

**SOP-8**

**Pin Definition:**

1. EN	5. FB
2. Comp	6. Vss
3. Ocset	7. LX
4. Vcc	8. Gate

### General Description

The TS2507 integrates Pulse-Width-Modulation (PWM) control circuit into a single chip. These device include a reference voltage source, oscillation circuit, error amplifier and etc. TS2507 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit is able to vary the duty ratio linearly from 0 up to 100%. This controller also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup. An enable function, an over current protect function and short circuit protect function are built inside, and when OCP or SCP happens, the operation frequency will be reduced. Also, an internal compensation block is built in to minimum external component count. With the addition of an external P-channel Power MOS, a coil, capacitors, and a diode connected externally, these components can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP-8, providing such outstanding features as low current consumption. Since this converter can accommodate an input

### Features

- Input Voltage: 3.6V~24V
- Output Voltage: 0.8V~Vcc
- Duty Ratio: 0%~100% PWM Control
- Oscillation Frequency: 330kHz typ.
- Soft-Start (SS), Current Limit (CL), Enable Function
- Thermal Shutdown Function
- Short Circuit Protect (SCP)
- External SW P-Channel MOSFET
- Low ESR Output Capacitor Application
- SOP-8 Pb-Free Package

### Ordering Information

Part No.	Package	Packing
TS2507CS RL	SOP-8	2.5Kpcs / 13" Reel

### Application

- Simple High-efficiency Step down Regulator
- On-Card Switching Regulators

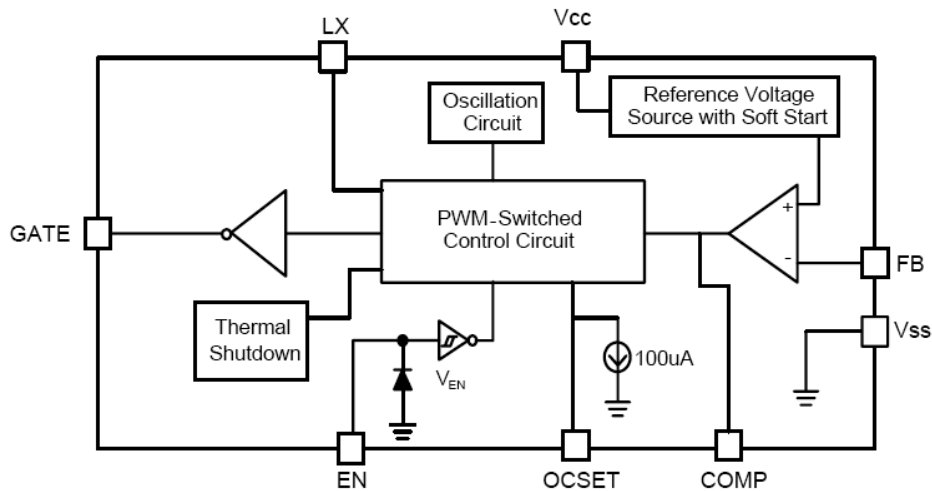
### Absolute Maximum Rating

Parameter	Symbol	Rating	Unit
V <sub>CC</sub> Pin Voltage	V <sub>CC</sub>	V <sub>SS</sub> - 0.3 to V <sub>SS</sub> + 26	V
Feedback Pin Voltage	V <sub>FB</sub>	V <sub>SS</sub> - 0.3 to V <sub>CC</sub>	V
ON/OFF Pin Voltage	V <sub>EN</sub>	V <sub>SS</sub> - 0.3 to V <sub>CC</sub> + 0.3	V
Switch Pin Voltage	V <sub>SW</sub>	V <sub>SS</sub> - 0.3 to V <sub>CC</sub> + 0.3	V
Power Dissipation	P <sub>D</sub>	Internally limited	mW
Storage Temperature Range	T <sub>ST</sub>	-40 to +150	°C
Operating Temperature Range	T <sub>OP</sub>	-20 to +125	°C
Operating Supply Voltage	V <sub>OP</sub>	+3.6 to +24	V
Thermal Resistance from Junction to case	θ <sub>JC</sub>	40	°C/W
Thermal Resistance from Junction to ambient	θ <sub>JA</sub>	120	°C/W

