AMC3202

1.5A 280kHz Boost Regulators

ADDtek
www.addmtek.com

DESCRIPTION

The AMC3202 is a 280kHz switching regulator with a high efficiency, 1.5A integrated switch. The part operates over a wide input voltage range, from 2.7V to 30V. The AMC3202 utilizes current mode architecture, which allows excellent load and line regulation, as well as a practical means for limiting current. Combining high frequency operation with a highly integrated regulator circuit results in an extremely compact power supply solution.

Build-in thermal protection to prevent the chip over heat damage.

FEATURES

- **Integrated Power Switch: 1.5A Guaranteed.**
- **Wide Input Range: 2.7V to 30V.**
- **43V Build-in Power Switch Input Voltage.**
- **High Frequency Allows for Small Components.**
- **Minimum External Components.**
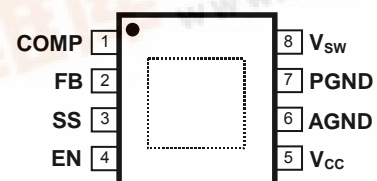- **Built in Over Current Protection.**

TYPICAL APPLICATION CIRCUIT
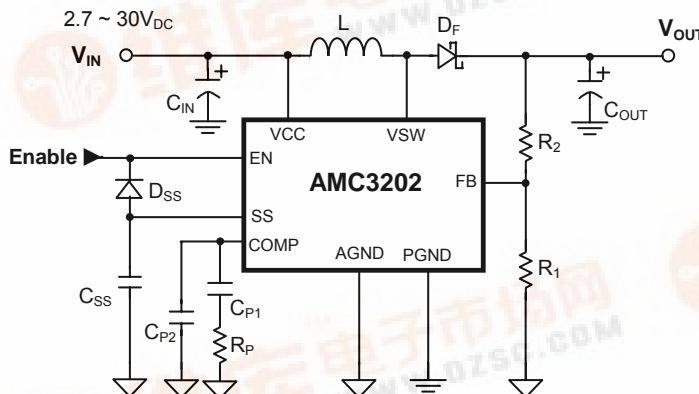
APPLICATIONS

- TFT-LCD Power Management
- LED Backlight

PACKAGE PIN OUT

SO-8
(Top View)

ORDER INFORMATION

DM	SO
	8 pin
	AMC3202DMF (Lead Free)

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number (i.e. AMC3202DMFT). The letter "F" is marked for Lead Free process.

AMC3202

ABSOLUTE MAXIMUM RATINGS (Note)

Input Voltage, V_{CC}	30V
Switch Input Voltage, V_{SW}	43V
Maximum Operating Junction Temperature, T_J	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	260°C

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.

