# Switching Regulator Power Controller

## Features

- **2.2V~6V Supply Voltage Operating Range**
- **Low Current Consumption: 5mA in Operation, 1μA or Less in Stand-by**
- **20kHz to 1MHz Operation Frequency Range**
- **Built-In Soft Start Circuit**
- **Built-In Timer-Latch Type Short Circuit Detection and Protection (SCP) Circuit**
- **Use External Resistor to Set a Fixed Output Current**

## General Description

The G5180 is a single-channel PWM control IC for low voltage DC/DC conversion incorporating a soft start function and short circuit detection function. The device has a low minimum operating voltage of 2.2V and is ideal for the power supply of battery-operated electronic equipment.

## Applications

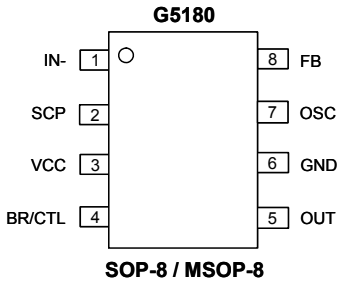
- **LCD Displays**
- **PDAs**
- **Digital Still Cameras**

## Ordering Information

| ORDER NUMBER | MARKING | TEMP. RANGE | PACKAGE (Pb free) |
|---|---|---|---|
| G5180P1U | G5180 | 0°C to 85°C | SOP-8 |
| G5180P8U | G5180 | 0°C to 85°C | MSOP-8 |

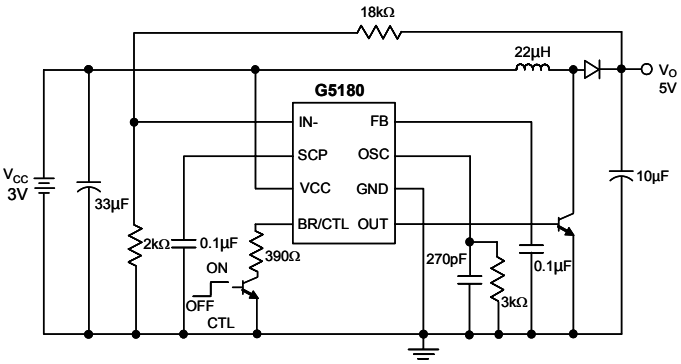
Note: P1: SOP-8; P8: MSOP-8
U: Tape & Reel

## Pin Configuration




SOP-8 / MSOP-8

## Typical Application Circuit



## Absolute Maximum Ratings

Power Supply Voltage, $V_{CC}$. . . . . .7V
VCC, IN- to GND. . . . . .-0.3V to +7V
SCP, BR/CTL, OUT, OSC, FB to GND
. . . . . .. . . -0.3V to (VCC+0.3V)

Operating Temperature, $T_{OP}$ . . . . . 0°C to +85°C
Storage Temperature Range, $T_{STG}$ . . .-65°C to+165°C
Reflow Temperature (soldering, 10sec) . . . . . 260°C

## Electrical Characteristics

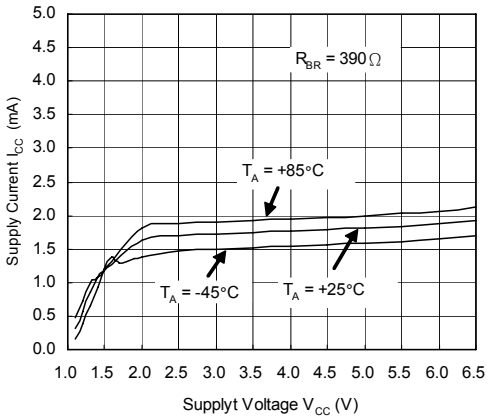
**$V_{CC}$=2.2V, $T_A$=25°C, unless otherwise noted.**

