

### GENERAL DESCRIPTION

The CM2593/P is a monolithic integrated circuit that provide all the active functions for a step-down switching regulator, capable of driving a 2A load without additional transistor component. Requiring a minimum number of external component, the board space can be saved easily. The external shutdown function can be controlled by TTL logic level and then come into standby mode. The internal compensation makes feedback control have good line and load regulation without external design. Regarding protected function, thermal shutdown is to prevent over temperature operating from damage, and current limit is against over current operating of the output switch. The CM2593/P operates at a switching frequency of 150Khz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Other features include a guaranteed  $\pm 4\%$  tolerance on output voltage under specified input voltage and output load conditions, and  $\pm 15\%$  on the oscillator frequency. The output version included fixed 3.3V, 5V, and an adjustable type. The packages are available in a standard 8-lead SOP8.

### FEATURES

- ◆ 3.3V, 5V and adjustable output versions
- ◆ Adjustable version output voltage range, 1.23V to 37V  $\pm 4\%$  max over line and load condition
- ◆ SOP-8L packages
- ◆ Voltage mode non-synchronous PWM control
- ◆ Thermal-shutdown and current-limit protection
- ◆ ON/OFF shutdown control input
- ◆ Input voltage range up to 40V
- ◆ Output load current: 2A
- ◆ 150 kHz fixed frequency internal oscillator
- ◆ Low power standby mode
- ◆ Built-in switching transistor on chip

### APPLICATIONS

- ◆ Simple High-efficiency step-down(buck) regulator
- ◆ Efficient pre-regulator for linear regulators
- ◆ On-card switching regulators
- ◆ Battery / Car Charger
- ◆ Positive to negative converter
- ◆ Digital Still and Video Cameras