BLOCK DIAGRAM
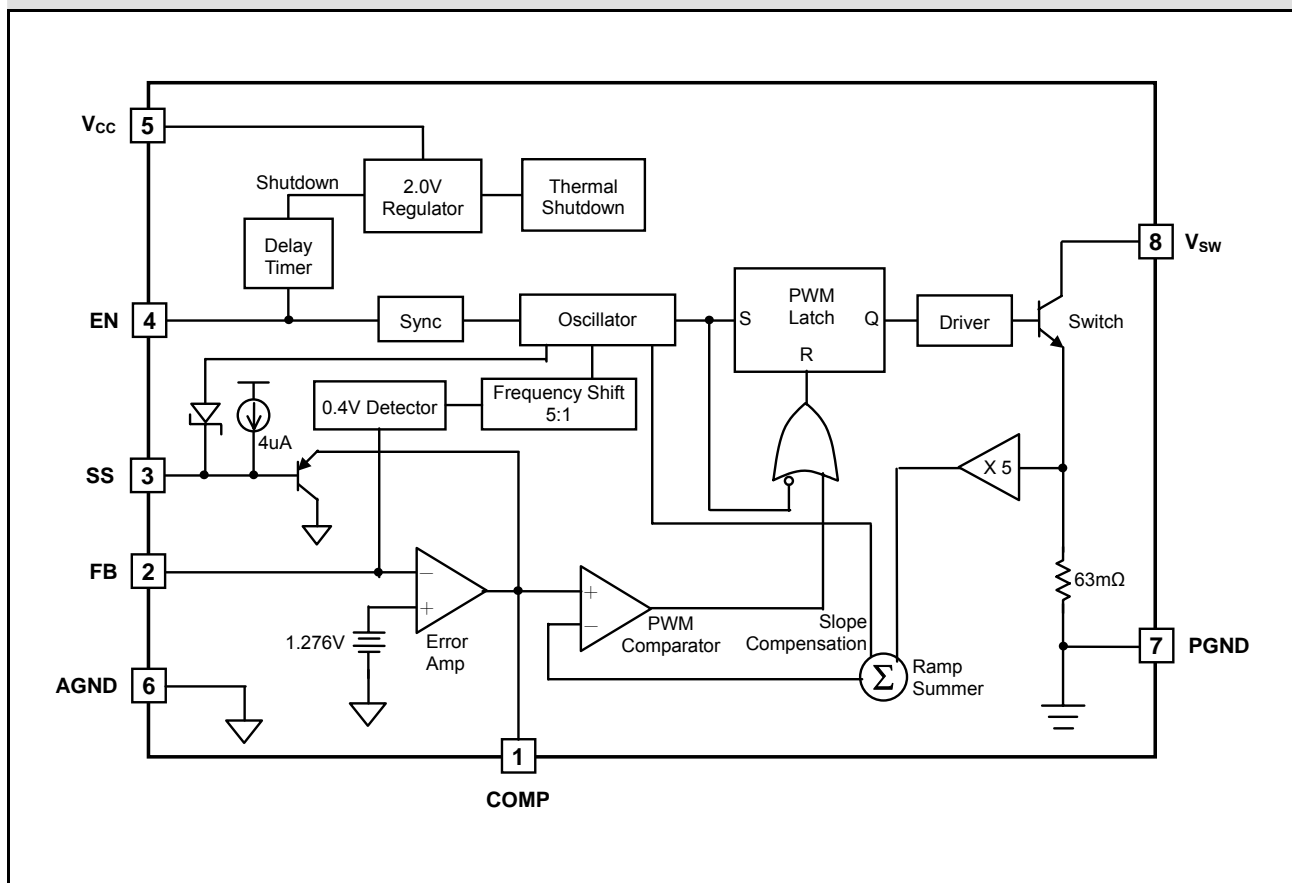
PIN DESCRIPTION

Pin Number	Pin Name	Pin Function
1	COMP	Loop compensation pin. This pin is the output of the error amplifier and is used for loop compensation. Loop compensation can be implemented by a simple RC network.
2	FB	Feedback pin. Sense the output voltage and referenced to 1.276V. When the voltage at this pin falls below 0.4V, chip switching-frequency reduces to a much lower frequency.
3	SS	Soft Start pin. Left this pin floating if soft start function is not used.
4	EN	Enable pin. A TTL low will shut down the chip and high enable the chip. This pin may also be used to synchronize the part to nearly twice the base frequency. If synchronization is not used, this pin should be either tied high or left floating for normal operation.
5	VCC	Input power supply pin. Supply power to the IC and should have a bypass capacitor connected to AGND.
6	AGND	Analog ground. Provide a clean ground for the controller circuitry and should not be in the path of large currents. This pin is connected to the IC substrate.
7	PGND	Power ground. This pin is the ground connection for the emitter of the power switching transistor. Connection to a good ground plane is essential.
8	V_{SW}	High current switch pin. Connect to the collector of the internal power switch. The open voltage across the power switch can be as high as 40V. To minimize radiation, use a trace as short as practical.
Exposed Pad	Heat Pad (PGND)	Heat pad. Connect to power ground. Must be soldered to electrical ground on PCB.

