Description

TN9350 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.

TN9350 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.

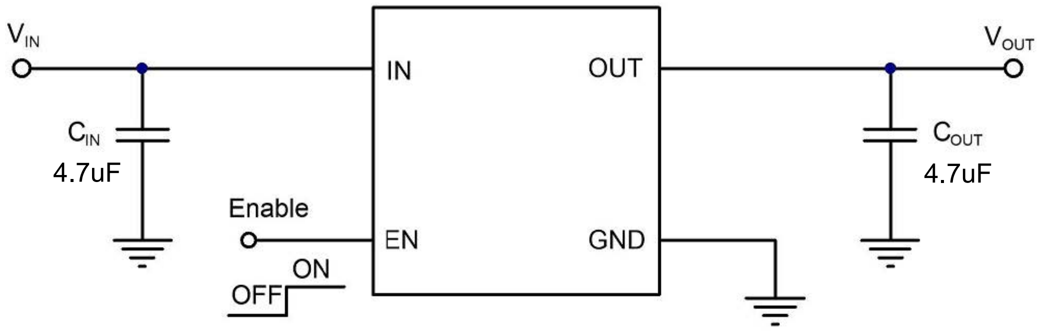
Features

- Wide Input Voltage Range: 2.5V to 6.5V
- Maximum Output Current: 400mA(@V_{IN}-V_{OUT}=0.5V)
- Standard Fixed Output Voltage Options: 1.2V~3.6V(customized by every 0.1V step)
- Low Quiescent Current: 50uA(Typ.)
- PSRR=75dB@1KHz
- Low Dropout Voltage: 220mV@I_{OUT}=200mA
- Low Output Voltage Accuracy: ±2%
- VOUT fast discharge
- Fold-back circuit current limit
- Available Packages: SOT-23, SOT-23-3, SOT-89, SOT-23-5 and DFN1x1-4L

Applications

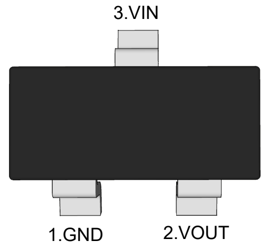
- Digital cameras
- Cellphones
- Bluetooth and wireless handsets
- Other portable electronic devices

Typical Application Circuit



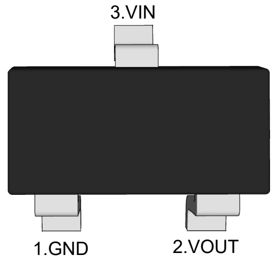
Pin Distribution

SOT-23



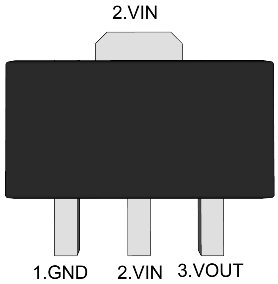
(Top View)

SOT-23-3



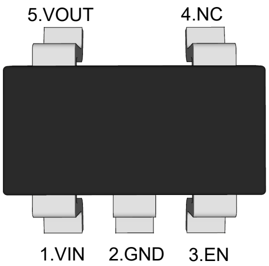
(Top View)

SOT-89



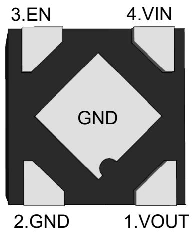
(Top View)

SOT-23-5



(Top View)

DFN1x1-4L



(Bottom View)

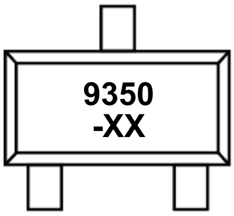
Functional Pin Description

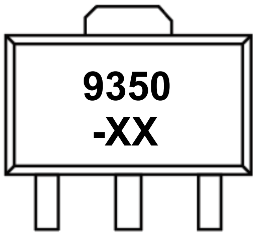
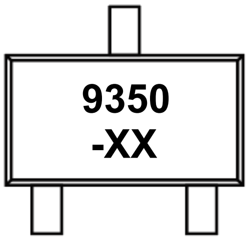
Pin Name	Pin Function
VIN	Power Input Voltage
GND	Ground
EN	Chip Enable (Active High). Note that this pin is high impedance
NC	NO Connected
VOUT	Output Voltage

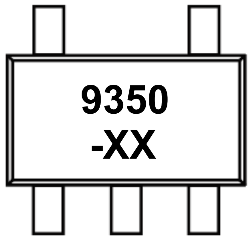
Ordering Information

TN9350□ □□□

- 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

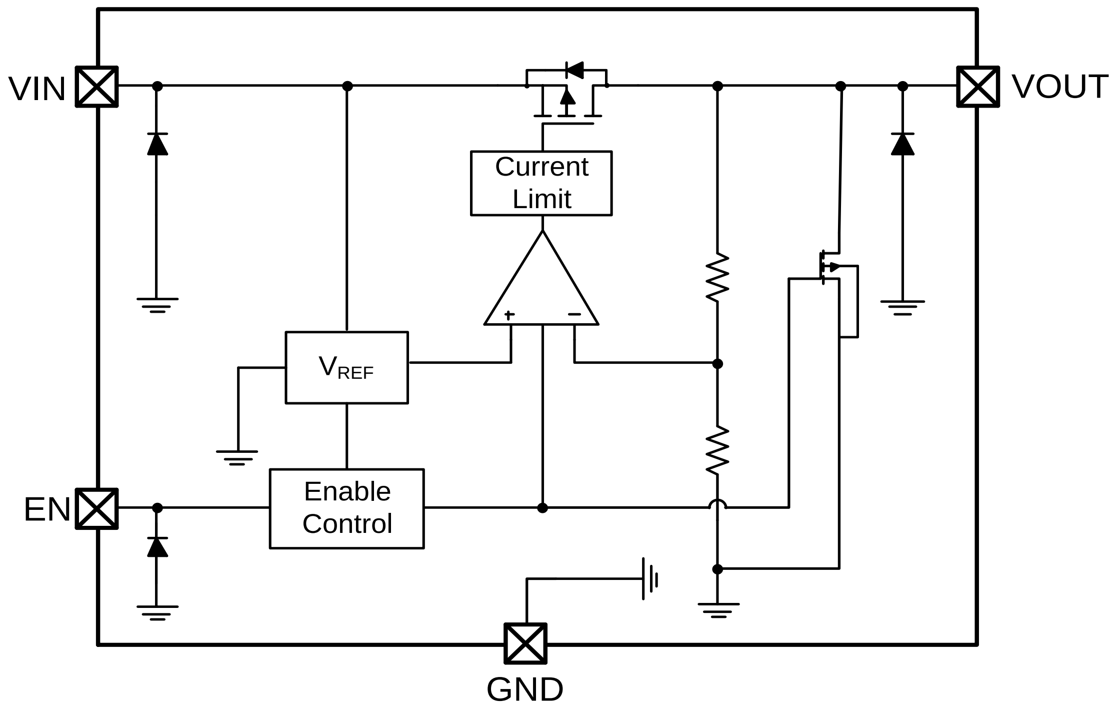
Orderable Device	Package	Reel (inch)	Package Qty (PCS)	Eco Plan [Note]	MSL Level	Marking Code
TN9350L12SA	SOT-23	7	3000	RoHS & Green	MSL1	 XX:Output Voltage e.g. 1.8:1.8V
TN9350L15SA						
TN9350L18SA						
TN9350L22SA						
TN9350L25SA						
TN9350L26SA						
TN9350L27SA						
TN9350L28SA						
TN9350L29SA						
TN9350L30SA						
TN9350L33SA						
TN9350L36SA						

