5A,30V,500KHz Step-Down Converter

DESCRIPTION

The EUP3489 is current mode, step-down switching regulator capable of driving 5A continuous load with excellent line and load regulation. The EUP3489 operates with an input voltage range from 4.75V to 30V and the output voltage is externally set from 1.222V to 26V with a resistor divider.

Fault condition protection includes cycle-by-cycle current limit and thermal shutdown. In shutdown mode the regulator draws 3μA of supply current. Internal soft-start minimizes the inrush supply current and the output overshoot at initial startup.

The EUP3489 require a minimum number of external components.

FEATURES

- 4.75V to 30V Wide Input Operating Range
- Output Adjustable from 1.222V to 26V
- Up to 5A Output Current
- 3μA Low Shutdown Current
- 0.1Ω Internal DMOS Output Switch
- Up to 90% Efficiency
- Fixed 500kHz Switching Frequency
- Internal Compensation
- Internal Soft Start
- Cycle-by-Cycle Current Limit Protection
- Thermal Shutdown Protection
- Input Supply Undervoltage Lockout
- Available SOP-8 (EP) Package
- RoHS Compliant and 100% Lead(Pb)-Free Halogen-Free

APPLICATIONS

- LCD TV
- Battery Charger
- DSL Modems
- Distributive Power Systems
- Pre-regulator for Linear Regulators

Typical Application Circuit

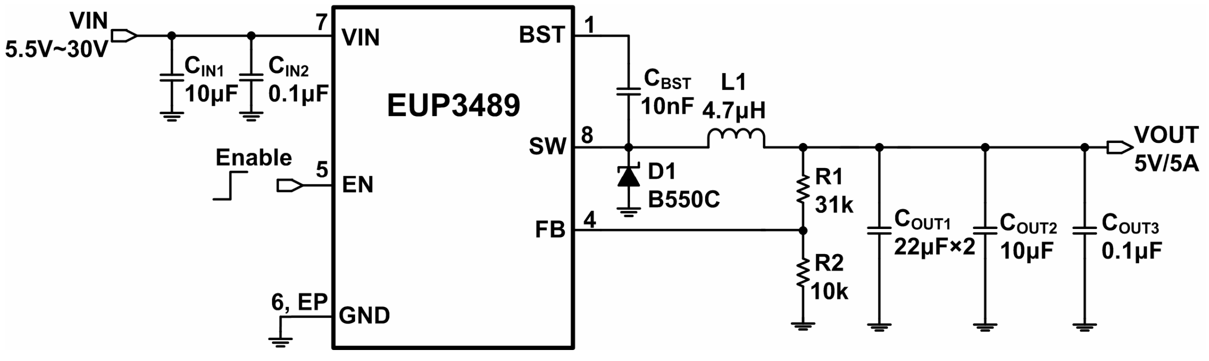
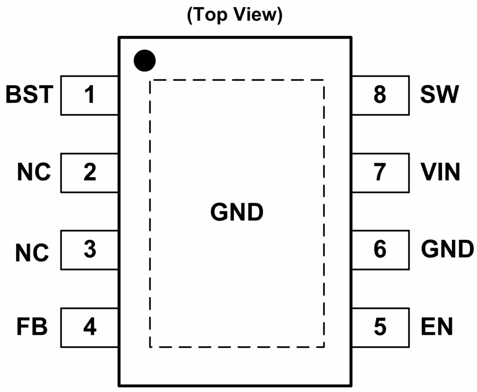


Figure 1. 5V Application Circuit

Pin Configurations

Package Type	Pin Configurations
SOP-8 (EP)	

