

POWER MANAGEMENT

Description

The SC4501 is a high-frequency current-mode step-up switching regulator with an integrated 2A power transistor. Its high switching frequency (programmable up to 2MHz) allows the use of tiny surface-mount external passive components. Programmable soft-start eliminates high inrush current during start-up. The internal switch is rated at 32V making the converter suitable for high voltage applications such as Boost, SEPIC and Flyback.

The operating frequency of the SC4501 can be set with an external resistor. The ability to set the operating frequency gives the SC4501 design flexibilities. A dedicated COMP pin allows optimization of the loop response. The SC4501 is available in thermally enhanced 8-Pin MSOP and 10-pin MLPD packages.

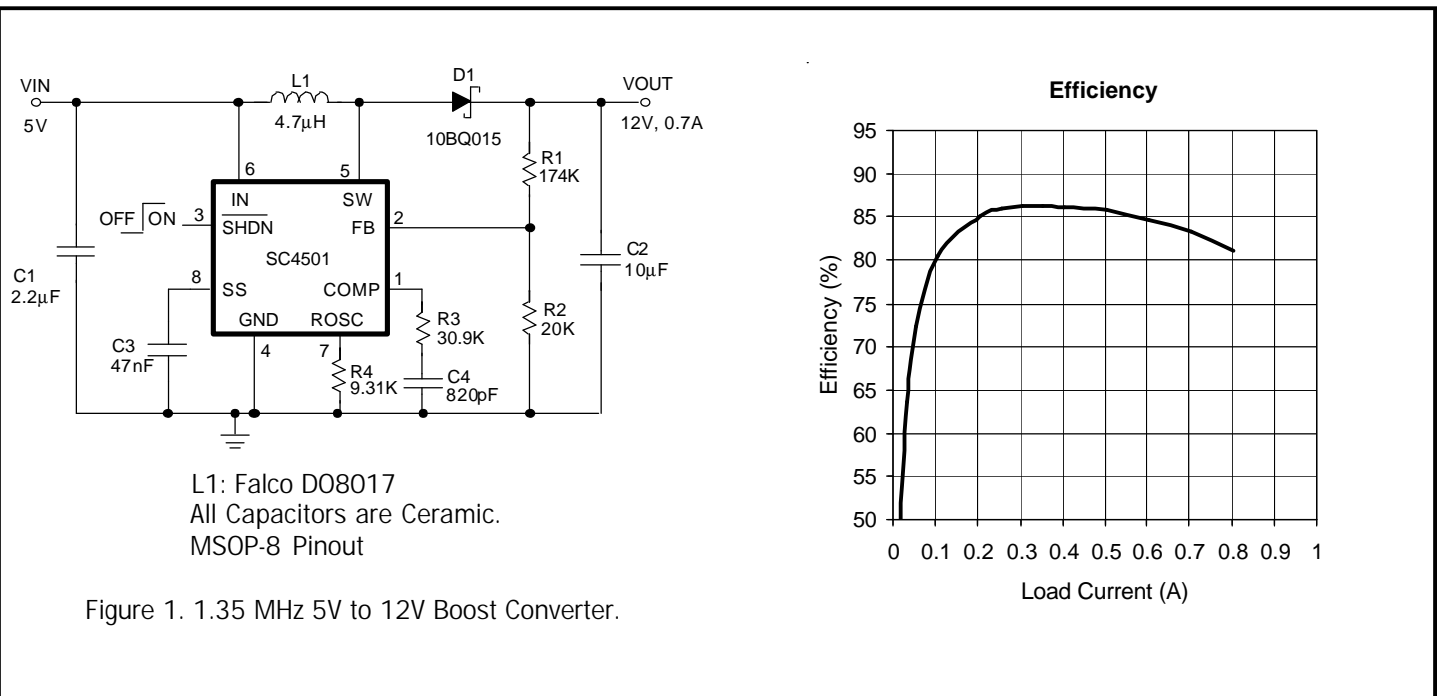
Features

- ◆ Low saturation voltage switch: 250mV at 2A
- ◆ Constant switching frequency current-mode control
- ◆ Programmable switching frequency up to 2MHz
- ◆ Soft-Start function
- ◆ Input voltage range from 1.4V to 16V
- ◆ Output voltage up to 32V
- ◆ Low shutdown current
- ◆ Adjustable undervoltage lockout threshold
- ◆ Small low-profile thermally enhanced packages

Applications

- ◆ Flat screen LCD bias supplies
- ◆ TFT bias supplies
- ◆ XDSL power supplies
- ◆ Medical equipments
- ◆ Digital video cameras
- ◆ Portables devices
- ◆ White LED power supplies

Typical Application Circuit



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Absolute Maximum Rating

Exceeding the specifications below may result in permanent damage to the device, or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not implied.