| PARAMETER | | SYMBOL | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Under voltage lockout (UVLO) | Threshold voltage | $V_{TH}$ | | 1.3 | 1.5 | 1.7 | V |
| Soft start | Charging current | $I_{CS}$ | $V_{SCP}$=0V | -1.5 | -1 | -0.7 | µA |
| | Voltage at soft start completion | $V_{ts}$ | | 0.7 | 0.8 | 0.9 | V |
| Short circuit detection and protection (SCP) | Charging current | $I_{CSCP}$ | $V_{SCP}$=0V | -1.5 | -1 | -0.7 | µA |
| | Threshold voltage | $V_{tSCP}$ | | 0.7 | 0.8 | 0.9 | V |
| Sawtooth waveform oscillator (OSC) | Oscillation frequency | $f_{OSC}$ | $R_T$=3.0kΩ, $C_T$=270pF | --- | 500 | --- | kHz |
| | Frequency input Stability | $f_{\Delta V}$ | $V_{CC}$=2.2V to 6V | --- | 2 | --- | % |
| | Frequency variation with temperature | $f_{\Delta T}$ | $T_A$=0°C to 85°C | --- | 5 | --- | % |
| Error amplifier | Input threshold voltage | $V_T$ | $V_{FB}$=450mV | 480 | 500 | 520 | mV |
| | $V_T$ input stability | $V_{T\Delta V}$ | $V_{CC}$=2.2 to 6V | -10 | 5 | 10 | mV |
| | $V_T$ variation with temperature | $V_{T\Delta T}$ | $T_A$=0°C to 85°C | --- | 1 | --- | % |
| | Input bias current | $I_B$ | $V_{IN-}$=0V | -1 | 0 | 1 | µA |
| | Voltage gain | $A_V$ | | 100 | 140 | 180 | V/V |
| | Frequency bandwidth | BW | Av=0dB | --- | 6 | --- | MHz |
| | Maximum output voltage range | $V_{OMax}^+$ | | 0.78 | 2 | --- | V |
| | | $V_{OMax}^-$ | | --- | 0.05 | 0.2 | V |
| | Output source current | $I_{OMax}^+$ | $V_{FB}$=450mV | --- | -60 | -24 | µA |
| | Output sink current | $I_{OMax}^-$ | | 24 | 700 | --- | µA |
| Idle period adjustment section | Maximum duty cycle | $T_{DUTY}$ | $R_T$=3.0kΩ, $C_T$=270pF, $V_{FB}$=0.8V | 75 | 85 | 95 | % |
| Output section | Output voltage | $V_{OH1}$ | $R_B$=390Ω, $I_O$=-15mA | 1 | 1.2 | --- | V |
| | | $V_{OH2}$ | $R_B$=750Ω, $V_{CC}$=2.2V, $I_O$=-10mA | 0.8 | 1 | --- | V |
| | | $V_{OL1}$ | $R_B$=390Ω, $I_O$=15mA | --- | 0.1 | 0.2 | V |
| | | $V_{OL2}$ | $R_B$=750Ω, $V_{CC}$=2.2V,$I_O$=10mA | --- | 0.1 | 0.2 | V |
| | Output source current | $I_O^+$ | $R_B$=390Ω, $V_O$=0.9V | --- | -30 | -20 | mA |
| | Output sink current | $I_O^-$ | $R_B$=390Ω, $V_O$=0.3V | 30 | 60 | --- | mA |
| | Pull down resistance | $R_O$ | | 20 | 30 | 50 | kΩ |
| Output current Setting /Control Section | Pin voltage | $V_{BR}$ | $R_B$=390Ω | 0.2 | 0.3 | 0.4 | V |
| | Input off condition | $I_{OFF}$ | | -3 | --- | 0 | µA |
| | Input on condition | $I_{ON}$ | | --- | --- | -40 | µA |
| | Pin current range | $I_{BR}$ | | -1.8 | --- | -0.1 | mA |
| Entire device | Stand-by current | $I_{CCS}$ | BR/CTL pin open or $V_{CC}$ | -1 | --- | 1 | µA |
| | Average supply current | $I_{CC}$ | $R_B$=390Ω | --- | 2 | 5 | mA |

