

## Low Dropout Regulators

### Description

SL9350 Series are a high accuracy, low noise, high speed, low dropout CMOS Linear regulator with high ripple rejection and fast discharge function. The device offers a new level of cost effective performance in cellular phones, surveillance system, Bluetooth, wireless and other portable electronic devices.

SL9350 Series can provide product selections of output value in the range of 1.2V~3.6V by every 0.1V step.

The current limiter's fold-back circuit also operates as a short circuit protection and an output current limiter at the output pin.

The SL9350 Series are available in standard SOT-23, SOT-89, SOT-23-3, SOT23-5 and DFN1x1-4L packages. Standard products are Pb-free and Halogen-free.

### Features

- Maximum Output Current: 400mA(@ $V_{IN}-V_{OUT}=0.5V$ )
- Output Voltage Range: 1.2V~3.6V(customized by every 0.1V step)
- Low Quiescent Current: 50uA(Typ.)
- Low Dropout Voltage: 220mV@ $I_{OUT}=200mA$
- 0.01%/V Line Regulation
- 75dB PSRR @ 1KHz
- Standby Current: < 1μA
- VOUT fast discharge

### Applications

- Digital cameras
- Cellphones
- Bluetooth and wireless handsets
- Other portable electronic devices

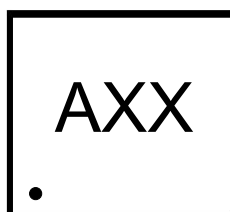
### Marking Code

#### 1.SOT



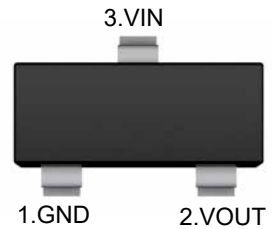
XX:Output Voltage  
e.g. 3.0:3.0V 3.3:3.3V

#### 2.DFN

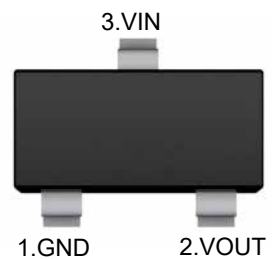


A: Product Code  
XX:Output Voltage  
e.g. 30:3.0V 33:3.3V

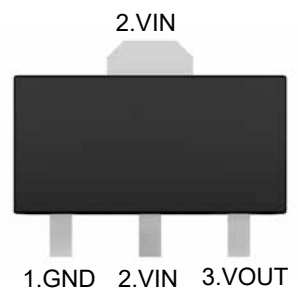
#### SOT-23



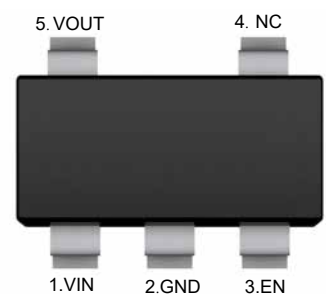
#### SOT-23-3



#### SOT-89

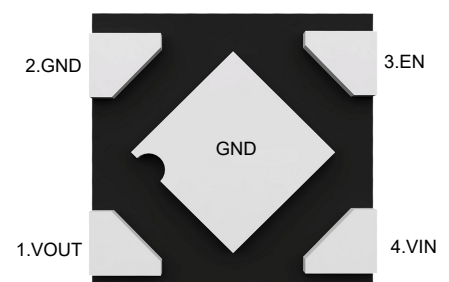


#### SOT-23-5



#### DFN1x1-4L

##### Bottom View



## Functional Pin Description

| Pin Name | Pin Function  |
|----------|---|
| VIN      | Power Input Voltage   |
| GND      | Ground  |
| EN       | Chip Enable (Active High). Note that this pin is high impedance |
| NC       | NO Connected  |
| VOUT     | Output Voltage  |

## Ordering Information

SL9350□□□□

Package Type

SA:SOT-23 SQ:SOT-89

SC:SOT-23-3 SE:SOT-23-5

DE:DFN1x1-4L

Output Voltage

12 : 1.2V 15 : 1.5V 18 : 1.8V

22 : 2.2V 25 : 2.5V 26 : 2.6V

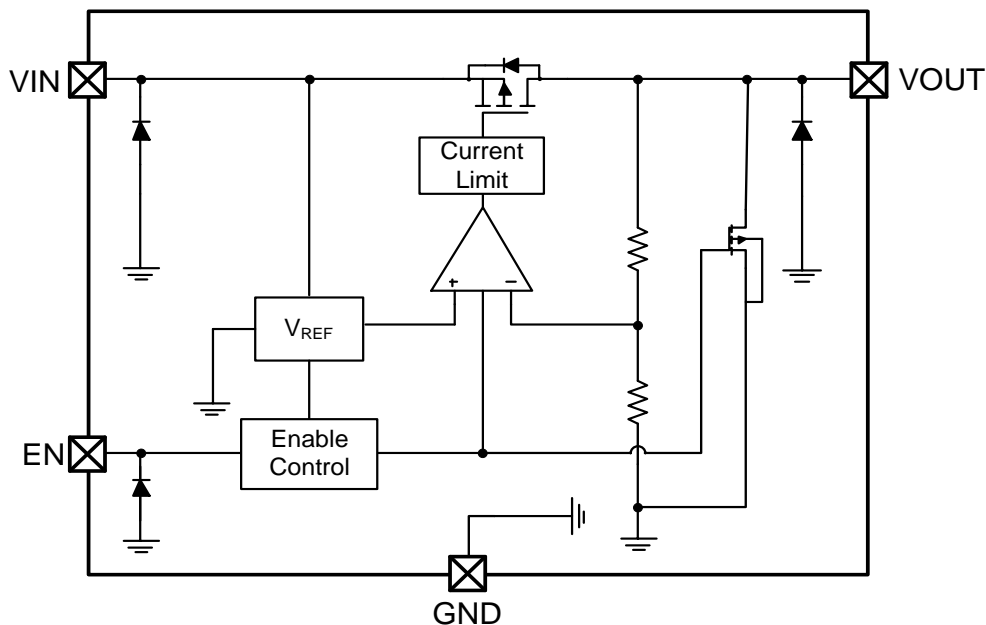
27 : 2.7V 28 : 2.8V 29 : 2.9V

30 : 3.0V 33 : 3.3V 36 : 3.6V

Output current tap

L : 300mA

## Function Block Diagram



## Absolute Maximum Ratings <sup>Note1</sup>

Ratings at 25°C ambient temperature unless otherwise specified.