Pin Description

Pin Name	SOP-8 (EP)	DESCRIPTION
BST	1	High-Side Gate Driver Bootstrap Supply. BST provides power to the gate driver of high-side N-channel MOSFET switch. Connect a 10nF or greater capacitor from SW to BST.
NC	2, 3	No Internal Connection
FB	4	Output Feedback Input. FB senses the output voltage to regulate that voltage. Connect FB to an external resistor divider to set the output voltage. The feedback threshold is 1.222V. See Setting the Output Voltage.
EN	5	Enable Input. EN is a logic input that controls the regulator on or off. Drive EN logic high than 1.4V to turn on the regulator, and set EN logic low than 0.4V to turn it off. Directly connect EN to IN (or through a resistance) for automatic startup.
GND	6	Ground
VIN	7	Input Supply Pin. IN supplies the power to the IC and the high side power switch. Connect IN to a 4.75V to 30V power source. Bypass VIN to GND with a suitably large value capacitor to minimize input ripple to the IC. The bypass capacitor must be close to the IC within 4mm. See Input Capacitor
SW	8	Power Switcher Output. Connect the output LC filter from SW to the output.
Thermal Pad	-	Ground. (Thermal pad must be connected to the ground of PCB.)

Ordering Information

Order Number	Package Type	Marking	Operating Temperature Range
EUP3489WIR1	SOP-8 (EP)	xxxxx P3489	-40°C to +85°C

EUP3489 □ □ □ □

- Lead Free Code
  1: Lead Free, Halogen Free
- Packing
  R: Tape & Reel
- Operating temperature range
  I: Industry Standard
- Package Type
  W: SOP (EP)

Block Diagram

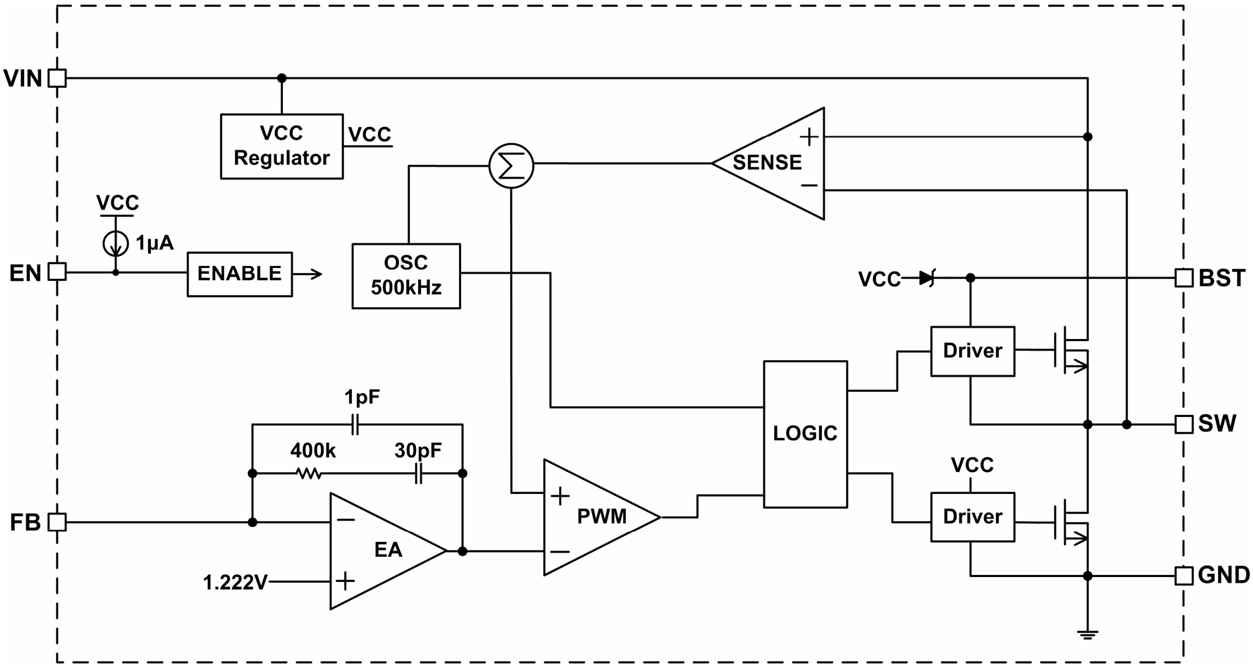


Figure 2. Functional Block Diagram

Absolute Maximum Ratings (1)