TN9350L12SQ	SOT-89	7/13	1000/3000	RoHS & Green	MSL1	 XX:Output Voltage e.g. 1.8:1.8V
TN9350L15SQ						
TN9350L18SQ						
TN9350L22SQ						
TN9350L25SQ						
TN9350L26SQ						
TN9350L27SQ						
TN9350L28SQ						
TN9350L29SQ						
TN9350L30SQ						
TN9350L33SQ						
TN9350L36SQ						
TN9350L12SC	SOT-23-3	7	3000	RoHS & Green	MSL3	 XX:Output Voltage e.g. 1.8:1.8V
TN9350L15SC						
TN9350L18SC						
TN9350L22SC						
TN9350L25SC						
TN9350L26SC						
TN9350L27SC						
TN9350L28SC						
TN9350L29SC						
TN9350L30SC						
TN9350L33SC						
TN9350L36SC						

TN9350L12SE	SOT-23-5	7	3000	RoHS & Green	MSL3	 XX:Output Voltage e.g. 1.8:1.8V
TN9350L15SE						
TN9350L18SE						
TN9350L22SE						
TN9350L25SE						
TN9350L26SE						
TN9350L27SE						
TN9350L28SE						
TN9350L29SE						
TN9350L30SE						
TN9350L33SE						
TN9350L36SE						
TN9350L12DE	DFN1x1-4L	7	10000	RoHS & Green	MSL1	 XX:Output Voltage e.g. 18:18V
TN9350L15DE						
TN9350L18DE						
TN9350L22DE						
TN9350L25DE						
TN9350L26DE						
TN9350L27DE						
TN9350L28DE						
TN9350L29DE						
TN9350L30DE						
TN9350L33DE						
TN9350L36DE						

Note:
RoHS: TN defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials.
Green: TN defines "Green" to mean Halogen-Free and Antimony-Free.

Function Block Diagram



Absolute Maximum Ratings Note1

Ratings at 25℃ 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	--
ESD Voltage	HBM	2	KV

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

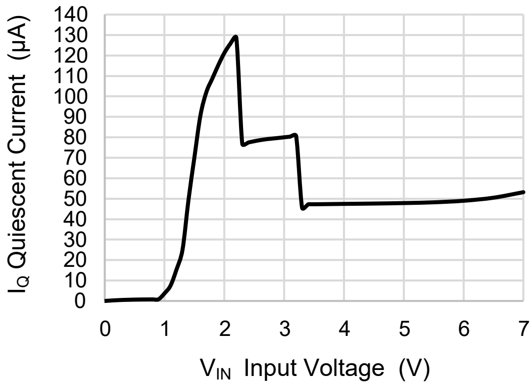
Electrical Characteristics

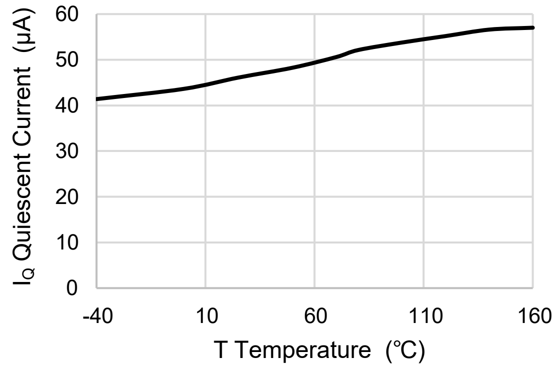
V_{IN}=V_{OUT}+1V, T_A=25℃ , unless otherwise noted.)

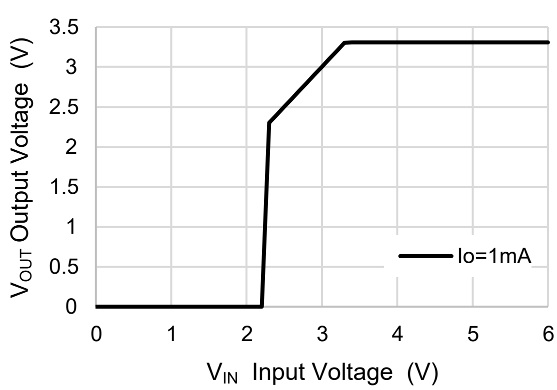
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}		2.5	--	6.5	V
Output Voltage Accuracy	ΔV_{OUT}	V_{OUT} <1.8V V_{IN}=2.7V, I_{OUT}=1mA	-3	--	+3	%
		V_{OUT} ≥1.8V, I_{OUT}=1mA	-2	--	+2	%
Quiescent Current	I_Q	V_{IN}=5V, I_{OUT}=0mA	--	50	--	μA
Dropout Voltage	V_{DROP}	V_{OUT}≥2.5V, I_{OUT}=200mA	--	220	250	mV
		V_{OUT}≥2.5V, I_{OUT}=300mA	--	320	350	mV
Line Regulation	ΔV_{LINE}	V_{IN}=2.7~5.5V, I_{OUT}=1mA	--	0.01	0.15	%/V
Load Regulation	ΔV_{LOAD}	V_{OUT}>1.8V, I_{OUT}=1~300mA V_{OUT}≤1.8V, I_{OUT}=1~200mA	--	40	70	mV
Short Circuit/Start Carrying Current	I_{SHORT}	V_{EN}=V_{IN}, VOUT Short to GND with 1Ω	--	100	--	mA
Current Limit	I_{LIMIT}	V_{IN}=V_{OUT}+1V	--	360	--	mA
Standby Current	$I_{Standby}$	V_{EN}=0	--	--	1	μA
Power Supply Rejection Rate	PSRR	V_{IN}=5V_{DC}+0.5V_{P-P} f=1KHz, I_{OUT}=10mA	--	75	--	dB
		V_{IN}=5V_{DC}+0.5V_{P-P} 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}= 0~5.5V	--	--	1.0	μA
Output Noise Voltage	eN	10Hz to 100KHz, C_{OUT}=1μF	--	100	--	μV_{RMS}
Output Discharge Resistance	R_{DIS}	V_{IN}=5.0V, V_{EN}= 0V	--	160	--	Ω