### Electrical Specifications ( $V_{IN}=12V$ , $T_a=25^{\circ}C$ unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units	
Feedback Voltage	$V_{FB}$	$I_{OUT}=0.1A$	0.784	0.800	0.816	V	
Quiescent Current	$I_q$	$V_{FB}=1.2V$ force driver off	--	3	5	mA	
Feedback Bias Current	$I_{FB}$	$I_{OUT}=0.1A$	--	0.1	0.5	uA	
Shutdown Supply Current	$I_{SD}$	$V_{EN}=0V$	--	2	10	uA	
OCSET pin bias current	$I_{OCSET}$		95	110	125	uA	
Line Regulation	$\Delta V_{OUT}/V_{OUT}$	$V_{CC} = 5V\sim 24V$ , $I_{OUT}=0.2A$	--	0.6	1.2	%	
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	$I_{OUT} = 0.1$ to $5A$	--	0.3	0.5	%	
Oscillation Frequency	$F_{OSC}$	SW pin	260	330	400	KHz	
EN Pin Logic input threshold voltage	$V_{SH}$	High (regulator ON)	2.0	--	--	V	
	$V_{SL}$	Low (regulator OFF)	--	--	0.8		
EN Pin Input Current	$I_{SH}$	$V_{EN}=2.5V$ (ON)	--	20	--	uA	
	$I_{SL}$	$V_{EN}=0.3V$ (OFF)	--	-10	--	uA	
Soft-Start Time	$T_{SS}$		0.3	4	8	ms	
LX Rise Time	$T_{LXR}$	$C_{LX}=1000pF$	--	45	--	nS	
LX Fall Time	$T_{LXF}$	$C_{LX}=1000pF$	--	45	--		
Efficiency	EFFI	$V_{OUT} = 5V$	$I_{OUT} = 2A$	--	92	--	%
			$I_{OUT} = 3A$	--	91	--	
Thermal shutdown Temp	$T_{SD}$		--	125	--	$^{\circ}C$	

