# 300mA Low-Dropout Linear Regulators

## Features

- 90µA Quiescent Current
- Guaranteed 300mA Output Current
- Dropout Voltage is 0.4V @ $I_O$ = 300mA
- Over-Temperature Protection and Short-Circuit Protection
- Stable With Low Cost Ceramic Capacitors
- Fixed Output Voltage :1.5V, 1.8V, 2.5V, 3.3V

## Applications

- Cordless Phones
- PDAs
- Hand-Held Devices
- Bar Code Scanners
- Electronic Scales

## General Description

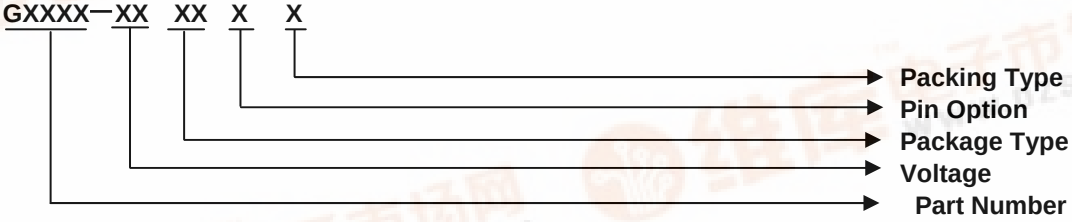
The G9131 is a low supply current, low dropout linear regulator that comes in a space saving SOT-23 package. The supply current at no-load is 90µA. An over temperature protection circuit is built-in in the G9131 to prevent thermal overload. These power saving features make the G9131 ideal for use in the battery-powered applications such as notebook computers, cellular phones, and PDA's.

## Ordering Information

| ORDER NUMBER | ORDER NUMBER (Pb free) | MARKING | VOLTAGE | TEMP. RANGE | PACKAGE |
|---|---|---|---|---|---|
| G9131-15T73U | G9131-15T73Uf | 35xx | 1.5V | -40°C to +85°C | SOT-23 |
| G9131-18T73U | G9131-18T73Uf | 38xx | 1.8V | -40°C to +85°C | SOT-23 |
| G9131-25T73U | G9131-25T73Uf | 32xx | 2.5V | -40°C to +85°C | SOT-23 |
| G9131-33T73U | G9131-33T73Uf | 31xx | 3.3V | -40°C to +85°C | SOT-23 |
| G9131-33T24U | G9131-33T24Uf | 31xx | 3.3V | -40°C to +85°C | SOT-89 |

* For other package types, pin options and package, please contact us at sales@gmt.com.tw

## Order Number Identification




**PACKAGE TYPE**

T2 : SOT-89
T7 : SOT-23

**PIN OPTION**

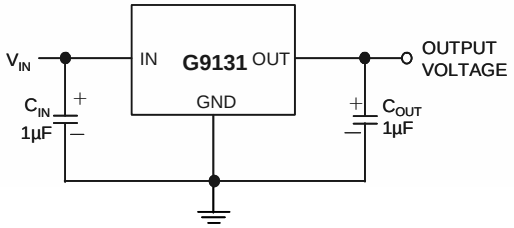
| | 1 | 2 | 3 |
|---|---|---|---|
| 1 : | $V_{OUT}$ | GND | $V_{IN}$ |
| 2 : | $V_{OUT}$ | $V_{IN}$ | GND |
| 3 : | GND | $V_{OUT}$ | $V_{IN}$ |
| 4 : | GND | $V_{IN}$ | $V_{OUT}$ |
| 5 : | $V_{IN}$ | GND | $V_{OUT}$ |
| 6 : | $V_{IN}$ | $V_{OUT}$ | GND |

**PACKING**

U: Tape & Reel Direction

## Package Type


## Typical Application



## Absolute Maximum Ratings (Note 1)

Input Voltage.....7V
Power Dissipation Internally Limited (Note2)
Maximum Junction Temperature.....150°C
Storage Temperature Range.....-65°C ≤ $T_J$ ≤+150°C
Reflow Temperature (soldering, 10sec) .....260°C
Thermal Resistance Junction to Ambient, ($\theta_{JA}$)
SOT-23(1) .....276°C/W
SOT-89(1) .....173°C/W
Thermal Resistance Junction to Case, ($\theta_{JC}$)
SOT-89..... .24°C/W

## Operating Conditions (Note 1)

Input Voltage..... .....3V ~ 6V
Temperature Range.....-40°C ≤ $T_A$ ≤85°C

Note (1): See Recommended Minimum Footprint.

