# High Efficiency, Constant Current Output for 4 Series LEDs Driver

## Features

- **Driving Up to 4 LEDs**
- **Auto Trigger/Release OVP Function (G5115/G5119)**
- **Input Voltage Range: 1.7V ~ 6.5V**
- **Precise Dimming Control Using PWM Signal**
- **50μA No Switching Current**
- **Internal 18V Switch With 0.8Ω Rds(on)**
- **Soft Start Function Included**
- **Up to 85% Efficiency**

## Applications

- **White LED Backlight Display for PDA**
- **Pocket PC**
- **Smart Phones**
- **Handheld Devices**
- **Cellular Phones**

## General Description

The G5115/G5117/G5119 are high efficiency boost converters with constant current output that drives up to 4 white LEDs. The continuous LED current is set with the FB pin regulated voltage across an external sense resistor (Rs) connected from that pin to ground. A dimming PWM waveform to $\overline{\text{SHDN}}$ pin controls LED average current proportional to its duty makes the brightness of LEDs also proportional to the duty.

Low FB regulation voltage and low switch turned on resistance result in high converting efficiency from wide battery voltage range to high LED series voltage.

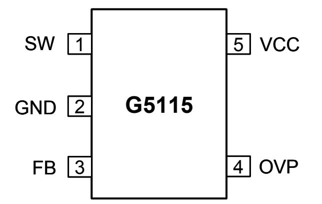
An over-voltage protection prevents device damage while LEDs is open. It is easy to release protection state by just put the load path closed.

## Ordering Information

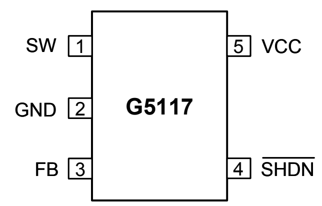
| ORDER NUMBER | ORDER NUMBER (Pb free) | MARKING | TEMP. RANGE | PACKAGE |
|---|---|---|---|---|
| G5115T1U | G5115T1Uf | 5115X | -40°C ~ +85°C | SOT-23-5 |
| G5117T1U | G5117T1Uf | 5117X | -40°C ~ +85°C | SOT-23-5 |
| G5119P8U | G5119P8Uf | G5119 | -40°C ~ +85°C | MSOP-8L |

Note:T1 : SOT-23-5 P8 : MSOP-8L
U : Tape & Reel

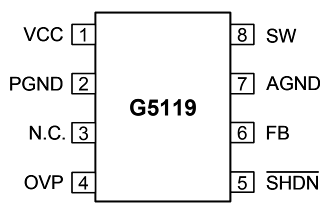
## Pin Configuration




SOT-23-5

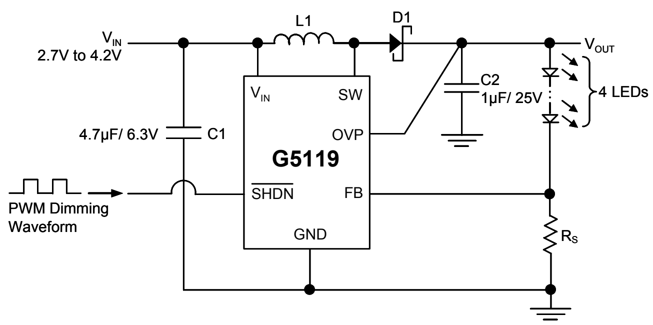



SOT-23-5




MSOP-8

## Typical Application Circuit



## Absolute Maximum Ratings

SW, OVP to GND……..………..………….-0.3V to +18V
VCC, SHDN to GND…………………………..-0.3V to +7V
FB to GND……………………………………-0.3V to VCC
Operating Temperature…………………….-40°C to 85°C

Junction Temperature ………………………………125°C
Storage Temperature………………………-65°C to 150°C
Reflow Temperature (soldering, 10sec)……………260°C

Stress beyond those listed under "Absolute Maximum Rating" may cause permanent damage to the device.