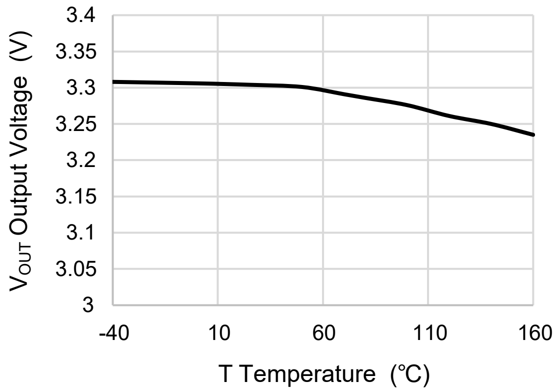
Typical Electrical Curves

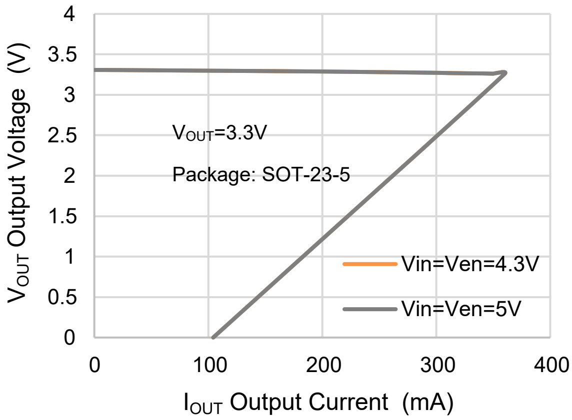
C_{IN}=4.7uF, C_{OUT}=4.7uF, V_{IN}=4.3V, V_{OUT}=3.3V T_A=25°C, Package is SOT-23-5(unless otherwise noted)