- Input Voltage (V_{IN}) -- -0.3V to 34V
- Enable Input (V_{EN}) -- -0.3V to 34V
- Switch Voltage (V_{SW}) -- -1V to V_{IN} +0.3V
- Boot Strap Voltage (V_{BST}) -- V_{SW}-0.3V to V_{SW} +6V
- All Other Pins --- -0.3V to 6V
- Junction Temperature --- 150°C
- Storage Temperature -- -65°C to +150°C
- Lead Temp (Soldering, 10sec) -- 260°C
- Thermal Resistance θ_{JA} (SOP-8_EP) -- 60°C/W

Recommend Operating Conditions (2)

- Supply Voltage (V_{IN}) -- 4.75V to 30V
- Operating Temperature Range --- -40°C to +85°C

Note (1): Stress beyond those listed under “Absolute Maximum Ratings” may damage the device.

Note (2): The device is not guaranteed to function outside the recommended operating conditions.

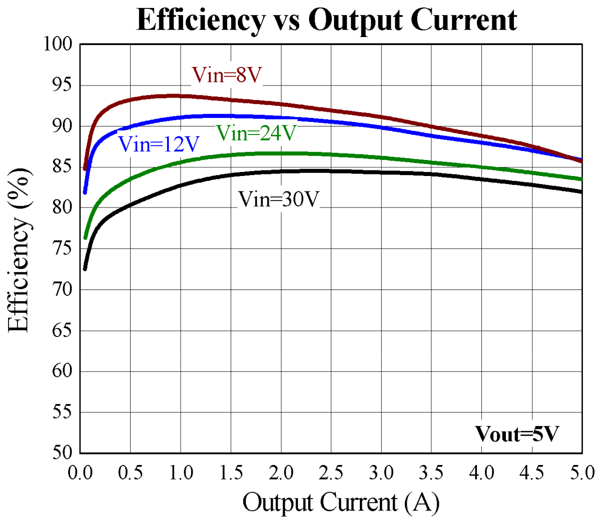
Electrical Characteristics

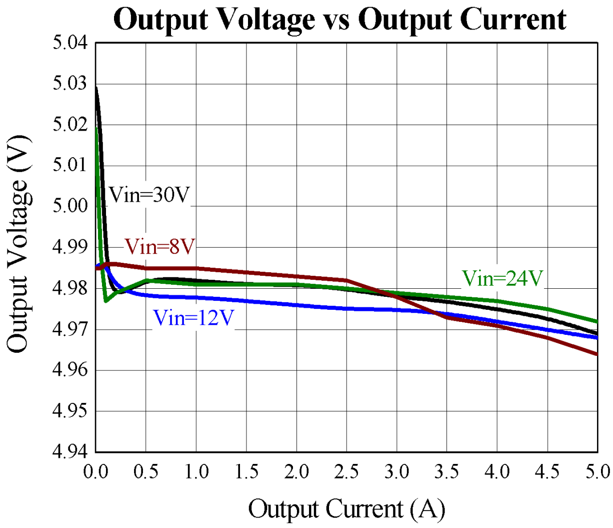
The ● denote specifications which apply over the full operating temperature range, otherwise specifications are T_A=+25°C. V_{IN}=12V unless otherwise specified.