### TYPICAL APPLICATIONS

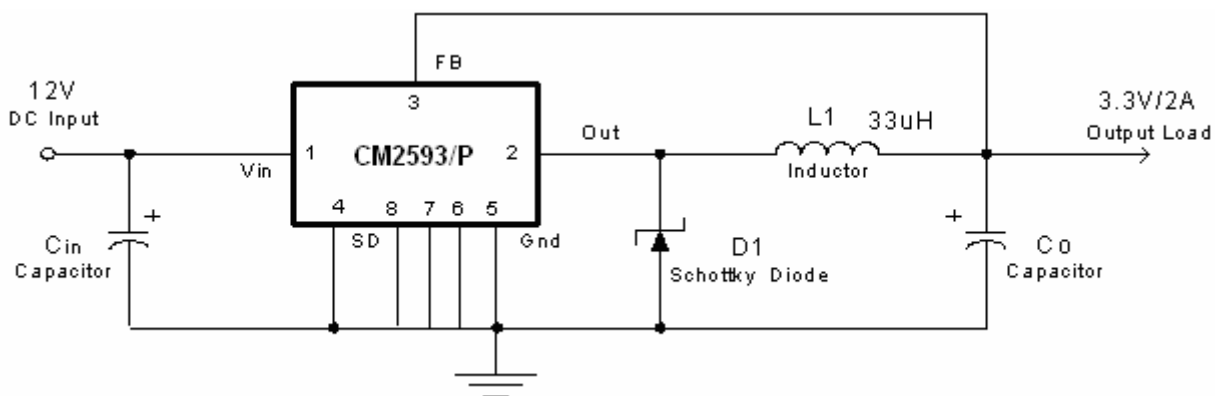
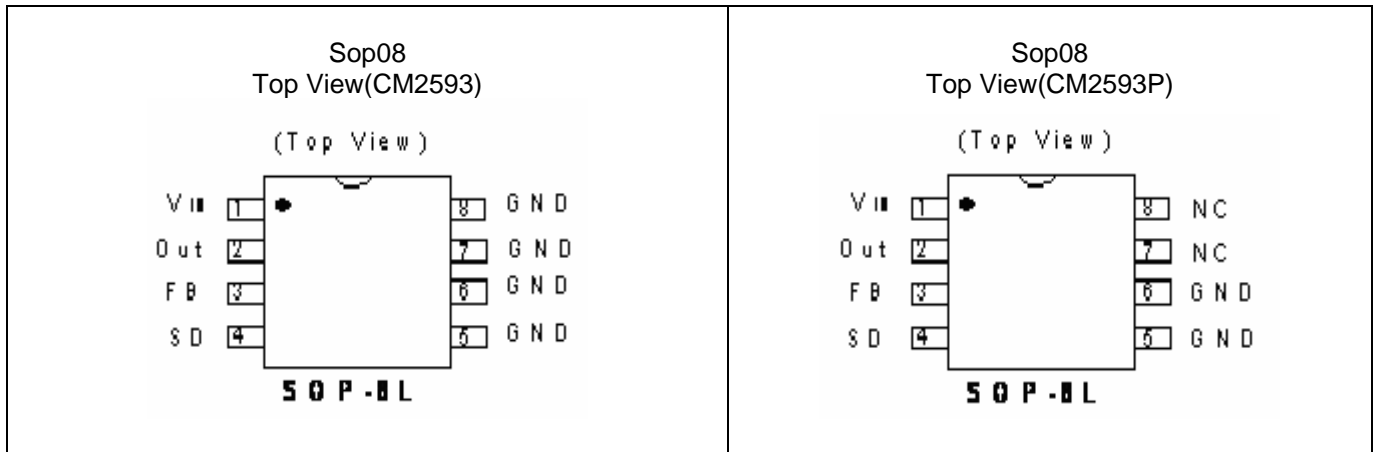
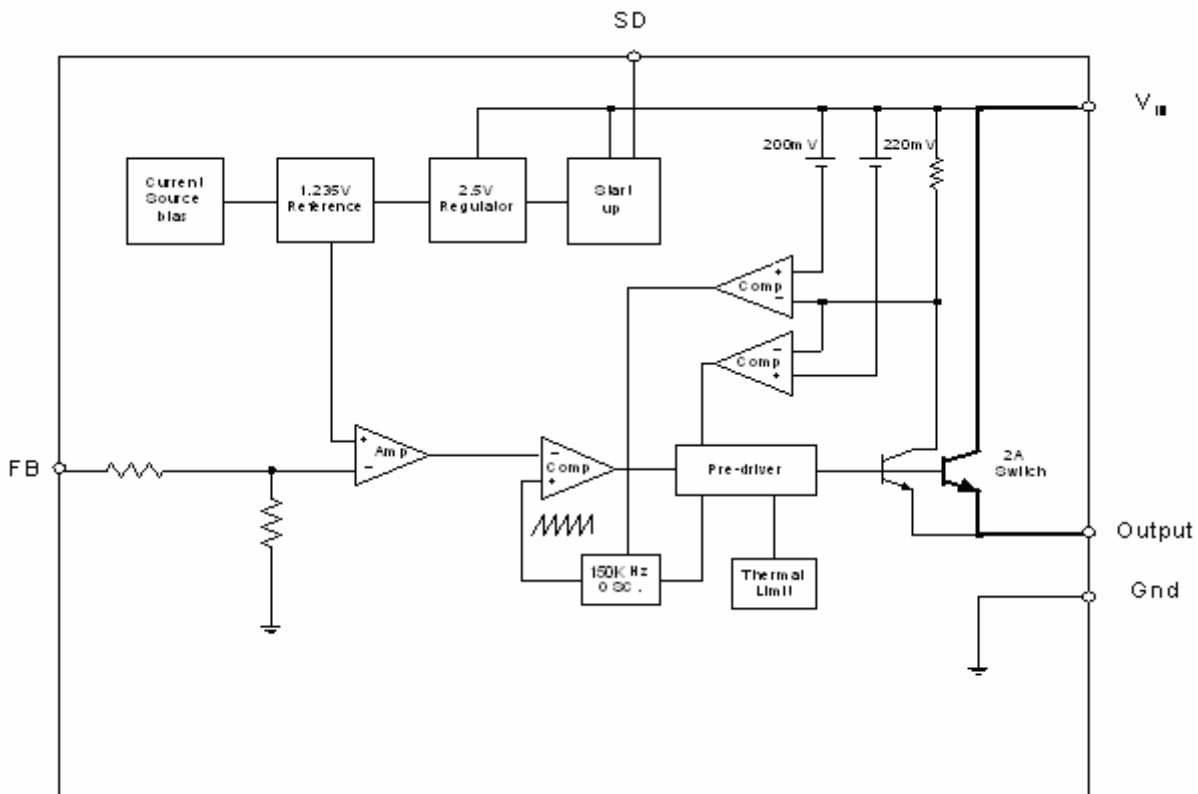


Figure 1. Basic Application Circuit with CM2593/P fixed version

### PIN CONFIGURATION

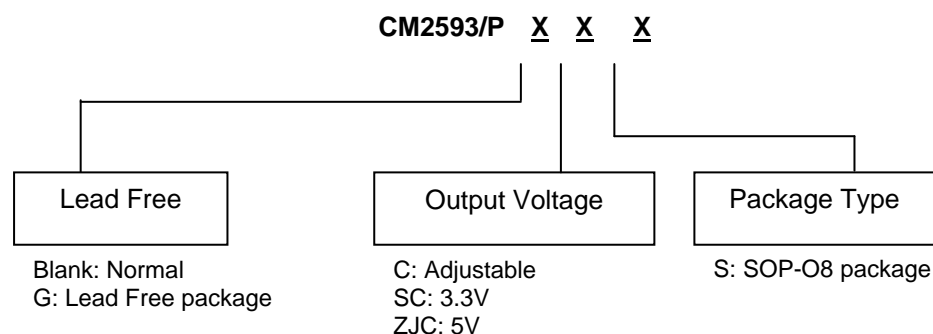


### BLOCK DIAGRAM



**PIN DESCRIPTION**

| Pin No. | Symbol          | Description                     |
|---------|-----------------|---------------------------------|
| 1       | V <sub>IN</sub> | Operating voltage input         |
| 2       | Out             | Switching output                |
| 3       | FB              | Output voltage feedback control |
| 4       | SD              | ON/OFF Shutdown                 |
| 5-8     | GND             | Ground Pin                      |