Parameter	Symbol	Typ	Units
Supply Voltage	V_{IN}	-0.3 to 16	V
SW Voltage	V_{SW}	-0.3 to 32	V
FB Voltages	V_{FB}	-0.3 to 2.5	V
SHDN Voltage	V_{SHDN}	-0.3 to $V_{IN} + 1$	V
Operating Temperature Range	T_A	-40 to +85	°C
Thermal Resistance Junction to Ambient (MSOP-8)	θ_{JA}	40	°C/W
Thermal Resistance Junction to Ambient (MLPD-10)	θ_{JA}	40	
Maximum Junction Temperature		125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10s (MSOP) Peak IR Reflow Temperature 10 - 40s (MLP)	T_{LEAD} T_{PKG}	260	°C

Electrical Characteristics

Unless specified: $V_{IN} = 2V$, $SHDN = 1.5V$, $R_{OSC} = 7.68k\Omega$, $-40^\circ C < T_A = T_J < 85^\circ C$

Parameter	Test Conditions	Min	Typ	Max	Unit
Minimum Operating Voltage			1.3	1.4	V
Maximum Operating Voltage				16	V
Feedback Voltage	$T_A = 25^\circ C$	1.224	1.242	1.260	V
	$-40^\circ C < T_A < 85^\circ C$	1.217		1.267	V
Feedback Voltage Line Regulation	$1.5V < V_{IN} < 16V$		0.01		%
FB Pin Bias Current			40	80	nA
Error Amplifier Transconductance			60		$\mu\Omega^{-1}$
Error Amplifier Open-Loop Gain			49		dB
COMP Source Current	$V_{FB} = 1.1V$		5		μA
COMP Sink Current	$V_{FB} = 1.4V$		5		μA
V_{IN} Quiescent Supply Current	$V_{SHDN} = 1.5V$, $V_{COMP} = 0$ (Not Switching)		1.1	1.6	mA
V_{IN} Supply Current in Shutdown	$V_{SHDN} = 0$		12	18	μA
Switching Frequency		1.3	1.5	1.7	MHz
Maximum Duty Cycle		85	90		%
Minimum Duty Cycle				0	%
Switch Current Limit		2	2.8		A
Switch Saturation Voltage	$I_{SW} = 2A$		250	400	mV
Switch Leakage Current	$V_{SW} = 5V$		0.01	1	μA

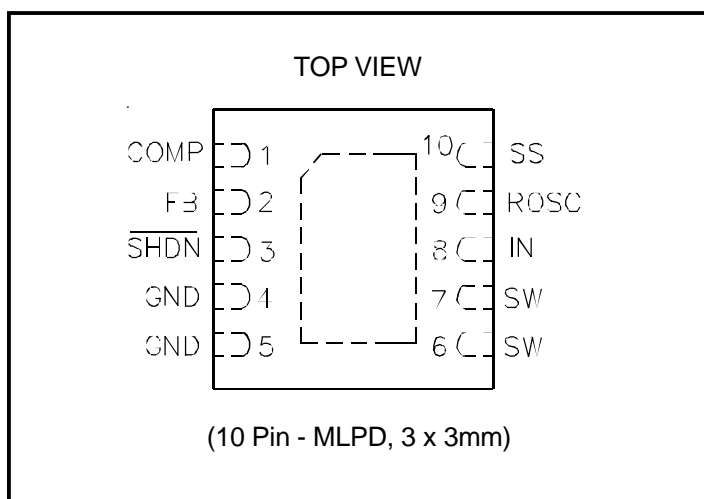
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Electrical Characteristics (Cont.)

 Unless specified: $V_{IN} = 2V$, $\overline{SHDN} = 1.5V$, $R_{OSC} = 7.68k\Omega$, $-40^{\circ}C < T_A = T_J < 85^{\circ}C$

Parameter	Test Conditions	Min	Typ	Max	Unit
Shutdown Threshold Voltage		1.02	1.1	1.18	V
Shutdown Pin Current	$V_{SHDN} = 1.2V$		-4.6		μA
	$V_{SHDN} = 0$		0	0.1	μA
Soft-Start Charging Current	$V_{SS} = 0.3V$		1.5		μA
Thermal Shutdown Temperature			160		$^{\circ}C$
Thermal Shutdown Hysteresis			10		$^{\circ}C$