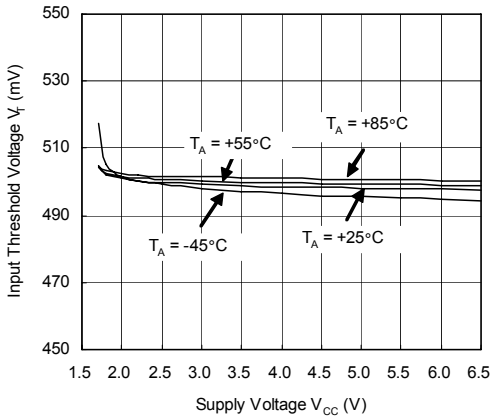
## Typical Performance Characteristics

**$V_{CC}$= 2V, $R_{BR}$=390Ω, $R_T$=3kΩ, $C_T$=270pF, $T_A$= 25°C, unless otherwise noted.**

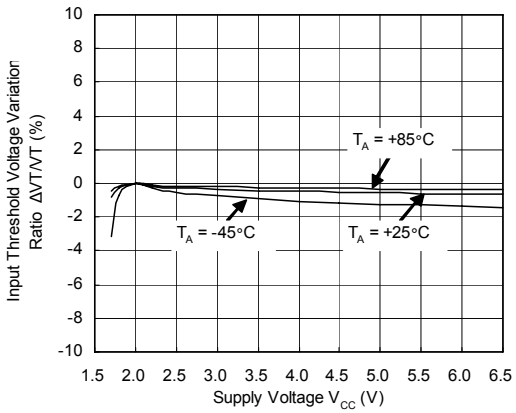
**Supply Current $I_{CC}$ vs. Supply Voltage $V_{CC}$**