**ORDERING INFORMATION**

**ABSOLUTE MAXIMUM RATINGS**

| Symbol           | Parameter                | Rating             | Unit |
|------------------|--------------------------|--------------------|------|
| V <sub>CC</sub>  | Supply Voltage           | +45                | V    |
| V <sub>SD</sub>  | ON/OFF Pin input voltage | -0.3 to +25        | V    |
| V <sub>FB</sub>  | Feedback Pin voltage     | -0.3 to +25        | V    |
| V <sub>OUT</sub> | Output voltage to Ground | -1                 | V    |
| P <sub>D</sub>   | Power dissipation        | Internally limited | W    |
| T <sub>ST</sub>  | Storage temperature      | -65 to +150        | °C   |
| T <sub>OP</sub>  | Operating temperature    | -40 to +125        | °C   |
| V <sub>OP</sub>  | Operating voltage        | +4.5 to +45        | V    |
| θ <sub>Ja</sub>  | Thermal Resistance       | 75                 | °/W  |
| θ <sub>Jc</sub>  | Thermal Resistance       | 14                 | °/W  |

**■ ELECTRICAL CHARACTERISTICS(All Output Voltage Versions)**

 Unless otherwise specified,  $V_{IN}=12V$  for 3.3V, 5V, adjustable version and  $V_{IN}=24V$  for the 12V version.  $I_{LOAD} = 0.2A$ 

| Symbol     | Parameter                                     |                        | Conditions  | Min. | Typ. | Max.  | Unit        |
|------------|---|------------------------|---|------|------|-------|-------------|
| $I_B$      | Feedback bias current                         |                        | $V_{FB}=1.3V$<br>(Adjustable version only)                          |      | -10  | -50   | nA          |
|            |   |                        |   |      |      | -100  |             |
| $F_{OSC}$  | oscillator frequency                          |                        | $T_J=25^{\circ}C$<br>$-40^{\circ}C \leq T_J \leq 125^{\circ}C$      |      | 127  | 150   | Khz         |
|            |   |                        |   |      |      | 173   |             |
| $F_{scp}$  | Oscillator frequency of short circuit protect |                        | When current limit occurred and $V_{FB} < 0.55V$                    |      | 30   | 60    | Khz         |
| $V_{SAT}$  | saturation voltage                            |                        | $I_{OUT}=1.5A$<br>no outside circuit<br>$V_{FB}=0V$ force driver on |      | 1.15 | 1.4   | V           |
|            |   |                        |   |      |      | 1.5   |             |
| DC         | Max. Duty Cycle(ON)                           |                        | $V_{FB}=0V$ force driver on   |      | 100  |       | %           |
|            | Min. Duty cycle(OFF)                          |                        | $V_{FB}=12V$ force driver off                                       |      | 0    |       |             |
| $I_{CL}$   | current limit                                 |                        | peak current<br>no outside circuit<br>$V_{FB}=0$ force driver on    | 2.4  | 2.8  | 3.3   | A           |
|            |   |                        |   |      |      | 3.6   |             |
| $I_L$      | Output = 0                                    | Output leakage current | no outside circuit<br>$V_{FB}=12$ force driver off                  |      |      | -200  | uA          |
|            | Output = 1                                    |                        | $V_{IN}=24V$  |      | -5   | mA    |             |
| $I_Q$      | Quiescent Current                             |                        | $V_{FB}=12$ force driver off  |      | 5    | 10    | mA          |
| $I_{STBY}$ | Standby Quiescent Current                     |                        | ON/OFF pin=5V<br>$V_{IN}=24V$                                       |      | 70   | 150   | uA          |
|            |   |                        |   |      |      | 200   |             |
| $V_{IL}$   | ON/OFF pin logic input threshold voltage      |                        | Low (regulator ON)  | -    |      | 0.6   | V           |
| $V_{IH}$   |   |                        | High (regulator OFF)  | 2.0  | 1.3  | -     |             |
| $I_H$      | ON/OFF pin logic input current                |                        | $V_{LOGIC}=2.5V$ (OFF)  |      |      | -0.01 | uA          |
| $I_L$      | ON/OFF pin input current                      |                        | $V_{LOGIC}=0.5V$ (ON)   |      | -0.1 | -1    |             |
| $T_S$      | Over temperature shutdown threshold           |                        | $T_J$ increasing  |      | 175  |       | $^{\circ}C$ |
|            |   |                        | $T_J$ decreasing  |      | 150  |       |             |

## CM2593/P

### 2A Step Down VOLTAGE REGULATOR

|                      | Symbol    | Parameter       | Conditions   | Typ.  | Limit                      | Unit                        |
|----------------------|-----------|-----------------|--|-------|----------------------------|-----------------------------|
| <b>CM2593/P-ADJ</b>  | $V_{FB}$  | Output Feedback | $5V \leq V_{IN} \leq 40V$<br>$0.2A \leq I_{LOAD} \leq 2A$<br>$V_{OUT}$ programmed for 3V | 1.235 | 1.193/1.18<br>1.267/1.28   | V<br>$V_{MIN}$<br>$V_{MAX}$ |
|                      | $\eta$    | Efficiency      | $V_{IN} = 12V, I_{LOAD}=2A$  | 75    |                            | %                           |
| <b>CM2593/P-3.3V</b> | $V_{OUT}$ | Output voltage  | $5.5V \leq V_{IN} \leq 40V$<br>$0.2A \leq I_{LOAD} \leq 2A$                              | 3.3   | 3.168/3.135<br>3.432/3.465 | V<br>$V_{MIN}$<br>$V_{MAX}$ |
|                      | $\eta$    | Efficiency      | $V_{IN} = 12V, I_{LOAD}=2A$  | 75    |                            | %                           |
| <b>CM2593/P-5V</b>   | $V_{OUT}$ | Output voltage  | $8V \leq V_{IN} \leq 40V$<br>$0.2A \leq I_{LOAD} \leq 2A$                                | 5     | 4.8/4.75<br>5.2/5.25       | V<br>$V_{MIN}$<br>$V_{MAX}$ |
|                      | $\eta$    | Efficiency      | $V_{IN} = 12V, I_{LOAD}=2A$  | 80    |                            | %                           |