Pin Configurations



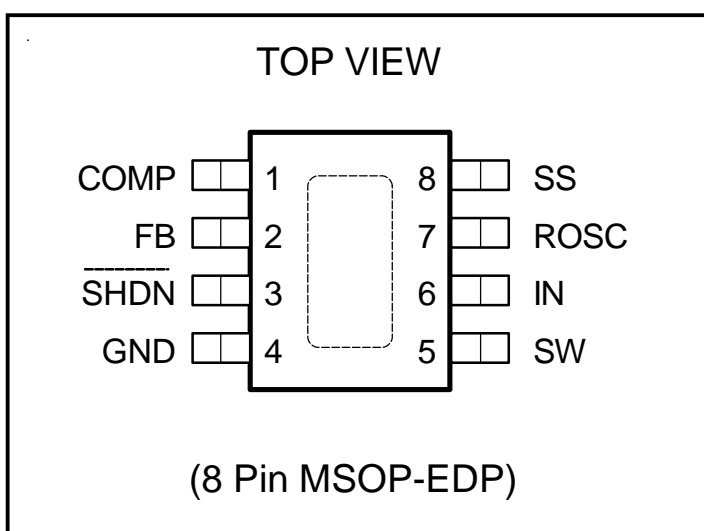
Ordering Information

Device ⁽¹⁾⁽²⁾	Package	Temp. Range(T_A)
SC4501MLTRT	MLPD-10	-40 - 85 $^{\circ}C$
SC4501MSETRT	MSOP-8-EDP	

Notes:

(1) Only available in tape and reel packaging. A reel contains 3000 devices for MLP package and 2500 devices for MSOP.

(2) Lead free product. This product is fully WEEE and RoHS compliant.



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Pin Descriptions (MSOP-8)

Pin	Pin Name	Pin Function
1	COMP	The output of the internal transconductance error amplifier. This pin is used for loop compensation.
2	FB	The inverting input of the error amplifier. Tie to an external resistive divider to set the output voltage.
3	$\overline{\text{SHDN}}$	Shutdown Pin. The accurate 1.1V shutdown threshold and the 4.6 μ A shutdown pin current hysteresis allow the user to set the undervoltage lockout threshold and hysteresis for the switching regulator. Pulling this pin below 0.1V causes the converter to shut down to low quiescent current. Tie this pin to IN if the UVLO and the shutdown features are not used. This pin should not be left floating.
4	GND	Ground. Tie to the ground plane.
5	SW	Collector of the internal power transistor. Connect to the boost inductor and the rectifying diode.
6	IN	Power Supply Pin. Bypassed with capacitors close to the pin.
7	ROSC	A resistor from this pin to the ground sets the switching frequency.
8	SS	Soft-Start Pin. A capacitor from this pin to the ground lengthens the start-up time and reduces start-up current.
	Exposed Pad	The exposed pad must be soldered to the ground plane on the PCB for good thermal conduction.