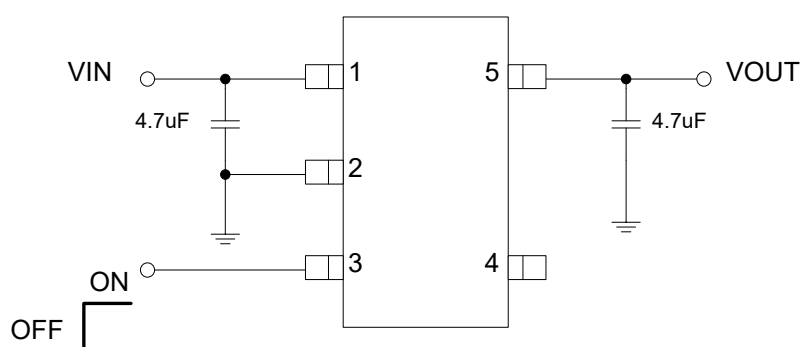
| Parameter                               |           | Value      | Unit |
|---|-----------|------------|------|
| Maximum Input Voltage                   |           | -0.3~8     | V    |
| Output Current                          |           | 400        | mA   |
| Power Dissipation                       | SOT-23    | 400        | mW   |
|   | SOT-89    | 600        | mW   |
|   | SOT-23-3  | 450        | mW   |
|   | SOT-23-5  | 450        | mW   |
|   | DFN1x1-4L | 550        | mW   |
| Thermal Resistance, Junction-to-Ambient | SOT-23    | 250        | °C/W |
|   | SOT-89    | 165        | °C/W |
|   | SOT-23-3  | 220        | °C/W |
|   | SOT-23-5  | 220        | °C/W |
|   | DFN1x1-4L | 180        | °C/W |
| Junction Temperature                    |           | -40 ~ +125 | °C   |
| Operating Ambient Temperature           |           | -40 ~ +85  | °C   |
| Storage Temperature Range               |           | -55~ +150  | °C   |
| Lead Temperature&Time                   |           | 260°C, 10S | --   |

Note1: Exceed these limits to damage to the device. Exposure to absolute maximum rating conditions may affect.

## Recommended Operating Conditions

| Parameter                     |  | Value     | Unit |
|-------------------------------|--|-----------|------|
| Supply Voltage                |  | 2.5~6.5   | V    |
| Maximum Output Current        |  | 300       | mA   |
| Operating Ambient Temperature |  | -40 ~ +85 | °C   |

## Typical Application Circuit



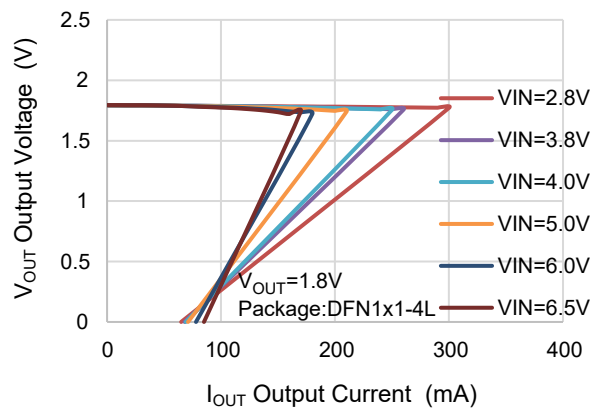
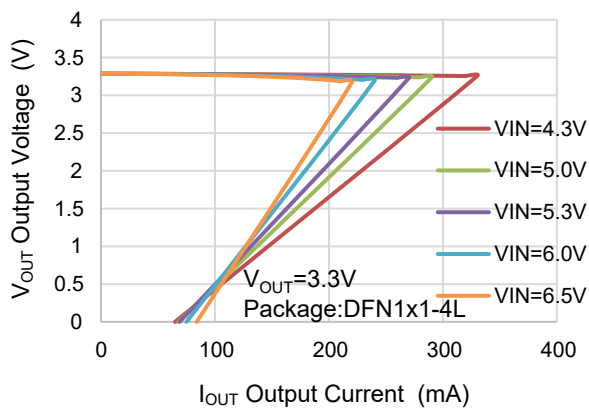
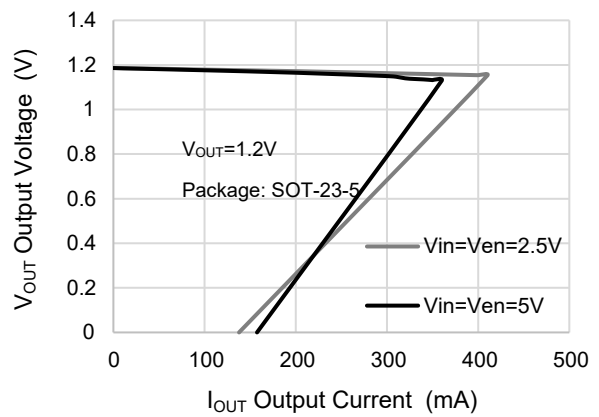
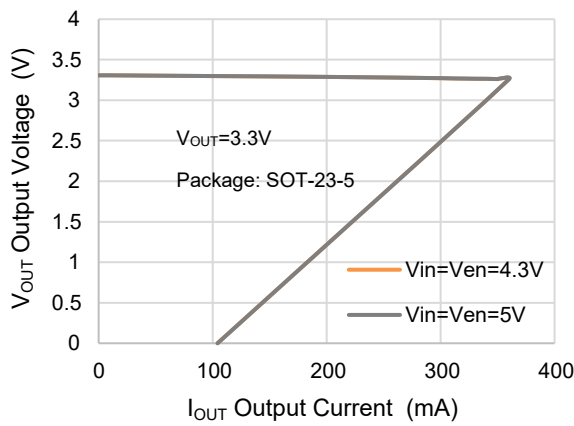
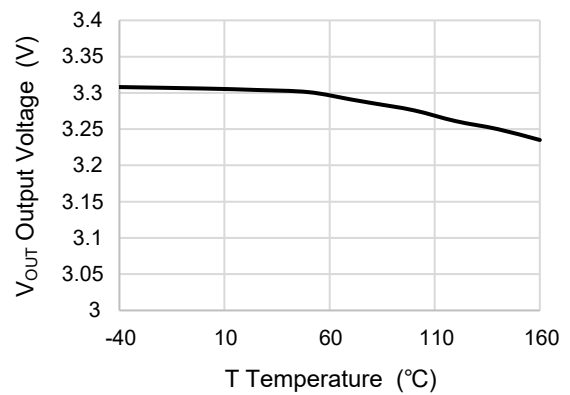
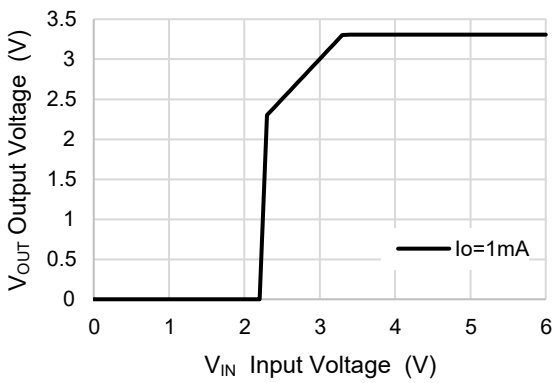
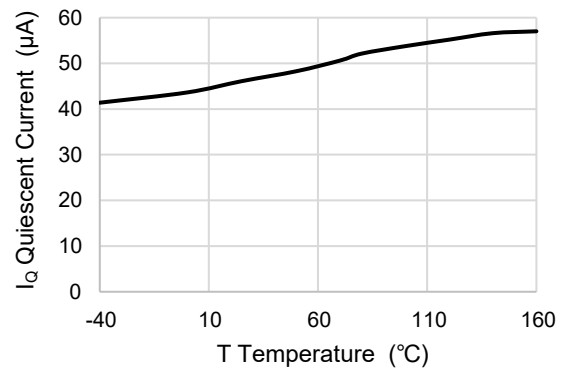
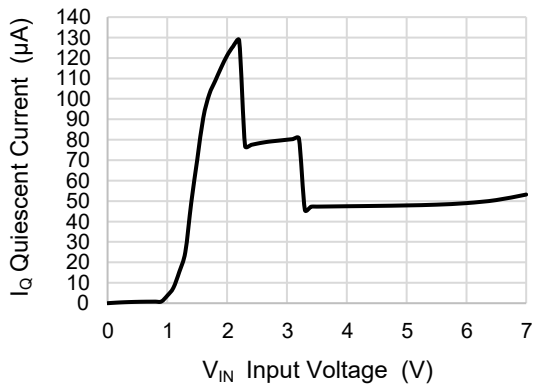
## Electrical Characteristics