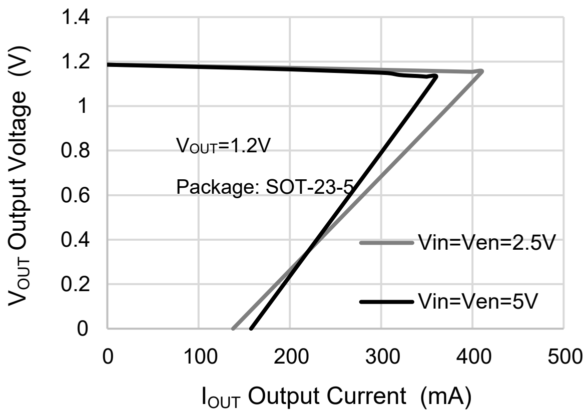


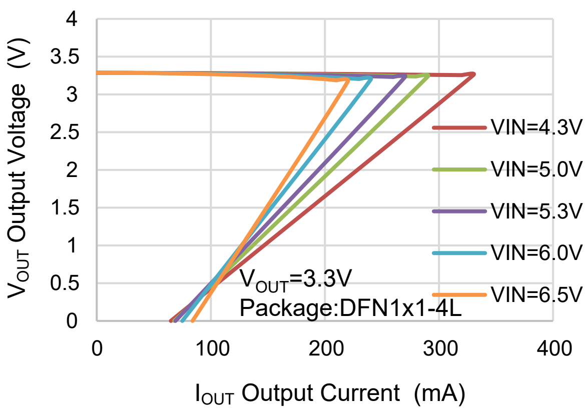


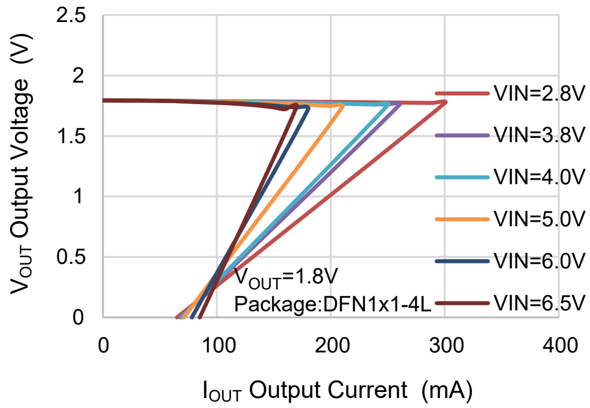


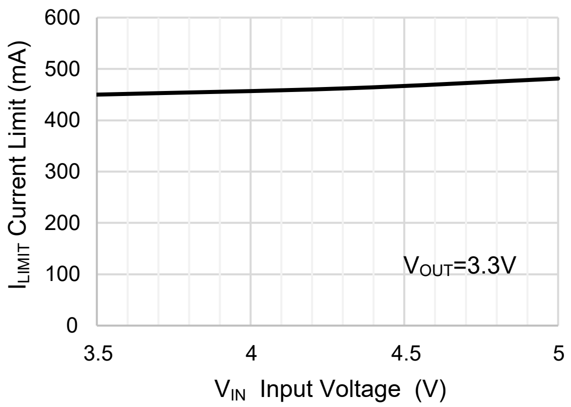


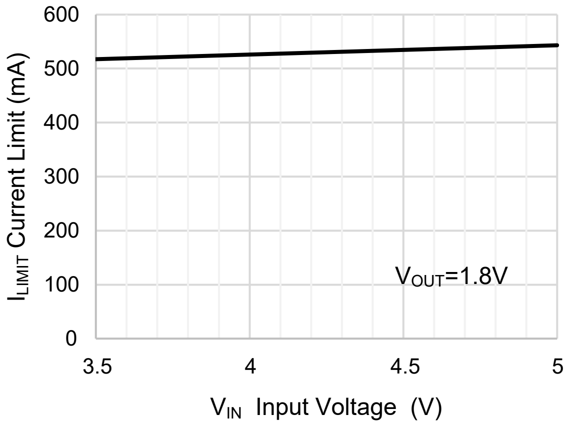


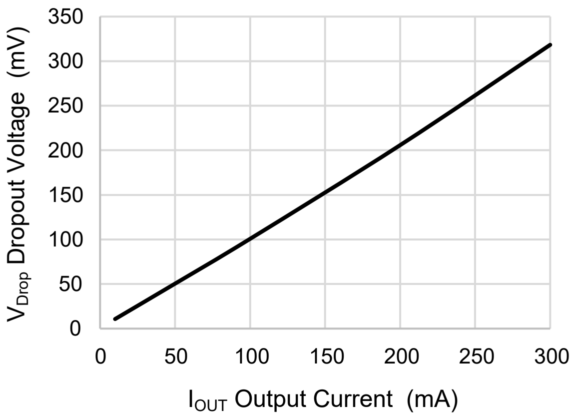


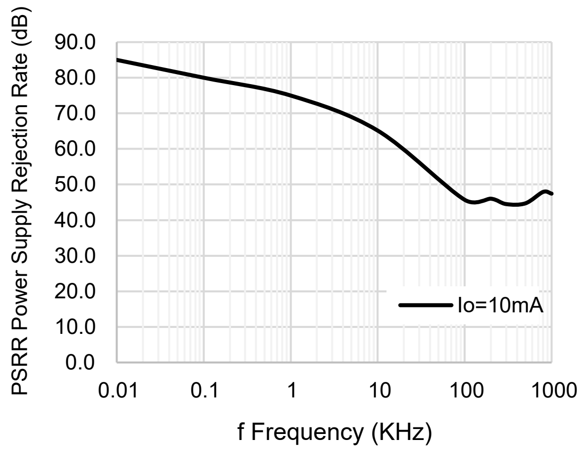






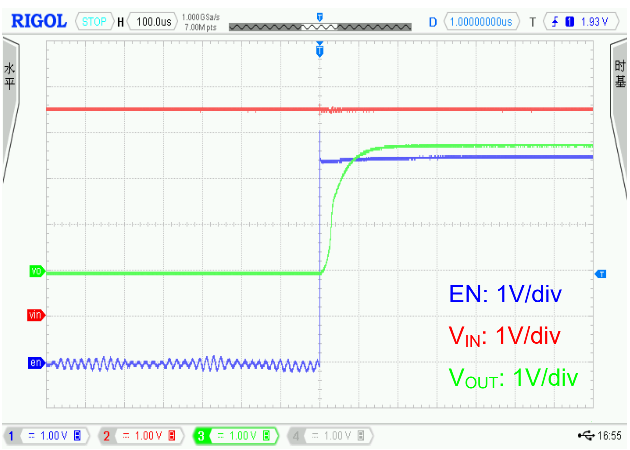




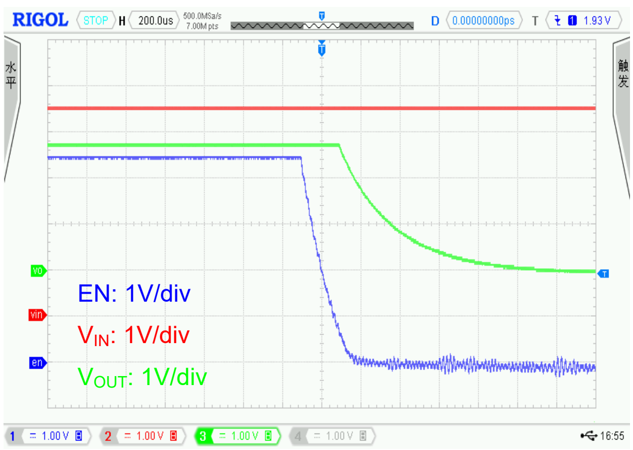


EN ON / OFF

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