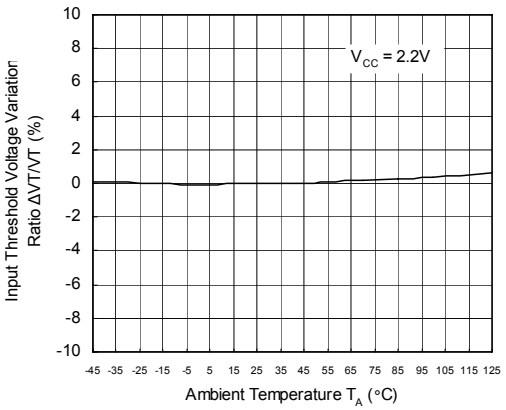

**Input Threshold Voltage $V_T$ vs. Supply Voltage $V_{CC}$**



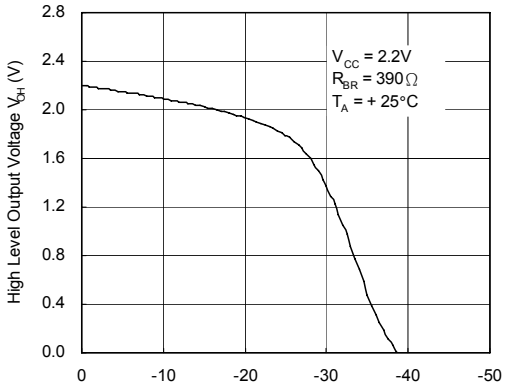

**Input Threshold Voltage Variation Ratio $\Delta V_T/V_T$ vs. Supply Voltage $V_{CC}$**



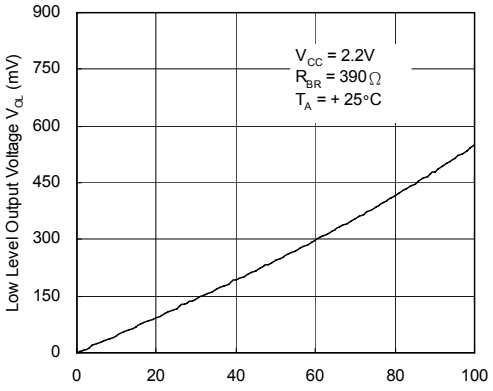

**Input Threshold Voltage Variation Ratio $\Delta V_T/V_T$ vs. Ambient Temperature $T_A$**




**High Level Output Voltage $V_{OH}$ vs. Output Source Current $I_O^+$**

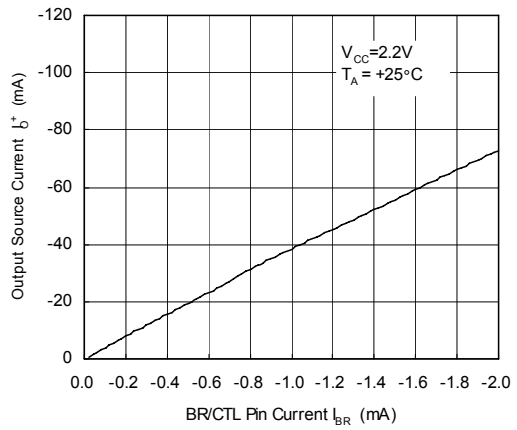



**Low Level Output Voltage $V_{OL}$ vs. Output Sink Current $I_O^-$**

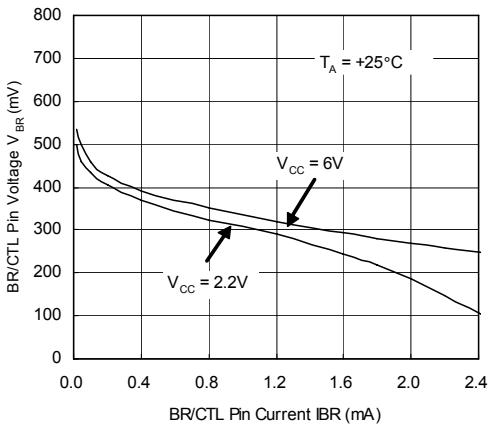


## Typical Performance Characteristics (continued)

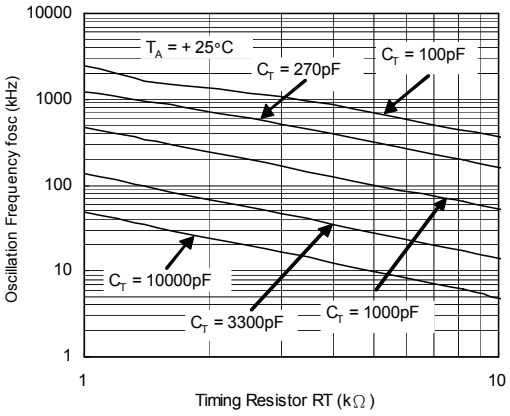
**Output Source Current $I_O^+$ vs. BR/CTL Pin Current $I_{BR}$**