### Block Diagram

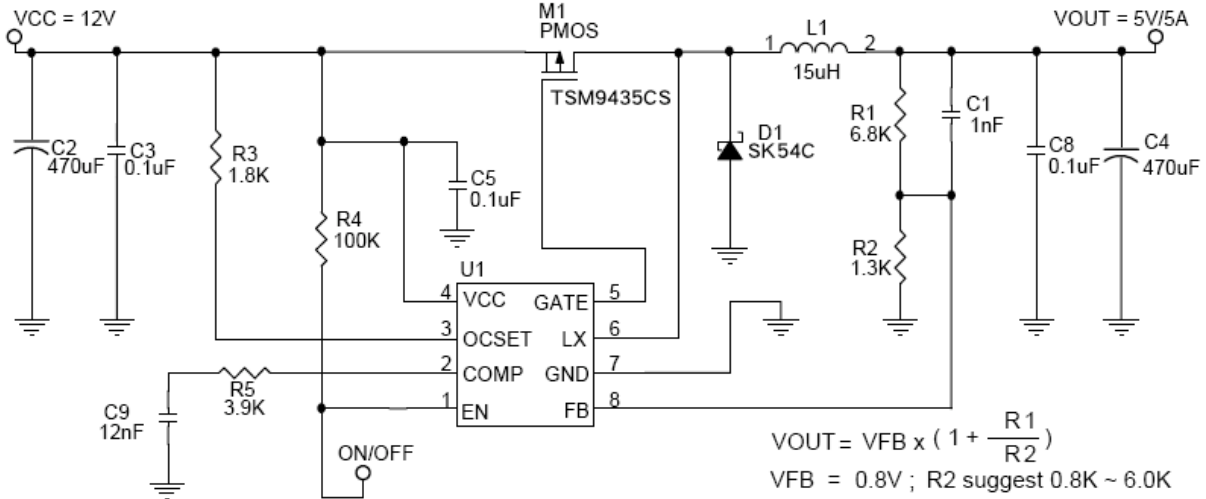


### Pin Assignment

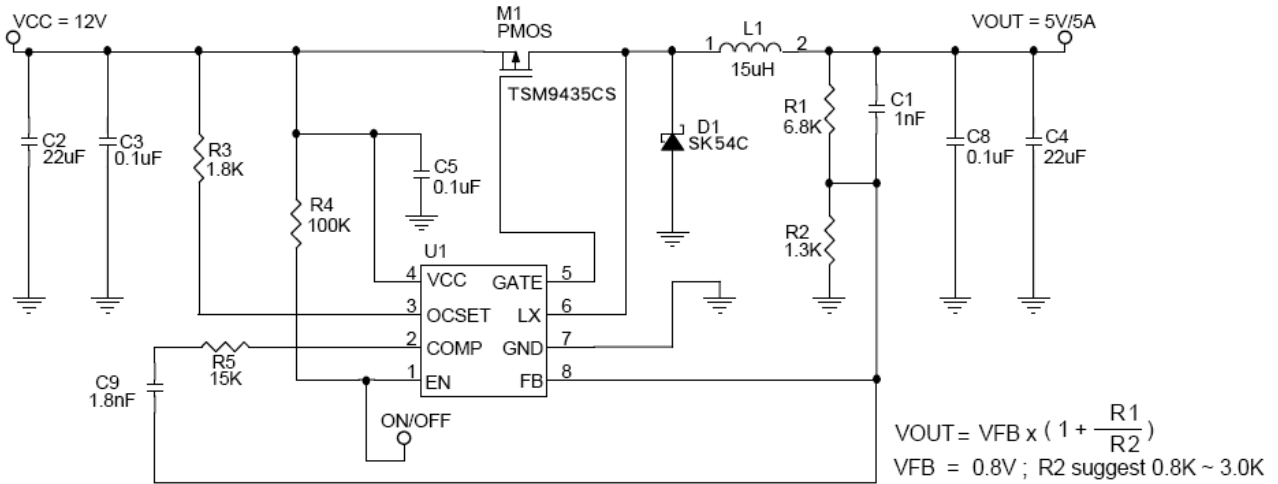
Name	Description	Name	Description
<b>EN</b>	Shutdown Control Input. H : normal operation (Step-down) L : Shutdown mode	<b>Gate</b>	Gate drive for external P-channel MOSFET.
<b>Comp</b>	Compensation pin	<b>LX</b>	LX is the current sense input.
<b>OCSET</b>	Add an external resistor to set max switch output current.	<b>Vss</b>	GND pin
<b>Vcc</b>	IC power supply pin	<b>FB</b>	Feedback pin