## Electrical Characteristics

**$V_{IN}$ =5V, $I_O$ = 300mA, $C_{IN}$=1µF, $C_{OUT}$ =1µF. All specifications apply for $T_A$ = $T_J$ = 25°C. [Note 3]**

| PARAMETER | CONDITION | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Output Voltage | 5mA ≤ $I_O$ ≤ 300mA | $V_O$=3.3V | 3.234 | 3.3 | 3.366 | V |
| | | $V_O$=2.5V | 2.45 | 2.5 | 2.55 | |
| | | $V_O$=1.8V | 1.764 | 1.8 | 1.845 | |
| | | $V_O$=1.5V | 1.455 | 1.5 | 1.545 | |
| Line Regulation | 4V ≤ $V_{IN}$ ≤ 6V, $I_O$ = 10mA | | --- | 15 | --- | mV |
| Load Regulation | 10mA ≤ $I_O$ ≤ 300mA | | --- | 10 | --- | mV |
| Quiescent Current | $V_{IN}$ = 5V | | --- | 90 | 150 | µA |
| Ripple Rejection | $f_i$ = 120 Hz, $1V_{P-P}$, Io = 100mA | | --- | 45 | --- | dB |
| Dropout Voltage | $I_O$ = 300mA | $V_O$=3.3V | --- | 0.4 | --- | V |
| | | $V_O$=2.5V | --- | 0.5 | --- | |
| | | $V_O$=1.8V | --- | 0.8 | --- | |
| | | $V_O$=1.5V | --- | 0.9 | --- | |
| Short Circuit Current | | | --- | 0.65 | --- | A |
| Current Limit | | | --- | 0.8 | --- | A |
| Over Temperature | | | --- | 145 | --- | °C |
| Over Temperature Hysterics | | | --- | 25 | --- | °C |

**Note 1:** Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Conditions are conditions under which the device functions but the specifications might not be guaranteed. For guaranteed specifications and test conditions see the Electrical Characteristics.

**Note2:** The maximum power dissipation is a function of the maximum junction temperature, $T_{Jmax}$; total thermal resistance, $\theta_{JA}$, and ambient temperature $T_A$. The maximum allowable power dissipation at any ambient temperature is $T_{jmax}$-$T_A$ / $\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and IC will go into thermal shutdown. For the G9131 in SOT-23 package, $\theta_{JA}$ is 276°C/W and in the SOT-89 package is 173°C/W (See Recommended Minimum Footprint). The safe operation in SOT-89 & SOT-23 package, it can see "Typical Performance Characteristics" (Safe Operating Area).

**Note3:** Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

**Note4:** The type of output capacitor should be tantalum, aluminum or ceramic.

## Definitions

**Dropout Voltage**

The input/output Voltage differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100mV below its nominal value, dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

**Line Regulation**

The change in output voltage for a change in input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that average chip temperature is not significantly affected.

**Load Regulation**

The change in output voltage for a change in load current at constant chip temperature. The measurement is made under conditions of low dissipation or by using pulse techniques such that average chip temperature is not significantly affected.

**Maximum Power Dissipation**

The maximum total device dissipation for which the regulator will operate within specifications.

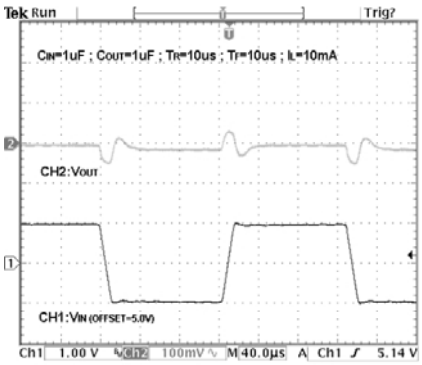
**Quiescent Bias Current**

Current which is used to operate the regulator chip and is not delivered to the load.