Block Diagram

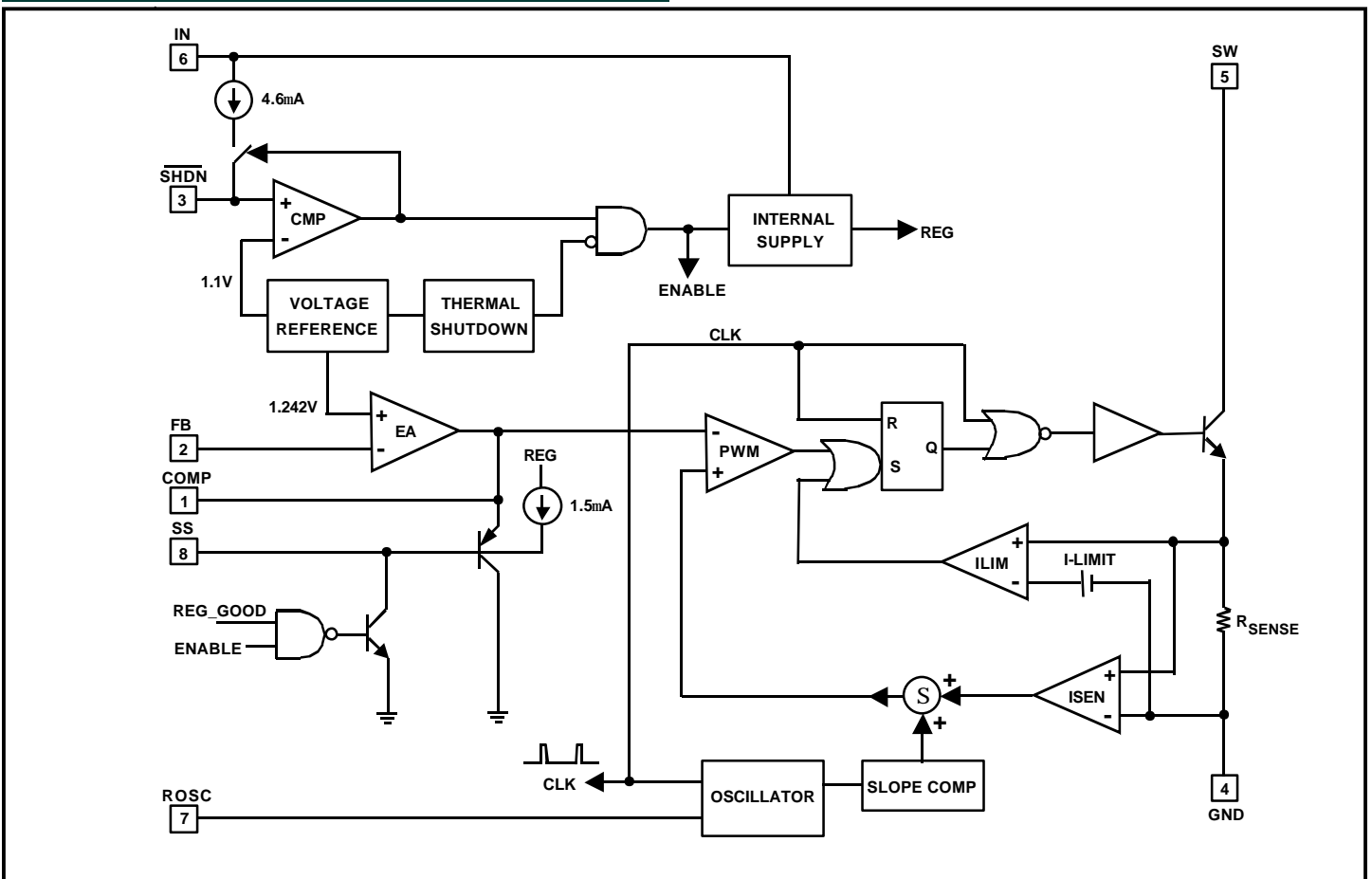


Figure 2. SC4501 (MSOP-8) Block Diagram.

POWER MANAGEMENT

Pin Descriptions (MLPD - 10)

Pin	Pin Name	Pin Function
1	COMP	The output of the internal transconductance error amplifier. This pin is used for loop compensation.
2	FB	The inverting input of the error amplifier. Tie to an external resistive divider to set the output voltage.
3	SHDN	Shutdown Pin. The accurate 1.1V shutdown threshold and the 4.6uA shutdown pin current hysteresis allow the user to set the undervoltage lockout threshold and hysteresis for the switching regulator. Pulling this pin below 0.1V causes the converter to shut down to low quiescent current. Tie this pin to IN if the UVLO and the shutdown features are not used. This pin should not be left floating.
4,5	GND	Ground. Tie both pins to the ground plane. Pins 4 and 5 are not internally connected.
6,7	SW	Collector of the internal power transistor. Connect to the boost inductor and the rectifying diode.
8	IN	Power Supply Pin. Bypassed with capacitors close to the pin.
9	ROSC	A resistor from this pin to the ground sets the switching frequency.
10	SS	Soft-Start Pin. A capacitor from this pin to the ground lengthens the start-up time and reduces start-up current.
	Exposed Pad	The exposed pad must be soldered to the ground plane on the PCB for good thermal conduction.