Specifications with boldface type are for full operating temperature range, the other type are for  $T_J=25^\circ C$ .

## FUNCTIONAL DESCRIPTION

### Pin Functions

#### **+V<sub>IN</sub>**

This is the positive input supply for the IC switching regulator. A suitable input bypass capacitor must be present at this pin to minimize voltage transients and to supply the switching currents needed by the regulator.

#### **Out**

Internal switch and power output. The voltage at this pin switches between  $(+V_{IN} - V_{SAT})$  and approximately  $-0.5V$ , with a duty cycle of approximately  $V_{OUT} / V_{IN}$ . The PC board copper area connected to this pin should be kept a minimum in order to reduce the coupling sensitivity to the circuitry

#### **Ground**

Circuit ground.

#### **Feedback**

Complete the feedback loop by sensing the regulated output voltage

#### **$\overline{ON/OFF}$**

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supply current to approximately 100uA. Pulling this pin below a threshold voltage of approximately 1.3V turns the regulator on, and pulling this pin above 1.3V (up to a maximum of 25V) shuts the regulator down. If this shutdown feature is not needed, the  $\overline{ON/OFF}$  pin can be wired to the ground pin or it can be left open, in either case the regulator will be in the ON condition.

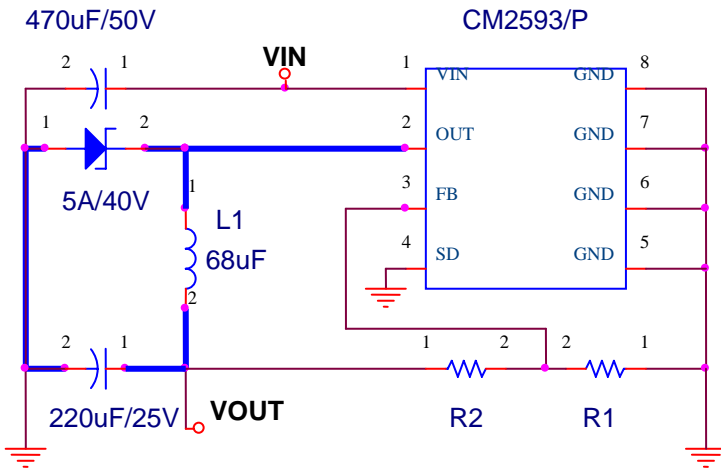
### Thermal Considerations

The SOP-8 package needs a heat sink under most conditions. The size of the heat-sink depends on the input voltage, the output voltage, the load current and the ambient temperature. The CM2593/P junction temperature rises above ambient temperature for a 2A load and different input and output voltages. The data for these curves was taken with the CM2593/P (SOP-8 package) operating as a buck switching regulator in an ambient temperature of 25°C (still air). These temperature increments are all approximate and are affected by many factors. Some of these factors include board size, shape, thickness, position, location, and even board temperature. Other factors are trace width, total printed circuit copper area, copper thickness, single or double-sided, multi-layer board and amount of solder on the board. Higher ambient temperatures require more heat sinking.

For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (One exception is the out(switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower thermal resistance) to the surrounding air, and moving air lowers the thermal resistance even further.