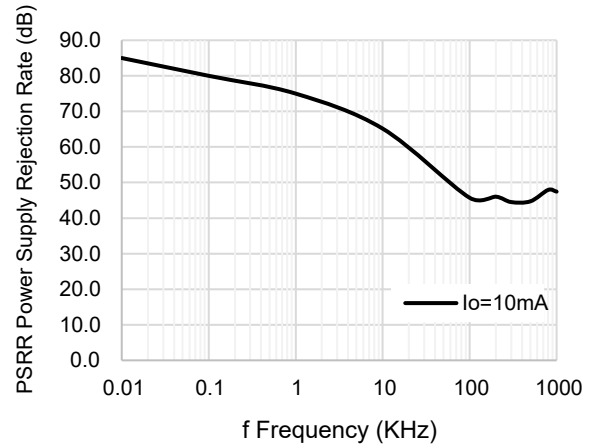
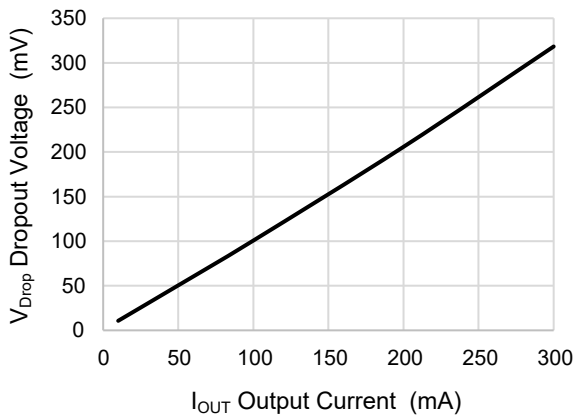
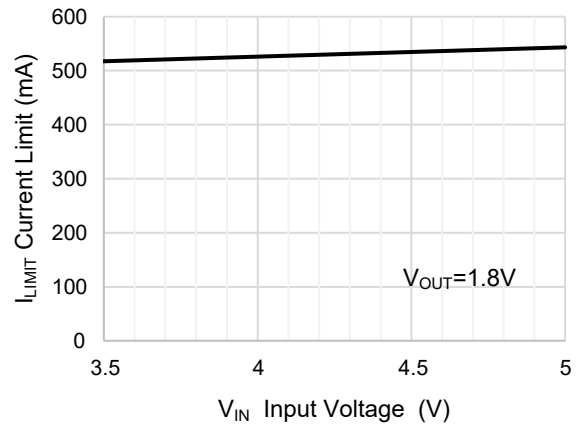
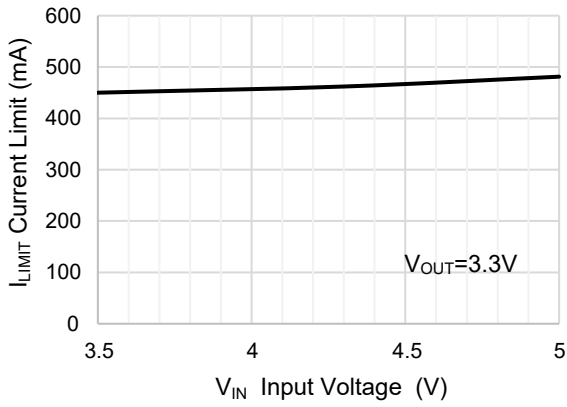
$V_{IN}=V_{OUT}+1V$ ,  $T_A=25^{\circ}C$ , unless otherwise noted.)