**Application Circuit**

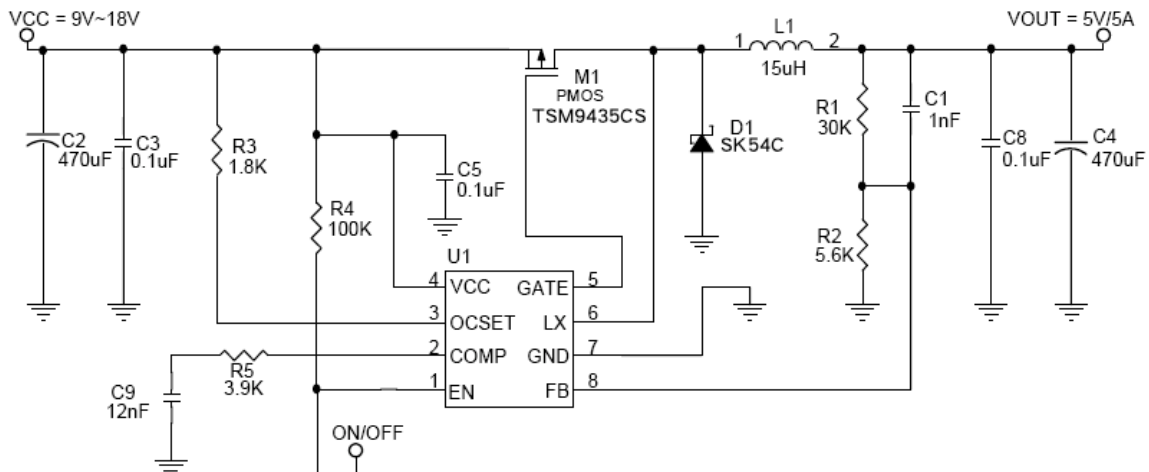
**A. Typical Application Circuit**



**B. MLCC (TS2507)**



**C. Standby Current (I<sub>OUT</sub>=0A) < 4mA**



### Function Descriptions

#### PWM Control

The TS2507 integrates Pulse-Width-Modulation (PWM) control circuit into a single chip. the pulse width varies in a range from 0 to 100%, according to the load current. The ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant. Therefore, these controllers provide a low-ripple power over broad ranges of input voltage and load current.

#### RDS(ON) Current Limiting

The current limit threshold is setting by the external resistor (R3) connecting from VCC supply to OCSET pin. The internal 110uA sink current crossing the resistor sets the voltage at pin of OCSET. When the PWM voltage is less than the voltage at OCSET, an over-current condition is triggered. Please refer to the formula for setting the current limit value

$$I_{SW(MAX)} = \frac{I_{OCSET} \times R3 + 0.11}{R_{DS(ON)}} \quad (\text{Normally, The } I_{SW(MAX)} \text{ setting more than } I_{OUT} \text{ 1A})$$

Example:  $I_{SW} = (110\mu A * 1.8k + 0.11) / 50m\Omega$  (TSM9435CS) = 6.16A

#### Setting the Output Voltage

Application circuit item shows the basic application circuit with TS2507 adjustable output version. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.8V \times \left( 1 + \frac{R1}{R2} \right)$$

Table 1: Resistor select for output voltage setting

VOUT	R2	R1
5V	1.3K	6.8K
	5.6K	30K
3.3V	1.5K	4.7K
	5.6K	18K
2.5V	2.2K	4.7K
	5.6K	12K
1.8V	1.2K	1.5K
1.5V	2.2K	2K
1.2V	2K	1K
1V	2K	0.5K

#### Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency shall be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used.

The capacitor voltage rating should be at least 1.5 times greater than the input voltage, and often much higher voltage ratings are needed to satisfy.

#### Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. A low ESR capacitor sized for maximum RMS current must be used. the low ESR requirements needed for low output ripple voltage. The capacitor voltage rating should be at least 1.5 times greater than the input voltage, and often much higher voltage ratings are needed to satisfy.

### Function Descriptions (Continue)

#### Inductor Selection

For most designs, Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_L \times X}$$

Where is inductor Ripple Current. Large value inductors lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately 15% of the maximum input current 3A,  $\Delta I_L = 0.45A$ .

Table 2 Inductor select for output voltage setting (TS2507 at VCC=12V)

VOUT	2.5V	3.3V	5V	3.3V(5A)	5V(5A)
L1 Value	15uH	18uH	22uH	12uH	15uH

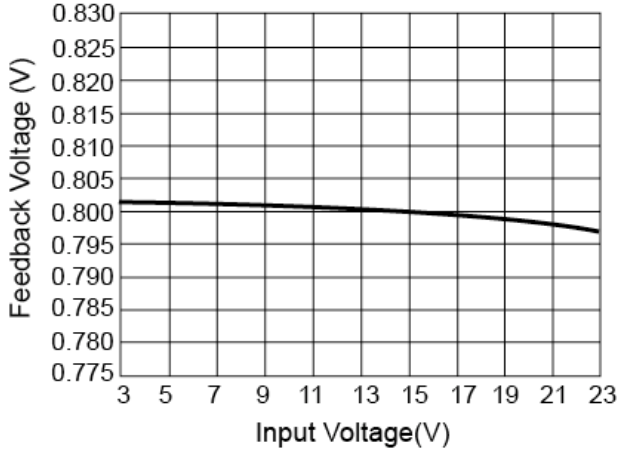
The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation ( $3A + 0.3A$ ).