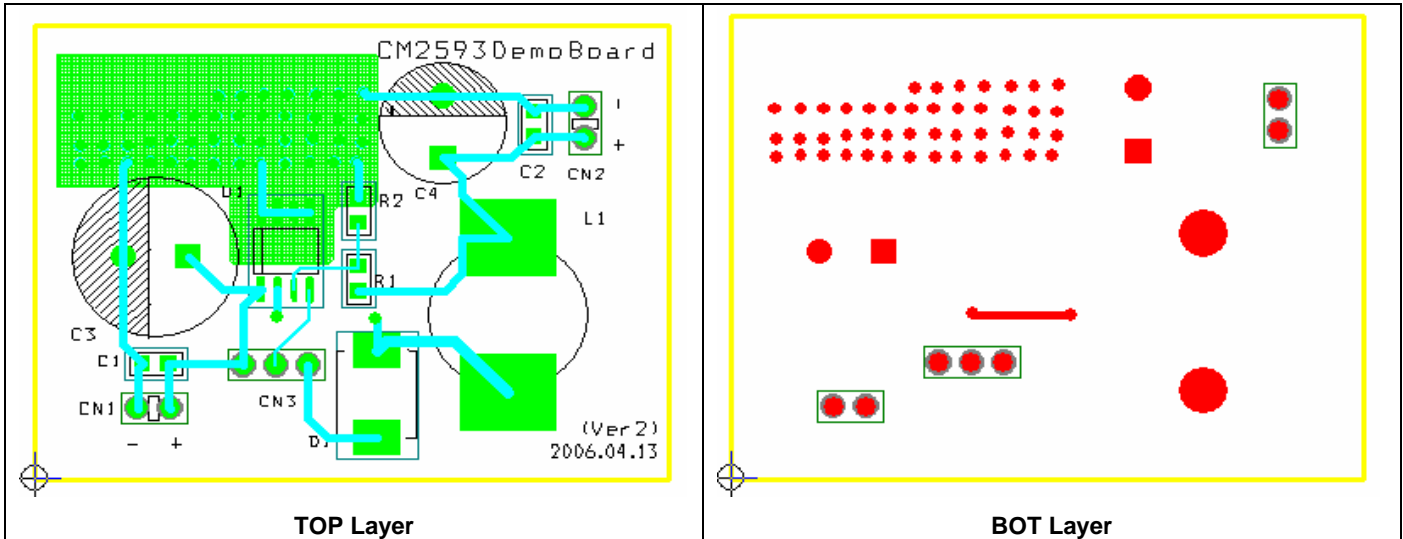
The effectiveness of the PC board to dissipate heat also depends on the size, quantity and spacing of other components on the board, as well as whether the surrounding air is still or moving. Furthermore, some of these components such as the catch diode will add heat to the PC board and heat can vary as the input voltage changes. For the inductor, depending on the physical size, type of core material and the DC resistance, it could either act as a heat sink taking heat away from the board, or it could add heat to the board.

### APPLICATIONS CIRCUIT



Output Voltage Fixed : R1=NC , R2=0  
 Output Voltage Adj :  $V_o = V_{ref} * (1 + (R2/R1))$   
 $V_{fb} = 1.235V$  ; R1=1K~5K

### APPLICATIONS Demo Board Layout

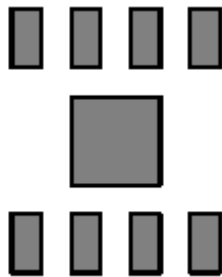
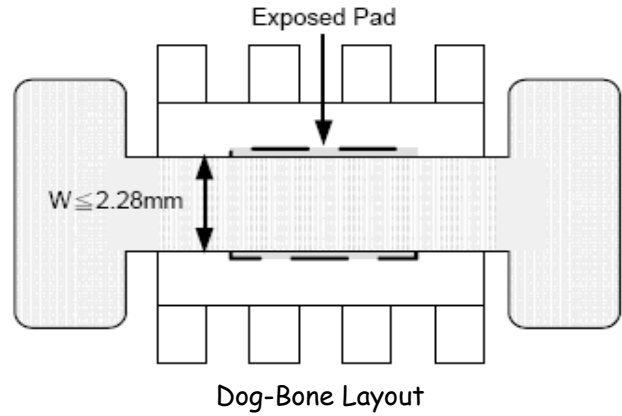
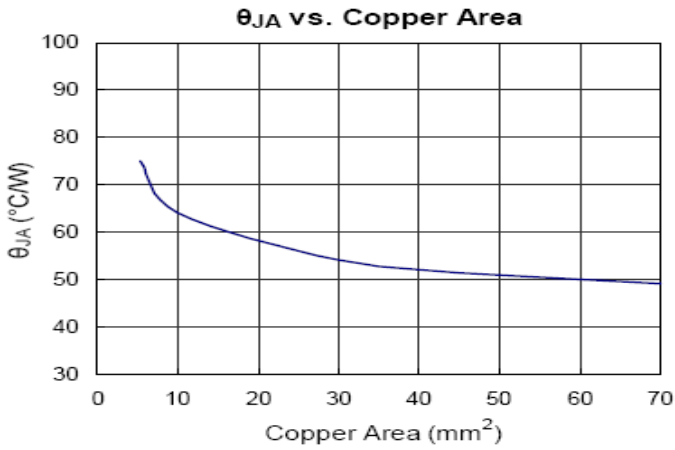


**Notice :**

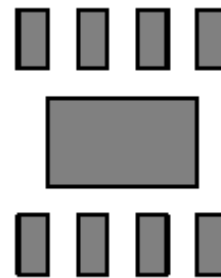
1. R1/R2 must be close to Pin3 (VFB ), but keep feedback wiring away from inductor.
2. Inductor/diode must be close to Pin2 (Vout ), heavy lines must be keep short and thick .
3. Please to refer to Circuit and Demo Board Layout (the Fig. as above)

**DIFFERENT HEATSINK AREA**

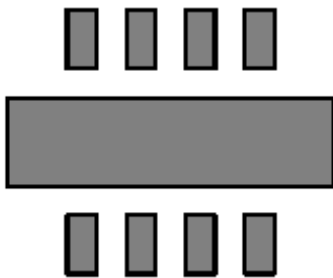
**Thermal Resistance vs. Different Cooper Area Layout Design**