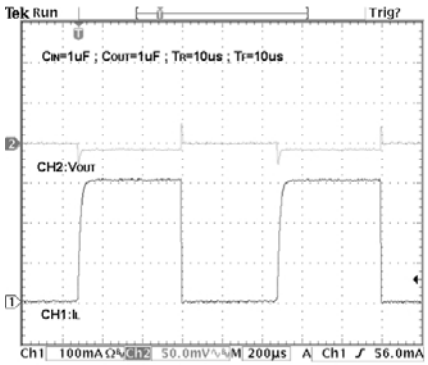
## Typical Performance Characteristics

**($V_{IN}$ = $V_O$ + 1V, $C_{IN}$ =1µF, $C_{OUT}$ =1µF, $T_A$ = 25°C, unless otherwise noted.)**

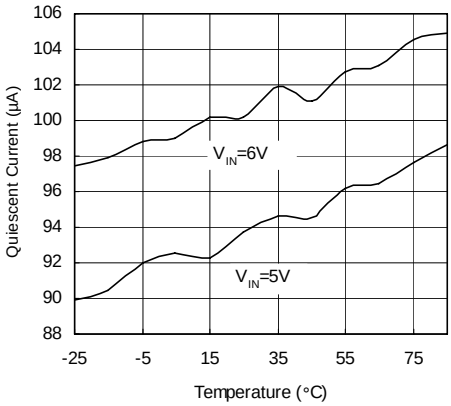
**Line Transient**



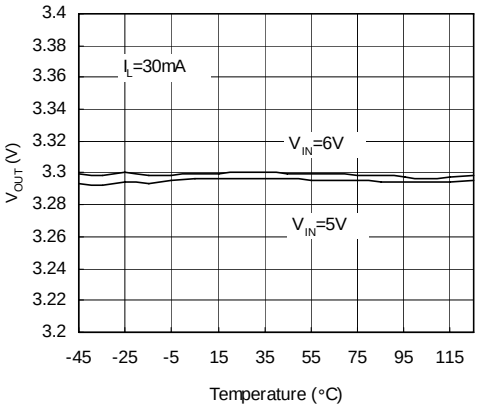

**Load Transient**



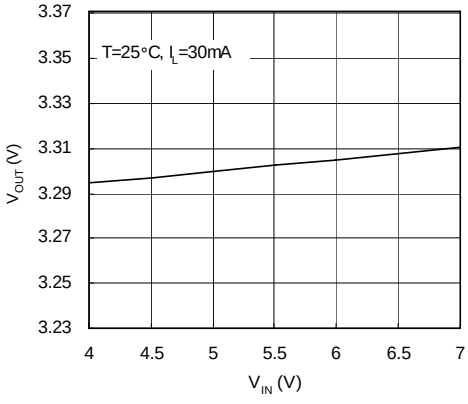

**Quiescent Current vs. Temperature**



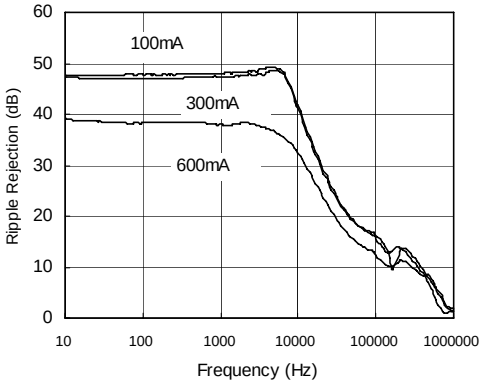

**Output Voltage vs. Temperature**




**$V_{IN}$ vs. $V_{OUT}$**



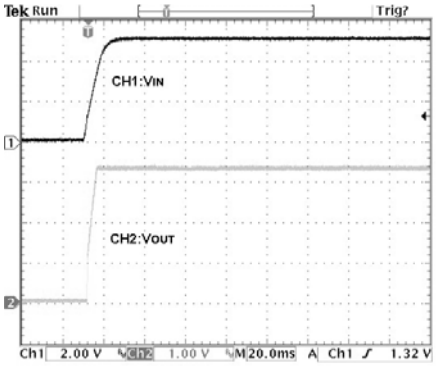

**Ripple Rejection vs. Frequency**



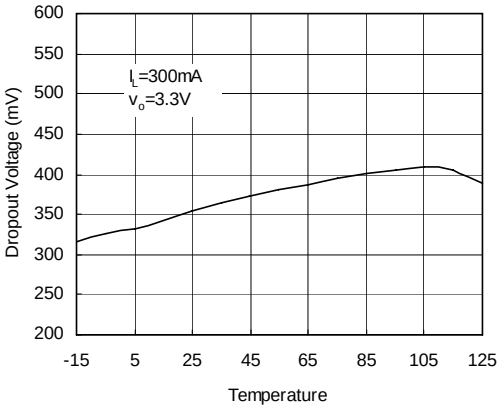
## Typical Performance Characteristics (continue)