#### Layout Guidance

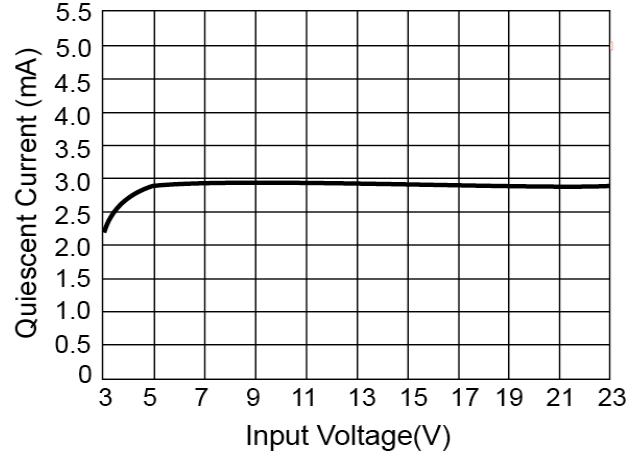
When laying out the PC board, the following suggestions should be taken to ensure proper operation of the TS2507. These items are also illustrated graphically in below.

1. The power traces, including the PMOS Drain & Source trace, the Schottky and the C2 trace should be kept short, direct and wide to allow large current flow.
2. Connect the C5 to the VCC & EN pins of the TS2507 as closely as possible to get good power filter effect.
3. Keep the switching node, away from the sensitive FB node.
4. Connect ground side of the C2 & D1 as closely as possible.
5. Connect PMOS Source and R3 as closely as possible.
6. Do not trace signal line under inductor.

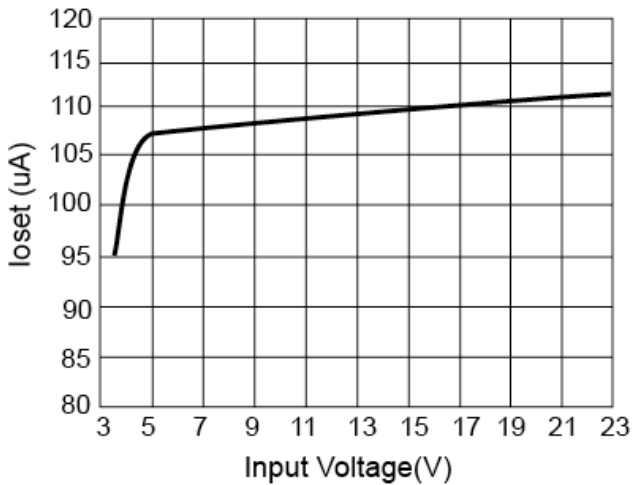
**Electrical Characteristics Curve**



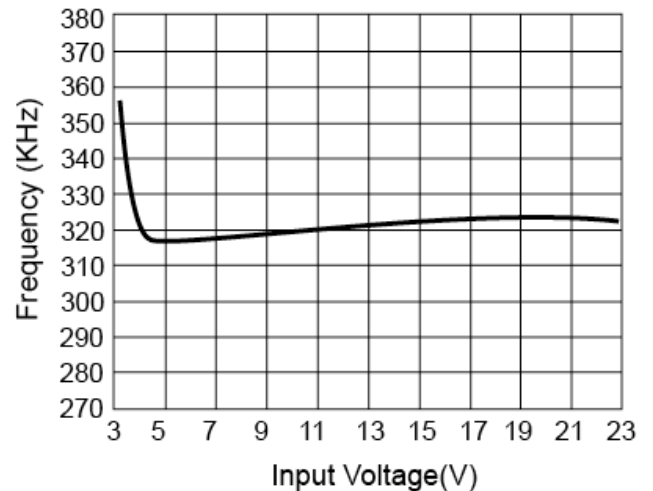
**Figure 1. Feedback Voltage vs. Input Voltage**



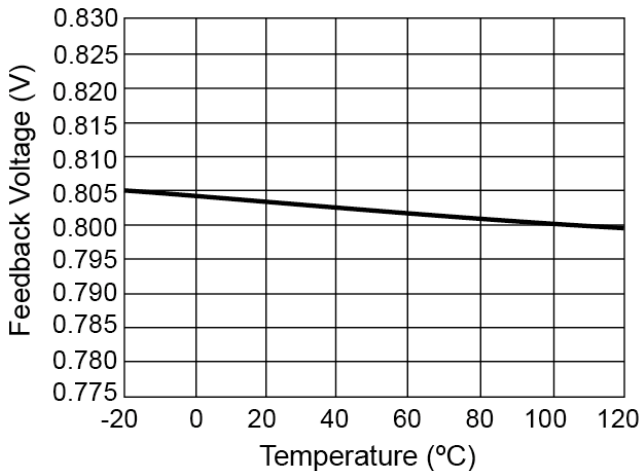
**Figure 2. Quiescent Current vs. Input Voltage**