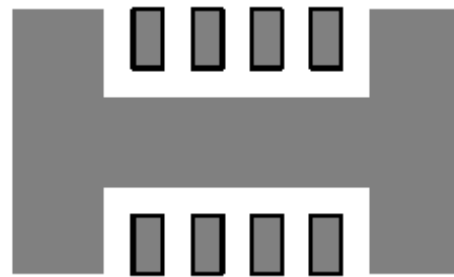
Minimum Footprint ,  $\theta_{JA} = 75^{\circ}\text{C}/\text{W}$



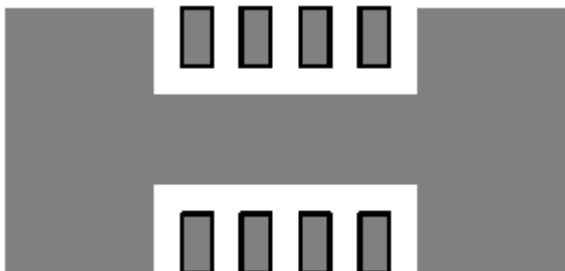
Copper Area =  $10\text{mm}^2$  ,  $\theta_{JA} = 64^{\circ}\text{C}/\text{W}$



Copper Area =  $30\text{mm}^2$  ,  $\theta_{JA} = 54^{\circ}\text{C}/\text{W}$



Copper Area =  $50\text{mm}^2$  ,  $\theta_{JA} = 51^{\circ}\text{C}/\text{W}$



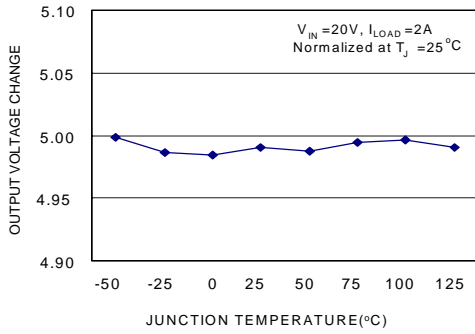
Copper Area =  $70\text{mm}^2$  ,  $\theta_{JA} = 49^{\circ}\text{C}/\text{W}$



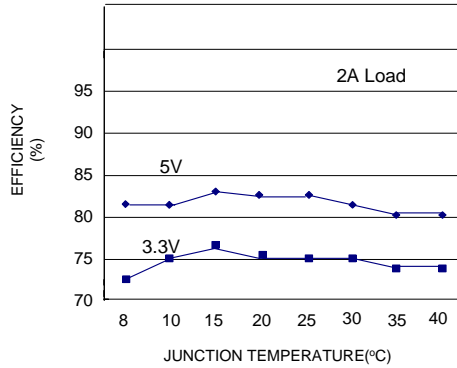
### Typical Performance Characteristics

(Test Figure 1 above unless otherwise specified)

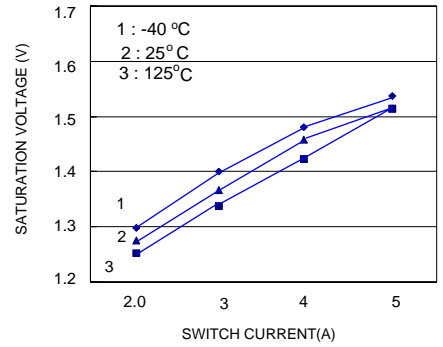
Typical Performance Characteristics  
Normalized Output Voltage