**Output Noise**

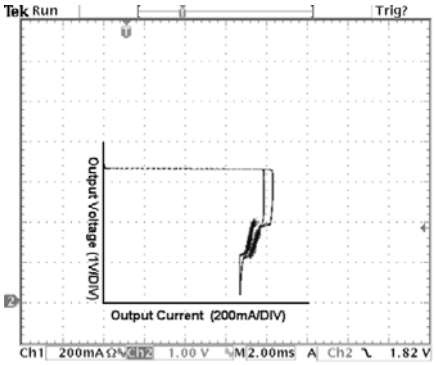

**Start-Up**



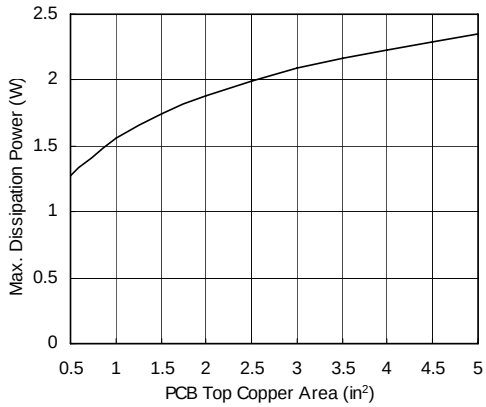

**Dropout Volatge vs. Temperature**



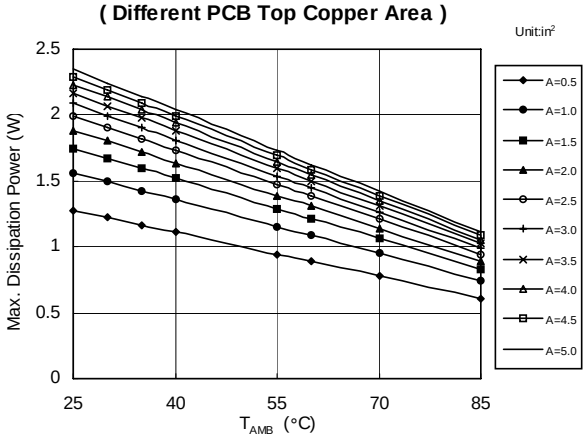

**Output Current vs. Output Voltage**




**SOT-89 Max. Power Dissipation vs. PCB Top Copper Area**
**$T_{AMB}$ = 25°C ; Still Air**

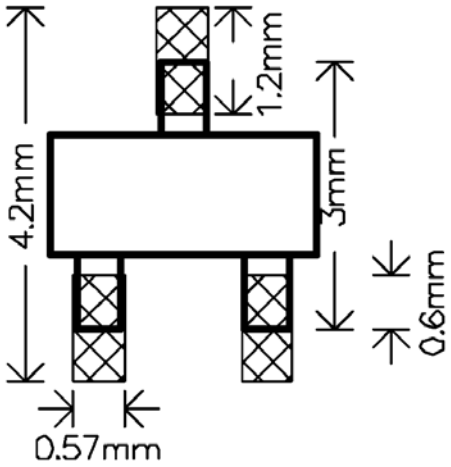



**SOT-89 Max. Power Dissipation vs. $T_{AMB}$ (still air)**
**( Different PCB Top Copper Area )**

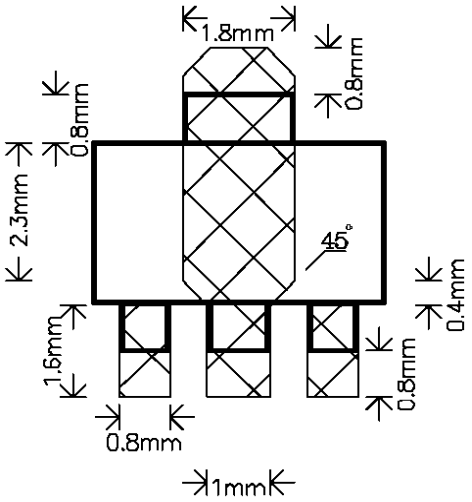


## Recommended Minimum Footprint

**SOT-23**




**SOT-89**



## Pin Description

| NAME | FUNCTION |
|---|---|
| IN | Regulator Input. Supply voltage can range from $V_{IN(min)}$ to +5.5V. Bypass with 1µF to GND. |
| GND | This is ground pin. |
| OUT | Regulator Output. Sources up to 300mA. Bypass with a 1µF, $<0.2\Omega$ typical ESR capacitor to GND. |

## Detailed Description

The block diagram of the G9131 is shown in Figure 1. It consists of an error amplifier, 1.25V bandgap reference, PMOS output transistor, internal feedback voltage divider, over current protection circuit, and over temperature protection circuit.

### Over Current Protection

The G9131 use a current sense-resistor to monitor the output current. A portion of the PMOS output transistor's current is mirrored to a resistor such that the voltage across this resistor is proportional to the output current. Once the output current exceeds limit threshold, G9131 would be protected with a limited output current. Further more, when the output is short to ground, the output current would be folded-back to a less limit.

### Over Temperature Protection

To prevent abnormal temperature from occurring, the G9131 has a built-in temperature monitoring circuit. When it detects the temperature is above 150°C, the output transistor is turned off. When the IC is cooled down to below 135°C, the output is turned on again. In this way, the G9131 will be protected against abnormal junction temperature during operation.