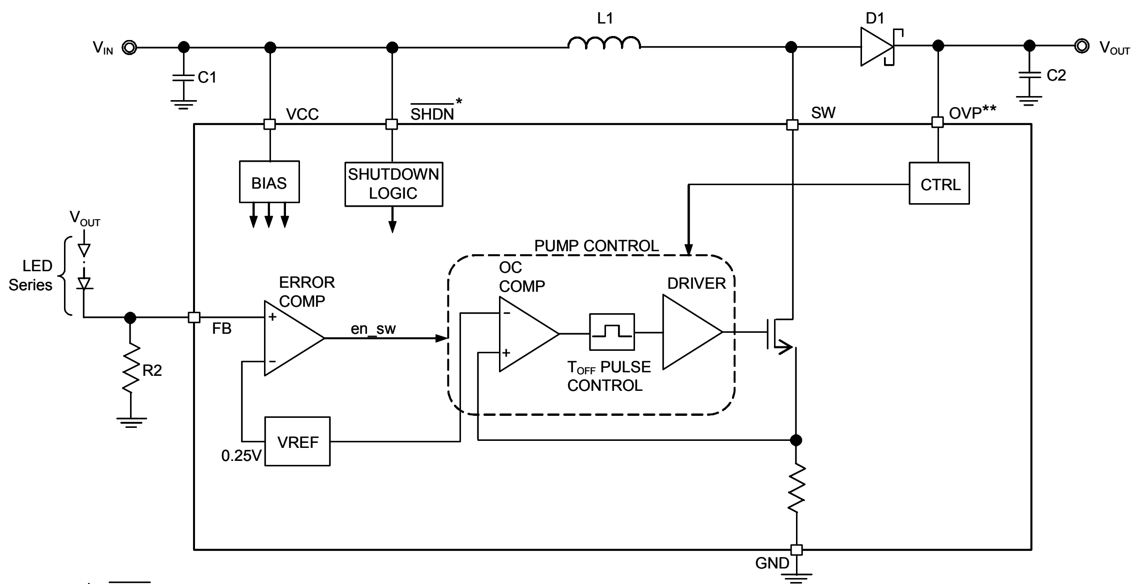
## Electrical Characteristics

**($V_{CC}=V_{\overline{SHDN}}$ =3.6V, $T_A$=25°C, unless specified)**

| PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Input Voltage Range | | 1.7 | --- | 6.5 | V |
| OV Protection Threshold | G5115/G5119, Trigger | 15 | 16 | 17 | V |
| | G5115/G5119, Release | --- | --- | 14 | V |
| OV Pin Input Current | G5115/G5119, $V_{ovp}$ = 16V | --- | 10 | 15 | μA |
| Quiescent Current | $V_{FB}$ = 0.3V | --- | 50 | 100 | μA |
| | $V_{\overline{SHDN}}$ = 0V | --- | 2.4 | 3 | μA |
| FB Comparator Trip Point | | 242 | 250 | 258 | mV |
| Switch Off Time | $V_{FB}$ = 0V | --- | 400 | --- | ns |
| Switch $R_{DS(ON)}$ | $I_{SW}$ = 150mA | --- | 0.8 | 1.2 | Ω |
| Switch Leakage Current | Switch Off, $V_{SW}$ = 18V | --- | 0.1 | 5 | μA |
| Switch Current Limit | | 200 | 250 | 300 | mA |
| $\overline{SHDN}$ Pin Voltage High | | 0.9 | --- | --- | V |
| $\overline{SHDN}$ Pin Voltage Low | | --- | --- | 0.25 | V |

Note.1:The G5115/G5117/G5119 are guaranteed to meet performance specifications from 0°C~85°C. Specifications over the -40°C~85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

## Block Diagram

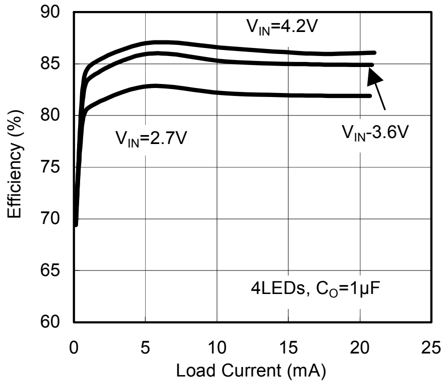



* SHDN pin only availiable for G5117/G5119
** OVP pin only availiable for G5115/G5119