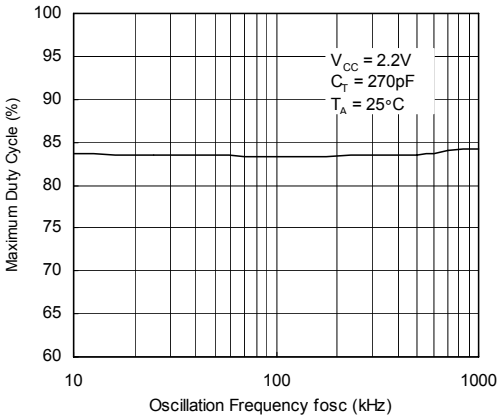

**BR/CTL Pin Voltage $V_{BR}$ vs. BR/CTL Pin Current $I_{BR}$**



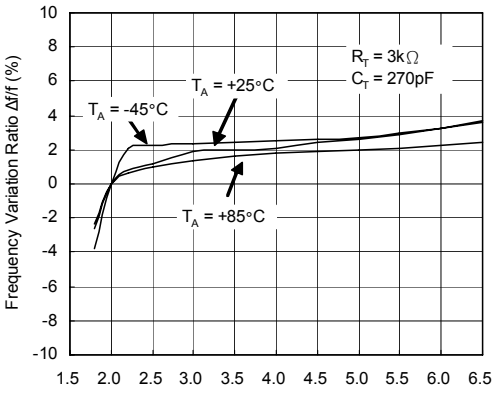

**Oscillation Freuency fosc vs. Timing Resistor $R_T$**



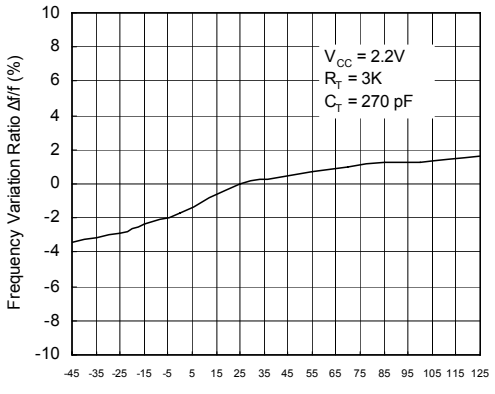

**Oscillation Frequency fosc vs. Maximum Duty Cycle**



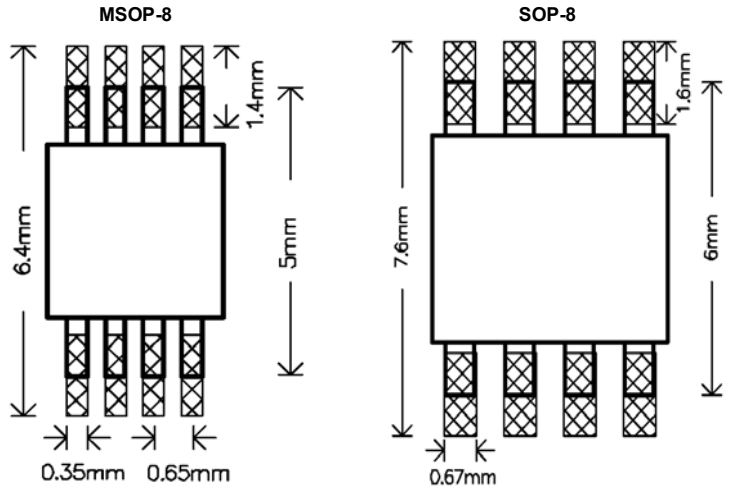

**Frequency variation ratio Δf/f vs. Supply Voltage $V_{CC}$**




**Frequency variation ratio Δf/f vs. Ambient Temperature $T_A$**



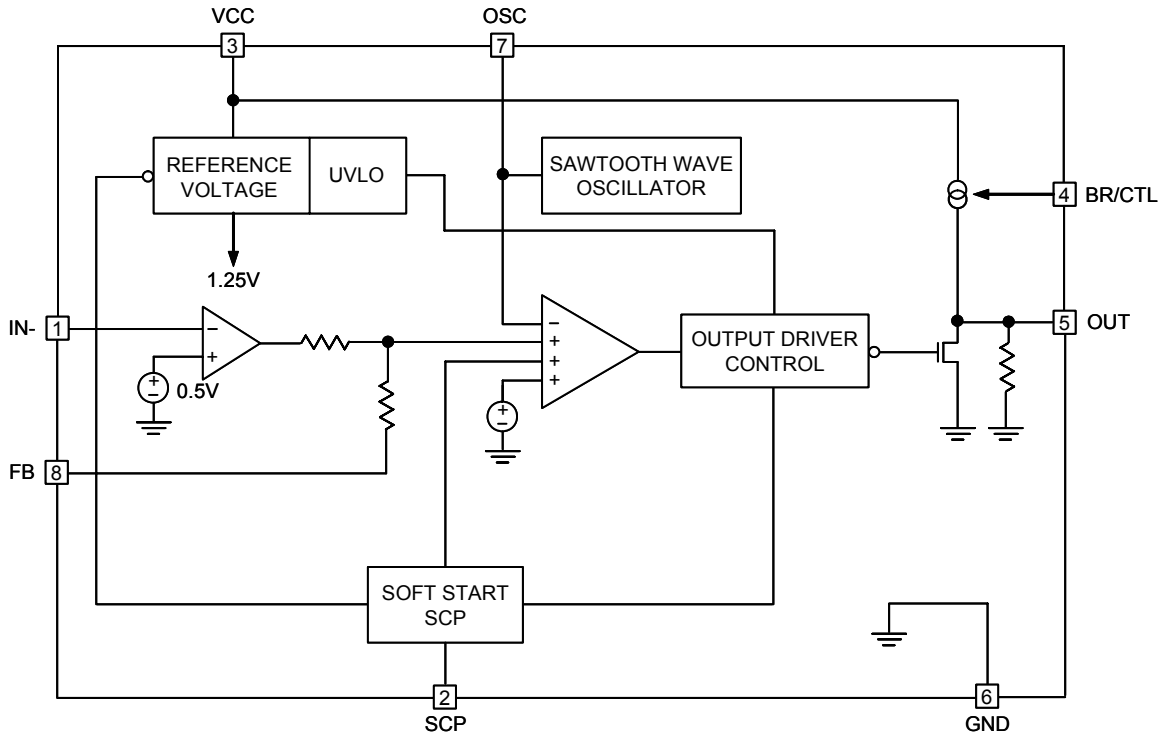
## Recommended Minimum Footprint



## Pin Description

| PIN | NAME | I/O | FUNCTION |
|---|---|---|---|
| 1 | IN- | I | Error amplifier inverting input |
| 2 | SCP | - | Soft start and SCP setting capacitor connection |
| 3 | VCC | - | Power supply |
| 4 | BR/CTL | I | Output current setting and control |
| 5 | OUT | O | Output |
| 6 | GND | - | Ground |
| 7 | OSC | - | Capacitor and resistor connection pin for setting the oscillation frequency |
| 8 | FB | O | Error amplifier output |

## Block Diagram



## Description

### Soft Start SCP

At power on, the G5180 enters the soft-start mode to prevent current spike and overshoot. The capacitor $C_S$ is charged from 0V with a constant current of 1μA.

The soft-start time for the duty cycle

$t_S = 0.8 \times C_S$ (μF)