| Parameter                            | Symbol            | Test Conditions  | Min. | Typ. | Max.     | Unit          |
|--------------------------------------|-------------------|--|------|------|----------|---------------|
| Input Voltage                        | $V_{IN}$          |  | 2.5  | --   | 6.5      | V             |
| Output Voltage Accuracy              | $\Delta V_{OUT}$  | $V_{OUT} < 1.8V$ , $V_{IN}=2.7V$ ,<br>$I_{OUT}=1mA$      | -3   | --   | +3       | %             |
|                                      |                   | $V_{OUT} \geq 1.8V$ , $I_{OUT}=1mA$                      | -2   | --   | +2       | %             |
| Quiescent Current                    | $I_Q$             | $V_{IN}=5V$ , $I_{OUT}=0mA$                              | --   | 50   | --       | $\mu A$       |
| Dropout Voltage                      | $V_{DROP}$        | $V_{OUT} \geq 2.5V$ , $I_{OUT}=200mA$                    | --   | 220  | 250      | mV            |
|                                      |                   | $V_{OUT} \geq 2.5V$ , $I_{OUT}=300mA$                    | --   | 320  | 350      | mV            |
| Line Regulation                      | $\Delta V_{LINE}$ | $V_{IN}=2.7\sim 5.5V$ , $I_{OUT}=1mA$                    | --   | 0.01 | 0.15     | %/V           |
| Load Regulation                      | $\Delta V_{LOAD}$ | $V_{OUT} > 1.8V$ , $I_{OUT}=1\sim 300mA$                 | --   | 40   | 70       | mV            |
|                                      |                   | $V_{OUT} \leq 1.8V$ , $I_{OUT}=1\sim 200mA$              | --   | 40   | 70       | mV            |
| Short Circuit/Start Carrying Current | $I_{SHORT}$       | $V_{EN}=V_{IN}$ , $V_{OUT}$ Short to GND with $1\Omega$  | --   | 100  | --       | mA            |
| Current Limit                        | $I_{LIMIT}$       | $V_{IN}=V_{OUT}+1V$                                      | --   | 360  | --       | mA            |
| Standby Current                      | $I_{Standby}$     | $V_{EN}=0$   | --   | --   | 1        | $\mu A$       |
| Power Supply Rejection Rate          | PSRR              | $V_{IN}=5V_{DC}+0.5V_{P-P}$<br>$f=1KHz$ , $I_{OUT}=10mA$ | --   | 75   | --       | dB            |
|                                      |                   | $V_{IN}=5V_{DC}+0.5V_{P-P}$<br>$f=1MHz$ , $I_{OUT}=10mA$ | --   | 45   | --       | dB            |
| EN Logic High Voltage                | $V_{ENH}$         | $V_{IN}=5.5V$ , $I_{OUT}=1mA$                            | 1.2  | --   | $V_{IN}$ | V             |
| EN Logic Low Voltage                 | $V_{ENIL}$        | $V_{IN}=5.5V$ , $V_{OUT}=0V$                             | --   | --   | 0.4      | V             |
| EN Input Current                     | $I_{EN}$          | $V_{EN}=0\sim 5.5V$                                      | --   | --   | 1.0      | $\mu A$       |
| Output Noise Voltage                 | eN                | 10Hz to 100KHz, $C_{OUT}=1\mu F$                         | --   | 100  | --       | $\mu V_{RMS}$ |
| Output Discharge Resistance          | $R_{DIS}$         | $V_{IN}=5.0V$ , $V_{EN}=0V$                              | --   | 160  | --       | $\Omega$      |

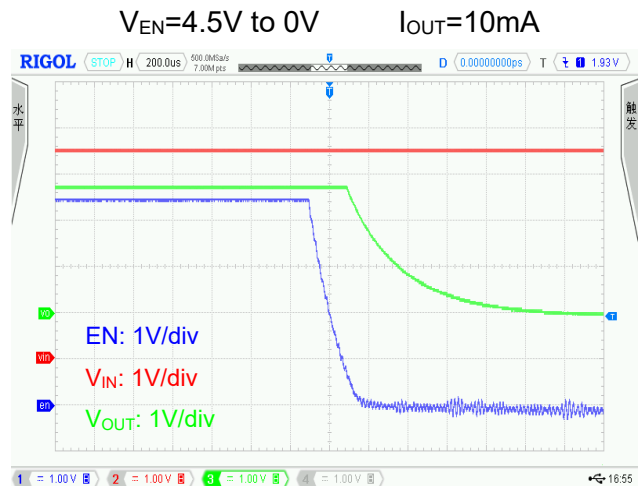
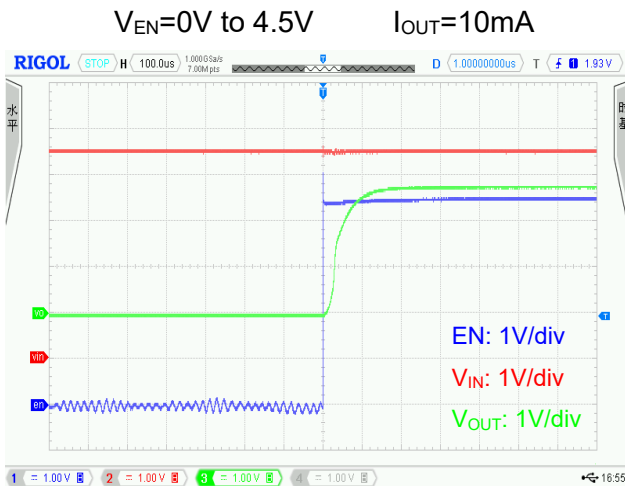
## Typical Electrical Curves

$C_{IN}=4.7\mu F$ ,  $C_{OUT}=4.7\mu F$ ,  $V_{IN}=4.3V$ ,  $V_{OUT}=3.3V$   $T_A=25^\circ C$ , Package is SOT-23-5(unless otherwise noted)