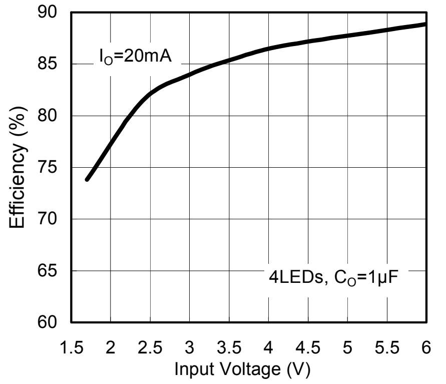
## Typical Performance Characteristics

**($V_{CC}$ = +3.6V, $V_{\overline{SHDN}}$ = +3.6V, L=10μH, $T_A$=25°C, unless otherwise noted)**

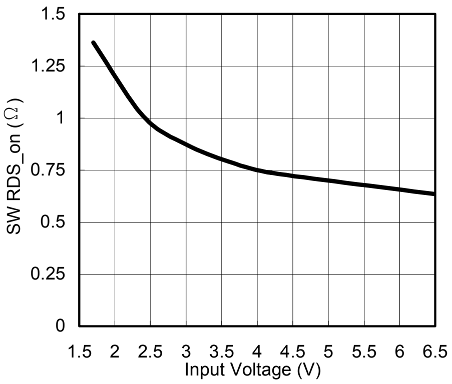
**Efficiency vs. Output Current**



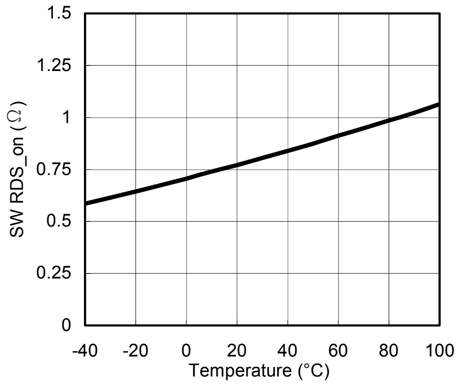

**Efficiency vs. Input Current**



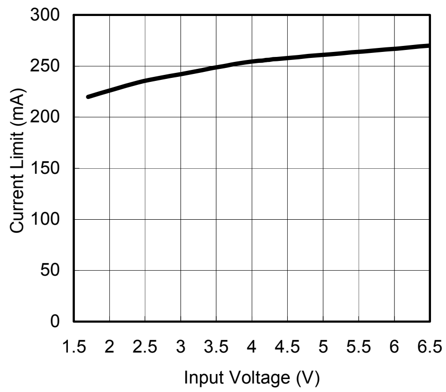

**SW RDS_on vs. Input Voltage**



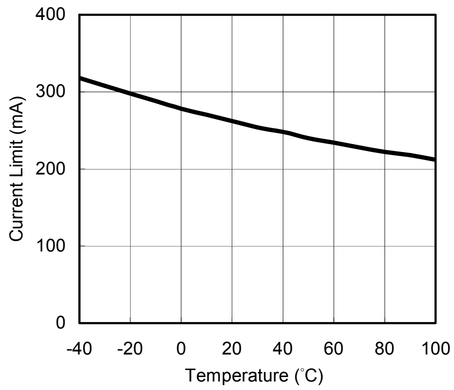

**SW RDS_on vs. Temperature**




**Current Limit vs. Input Voltage**

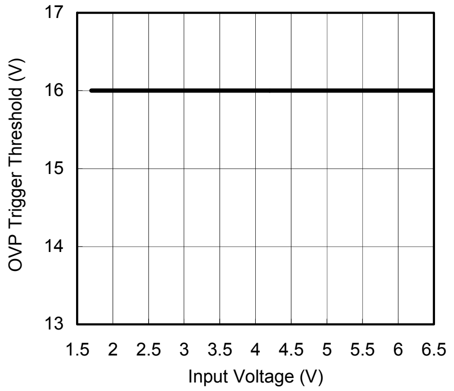



**Current Limit vs. Temperature**

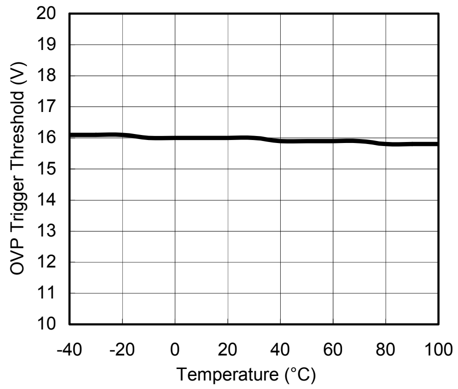


## Typical Performance Characteristics (Continued)

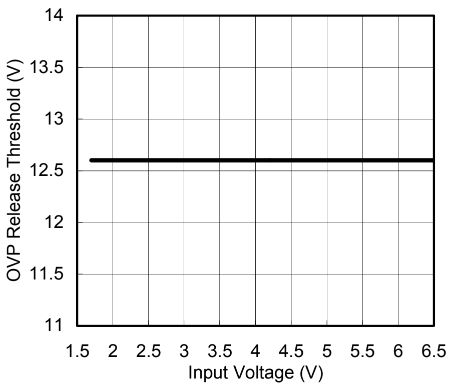
**OVP Trigger Threshold vs. Input Voltage**