When $V_{SCP}$ reaches 0.8V, the G5180 leaves the soft-start mode to enter the normal mode and enable the SCP function. If the output load conditions change rapidly causing the output to drop suddenly, the external capacitor $C_S$ will start to charge because the error amplifier output (FB pin) is fixed at $V_{OMax}^{+}$. When the external capacitor is charged above 0.8V, the output pin is set low. Once the latch circuit has set, the capacitor $C_S$ will be discharged to low state and the latch circuit will not reset until power is turned off or the power supply is restarted.
Short-circuit detection time (or full soft-start time):

$t_{PE} = 0.8 \times C_S$ (μF)

### Setting Oscillating Frequency

The oscillator circuit generates a triangular sawtooth wave with a peak of 0.8V and a trough of 0.1V using the timing capacitor ($C_T$) and the timing resistor ($R_T$) that are connected to the OSC pin. This oscillator can provide oscillating frequency in the range from 20kHz to 1MHz. The waveform of the OSC pin is shown as Figure 1.

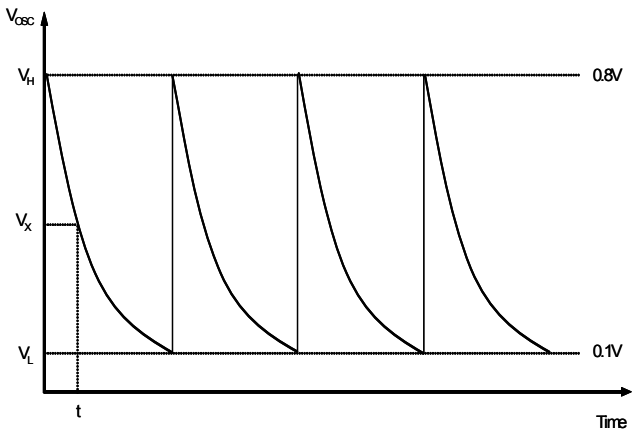



**Figure 1**

The cycle (T) can be determined as follows:

$$V_X = V_H \times e^{-t/(C_T \times R_T)} \quad t = -C_T \times R_T \times \ln\left(\frac{V_X}{V_H}\right)$$

$$T = -C_T \times R_T \times \ln(0.1/0.8) \approx 2.1 \times C_T \times R_T [s]$$

### Switching Regulator Function

#### Reference Voltage circuit

A temperature-compensated reference voltage (~1.25V) is generated by the reference voltage circuit from the voltage supplied by the power supply pin (pin 3). The circuit also sets the idle period besides providing the reference voltage for the switching regulator.