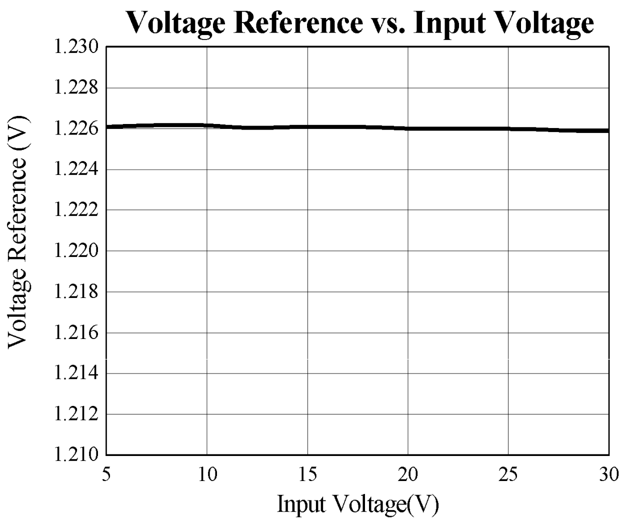
Parameters	Condition	EUP3489			Unit
		Min.	Typ.	Max.	
Feedback Reference Voltage	4.75V≤V_{IN}≤30V	1.202	1.222	1.239	V
High-Side Switch-On Resistance			100		mΩ
Low-Side Switch-On Resistance			10		Ω
Switch Leakage	V_{EN}=0V, V_{SW}=0V		0	10	μA
Current Limit			7.5		A
Current Sense Transconductance	Output Current to V_{COMP}		5.5		A/V
Oscillator Frequency		425	500	575	KHz
Short Circuit Oscillation Frequency	V_{FB} = 0V		125		KHz
Maximum Duty Cycle	V_{FB} = 1 V		90		%
Minimum On-Time			100		ns
Under Voltage Lockout Threshold Rising		3.8	4.2	4.5	V
Under Voltage Lockout Threshold Hysteresis			200		mV
EN Input Low Voltage				0.4	V
EN Input High Voltage		1.4			V
Enable Pull Up Current			1		μA
Shutdown Current	V_{EN} = 0V		3		μA
Quiescent Current	V_{EN} = 5V, V_{FB} = 1.5V		0.55	1	mA
Soft -Start Period			4		ms
Thermal Shutdown			150		°C

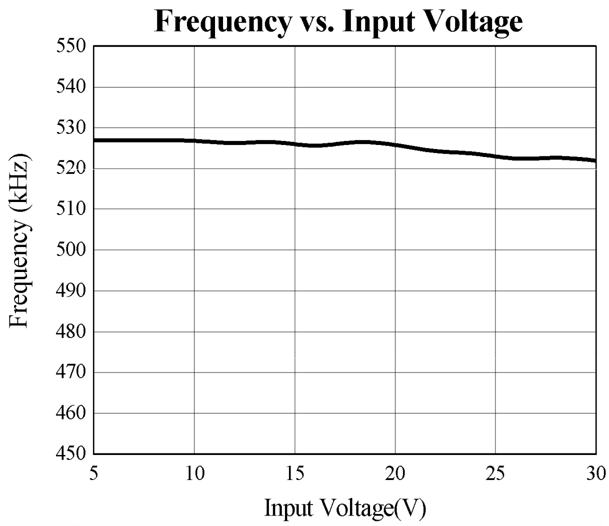
Typical Operating Characteristics

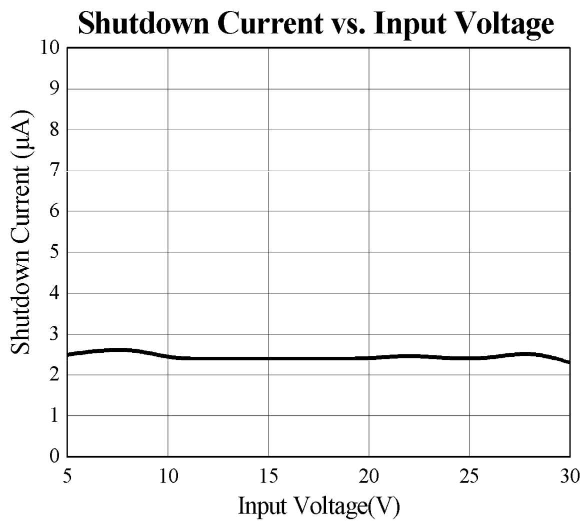
V_{IN}=12V, V_{OUT}=5V, See Figure 1, T_A=25°C, unless otherwise noted.