THERMAL DATA

Thermal Resistance from Junction to Ambient, θ_{JA}	165°C /W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
Connect the ground pin to ground using a large pad or ground plane for better heat dissipation.
All of the above assume no ambient airflow.

Maximum Power Calculation:

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_{A(MAX)}}{\theta_{JA}}$$

$T_J(^{\circ}C)$:   Maximum recommended junction temperature

$T_A(^{\circ}C)$:   Ambient temperature of the application

$\theta_{JA}(^{\circ\circ}C\,/W)$:   Junction-to-Ambient thermal resistance of the package, and other heat dissipating materials.

The maximum power dissipation for a single-output regulator is:

$$P_{D(MAX)} = [(V_{IN(MAX)} - V_{OUT(NOM)})] \times I_{OUT(NOM)} + V_{IN(MAX)} \times I_Q$$

Where: $V_{OUT(NOM)}$ = the nominal output voltage
$I_{OUT(NOM)}$ = the nominal output current, and
I_Q = the quiescent current the regulator consumes at $I_{OUT(MAX)}$
$V_{IN(MAX)}$ = the maximum input voltage

Then $\theta_{JA} = (+150\,^{\circ}C - T_A)/P_D$

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{IN}	2.7		30	V
Average Supply Current	I_{IN}			1.3	A
Output Voltage	V_{OUT}			42	V
Operating Free-air Temperature Range	T_A			85°C	°C

## DC ELECTRICAL CHARACTERISTICS

$V_{CC} = 3.3V$, $T_A = 25°C$, (Unless otherwise noted)

Parameter	Conditions	Min	Typ	Max	Unit
FB Reference Voltage	COMP tied to FB; Measure at FB; $2.7V \leqq V_{CC} \leqq 30V$	1.246	1.276	1.300	V
FB Input Current	FB=V_{REF}	-1.0	0.1	1.0	uA
FB Reference Voltage Line Regulation	COMP=FB, $2.7V \leqq V_{CC} \leqq 30V$	-	0.01	0.03	%/V
Error Amp Transconductance	$I_{COMP} = \pm 25uA$ (Note)	300	550	800	uMho
Error Amp Gain	(Note)	200	500	-	V/V
COMP Source Current	FB=1.0V, COMP=1.25V	25	50	90	uA
COMP Sink Current	FB=1.5V, COMP=1.25V	200	625	1500	uA
COMP High Clamp Voltage	FB=1.0V, COMP sources 25uA	1.5	1.7	1.9	V
COMP Low Clamp Voltage	FB=1.5V, COMP sinks 25uA	0.25	0.50	0.65	V
COMP Threshold	Reduce COMP from 1.5V until switching stops	0.75	1.05	1.30	V
Base Operating Frequency	FB=1V	230	280	310	kHz
Reduced Operating Frequency	FB=0V	30	52	120	kHz
Maximum Duty Cycle	FB=1V	90	94	-	%
FB Frequency Shift Threshold	Frequency drops to reduced operating frequency	0.36	0.40	0.44	V
Synchronization Range		320	-	500	kHz
Synchronization Pulse Transition Threshold	Rise time=20ns	2.5	-	-	V
EN Bias Current	EN=0V	-15	-3.0	-	uA
	EN=3.0V	-	3.0	8.0	
Shutdown Threshold		0.50	0.85	1.20	V
Shutdown Delay	$2.7V \leqq V_{CC} \leqq 12V$	12	80	350	uS
	$12V \leqq V_{CC} \leqq 30V$	12	36	200	