Block Diagram

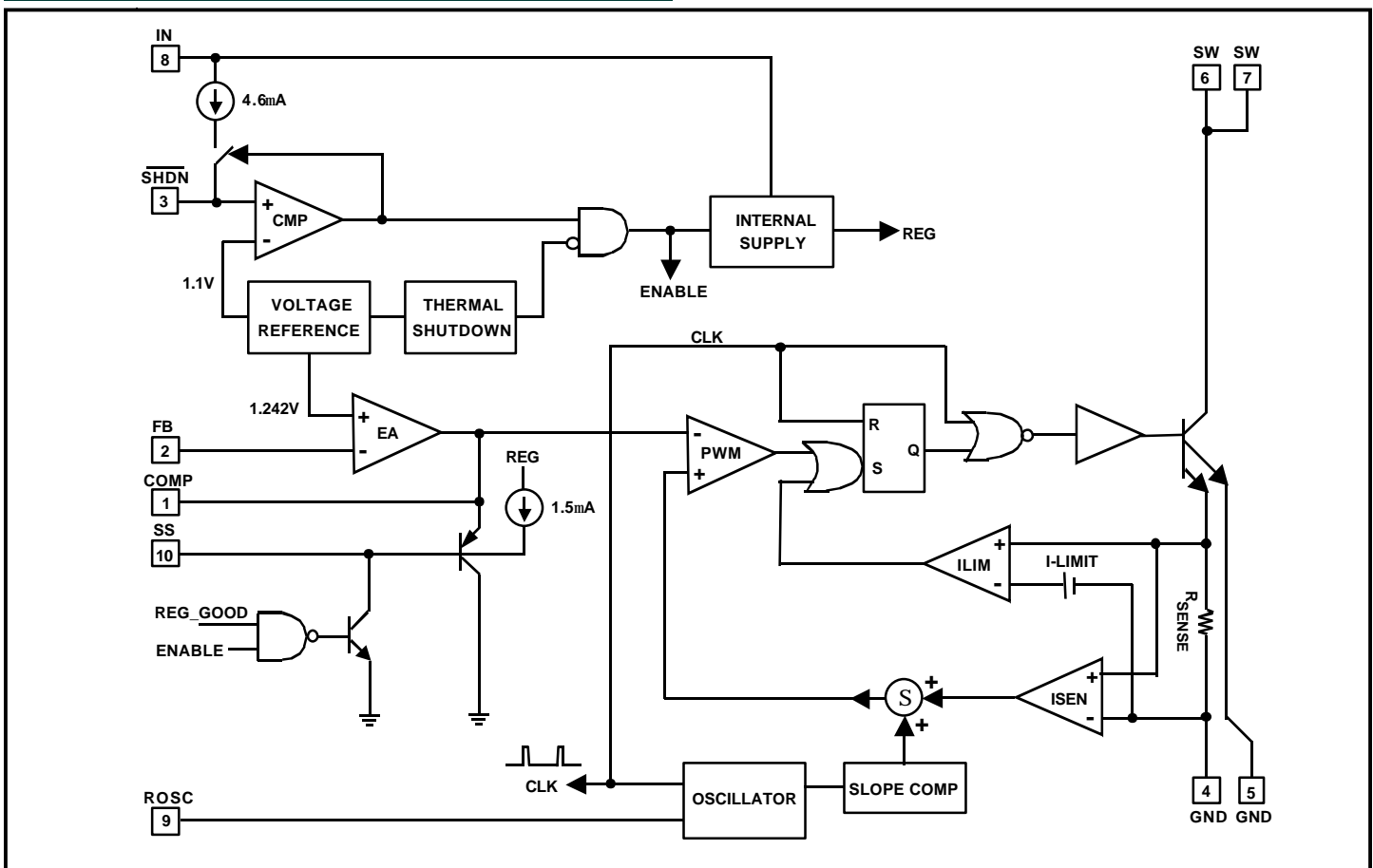
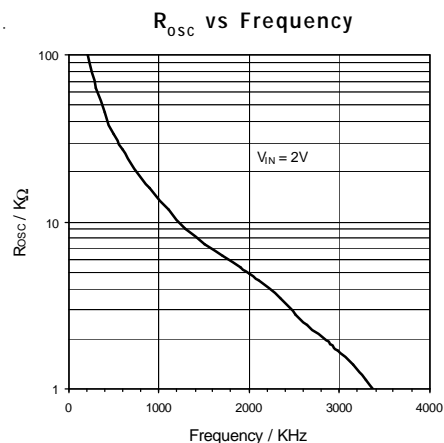


Figure 3. SC4501 (MLPD-10) Block Diagram.



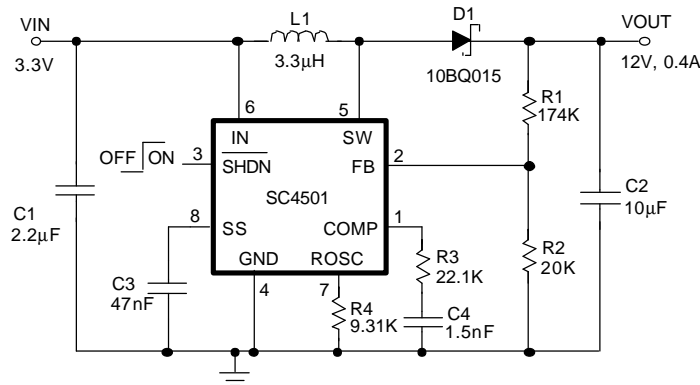
The SC4501 is a programmable constant-frequency peak current-mode step-up switching regulator with an integrated 2A power transistor. Referring to the block diagrams in Figures 2 and 3, the power transistor is switched on at the leading edge of the clock. Switch current is sensed with an integrated sense resistor. The sensed current is summed with the slope-compensating ramp before compared to the output of the error amplifier EA. The PWM comparator trip point determines the switch turn-on pulse width. The current-limit comparator ILIM turns off the power switch when the switch current exceeds the 2.8A current-limit threshold. ILIM therefore provides cycle-by-cycle current limit. Current-limit is not affected by slope compensation since the current comparator ILIM and the current-limit threshold determine it. Current-mode switching regulator is a dual-loop feedback control system. In the SC4501 the amplifier output COMP controls the peak inductor current. This is the inner current loop. The double reactive poles of the output LC filter are reduced to a single real pole by the inner current loop, easing loop compensation. Fast transient response can be obtained with simple compensation network. The error amplifier regulates the output voltage.