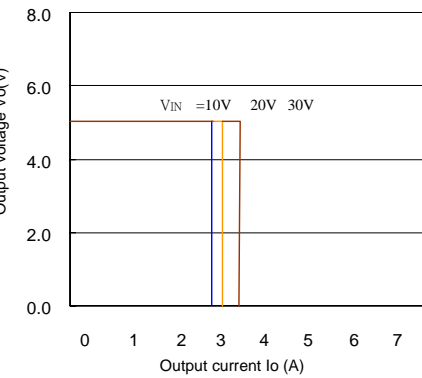
Efficiency



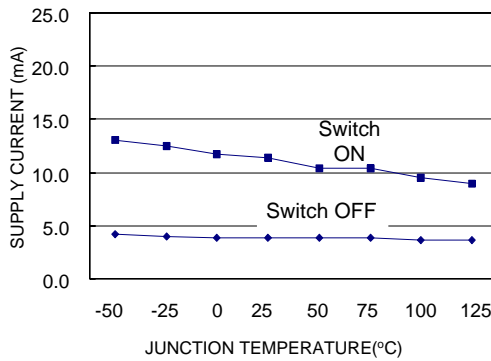
Switch Saturation Voltage



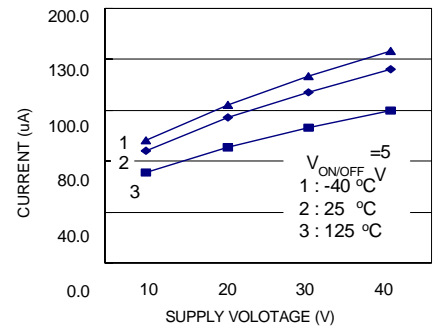
Switch Current Limit



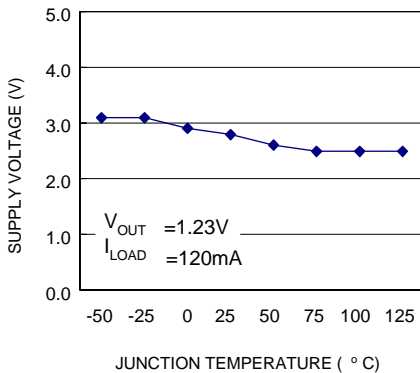
Operating Quiescent Current



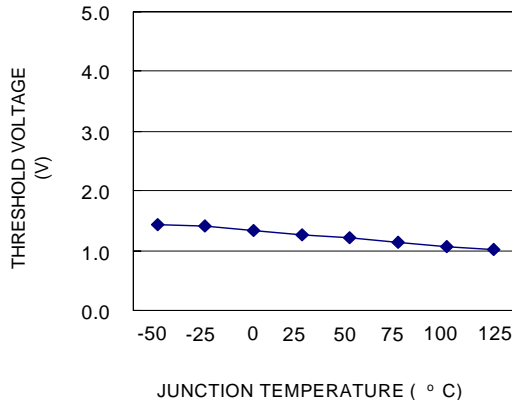
Shutdown Quiescent Current



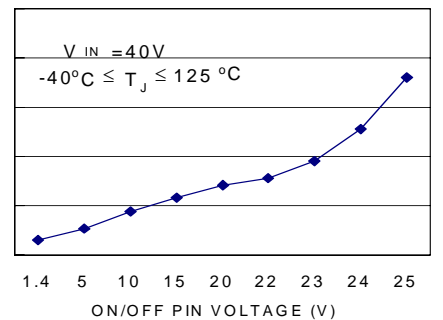
Minimum Operating Supply Voltage



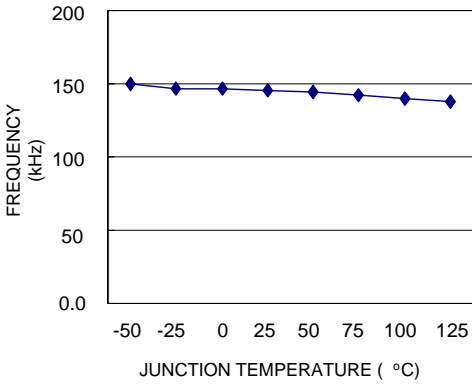
ON/OFF Threshold Voltage



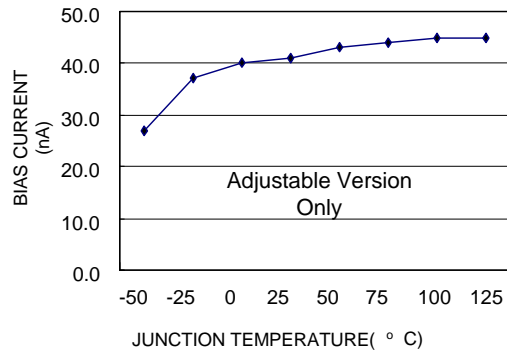
ON/OFF Pin Current (Sinking)