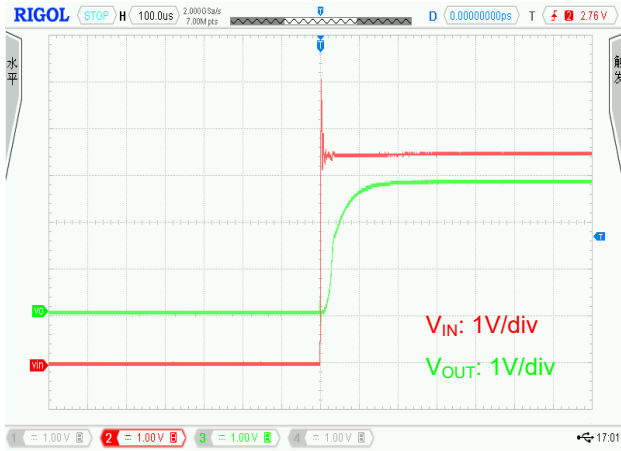


## EN ON / OFF



## Power ON / OFF

$V_{IN}=0V$  to  $4.5V$       $I_{OUT}=10mA$

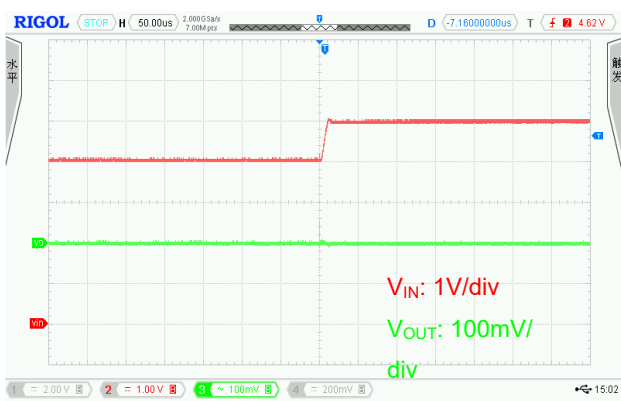


$V_{IN}=4.5V$  to  $0V$       $I_{OUT}=10mA$

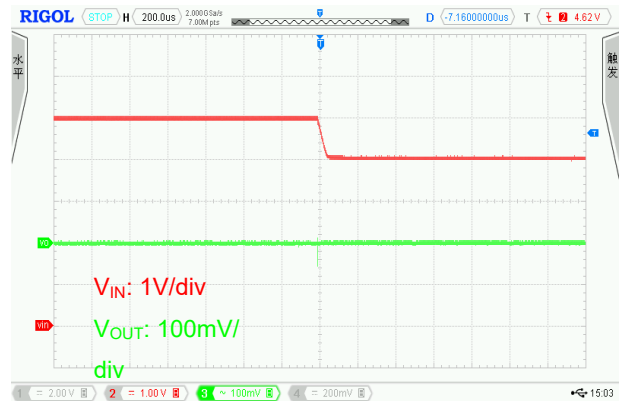


## Line Transient

$V_{IN}=4V$  to  $5V$       $I_{OUT}=10mA$



$V_{IN}=5V$  to  $4V$       $I_{OUT}=10mA$



## Load Transient

CH1:  $I_{OUT}$  CH2:  $V_{IN}$  CH3:  $V_{OUT}$

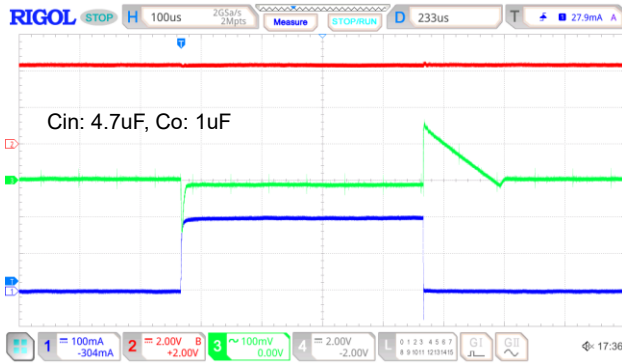
$V_{IN}=4.3V$ ,  $V_{OUT}=3.3V$       $I_{OUT}=1mA$  to



$V_{IN}=4.3V$ ,  $V_{OUT}=3.3V$       $I_{OUT}=1mA$  to  $100mA$



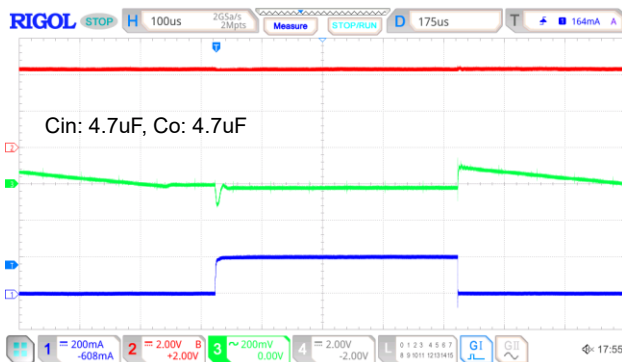
$V_{IN}=4.3V, V_{OUT}=3.3V$   $I_{OUT}=1mA$  to  $200mA$



$V_{IN}=4.3V, V_{OUT}=3.3V$   $I_{OUT}=1mA$  to  $300mA$



$V_{IN}=4.3V, V_{OUT}=3.3V$   $I_{OUT}=1mA$  to  $200mA$



$V_{IN}=4.3V, V_{OUT}=3.3V$   $I_{OUT}=1mA$  to  $300mA$



$V_{IN}=2.8V, V_{OUT}=1.2V$   $I_{OUT}=1mA$  to  $300mA$



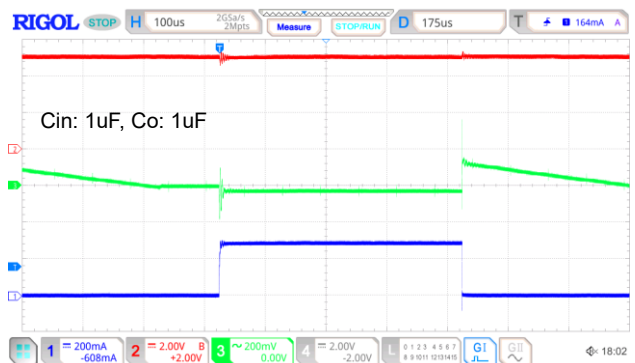
$V_{IN}=3.3V, V_{OUT}=1.2V$   $I_{OUT}=1mA$  to  $300mA$



$V_{IN}=4V, V_{OUT}=1.2V$   $I_{OUT}=1mA$  to  $300mA$



$V_{IN}=5V, V_{OUT}=1.2V$   $I_{OUT}=1mA$  to  $300mA$





## Function Descriptions

A minimum of 1 $\mu$ F capacitor must be connected from Vout to ground to insure stability. Input capacitor of 1 $\mu$ F is recommended to ensure the input voltage does not sag below the minimum dropout voltage during load transient event. Vin pin must always be dropout voltage higher than Vout in order for the device to regulate properly.