The switching frequency of the SC4501 can be programmed up to 2MHz with an external resistor from the R_{OSC} pin to the ground. For converters requiring extreme duty cycles, the operating frequency can be lowered to maintain the necessary minimum on time or the minimum off time.

The SC4501 requires a minimum input of 1.4V to operate. A voltage higher than 1.1V at the shutdown pin enables the internal linear regulator REG in the SC4501. After \overline{V} becomes valid, the soft-start capacitor is charged with a 1.5mA current source. A PNP transistor clamps the output of the error amplifier as the soft-start capacitor voltage rises. Since the COMP voltage controls the peak inductor current, the inductor current is ramped gradually during soft-start, preventing high input start-up current. Under fault condition ($V_{IN} < 1.4V$ or over temperature) or when the shutdown pin is pulled below 1.1V, the soft-start capacitor is discharged to the ground. Pulling the shutdown pin below 0.1V reduces the total supply current to 12 μ A.

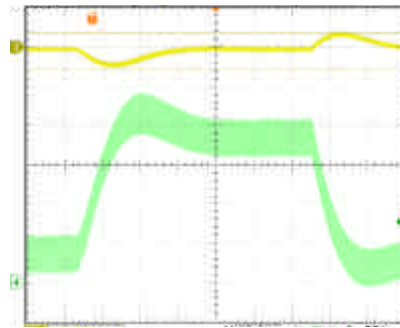
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Typical Application Circuits



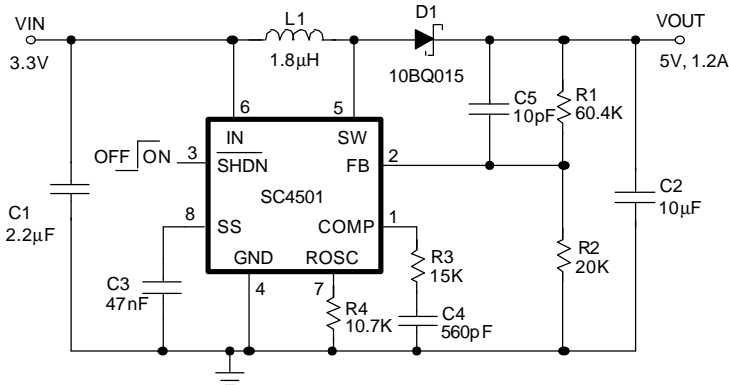
L1: Cooper-Bussmann SD25-3R3

Figure 4(a). 1.35 MHz All Ceramic Capacitor 3.3V to 12V Boost Converter. Pinout Shown is for MSOP-8.



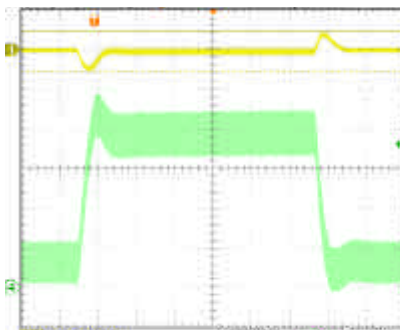
40µs/div

 Upper Trace : Output Voltage, AC Coupled, 1V/div
 Lower Trace : Inductor Current, 0.5A/div

 Figure 4(b). Load Transient Response of the Circuit in Figure 4(a). I_{LOAD} is switched between 0.1A and 0.4A at 1A/µs.


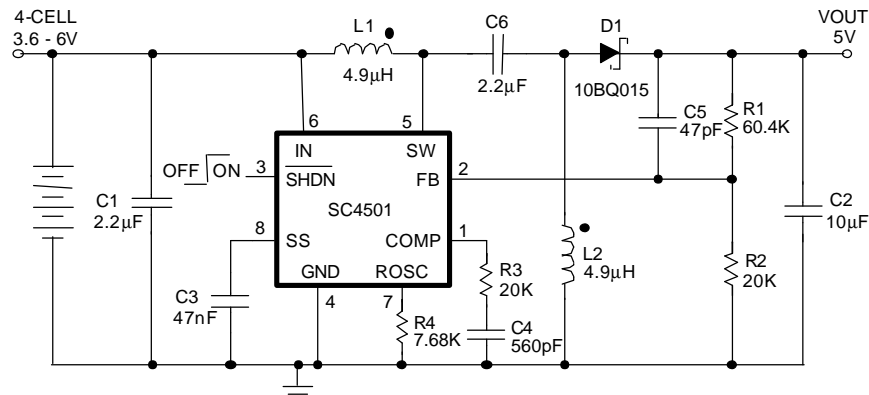
L1: Sumida CR43-1R8

Figure 5(a). 1.2 MHz All Ceramic Capacitor 3.3V to 5V Boost Converter. Pinout Shown is for MSOP-8.