### Operating Region and Power Dissipation

Since the G9131 is a linear regulator, its power dissipation is always given by $P = I_{OUT} (V_{IN} - V_{OUT})$. The maximum power dissipation is given by: $P_{D(MAX)} = (T_J - T_A)/\theta_{JA}$, Where $(T_J - T_A)$ is the temperature difference the G9131 die and the ambient air. For surface mount device, heat sinking is accomplished by using the heat spreading capabilities of the PC board and its copper traces. $\theta_{JA}$ is the thermal resistance of the chosen package to the ambient air. In the case of a SOT-23 package, the thermal resistance is typically 275.5°C/W. In SOT 89 $R_{\theta JA}$ is 172.5°C/W.

## Applications Information

### Capacitor Selection and Regulator Stability

Normally, use a 1µF capacitor on the input and a 1µF capacitor on the output of the G9131. Larger input capacitor values and lower ESR provide better supply-noise rejection and transient response. For stable operation over the full temperature range, with load currents up to 120mA, a minimum of 1µF is recommended.

### Power-Supply Rejection and Operation from Sources Other than Batteries

The G9131 is designed to deliver low dropout voltages and low quiescent currents in battery powered systems. Power-supply rejection is 47dB at low frequencies the output capacitor is the major contributor to the rejection of power-supply noise.

When operating from sources other than batteries, improve supply-noise rejection and transient response by increasing the values of the input and output capacitors, and using passive filtering techniques.

### Load Transient Considerations

The G9131 load-transient response graphs show two components of the output response: a DC shift of the output voltage due to the different load currents, and the transient response. Typical overshoot for step changes in the load current from 0mA to 300mA is 10mV. Increasing the output capacitor's value and decreasing its ESR attenuates transient spikes.

### Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the G9131 use a P-channel MOSFET pass transistor, their dropout voltage is a function of $R_{DS(ON)}$ multiplied by the load current.