## Application Information

SL9350 Series requires input and output decoupling capacitors. The device is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance. Please note that linear regulators with a low dropout voltage have high internal loop gains, which require care in guarding against oscillation caused by insufficient decoupling capacitors.

## Capacitor Selection

Normally, use a 1 $\mu$ F capacitor on the input and a 1 $\mu$ F capacitor on the output of the SL9350 Series. Larger input capacitor values and lower ESR (X5R, X7R) provide better supply noise rejection and transient response. A higher value output capacitor (4.7 $\mu$ F) may be necessary if large, fast transients are anticipated and the device is located several inches from the power source.

## Input-Output (Dropout) Voltage

A regulator's minimum input-to-output voltage differential (dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. Because the device uses a PMOS, its dropout voltage is a function of drain to source on resistance, RDS (on), multiplied by the load current:

$$VDROP = VIN - VOUT = RDS (on) \times IOUT$$

## Current Limit and Thermal Shutdown Protection

In order to prevent overloading or thermal condition from damaging the device, SL9350 Series has internal thermal and current limiting functions designed to protect the device. It will rapidly shut off PMOS pass element during overloading or over temperature condition.

## Thermal Considerations

The SL9350 Series can deliver a current of up to 300mA over the full operating junction temperature range. However, the maximum output current must be controlled at higher ambient temperature to ensure the junction temperature does not exceed 150°C. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

$$PD = (VIN - VOUT) \times IOUT$$

The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

$$PD (max) = (Tj (max) - Ta) / R\theta JA$$

Where Tj (max) is the maximum junction temperature of the die (150°C) and Ta is the maximum ambient temperature.

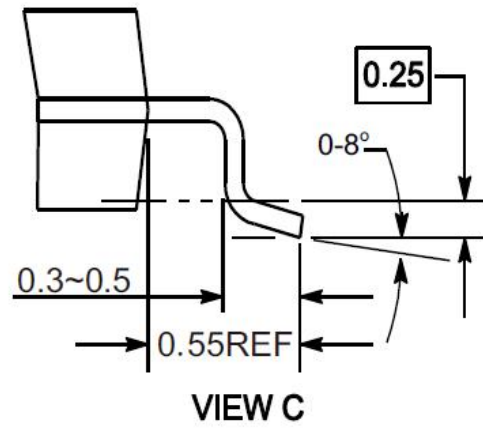
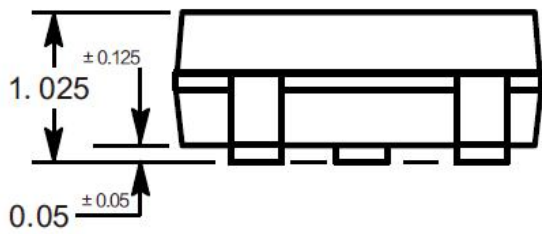
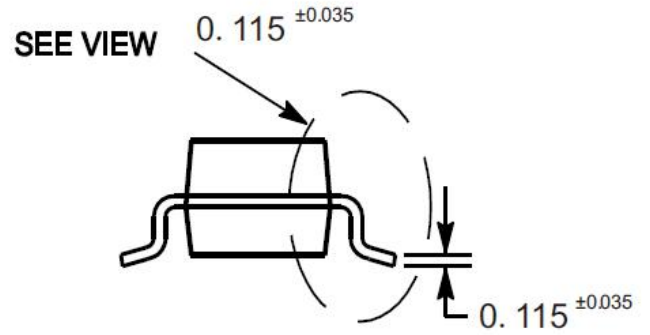
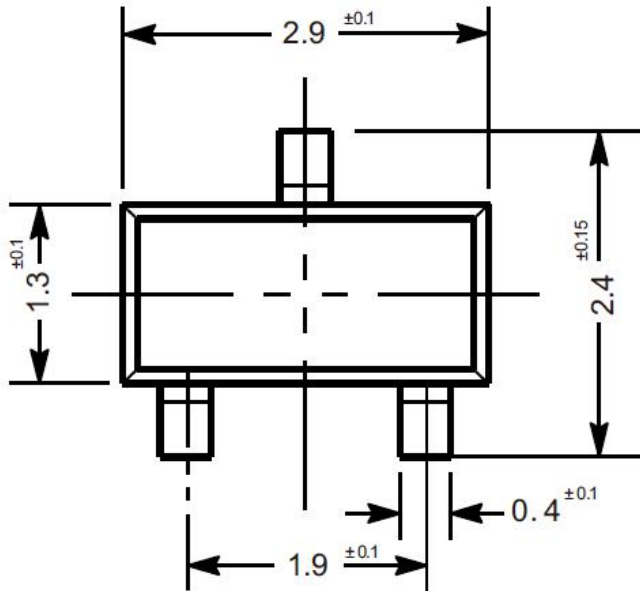
## PCB Layout

An input capacitance of  $\approx$ 4.7 $\mu$ F is required between the SL9350 Series input pin and ground (the amount of the capacitance may be increased without limit), this capacitor must be located a distance of not more than 1cm from the input and return to a clean analog ground. Input capacitor can filter out the input voltage spikes caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire. Otherwise, the actual voltage at the Vin pin may exceed the absolute maximum rating. The output capacitor also must be located a distance of not more than 1cm from output to a clean analog ground. Because it can filter out the output spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire.