Switch Saturation Voltage	I_{SWITCH}=1.5A	-	0.8	1.4	V
	I_{SWITCH}=1.0A, 0°C$\leqq$T$_J$$\leqq$85°C [Note]	-	0.55	-	
	I_{SWITCH}=1.0A, -40°C$\leqq$T$_J$$\leqq$0°C [Note]	-	0.75	-	
	I_{SWITCH}=10mA	-	0.09	0.45	
Switch Current Limit	50% duty cycle [Note]	1.6	1.9	2.4	A
	80% duty cycle [Note]	1.5	1.7	2.2	
Minimum Pulse Width	COMP=1.4V, I_{SW} = 1.0A	100	250	300	nS
Switch Leakage	V_{SW}=43V, V_{CC}=0V	-	2.0	10	uA
$\Delta I_{CC}/\Delta I_{sw}$	2.7V$\leqq$$V_{CC}$$\leqq$12V, 10mA$\leqq$$I_{SW}$$\leqq$1.0A	-	10	30	mA/A
	12V$\leqq$$V_{CC}$$\leqq$30V, 10mA$\leqq$$I_{SW}$$\leqq$1.0A	-	-	100	
	2.7V$\leqq$$V_{CC}$$\leqq$12V, 10mA$\leqq$$I_{SW}$$\leqq$1.5A	-	17	30	
	12V$\leqq$$V_{CC}$$\leqq$30V, 10mA$\leqq$$I_{SW}$$\leqq$1.5A	-	-	100	
Operating Current	I_{SW}=0; 2.7V$\leqq$$V_{CC}$$\leqq$30V	-	5.5	8.0	mA
Shutdown Mode Current	COMP$<$0.8V, EN=0V, 2.7V$\leqq$$V_{CC}$$\leqq$12V	-	12	60	uA
	COMP$<$0.8V, EN=0V, 12V$\leqq$$V_{CC}$$\leqq$30V	-	-	100	
Minimum Operation Input Voltage	V_{SW} switching, maximum I_{SW}=10mA	-	2.45	2.70	V
Thermal Shutdown		150	-	-	°C
Thermal Hysteresis		-	25	-	°C

Note: Guaranteed by design, not 100% tested in production.