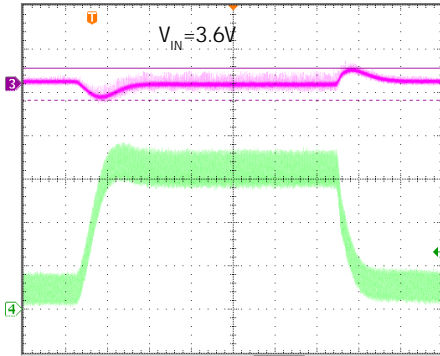
40µs/div

 Upper Trace : Output Voltage, AC Coupled, 0.5V/div
 Lower Trace : Inductor Current, 0.5A/div

 Figure 5(b). Load Transient Response of the Circuit in Figure 5(a). I_{LOAD} is switched between 0.2A and 1.1A at 1A/µs.


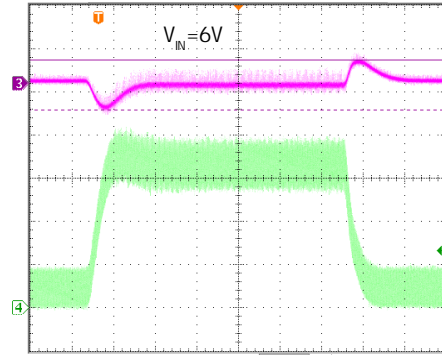
L1 and L2: Coiltronics CTX5-1

Figure 6(a). 1.5 MHz All Ceramic Capacitor 4-Cell to 5V SEPIC Converter. Pinout Shown is for MSOP-8.

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Typical Application Circuits

 40 μ s/div

Upper Trace : Output Voltage, AC Coupled, 0.2V/div
 Lower Trace : Input Inductor Current, 0.2A/div

Figure 6(b). Load Transient Response of the Circuit in Figure 6(a).
 I_{LOAD} is switched between 50mA and 350mA at 1A/ μ s.

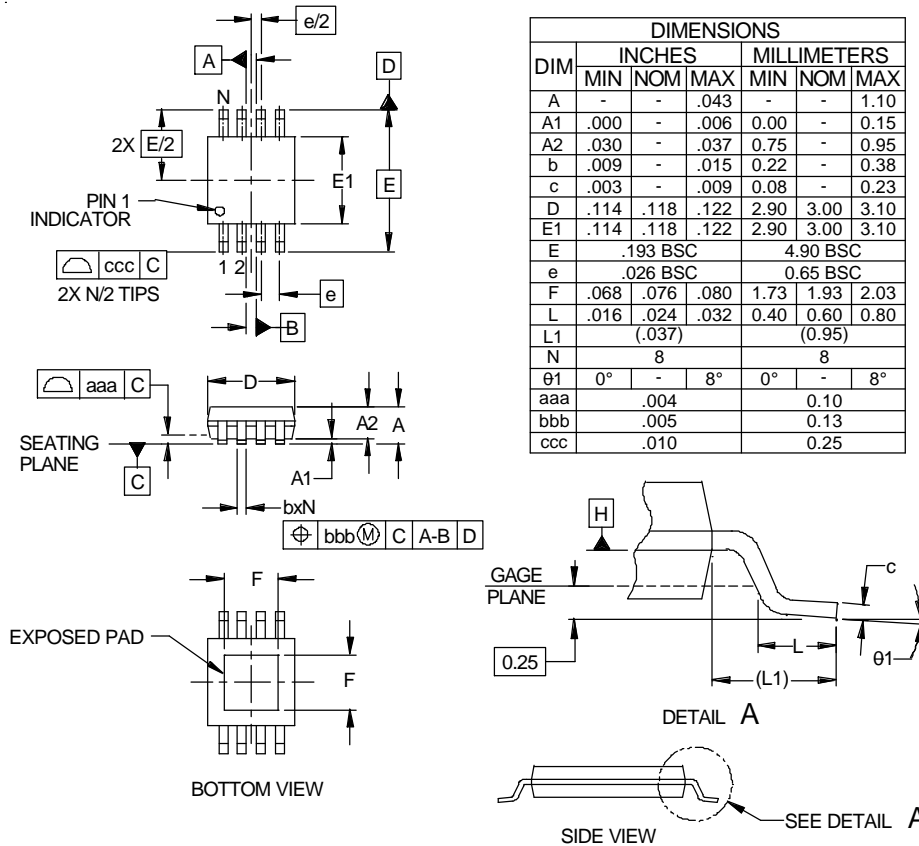

 40 μ s/div

Upper Trace : Output Voltage, AC Coupled, 0.2V/div
 Lower Trace : Input Inductor Current, 0.2A/div