## Package Outline

SOT-23

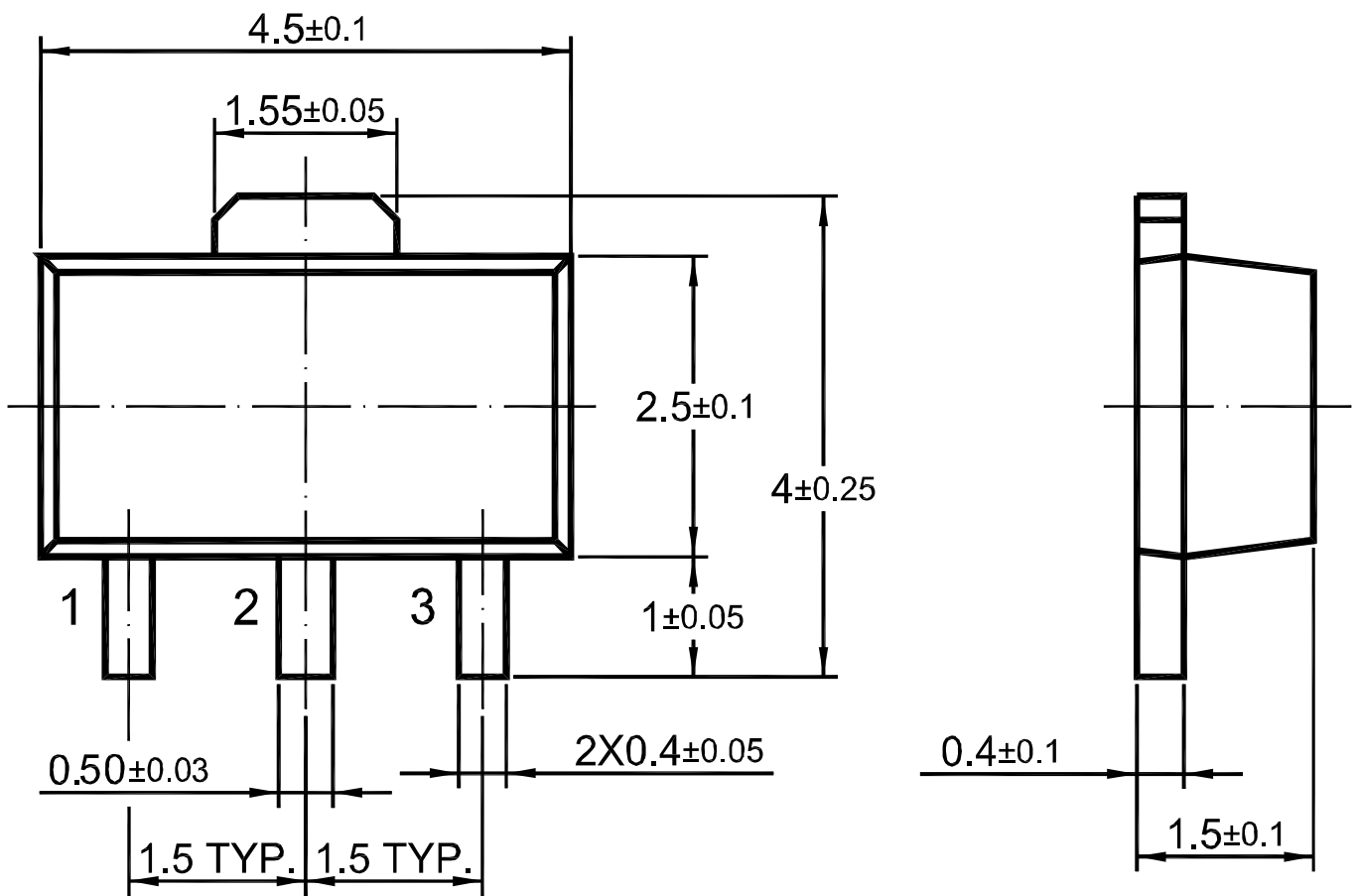
Dimensions in mm



## Package Outline

SOT-89

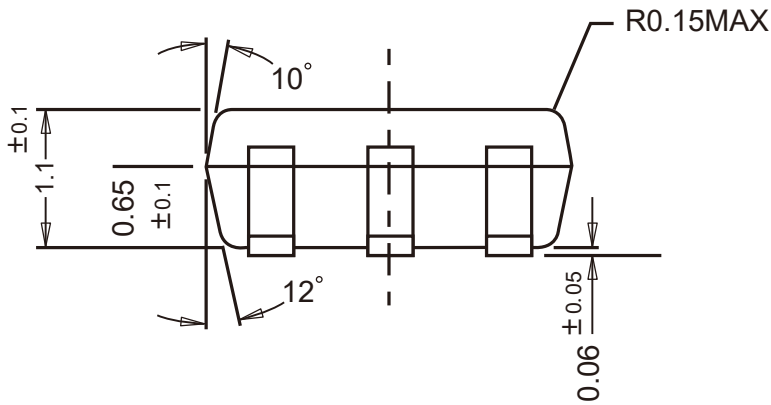
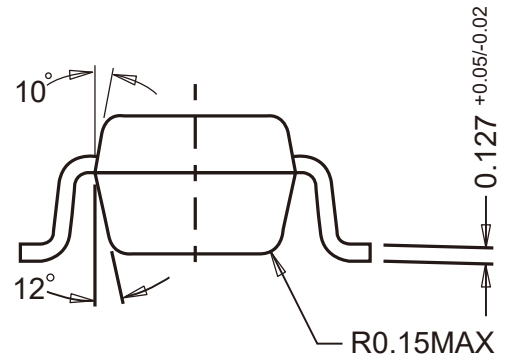
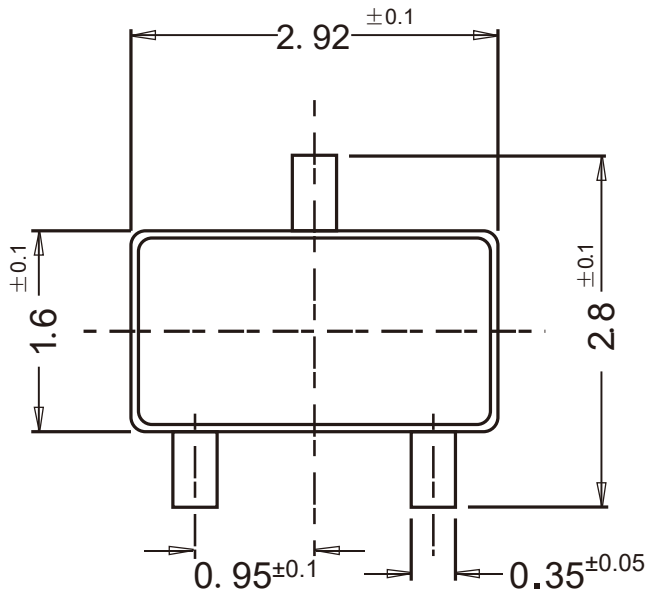
Dimensions in mm