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CHARACTERIZATION CURVES

Switch Frequency vs. FB
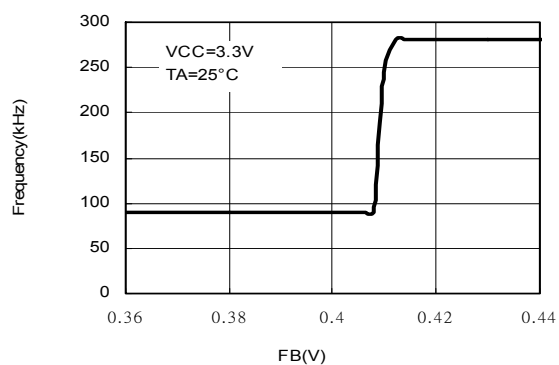
Icc vs. V$_{CC}$ During Shutdowm
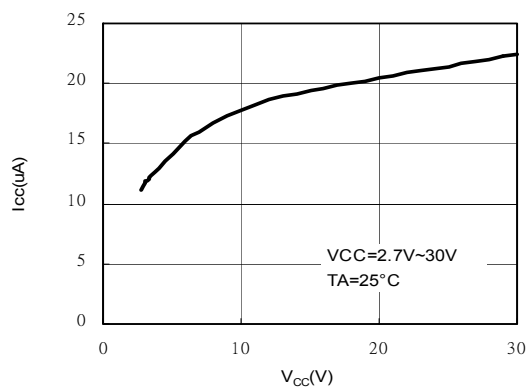
Reference Voltage vs. Temperature
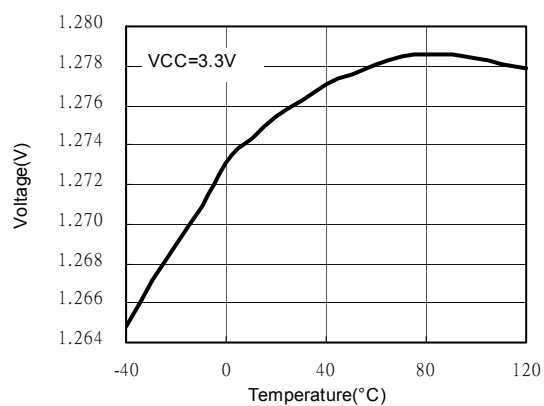
I$_{EN}$ vs. V$_{EN}$
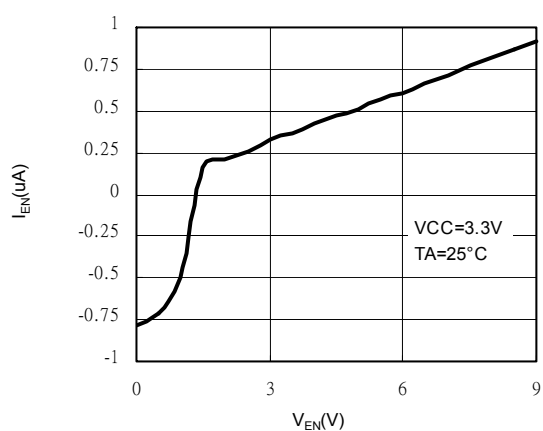
V$_{CE (SAT)}$ vs. I$_{SW}$
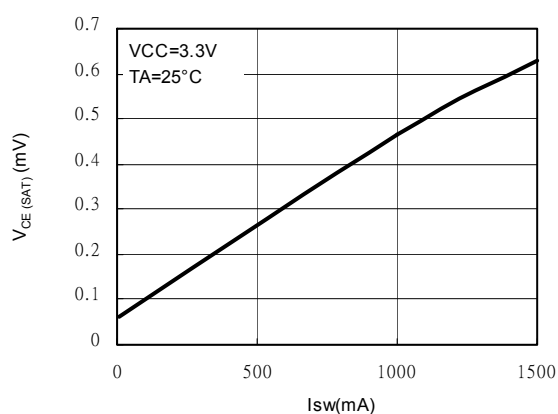
COMP Threshold vs. Temperature