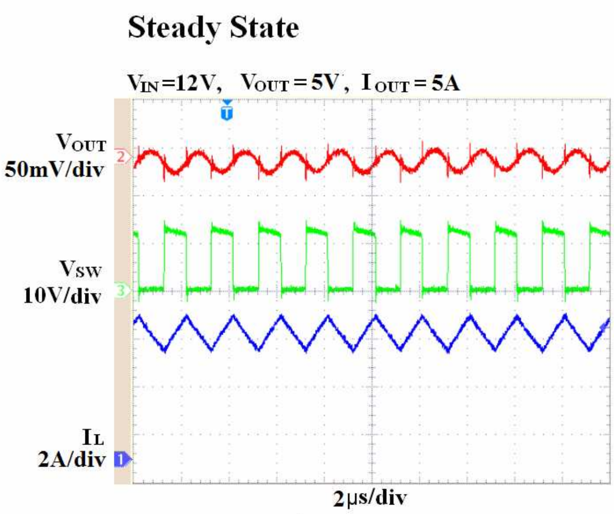










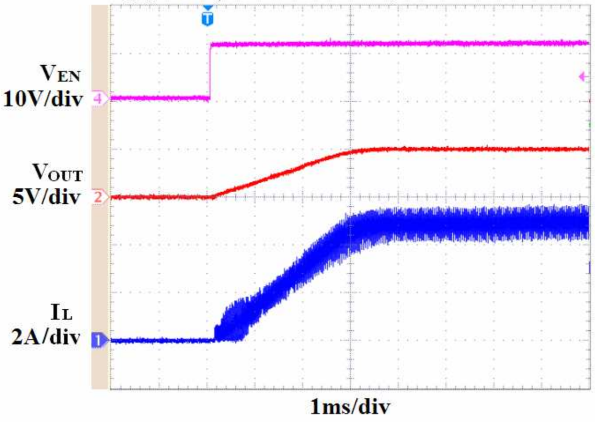


Typical Operating Characteristics (continued)

V_{IN}=12V, V_{OUT}=5V, See Figure 1, T_A=25°C, unless otherwise noted.

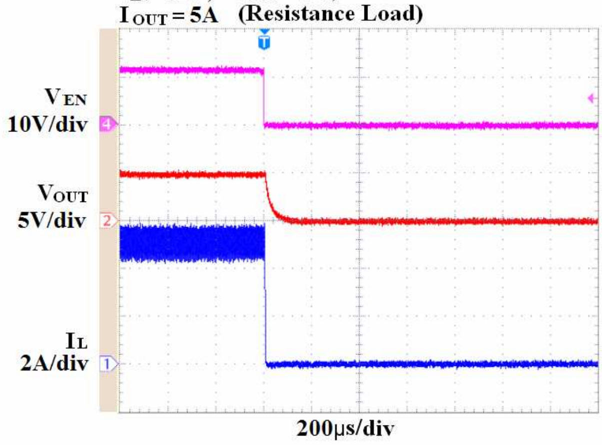
Startup through Enable

V_{IN}=12V, V_{OUT}=5V,
I_{OUT} = 5A (Resistance Load)



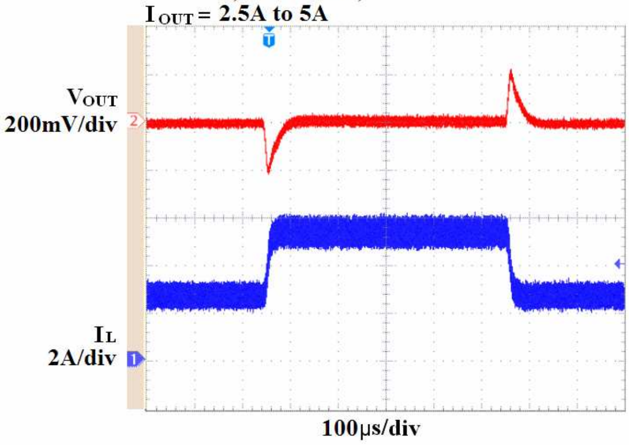
Shutdown through Enable

V_{IN}=12V, V_{OUT}=5V,
I_{OUT} = 5A (Resistance Load)