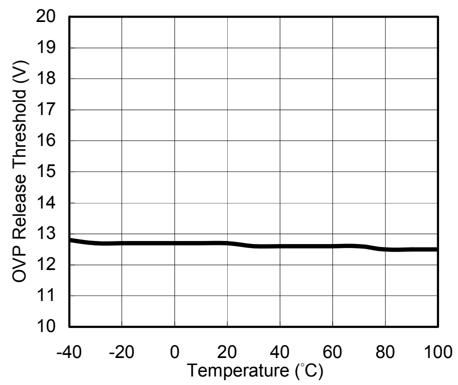

**OVP Trigger Threshold vs. Temperature**



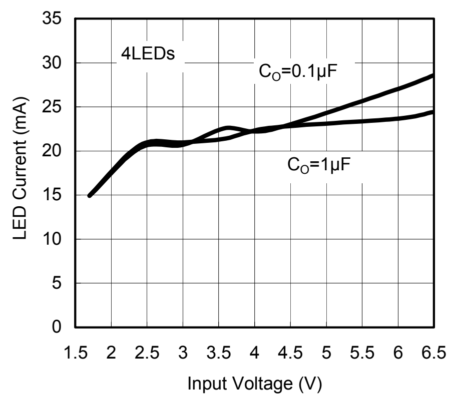

**OVP Release Threshold vs. Input Voltage**



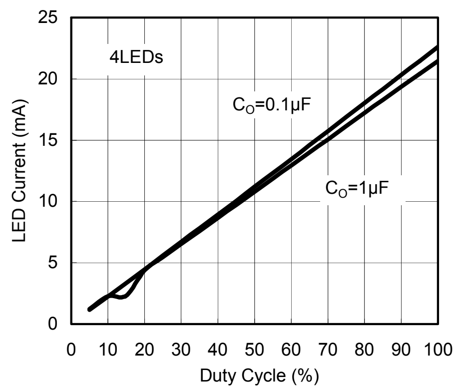

**OVP Release Threshold vs. Temperature**




**LED Current vs. Input Voltage**

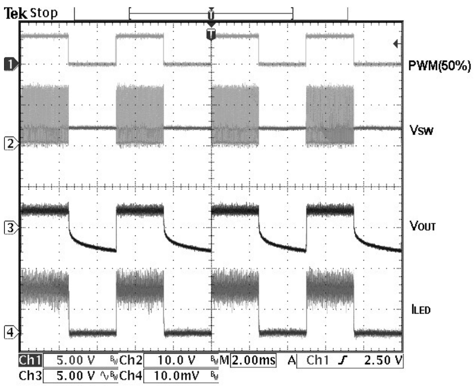



**LED Current vs. Duty Cycle**

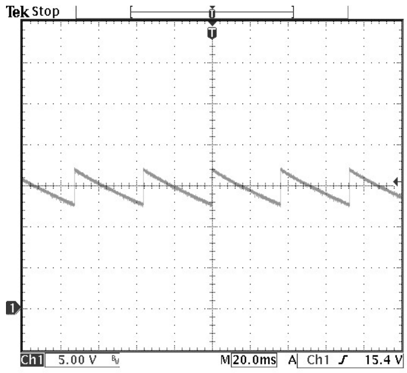


## Typical Performance Characteristics (Continued)

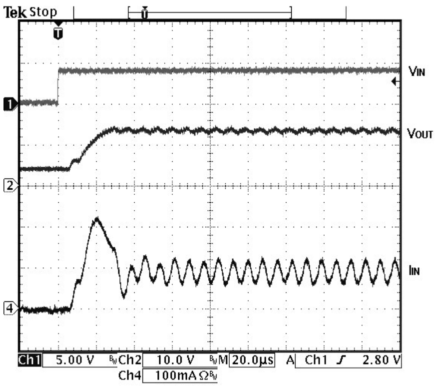
### PWM Dimming




### OVP Waveform




### G5119 Inrush Current Waveform



## Pin Description

| PIN | | | NAME | FUNCTION |
|---|---|---|---|---|
| G5115 SOT-23-5 | G5117 SOT-23-5 | G5119 MSOP-8 | | |
| 1 | 1 | 8 | SW | **Switch Pin**. The drain of the internal NMOS power switch. Connect this pin to inductor. |
| 2 | 2 | 2 | PGND | **Power Ground Pin**. |
| | | 7 | AGND | **Analog Ground Pin**. |
| 3 | 3 | 6 | FB | **Feedback Pin**. |
| | 4 | 5 | $\overline{SHDN}$ | **Active Low Shutdown Pin**. Tie this pin to logical high to enable the device or tied it to logical low to turn this device off. Internal 1.5MΩ pulled high. |
| 4 | | 4 | OVP | **Over Voltage Protection Sense Pin**. |
| 5 | 5 | 1 | VCC | **Input Supply Pin.** Bypass this pin with a capacitor as close to the device as possible. |

## Function Description

### Operation

The G5115/G5117/G5119 are boost converters with NMOS switch embedded. They operate in a PFM scheme with constant peak current control. The operation frequency is up to 1MHz and is determined by the current limit, inductor value, input voltage and minimum off time. The boost cycle is started when FB pin voltage drop below 0.25V as the NMOS switch turns on. During the switch on period, the inductor current ramps up until 250mA current limit is reached. Then turns the switch off, while the inductor current flows through external schottky diode, and ramps down to zero. During the switch off period, the inductor current provides for load current and also charges output capacitor. It makes the LED current higher and results in larger voltage drop on sense resistor Rs. The cycle stop when FB pin voltage is above 0.25V.

The current limit function acts as an inherent soft start by controlling the inrush current.