#### Error Amplifier

The error amplifier detects the output voltage of the switching regulator and sets the PWM control signal. The voltage gain is fixed. The system is made stable by connecting a phase compensation capacitor to the FB pin (pin 8).

#### PWM Comparator

The voltage comparator includes one inverting and three non-inverting inputs. The comparator is a voltage to pulse width converter that controls the ON time of the output pulse depending on the level of input voltage. The output level remains high when the sawtooth wave is lower than the error amplifier output voltage, the soft start setting voltage, and the idle period setting voltage.

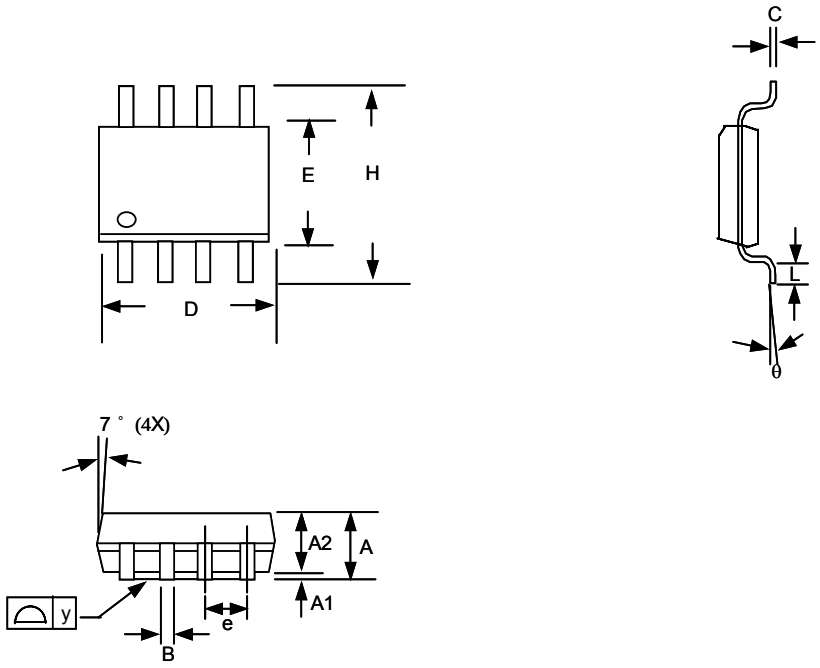
#### Output Circuit

The output circuit can drive an external NPN transistor or NMOS directly. The value of the ON/OFF current can be set by a resistor connected to the BR/CTL pin (pin 4). Stand-by mode (supply current 1μA or less) can be set by connecting the BR/CTL pin (pin 4) to $V_{CC}$ or by making the pin open.

#### Under-Voltage Lockout (UVLO)

Transients during powering on or instantaneous glitches in the supply voltage can cause the control IC to malfunction and damage the system. To prevent malfunction at low input voltage, the circuit compares the supply voltage to the internal reference voltage to detect a low input voltage. Once detected, the circuit sets the output pin low.