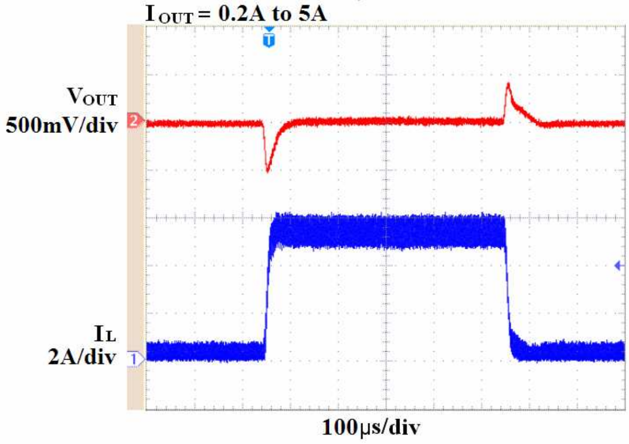
Load Transient

V_{IN}=12V, V_{OUT}=5V,
I_{OUT} = 2.5A to 5A



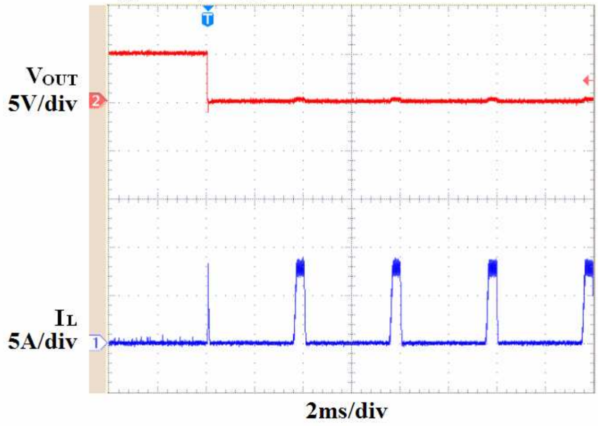
Load Transient

V_{IN}=12V, V_{OUT}=5V,
I_{OUT} = 0.2A to 5A



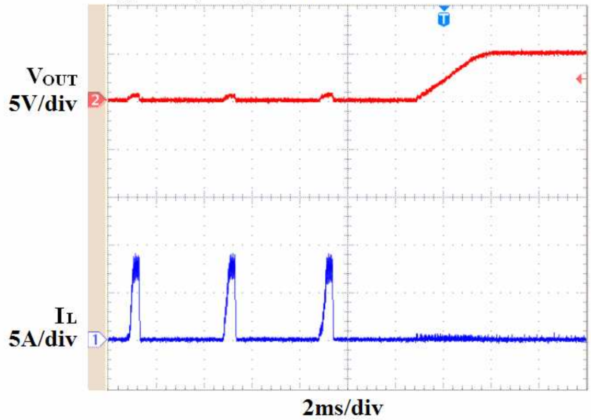
Short Circuit

V_{IN}=12V, V_{OUT}=5V



Short Circuit Recovery

V_{IN}=12V, V_{OUT}=5V



Functional Description

The EUP3489 is current-mode step-down switching regulator. The device regulates an output voltage as low as 1.222V from a 5.5V to 30V input power supply. The device can provide up to 5Amp continuous current to the output. The EUP3489 uses current-mode architecture to control the regulator loop. The output voltage is measured at FB through a resistive voltage divider and amplified through the internal error amplifier. Slope compensation is internally added to eliminate subharmonic oscillation at high duty cycle. The slope compensation adds voltage ramp to the inductor current signal which reduces maximum inductor peak current at high duty cycles.

The device uses an internal Hside n-channel switch to step down the input voltage to the regulated output voltage. Since the Hside n-channel switch requires gate voltage greater than the input voltage, a boostrap BST capacitor is connected between SW and BST to drive the n-channel gate. The BST capacitor is internally charged while the switch is off. An internal 10Ω switch from SW to GND is added to insure that SW is pulled to GND when the switch is off to fully charge the BST capacitor.

Application Information

Setting the Output Voltage

The output voltage is set through a resistive voltage divider (see Figure1). The voltage divider divides the output voltage down by the ratio:

$$V_{FB} = V_{OUT} * R2/(R1 + R2) = 1.222\,V$$

Thus the output voltage is :

$$V_{OUT} = 1.222\,V * (R1 + R2)/R2$$

Choose R2 value in the range 10k to 100k, R1 is determined by :

$$R1 = (V_{OUT}/1.222 - 1) * R2$$

Inductor

The inductor is required to supply constant current to the output load while being driven by the switched input voltage. A larger value inductor results in less ripple current and lower output ripple voltage. However, the larger value inductor has a larger physical size, higher series resistance, and lower saturation current. Choose an inductor that does not saturate under the worst-case load conditions. A good rule for determining the inductance is to allow the peak-to- peak ripple current in the inductor to be approximately 30% of the maximum load current. Also, make sure that the peak inductor current (the load current plus half the peak-to-peak inductor ripple current) is below the 3.6A minimum peak current limit.