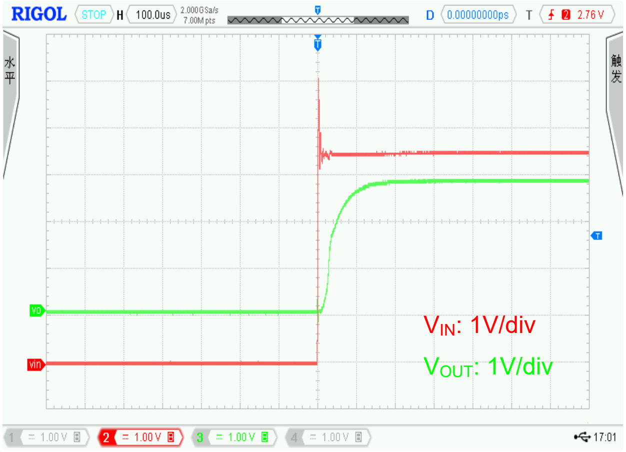


V_{EN}=4.5V to 0V I_{OUT}=10mA



Power ON / OFF

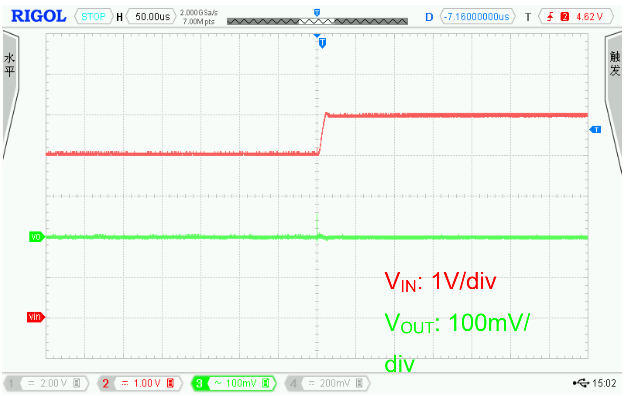
V_{IN}=0V to 4.5V I_{OUT}=10mA



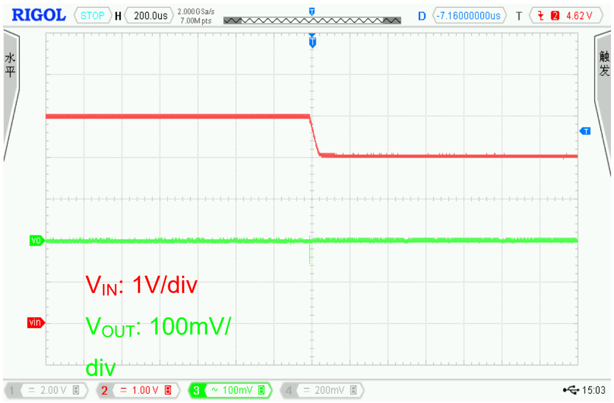
V_{IN}=4.5V to 0V I_{OUT}=10mA

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 50mA

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

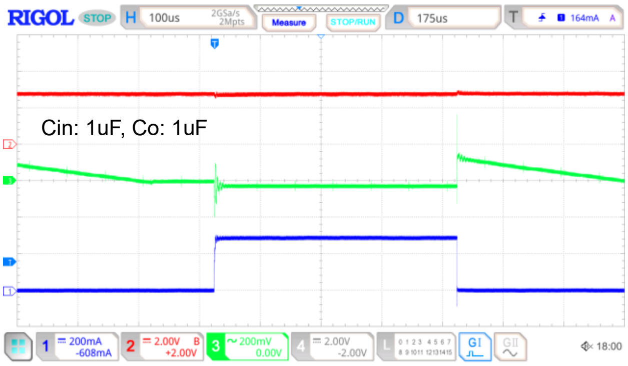
V_{IN}=4.3V, V_{OUT}=3.3V I_{OUT}=1mA to 200mA