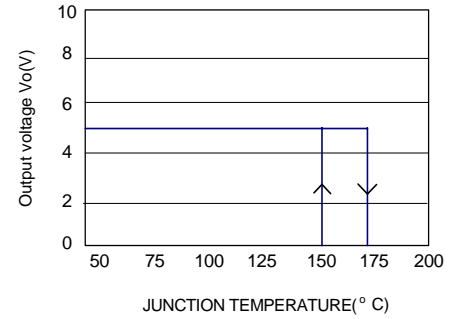
**Switch Frequency**



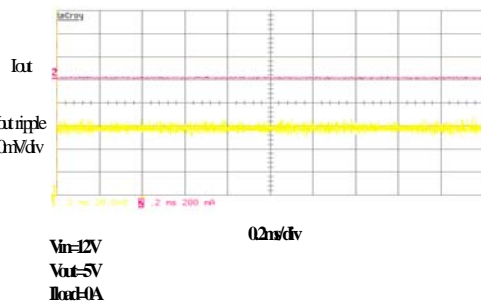
**Feedback Pin Bias Current**



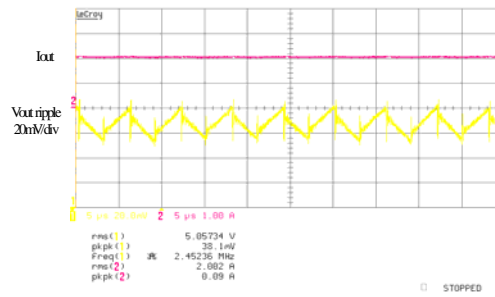
**Thermal protection**



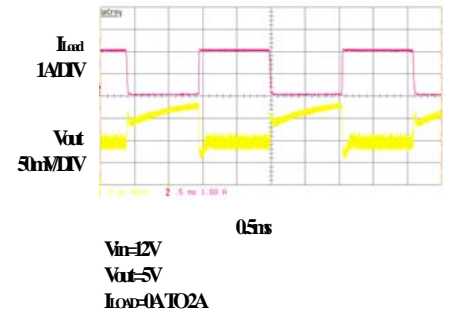
**Light Load operation**



**Heavy Load operation**

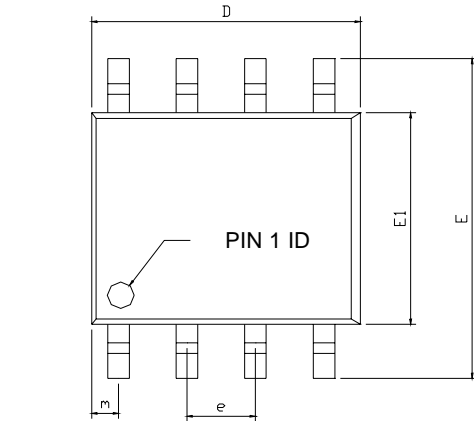


**Load step**

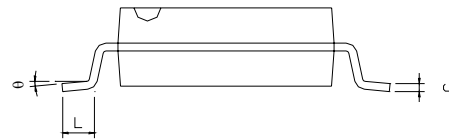
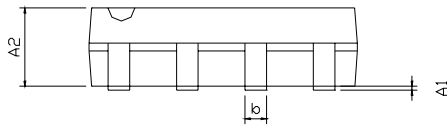


### PACKAGE DIMENSION

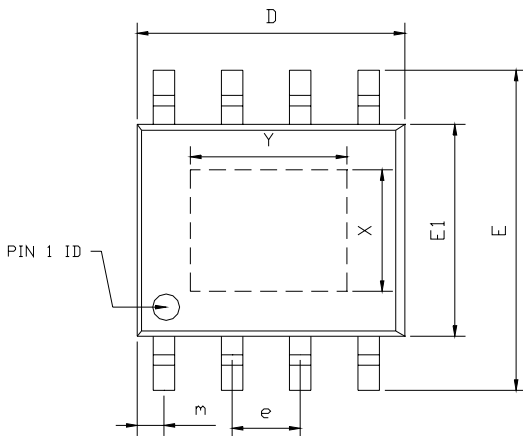
#### 8-PIN SOP (S08)



| SYMBOLS | DIMENSIONS IN MILLIMETERS |      |      | DIMENSIONS IN INCHS |       |       |
|---------|---------------------------|------|------|---------------------|-------|-------|
|         | MIN                       | NOM  | MAX  | MIN                 | NOM   | MAX   |
| A1      | 0.10                      | ---  | 0.25 | 0.004               | ---   | 0.010 |
| A2      | 1.40                      | ---  | 1.55 | 0.055               | ---   | 0.061 |
| b       | 0.30                      | ---  | 0.51 | 0.012               | ---   | 0.020 |
| C       | 0.15                      | ---  | 0.26 | 0.006               | ---   | 0.010 |
| D       | 4.60                      | ---  | 5.06 | 0.169               | ---   | 0.199 |
| E       | 5.79                      | ---  | 6.20 | 0.228               | ---   | 0.244 |
| E1      | 3.76                      | ---  | 4.01 | 0.148               | ---   | 0.158 |
| e       | ---                       | 1.27 | ---  | ---                 | 0.050 | ---   |
| L       | 0.38                      | ---  | 0.69 | 0.015               | ---   | 0.035 |
| m       | 0.43                      | ---  | 0.69 | 0.017               | ---   | 0.027 |
| θ       | 0°                        | ---  | 8°   | 0°                  | ---   | 8°    |

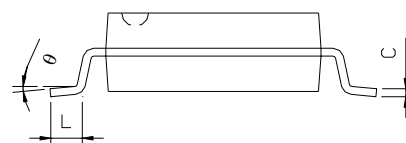
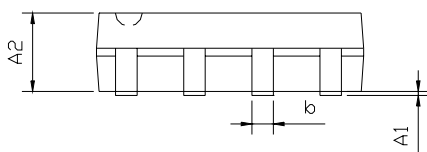


#### 8-Pin SOP w/ Power Pad (PS08)



| SYMBOLS | DIMENSIONS IN MILLIMETERS |      |      | DIMENSIONS IN INCHS |       |       |
|---------|---------------------------|------|------|---------------------|-------|-------|
|         | MIN                       | NOM  | MAX  | MIN                 | NOM   | MAX   |
| A1      | 0.10                      | ---  | 0.25 | 0.004               | ---   | 0.010 |
| A2      | 1.40                      | ---  | 1.55 | 0.055               | ---   | 0.061 |
| b       | 0.30                      | ---  | 0.51 | 0.012               | ---   | 0.020 |
| C       | 0.15                      | ---  | 0.26 | 0.006               | ---   | 0.010 |
| D       | 4.60                      | ---  | 5.06 | 0.169               | ---   | 0.199 |
| E       | 5.79                      | ---  | 6.20 | 0.228               | ---   | 0.244 |
| E1      | 3.76                      | ---  | 4.01 | 0.148               | ---   | 0.158 |
| e       | ---                       | 1.27 | ---  | ---                 | 0.050 | ---   |
| L       | 0.38                      | ---  | 0.69 | 0.015               | ---   | 0.035 |
| m       | 0.43                      | ---  | 0.69 | 0.017               | ---   | 0.027 |
| θ       | 0°                        | ---  | 8°   | 0°                  | ---   | 8°    |

EXPOSED PAD DIMENSION : (mm)  
PAD SIZE: X=2.34 ; Y=2.92



## IMPORTNT NOTICE

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