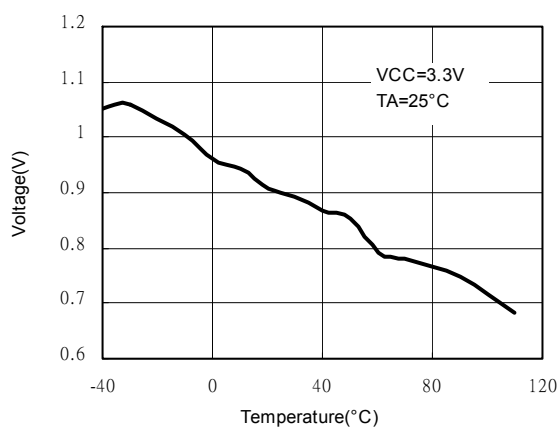
Shutdown Delay vs. Temperature
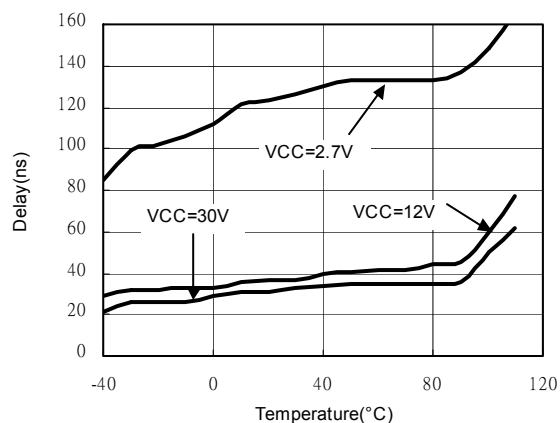
Switching FOSC vs. Temperature
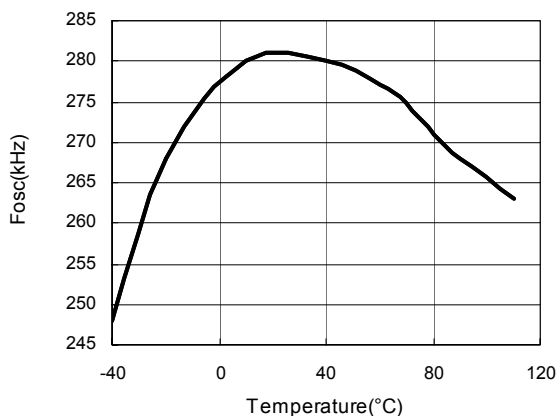
Minimum V_CC vs. Temperature
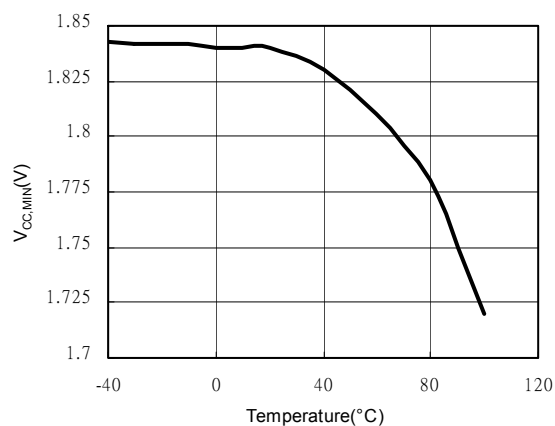
### Switch Leakage vs. Temperature
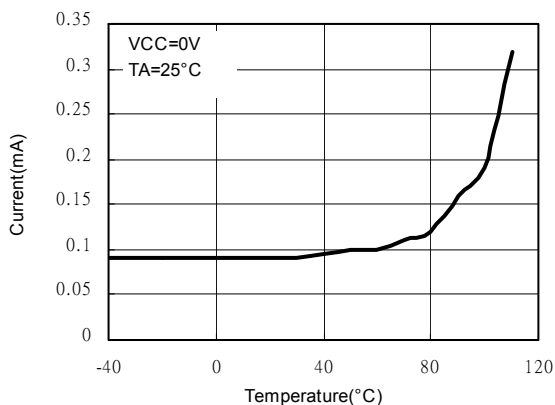
Max Duty Cycle vs. Temperature
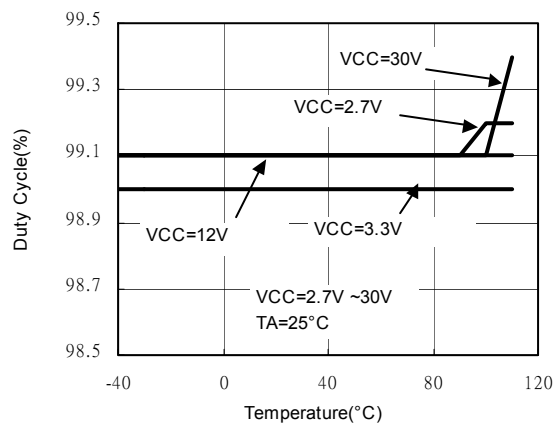
APPLICATION INFORMATION