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

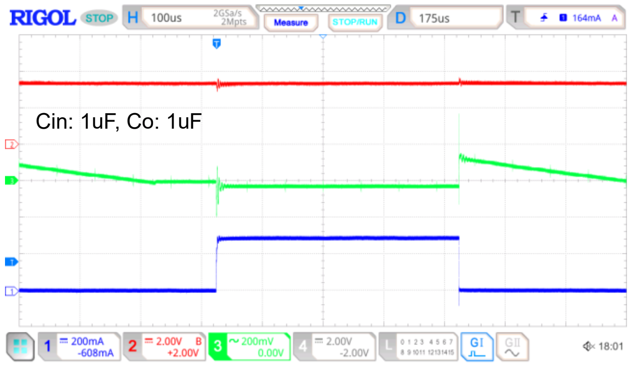
V_{IN}=4.3V, V_{OUT}=3.3V I_{OUT}=1mA to 200mA

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

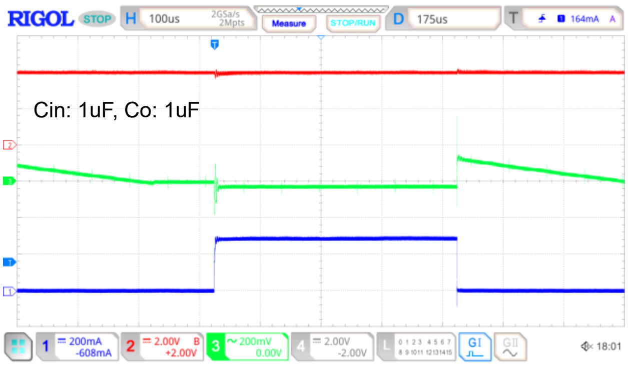
V_{IN}=2.8V, V_{OUT}=1.2V I_{OUT}=1mA to 300mA



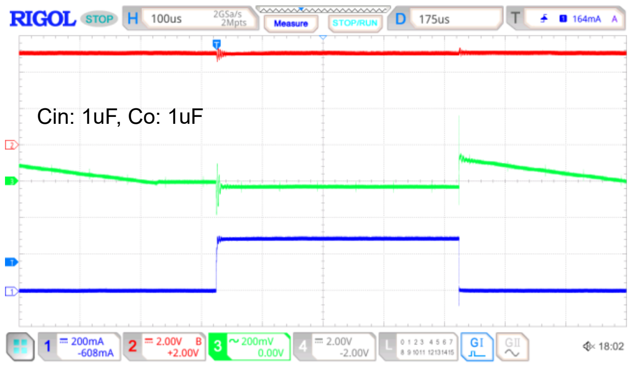
V_{IN}=3.3V, V_{OUT}=1.2V I_{OUT}=1mA to 300mA



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 1uF capacitor must be connected from Vout to ground to insure stability. Input capacitor of 1uF 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

TN9350 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 1μF capacitor on the input and a 1μF capacitor on the output of the TN9350 Series. Larger input capacitor values and lower ESR (X5R, X7R) provide better supply noise rejection and transient response. A higher value output capacitor (4.7μF) 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:

$$V_{DROP} = V_{IN} - V_{OUT} = R_{DS(on)} \times I_{OUT}$$

Current Limit and Thermal Shutdown Protection

In order to prevent overloading or thermal condition from damaging the device. TN9350 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 TN9350 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.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$$

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

$$P_{D(max)} = (T_{j(max)} - T_a) / R_{\theta JA}$$

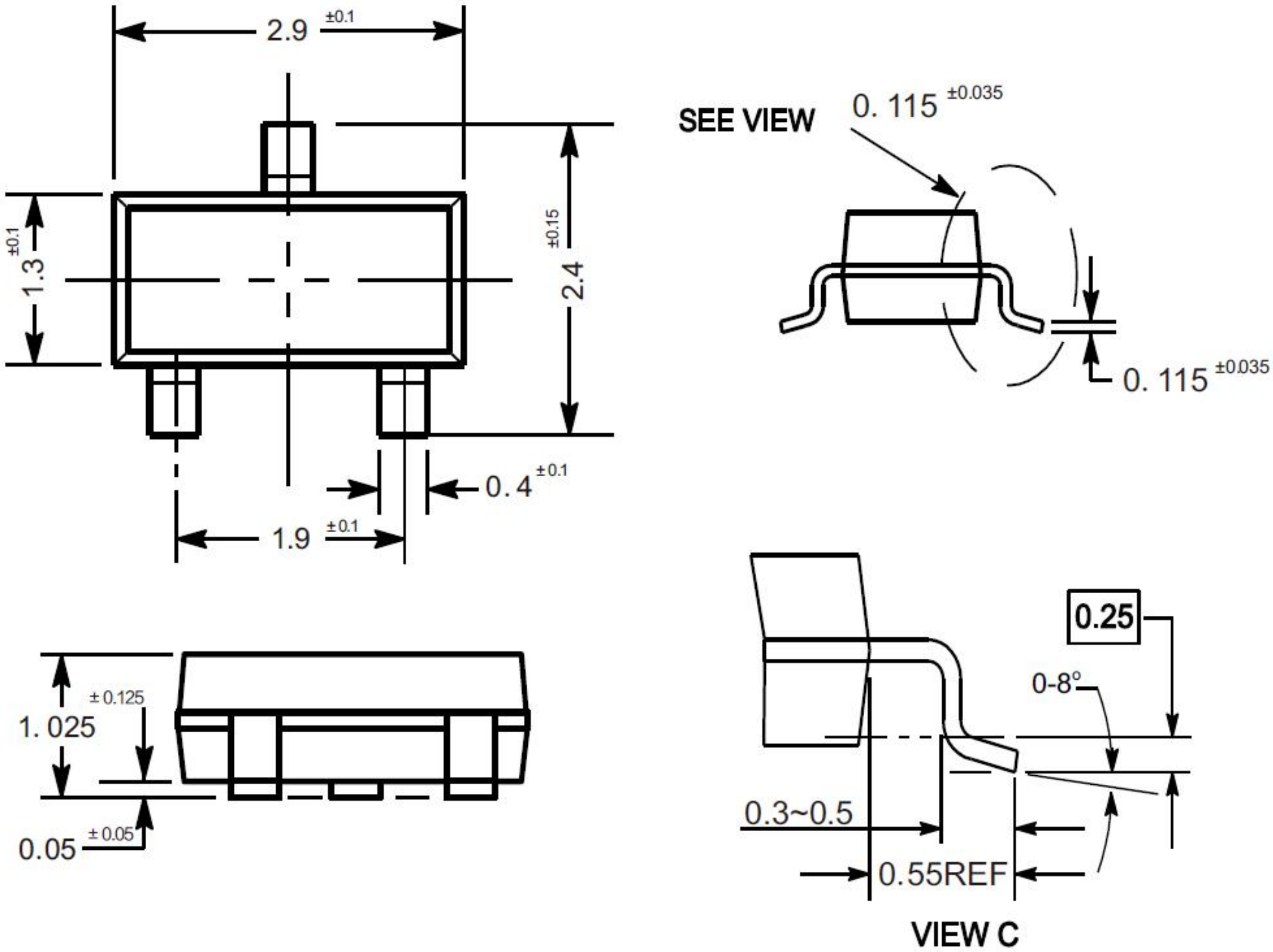
Where Tj (max) is the maximum junction temperature of the die (150°C) and Ta is the maximum ambient temperature.