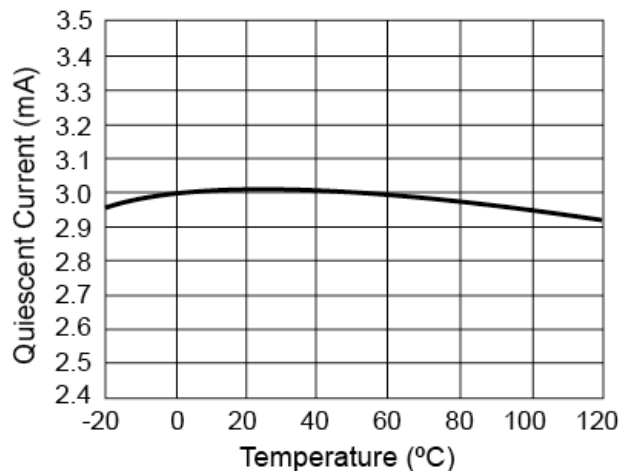
**Figure 3. IOSET vs. Input Voltage**



**Figure 4. Frequency vs. Input Voltage**

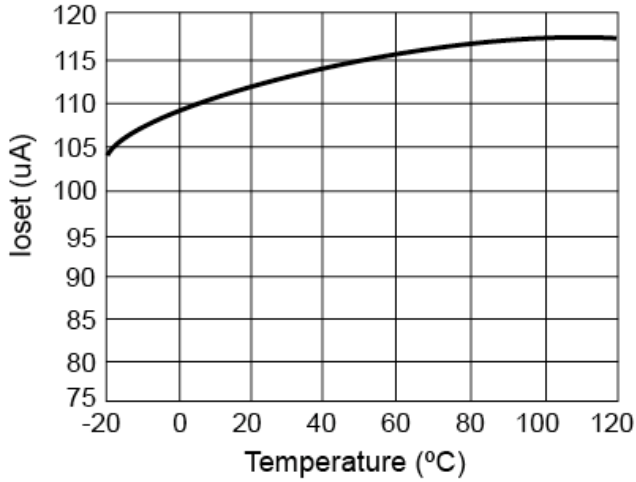


**Figure 5. Feedback Voltage vs. Temperature**

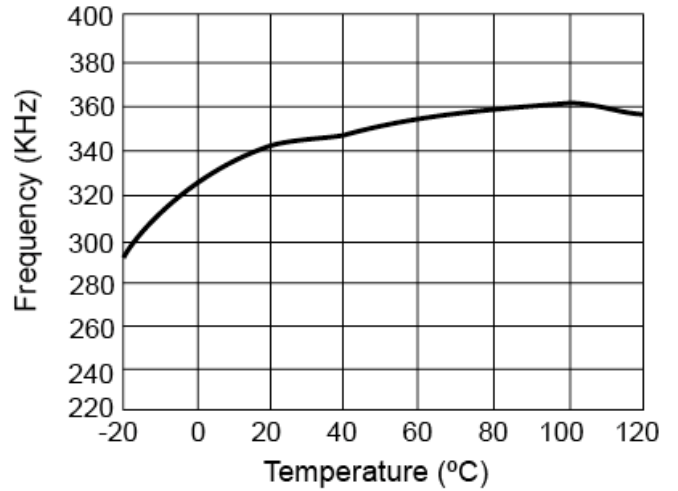


**Figure 6. Quiescent Current vs. Temperature**

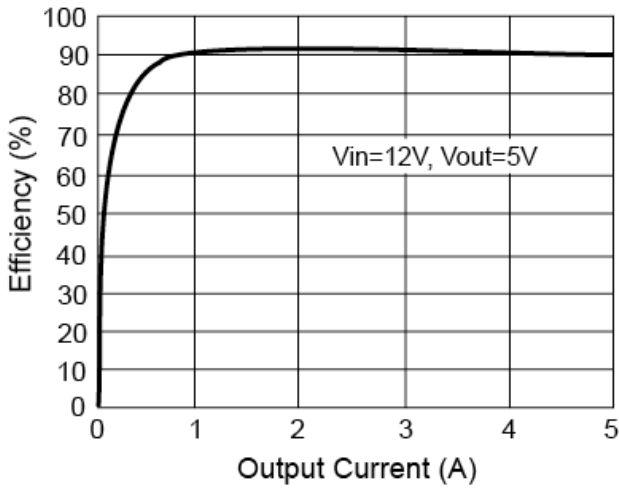
**Electrical Characteristics Curve**



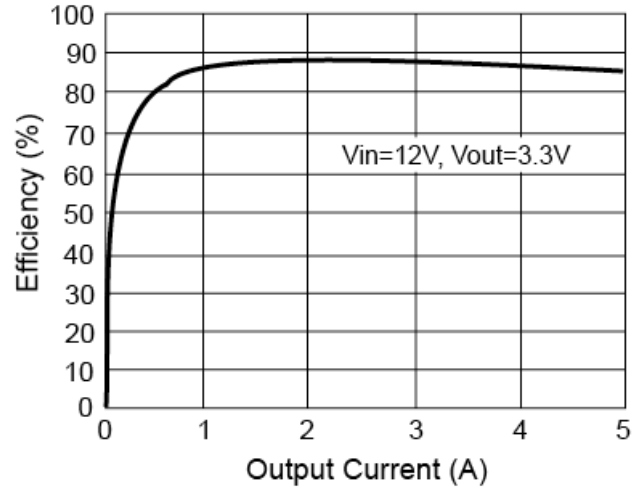