Operation:

The AMC3202 incorporates a current mode control scheme, in which the duty cycle of the switch is directly controlled by switch current rather than by output voltage. The output of the oscillator turns on the power switch at a frequency of 280kHz as shown in the block diagram. The power switch is turned off by the output of the PWM comparator.

A TTL low voltage will shut down the chip and high voltage enable the chip through EN pin. This pin may also be used to synchronize the part to nearly twice the base oscillator frequency. In order to synchronize to a higher frequency, a positive transition turns on the power switch before the output of the oscillator goes high, thereby resetting the oscillator. The synchronization operation allows multiple power supplies to operate at the same frequency. If synchronization is not used, this pin should be either tied high or left floating for normal operation.

Component Selection:
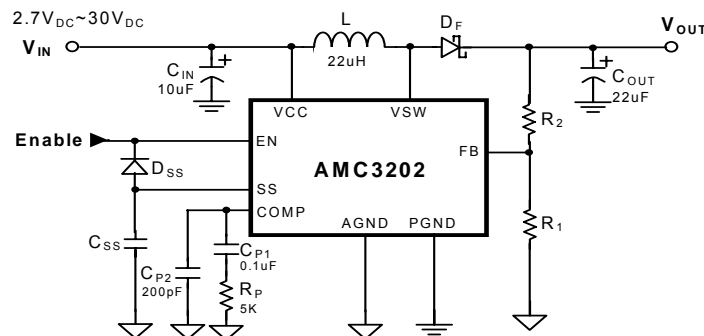
The AMC3202 develops a 1.276V reference from the FB pin to ground. Output voltage is set by connecting the FB pin to an output resistor divider and the maximum output voltage is determined by the VSW pin maximum voltage minus the output diode forward voltage. Referring to typical application circuit, the output voltage is set by the below formula (1):

$$V_{OUT} = 1.276V\left(1 + \frac{R2}{R1}\right) \qquad 2.7\text{V} \leqq \text{V}_{OUT} \leqq 43\text{V} - \text{V}_F \tag{1}$$

where, V_F is the output diode D_F forward voltage.

When choosing the inductor, one must consider factors such as peak current, core and ferrite material, output voltage ripple, EMI, temperature range, physical size, and cost. Lower values are chosen to reduce physical size of the inductor, and higher values reduce ripple voltage and core loss. In continuous conduction mode, the peak inductor current is equal to average current plus half of the ripple current, which should not cause inductor saturation. Based on the tolerance of the ripple current in the circuits, the following formula (2) can be referenced:

$$I_{Ripple} = \frac{V_{IN}\left(V_{OUT} - V_{IN}\right)}{fLV_{OUT}} \quad \text{where,} f = 280\text{kHz.} \tag{2}$$

In Boost circuits, the inductor becomes part of the input filter. In continuous mode, the input current waveform is triangular and does not contain a large pulsed current. This reduces the requirements imposed on the input capacitor selection. Capacitors in the range of 10uF to 100uF with an ESR less than $0.3\,\Omega$ work well up to full 1.5A switch current.

The V_{IN} ripple is determined by the product of the inductor current ripple and the ESR of input capacitor, and the V_{OUT} ripple comes from two major sources, namely ESR of output capacitor and the charging/discharging of the output capacitor. Ceramic capacitors have the lowest ESR, but too low ESR may cause loop stability problems. Aluminum Electrolytic capacitors exhibit the highest ESR, resulting in the poorest AC response. One option is to parallel a ceramic capacitor with an Aluminum Electrolytic capacitor.

Frequency Compensation

The goal of frequency compensation is to achieve desirable transient response and DC regulation while ensuring the stability of the system. A typical compensation network, as shown in the typical application circuit, provides a frequency response of two poles and one zero. The loop frequency compensation is performed on the output of the error amplifier (COMP pin) with a series RC network. The main pole is formed by the series capacitor and the output impedance of the error amplifier. The series resistor creates a zero, which improves loop stability and transient response. A second capacitor is sometimes used to reduce the switching frequency ripple on the COMP pin.

$$f_{P1} = \frac{1}{2\pi C_{P1} R_O} \qquad \text{where, } R_O = \text{error amplifier output resistance;}$$