PCB Layout

An input capacitance about 4 .7μF is required between the TN9350 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.

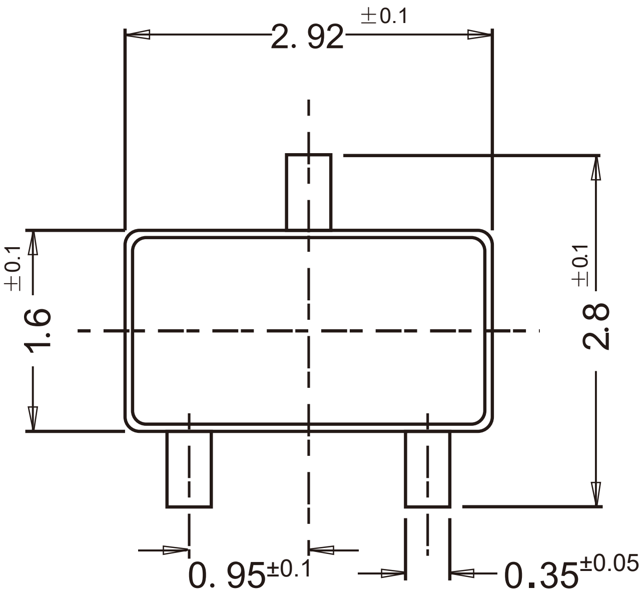
Package Outline

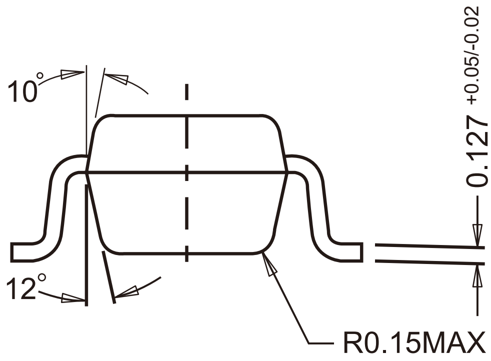
SOT-23
Dimensions in mm

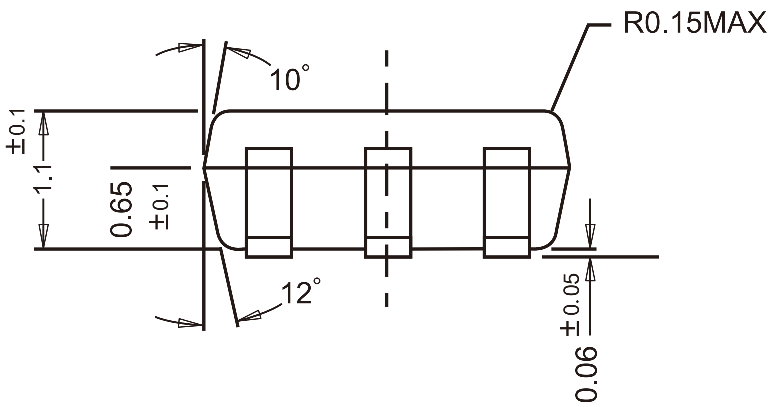


Package Outline

SOT-23-3
Dimensions in mm

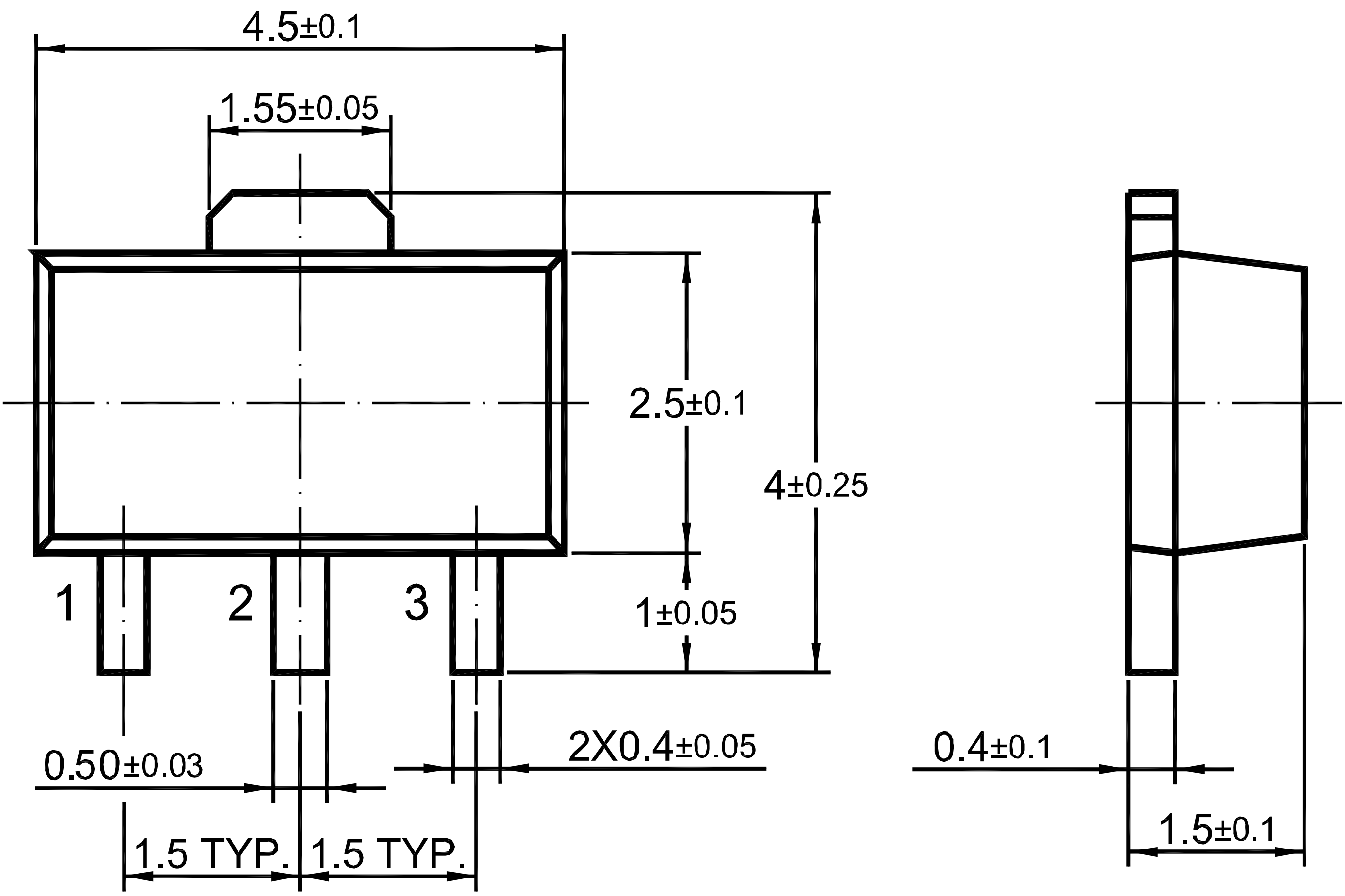






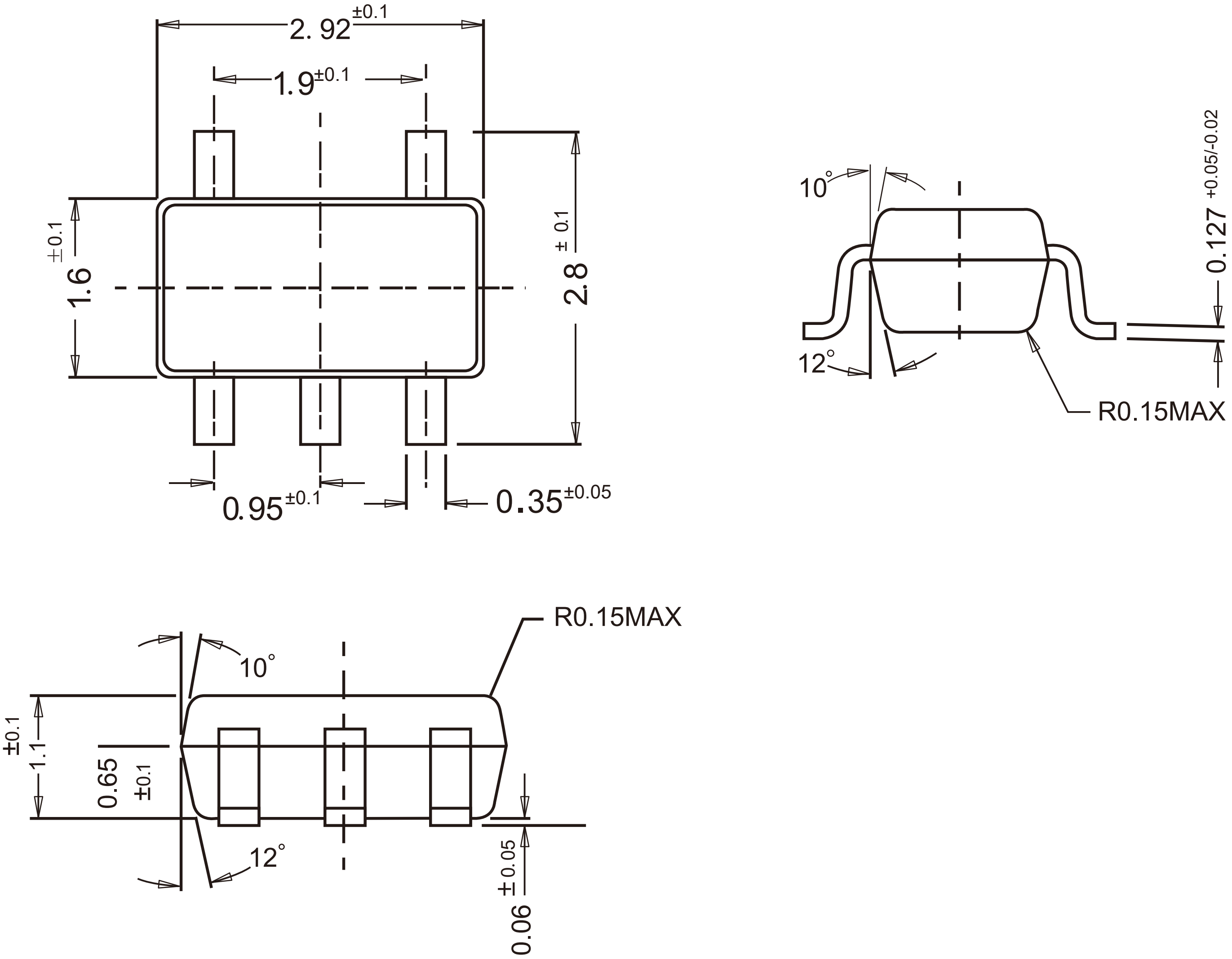
Package Outline

SOT-89
Dimensions in mm



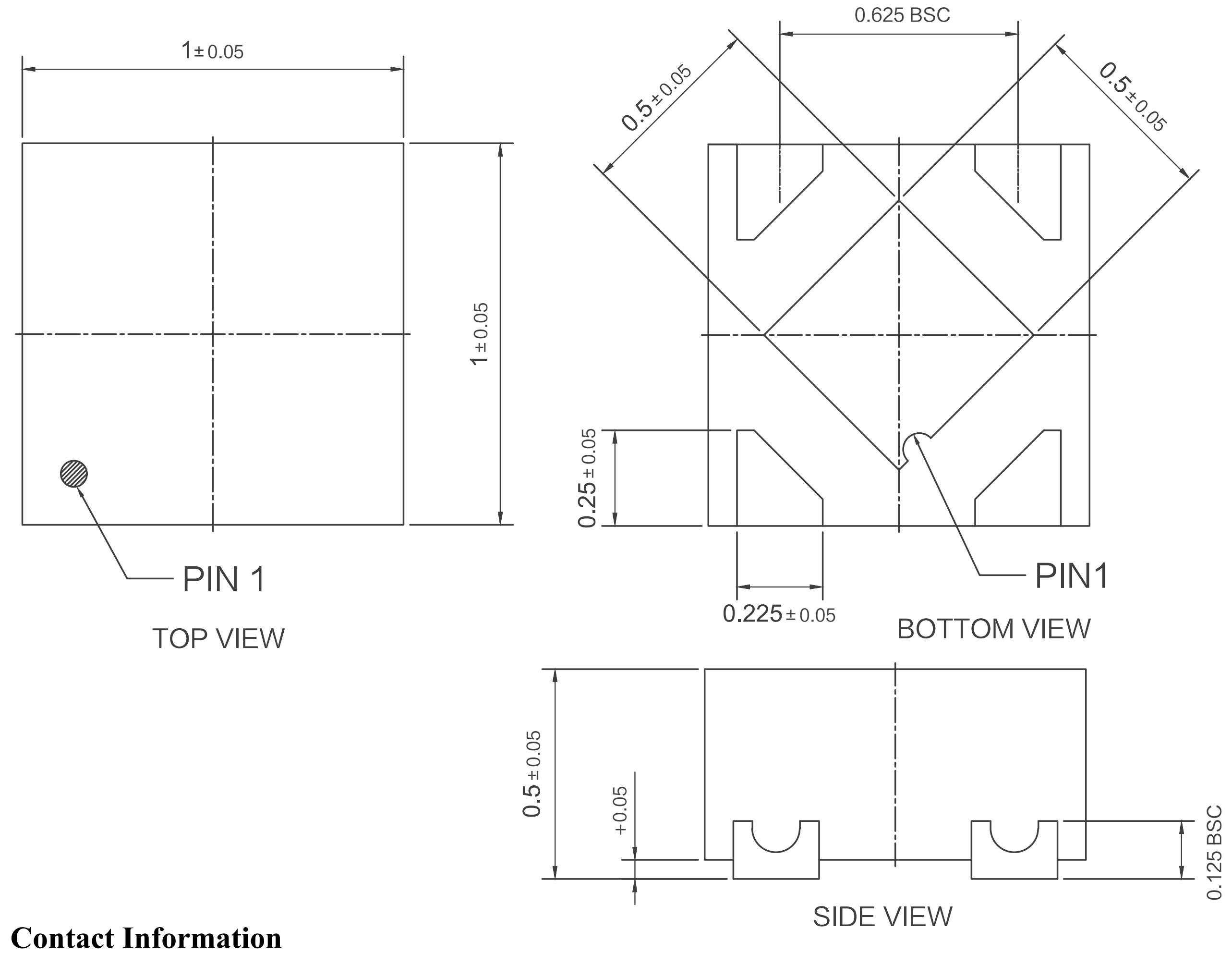
Package Outline

SOT-23-5
Dimensions in mm



Package Outline

DFN1x1-4L Dimensions in mm



Contact Information

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For additional information, please contact your local Sales Representative.

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Product Specification Statement

The product specification aims to provide users with a reference regarding various product parameters, performance, and usage. It presents certain aspects of the product's performance in graphical form and is intended solely for users to select product and make product comparisons, enabling users to better understand and evaluate the characteristics and advantages of the product. It does not constitute any commitment, warranty, or guarantee.

The product parameters described in the product specification are numerical values, characteristics, and functions obtained through actual testing or theoretical calculations of the product in an independent or ideal state. Due to the complexity of product applications and variations in test conditions and equipment, there may be slight fluctuations in parameter test values. TANI shall not guarantee that the actual performance of the product when installed in the customer's system or equipment will be entirely consistent with the product specification, especially concerning dynamic parameters. It is recommended that users consult with professionals for product selection and system design. Users should also thoroughly validate and assess whether the actual parameters and performance when installed in their respective systems or equipment meet their requirements or expectations. Additionally, users should exercise caution in verifying product compatibility issues, and TANI assumes no responsibility for the application of the product. TANI strives to provide accurate and up -to- date information to the best of our ability. However, due to technical, human, or other reasons, TANI cannot guarantee that the information provided in the product specification is entirely accurate and error-free. TANI shall not be held responsible for any losses or damages resulting from the use or reliance on any information in these product specifications.