Figure 6(c). Load Transient Response of the Circuit in Figure 6(a).
 I_{LOAD} is switched between 80mA and 600mA at 1A/ μ s.

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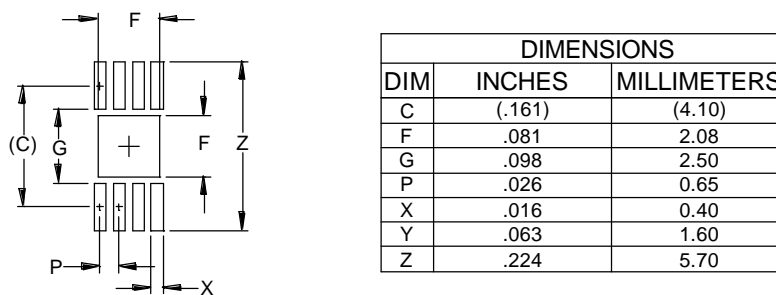
Outline Drawing - MSOP-8L-EDP



NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DATUMS **-A-** AND **-B-** TO BE DETERMINED AT DATUM PLANE **-H-**
3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
4. REFERENCE JEDEC STD MO-187, VARIATION AA-T.

Land Pattern - MSOP-8L-EDP

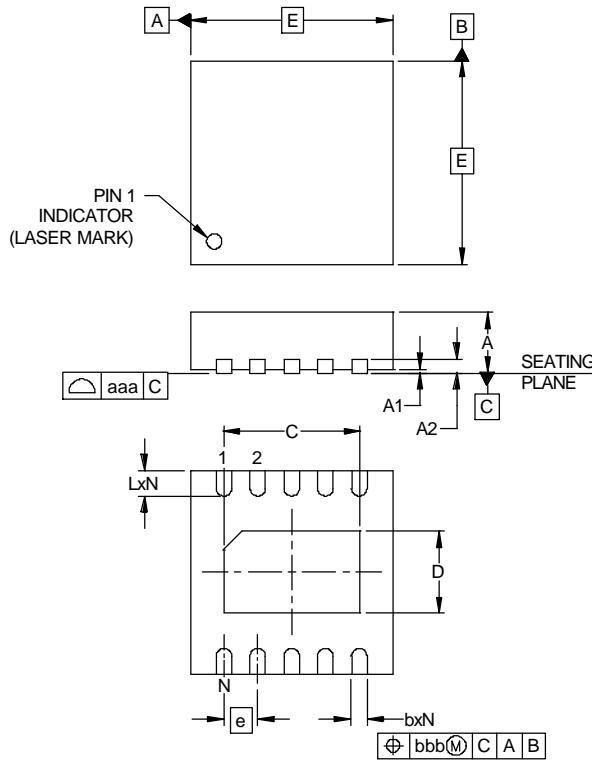


NOTES:

1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

POWER MANAGEMENT

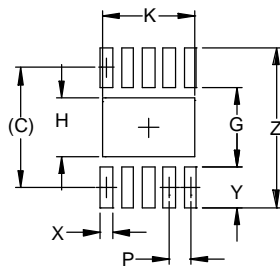
Outline Drawing - MLPD-10, 3 x 3mm



DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	.031	-	.039	0.80	-	1.00
A1	.000	-	.002	0.00	-	0.05
A2	-	(.008)	-	-	(0.20)	-
b	.007	.009	.011	0.18	0.23	0.30
C	.074	.079	.083	1.87	2.02	2.12
D	.042	.048	.052	1.06	1.21	1.31
E	.114	.118	.122	2.90	3.00	3.10
e	.020 BSC			0.50 BSC		
L	.012	.016	.020	0.30	0.40	0.50
N	10			10		
aaa	.003			0.08		
bbb	.004			0.10		

- NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
 2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS TERMINALS.

Land Pattern - MLPD-10, 3 x 3mm



DIM	DIMENSIONS	
	INCHES	MILLIMETERS
C	(.112)	(2.85)
G	.075	1.90
H	.055	1.40
K	.087	2.20
P	.020	0.50
X	.012	0.30
Y	.037	0.95
Z	.150	3.80

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