## Package Information

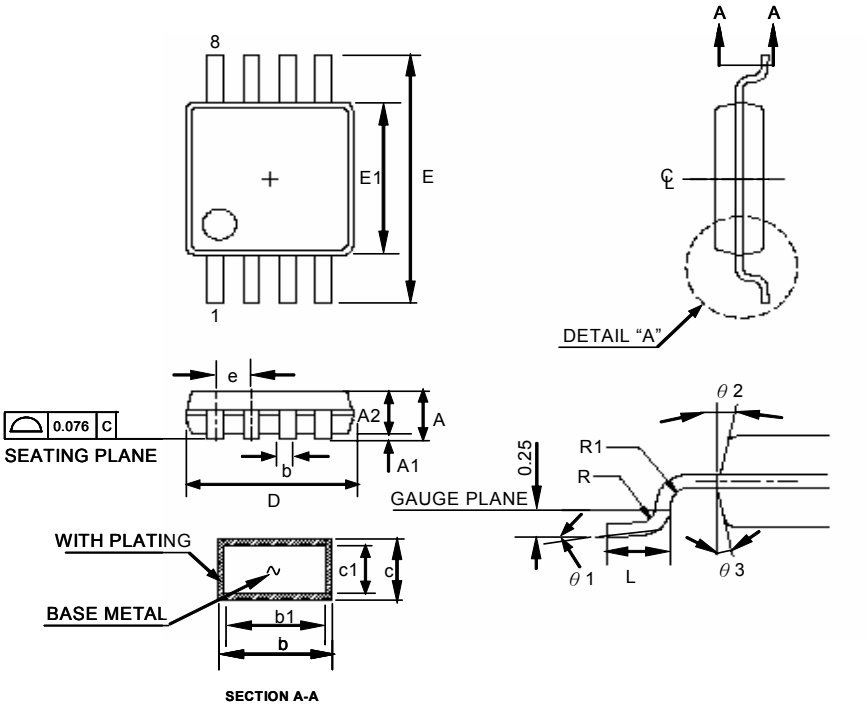



**SOP-8 Package**

**Note:**

1. Package body sizes exclude mold flash and gate burrs
2. Dimension L is measured in gage plane
3. Tolerance 0.10mm unless otherwise specified
4. Controlling dimension is millimeter converted inch dimensions are not necessarily exact.

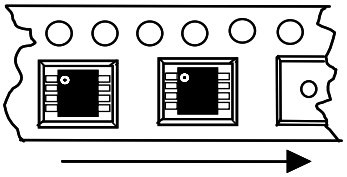
| SYMBOL | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 1.35 | 1.60 | 1.75 | 0.053 | 0.063 | 0.069 |
| A1 | 0.10 | ----- | 0.25 | 0.004 | ----- | 0.010 |
| A2 | ----- | 1.45 | ----- | ----- | 0.057 | ----- |
| B | 0.33 | ----- | 0.51 | 0.013 | ----- | 0.020 |
| C | 0.19 | ----- | 0.25 | 0.007 | ----- | 0.010 |
| D | 4.80 | ----- | 5.00 | 0.189 | ----- | 0.197 |
| E | 3.80 | ----- | 4.00 | 0.150 | ----- | 0.157 |
| e | ----- | 1.27 | ----- | ----- | 0.050 | ----- |
| H | 5.80 | ----- | 6.20 | 0.228 | ----- | 0.244 |
| L | 0.40 | ----- | 1.27 | 0.016 | ----- | 0.050 |
| y | ----- | ----- | 0.10 | ----- | ----- | 0.004 |
| $\theta$ | 0° | ----- | 8° | 0° | ----- | 8° |




**MSOP-8 Package**

| SYMBOL | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | ----- | ----- | 1.10 | ----- | ----- | 0.043 |
| A1 | 0.05 | ----- | 0.15 | 0.002 | ----- | 0.006 |
| A2 | 0.81 | 0.86 | 0.91 | 0.032 | 0.034 | 0.036 |
| b | 0.25 | ----- | 0.40 | 0.008 | ----- | 0.012 |
| b1 | 0.25 | 0.30 | 0.35 | 0.010 | 0.012 | 0.014 |
| c | 0.13 | ----- | 0.23 | 0.005 | | 0.009 |
| c1 | 0.13 | 0.15 | 0.18 | 0.005 | 0.006 | 0.007 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E1 | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| e | 0.65 BSC | | | 0.026 BSC | | |
| E | 4.90 BSC | | | 0.193 BSC | | |
| L | 0.445 | 0.55 | 0.648 | 0.0175 | 0.0217 | 0.0255 |
| θ1 | 0° | ----- | 6° | 0° | ----- | 6° |
| θ2 | 12 REF | | | 12 REF | | |
| θ3 | 12 REF | | | 12 REF | | |
| R | 0.09 | ----- | ----- | 0.004 | ----- | ----- |
| R1 | 0.09 | ----- | ----- | 0.004 | ----- | ----- |
| JEDEC | MO-187AA | | | | | |

## Taping Specification



**Feed Direction**
**Typical SOP/MSOP Package Orientation**

| PACKAGE | Q'TY/REEL |
|---|---|
| SOP-8 | 2,500 ea |
| MSOP-8 | 2,500 ea |