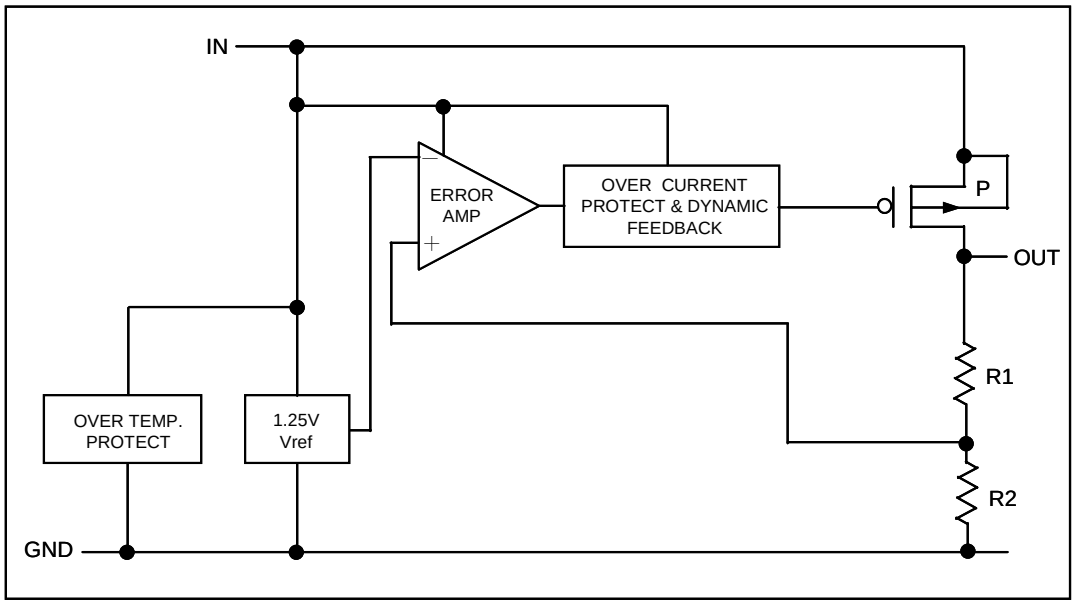
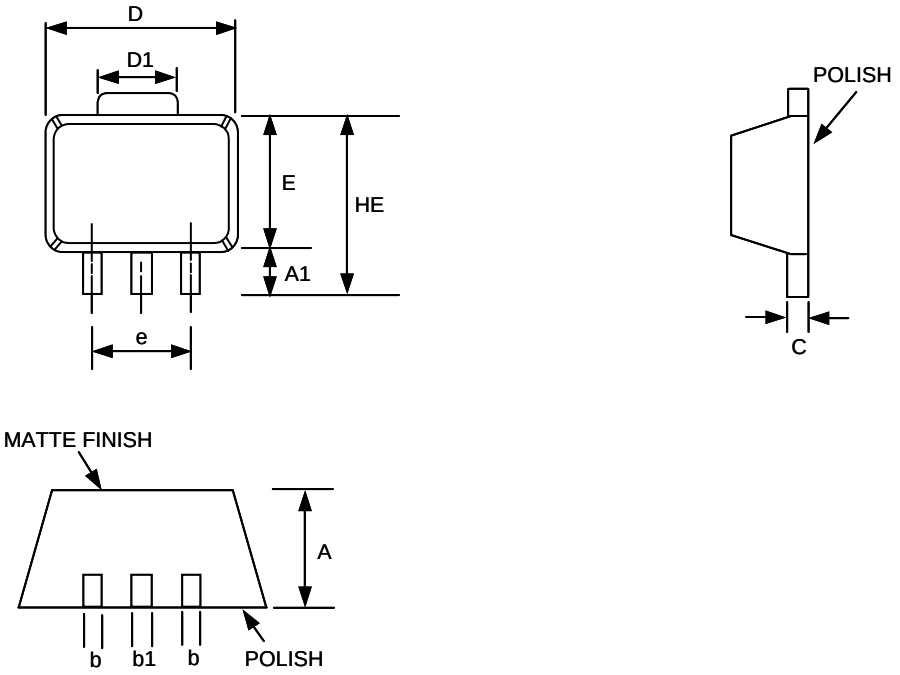


