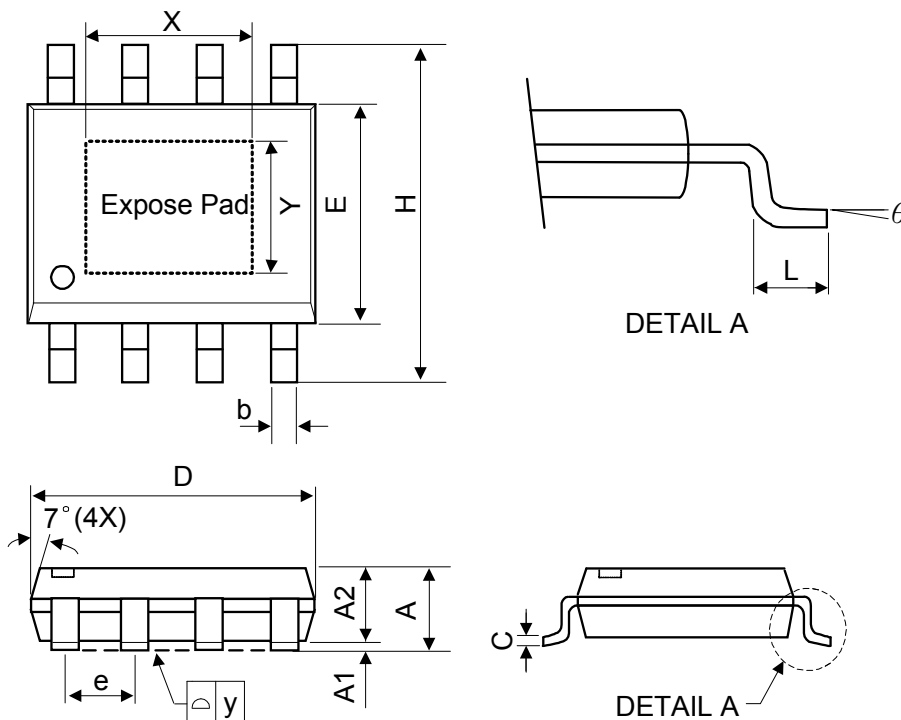
The MA2002 includes a soft-start timer that limits the voltage at the error amplifier output during startup to prevent excessive current at the input. This prevents premature termination of the source voltage at startup due to inrush current. This also limits the inductor current at startup, forcing the input current to rise slowly to the amount required to regulate the output voltage during soft-start.

### **Current Limit**

A resistor between OC and GND pin programs peak switch current. The resistor value should be between 0 to 150k. the current limit will be set from 6A to 1A. Keep traces at pin as short as possible. Do not put capacitance at OC pin. To set the over current point according to the following equation:

$$ICL=180000/(R3+30k)$$

## ❖ PACKAGE OUTLINES



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0	-	0.15	0	-	0.06
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	0.05
b	0.31	0.41	0.51	0.012	0.016	0.02
e	1.27 BSC			0.050 BSC		
y	-	-	0.1	-	-	0.004
X	-	2.34	-	-	0.092	-
Y	-	2.34	-	-	0.092	-
θ	0°	-	8°	0°	-	8°

Mold flash shall not exceed 0.25mm per side  
JEDEC outline: MS-012 BA