### PWM Dimming

To control the brightness of the LEDs, use a low frequency PWM waveform to turn G5117/G5119 on for duty 0%~100%. How bright the LEDs at 100% duty are determined by sense resistor Rs.

### Overvoltage Protection (OVP)

OVP is designed to prevent the damage of internal NMOS switch in case the increased impedance of the LED load (include the LED opened). Once the device detects over voltage at the output, the internal NMOS switch is kept off until the output voltage drops below 14V.

## Applications Information

### Inductor Selection

The PFM peak current control scheme of the G5115/G5117/G5119 is inherently stable. The inductor value does not affect the stability of the regulator. The selected inductor must have a saturation current that meets the maximum peak current of the converter. Another important inductor parameter is the DC resistance. The lower DC resistance has the higher the efficiency of the converter.

**Table 1. Recommended Inductors**

| PART | VALUE(μH) | MAX DCR (Ω) | VENDOR |
|---|---|---|---|
| LQH32CN100K11 | 10 | 0.39 | MURATA |
| 972AS-100M | 10 | 0.48 | TOKO |
| 960AW-100M | 10 | 0.18 | TOKO |

### Output Capacitor Selection

For better output voltage filtering, a low ESR output capacitor is recommended. Ceramic capacitors have a low ESR value, but depending on the application, tantalum capacitors can be used. The selection of the output capacitor value directly influences the output voltage ripple of the converter which also influences line regulation. The larger output voltage ripple, the larger line regulation, which means that the LED current changes if the input voltage changes. If a certain change in LED current gives a noticeable change in LED brightness, depends on the LED manufacturer and on the application. Applications requiring good line regulation ±1%/V (TYP) must use output capacitor values ±1μF.

**Table 2. Recommended Output Capacitors**

| PART | VALUE (μF) | VOLTAGE RATING (V) | VENDOR |
|---|---|---|---|
| TMK107BJ104MA | 0.1 | 25 | Tayo Yuden |
| TMK316BJ105KL | 1 | 25 | Tayo Yuden |
| TMK325BJ475MN | 4.7 | 25 | Tayo Yuden |

**Input Capacitor Selection**

For good input voltage filtering the capacitor value can be increased. Low ESR ceramic capacitors are recommended. A 4.7μF ceramic input capacitor is sufficient for most applications.