The inductance value can be calculated by the equation:

$$L = (V_{OUT}) * (V_{IN} - V_{OUT})/(V_{IN} * f * \Delta I)$$

Where V_{OUT} is the output voltage, V_{IN} is the input voltage, f is the switching frequency, and ΔI is the peak-to-peak inductor ripple current.

Input Capacitor

The input current to the step-down converter is discontinuous, and therefore an input capacitor C1 is required to supply the AC current to the step-down converter while maintaining the DC input voltage. A low ESR capacitor is required to keep the noise minimum at the IC. Ceramic capacitors are preferred, but tantalum or low-ESR electrolytic capacitors may also suffice. The input capacitor value should be greater than 10µF, and the RMS current rating should be greater than approximately 1/2 of the DC load current. In Figure 1, all ceramic capacitors should be placed close to the EUP3489.

Output Capacitor

The output capacitor is required to maintain the DC output voltage. Low ESR capacitors are preferred to keep the output voltage ripple low. The characteristics of the output capacitor also affect the stability of the regulator control loop. In the case of ceramic capacitors, the impedance at the switching frequency is dominated by the capacitance.The output voltage ripple is estimated to be:

$$V_{RIPPLE} \sim= 1.4 * V_{IN} * (f_{LC}/f)\hat{}\,2$$

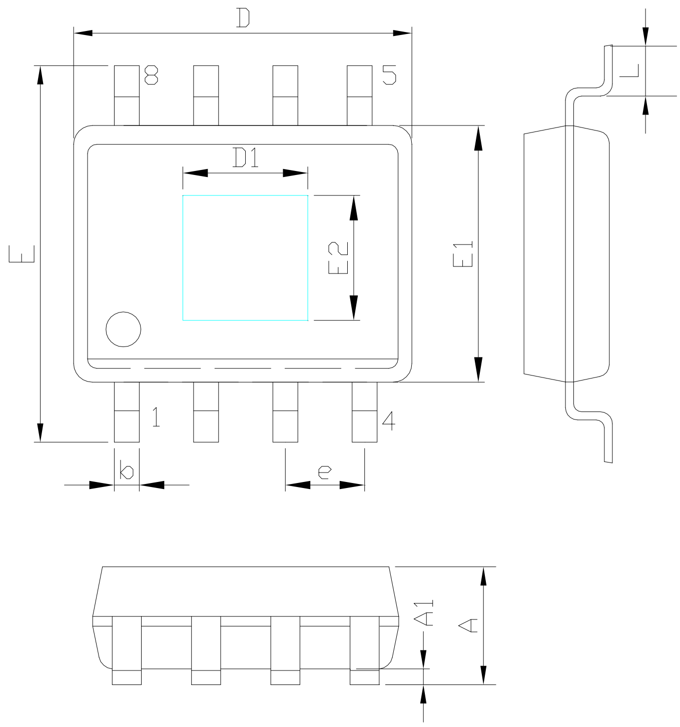
Where V_{RIPPLE} is the output ripple voltage, V_{IN} is the input voltage, f_{LC} is the resonant frequency of the LC filter, f is the switching frequency.

Output Rectifier Diode

The output rectifier diode supplies the current to the inductor when the high-side switch is off. A schottky diode is recommended to reduce losses due to the diode forward voltage and recovery times.

Packaging Information

SOP-8 (EP)



Remark: Exposed pad outline drawing is for reference only.

SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	1.35	-	1.75	0.053	-	0.069
A1	0.00	-	0.25	0.000	-	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E1	3.70	3.90	4.00	0.146	0.154	0.157
D1	2.67	2.97	3.50	0.105	0.117	0.138
E2	1.78	2.18	2.60	0.070	0.086	0.102
E	5.80	6.00	6.20	0.228	0.236	0.244
L	0.40	-	1.27	0.016	-	0.050
b	0.31	-	0.51	0.012	-	0.020
e	1.27 REF			0.050 REF		