**Figure 7. IOCSSET vs. Temperature**



**Figure 8. Frequency vs. Temperature**

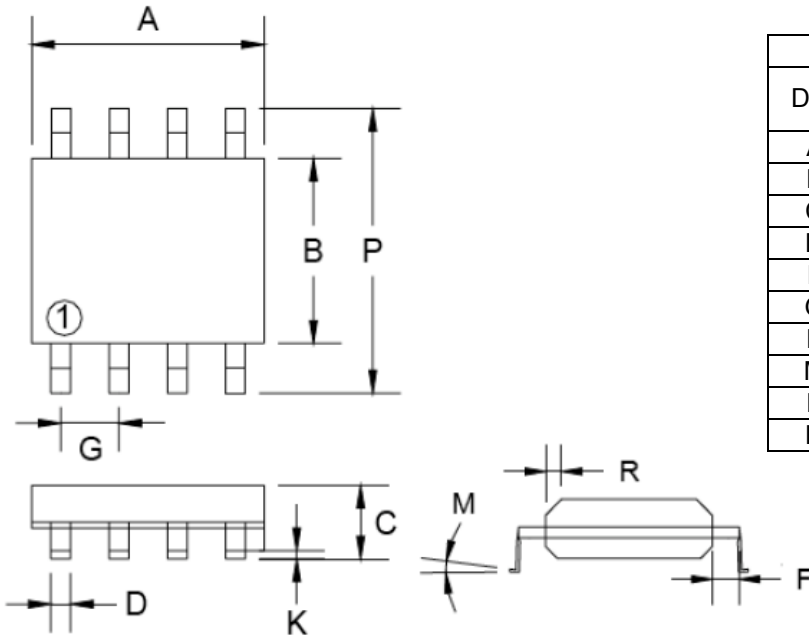


**Figure 9. Efficiency vs. Output Current**



**Figure 10. Efficiency vs. Output Current**

**SOP-8 Mechanical Drawing**



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

**Marking Diagram**



- Y** = Year Code
- M** = Month Code  
(A=Jan, B=Feb, C=Mar, D=Apl, E=May, F=Jun, G=Jul, H=Aug, I=Sep, J=Oct, K=Nov, L=Dec)
- L** = Lot Code



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