TANI reserves the right to revise or update the product specification and the products at any time without prior notice, and the user's continued use of the product specification is considered an acceptance of these revisions and updates. Prior to purchasing and using the product, users should verify the above information with TANI to ensure that the prod uct specification is the most current, effective, and complete. If users are particularly concerned about product parameters, please consult TANI in detail or request relevant product test reports. Any data not explicitly mentioned in the product specification shall be subject to separate agreement.

Users are advised to pay attention to the parameter limit values specified in the product specification and maintain a certain margin in design or application to ensure that the product does not exceed the parameter limit values defined in the product specification. This precaution should be taken to avoid exceeding one or more of the limit values, which may result in permanent irreversible damage to the product, ultimately affecting the quality and reliability of the system or equipment.

The design of the product is intended to meet civilian needs and is not guaranteed for use in harsh environments or precision equipment. It is not recommended for use in systems or equipment such as medical devices, aircraft, nuclear power, and similar systems, where failures in these systems or equipment could reasonably be expected to result in personal injury. TANI shall assume no responsibility for any consequences resulting from such usage.

Users should also comply with relevant laws, regulations, policies, and standards when using the product specification. Users are responsible for the risks and liabilities arising from the use of the product specification and must ensure that it is not used for illegal purposes. Additionally, users should respect the intellectual property rights related to the product specification and refrain from infringing upon any third- party legal rights. TANI shall assume no responsibility for any disputes or controv ersies arising from the above-mentioned issues in any form.