## Package Outline

SOT-23-3

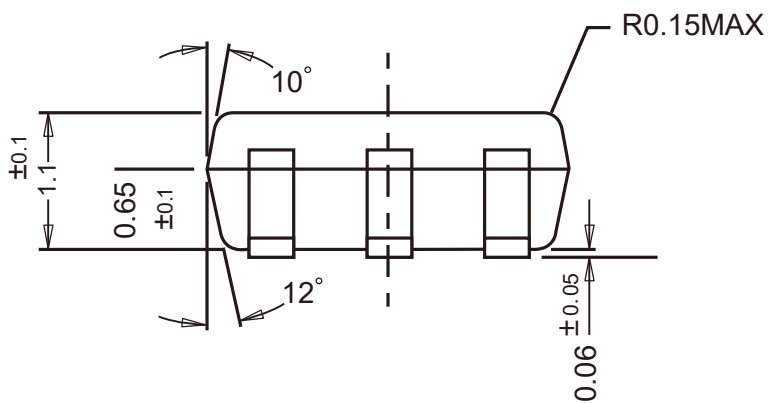
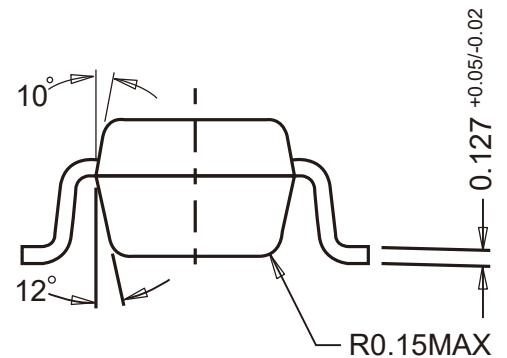
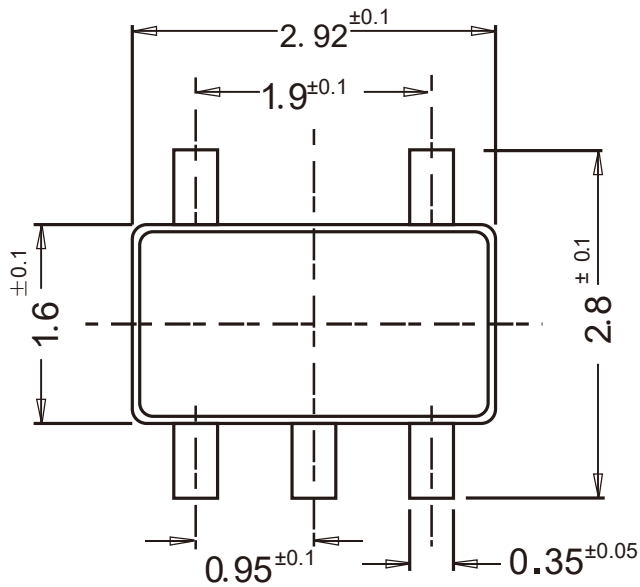
Dimensions in mm



## Package Outline

SOT-23-5

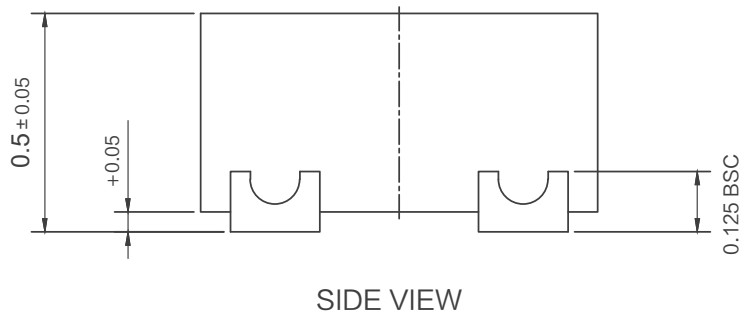
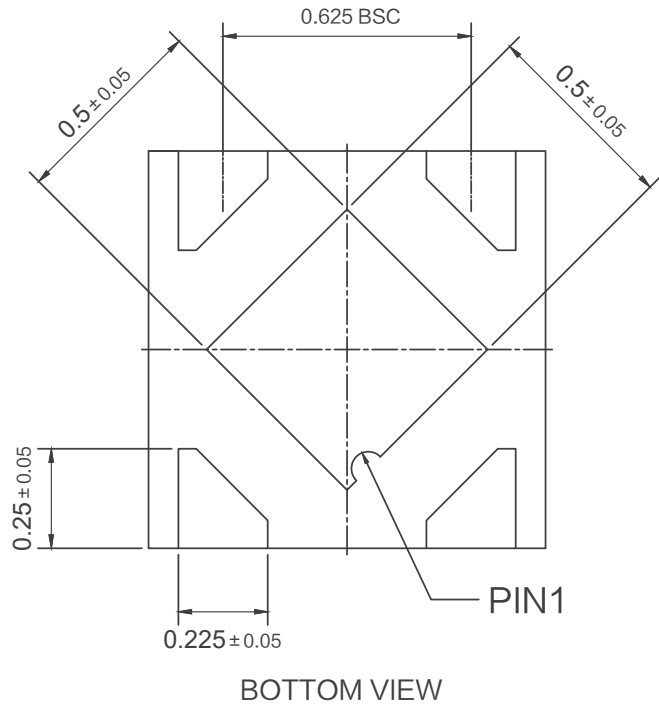
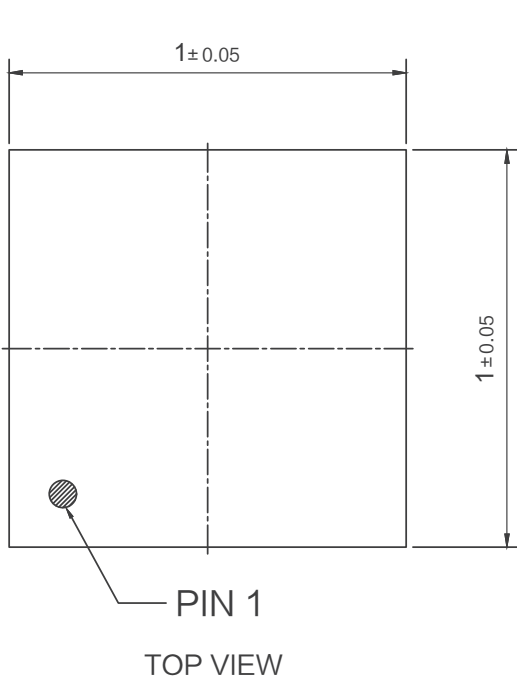
Dimensions in mm



## Package Outline

DFN1x1-4L

Dimensions in mm



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