**Table 3. Recommended Input Capacitors**

| PART | VALUE (μF) | VOLTATE RATING (V) | VENDOR |
|---|---|---|---|
| LMK212BJ105MG | 1 | 10V | Tayo Yuden |
| JMK212BJ475MG | 4.7 | 6.3V | Tayo Yuden |
| JMK212BJ106MG | 10 | 6.3V | Tayo Yuden |

**Diode Selection**

To achieve high efficiency a Schottky diode must be used. The current rating of the diode must meet the peak current rating of the converter. Schottky diodes, with their low forward voltage drop and fast switching speed, are best match for the G5115/G5117/G5119.

**Table 4. Recommended Diodes**

| PART | REVERSE VOLTAGE (V) | VENDOR |
|---|---|---|
| MBR0520 | 20 | On Semiconductor |

**Setting The LED Current**

The Converter regulates the LED current by regulating the voltage across the current sense resistor ($R_S$). The voltage across the sense resistor is regulated to the internal reference voltage of $V_{(FB)}$=250mV. The LED Current can be calculated:

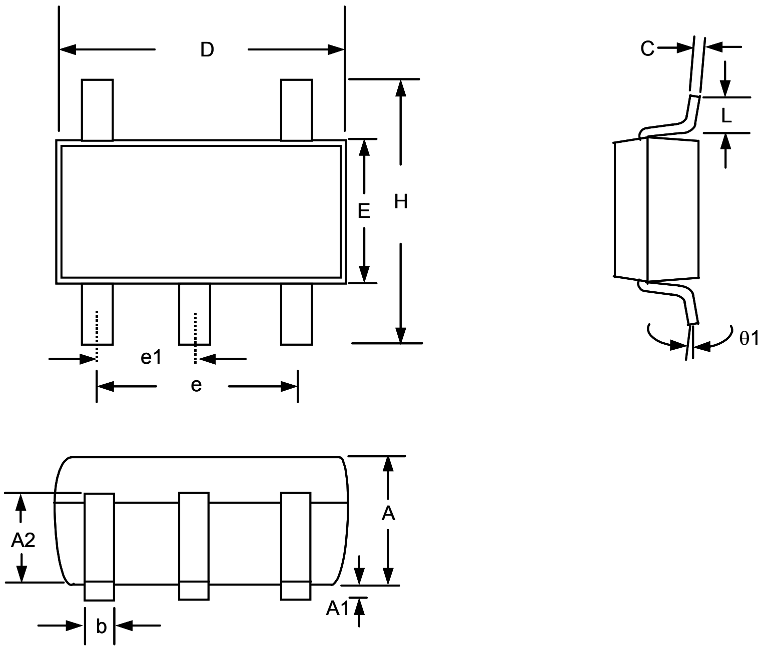
$$I_{LED} = \frac{V_{FB}}{R_S} = \frac{0.25V}{R_S}$$

The current programming method is used when the brightness of the LEDs is fixed or control by a PWM signal applied to the $\overline{\text{SHDN}}$ pin. When using a PWM signal on the $\overline{\text{SHDN}}$ pin, the LED brightness is only dependent on the PWM duty cycle, independent of the PWM frequency or amplitude, which simplifies the systems.

**Layout considerations**

In all switching power supplies the layout is an important step in the design, especially at high peak currents and switching frequencies. If the layout is not carefully done, the regulator might show noise problems and duty cycle jitter. The input capacitor should be placed as close as possible to the input pin for good input voltage filtering. The inductor and diode must be placed as close as possible to the switch pin to minimize noise coupling into other circuits. Since the feedback pin and network is a high impedance circuit, the feedback network should be routed away from the inductor.