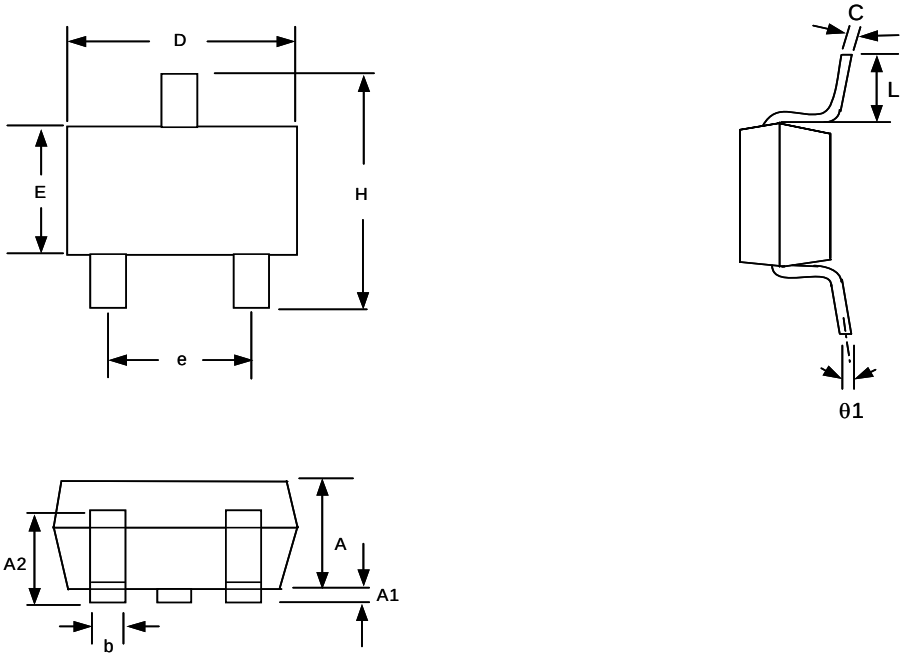

**Figure 1. Functional Diagram**

## Package Information




**SOT-89 (T2) Package**

| SYMBOL | DIMENSION IN MILLIMETER | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 |
| A1 | 0.80 | 1.04 | ----- | 0.031 | 0.041 | ----- |
| b | 0.36 | 0.42 | 0.48 | 0.014 | 0.016 | 0.018 |
| b1 | 0.41 | 0.47 | 0.53 | 0.016 | 0.018 | 0.020 |
| C | 038 | 0.40 | 0.43 | 0.014 | 0.015 | 0.017 |
| D | 4.40 | 4.50 | 4.60 | 0.173 | 0.177 | 0.181 |
| D1 | 1.40 | 1.60 | 1.75 | 0.055 | 0.062 | 0.069 |
| HE | ----- | ----- | 4.25 | ----- | ----- | 0.167 |
| E | 2.40 | 2.50 | 2.60 | 0.094 | 0.098 | 0.102 |
| e | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |



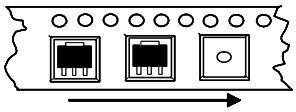

**SOT-23 (T7) Package**

**Note:**

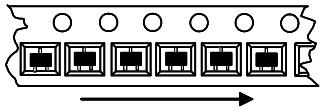
1.Package body sizes exclude mold flash protrusions or gate burrs
2.Tolerance ±0.1000 mm (4mil) unless otherwise specified
3.Coplanarity: 0.1000mm
4.Dimension L is measured in gage plane

| SYMBOL | DIMENSION 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) | ----- |
| H | 2.60 | 2.80 | 3.00 |
| L | 0.37 | ------ | ----- |
| $\theta$1 | 1° | 5° | 9° |

## Taping Specification



**Feed Direction**
**SOT-89 Package Orientation**



**Feed Direction**
**SOT-23 Package Orientation**

| PACKAGE | Q'TY/BY REEL |
|---|---|
| SOT-23 | 3,000 ea |
| SOT-89 | 1,000 ea |