$$f_{Z1} = \frac{1}{2\pi C_{P1} R_P}$$

$$f_{P2} = \frac{1}{2\pi C_{P2} R_P}$$

Soft Start

Through the addition of an external circuit, a soft-start function can be added to the AMC3202. Soft-start circuitry prevents the COMP pin from slamming high during startup, thereby inhibiting the inductor current from rising at a high slope. Referring to the figure shown in the following, the soft-start circuitry requires a minimum number of components and allows the soft-start circuitry to be activated any time when the EN pin is used to restart the converter.
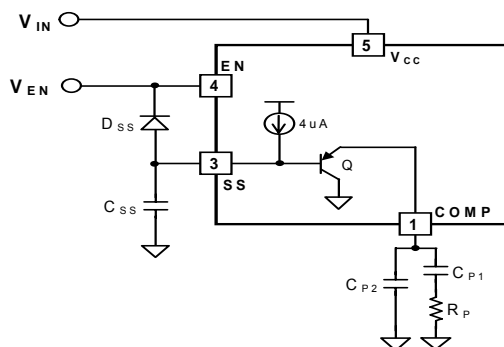
Resistor R_P and capacitors C_{P1} and C_{P2} form the compensation network. At turn on, the voltage at the COMP pin starts to come up, charging capacitor C_{SS} through internal transistor Q, clamping the voltage at the COMP pin such that switching begins when COMP reaches the COMP threshold, typically 1.05V. Therefore, C_{SS} slows down the startup of the circuit by limiting the voltage on the COMP pin. The soft-start time increases with the size of C_{SS}.

Diode D_{SS} discharges C_{SS} when the voltage on the EN pin is low. If the shutdown function is not used with this part, the cathode of D_{SS} should be connected to V_{IN}.

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PACKAGE

8-Pin Plastic S.O.I.C.
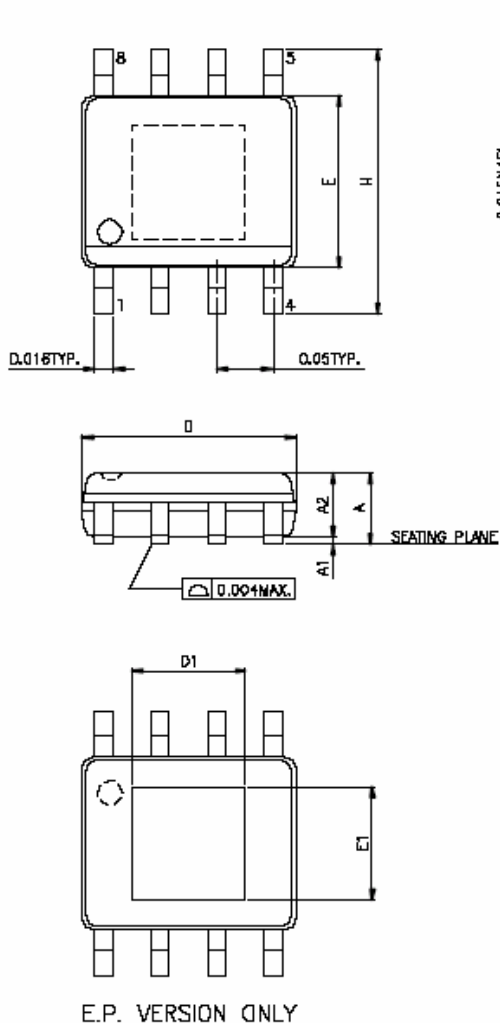
SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.002	0.006
A2	-	0.059
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
$\theta°$	0	8

UNIT: INCH

THERMALLY ENHANCED DIMENSIONS

PAD SIZE	E1	D1
90X90E	0.081 REF	0.081 REF
95X13E	0.086 REF	0.117 REF

UNIT: INCH

NOTES:

1. JEDEC OUTLINE. N/A

2. DIMENSIONS "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 15mm (.005in) PER SIDE.

3. DIMENSIONS "E" DOES NOT INCLUDE INTER-LEAD FLASH, OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED .25mm (.010in) PER SIDE.

E.P. VERSION ONLY
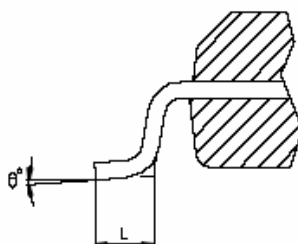
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