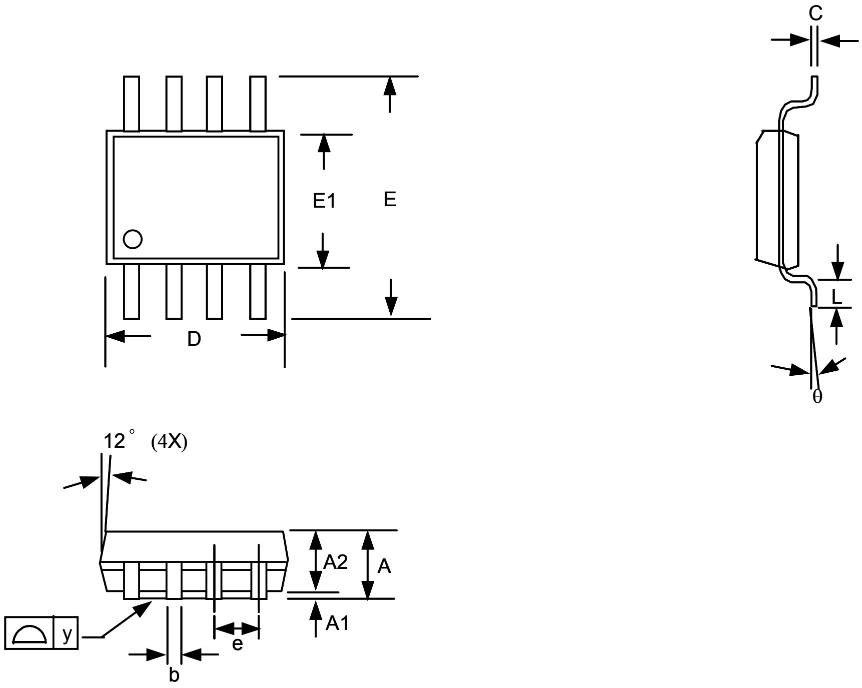
## Package Information




**SOT-23-5 Package**

**Note:**
1. Package body sizes exclude mold flash protrusions or gate burrs
2. Tolerance ±0.1000 mm (4mil) unless otherwise specified
3. Coplanarity: 0.1000mm
4. Dimension L is measured in gage plane

| SYMBOL | DIMENSIONS IN MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 1.00 | 1.10 | 1.30 |
| A1 | 0.00 | ----- | 0.10 |
| A2 | 0.70 | 0.80 | 0.90 |
| b | 0.35 | 0.40 | 0.50 |
| C | 0.10 | 0.15 | 0.25 |
| D | 2.70 | 2.90 | 3.10 |
| E | 1.40 | 1.60 | 1.80 |
| e | ----- | 1.90(TYP) | ----- |
| e1 | ----- | 0.95 | ----- |
| H | 2.60 | 2.80 | 3.00 |
| L | 0.37 | ------ | ----- |
| $\theta$1 | 1º | 5º | 9º |

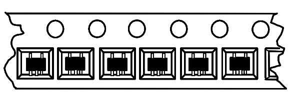



**MSOP-8 Package**

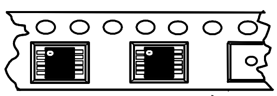
**Note:**
1. Package body sizes exclude mold flash and gate burrs
2. Dimension L is measured in gage plane
3. Tolerance 0.10mm unless otherwise specified
4. Controlling dimension is millimeter converted inch dimensions are not necessarily exact.
5. Followed from JEDEC MO-137

| SYMBOL | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.81 | 1.02 | 1.22 | 0.032 | 0.040 | 0.048 |
| A1 | 0.00 | ----- | 0.20 | 0.000 | ----- | 0.008 |
| A2 | 0.76 | 0.86 | 0.97 | 0.030 | 0.034 | 0.038 |
| b | 0.28 | 0.30 | 0.38 | 0.011 | 0.012 | 0.015 |
| C | 0.13 | 0.15 | 0.23 | 0.005 | 0.006 | 0.009 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 4.80 | 4.90 | 5.00 | 0.189 | 0.193 | 0.197 |
| E1 | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| e | ----- | 0.65 | ----- | ----- | 0.026 | ----- |
| L | 0.40 | 0.53 | 0.66 | 0.016 | 0.021 | 0.026 |
| y | ----- | ----- | 0.10 | ----- | ----- | 0.004 |
| $\theta$ | 0º | ----- | 6º | 0º | ----- | 6º |

## Taping Specification



Feed Direction
SOT-23-5 Package Orientation



Feed Direction
Typical MSOP Package Orientation

| PACKAGE | Q'TY/REEL |
|---|---|
| SOT-23-5 | 3,000 ea |
| MSOP-8 | 2,500 ea |