Description

The TN9312 family of low-dropout (LDO), low-power linear regulators offers very high power supply rejection ratio (PSRR) while maintaining very low 12μA ground current, suitable for RF applications. The family uses an advanced CMOS process and a PMOSFET pass device to achieve fast start-up, very low noise, excellent transient response, and excellent PSRR performance. The TN9312 is stable with a 1.0μF ceramic output capacitor, and uses a precision voltage reference and feedback loop to achieve a worst-case accuracy of 2% over all load, line, process, and temperature variations. It is fully specified from T_J = -40°C to +125°C and is offered in a small package, which is ideal for small form factor portable equipment such as wireless handsets and PDAs.

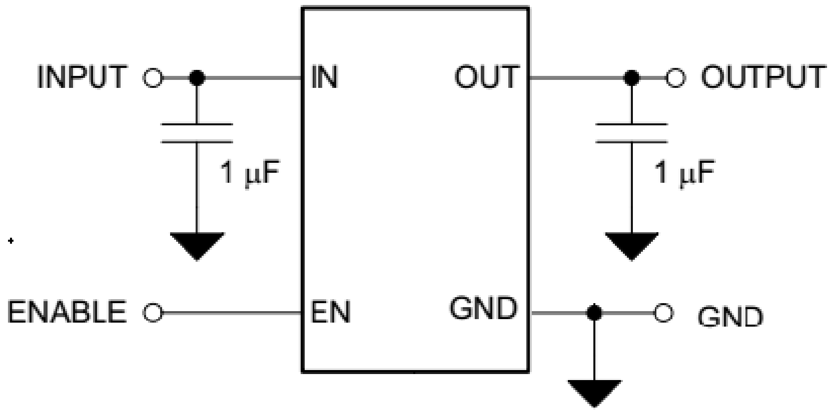
Features

- Wide Input Voltage Range: 1.9V to 5.5V
- Output Voltage Range:1.2V~4.5V
- Up to 300mA Load Current
- Other Output Voltage Options Available on Request
- Very Low IQ: 12μA
- Low Dropout: 180mV typical@3.3V
- Very High PSRR: 80db at 1KHz
- Ultra Low Noise: 10uVrms at 3.3V output (load=1mA)
- Excellent Load/Line Transient Response
- Line Regulation: 0.02%/V typical
- Short Circuit Protection:Typ.500mA(Current at short mode)
- With Auto Discharge
- Available Packages： SOT-23-5 and DFN1x1-4L

Applications

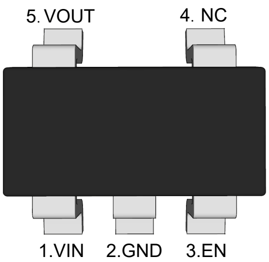
- Smart Phones and Cellular Phones
- PDAs
- MP3/MP4 Player
- Digital Still Cameras
- Portable instrument

Typical Application Circuit



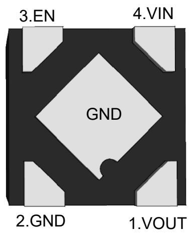
Pin Distribution

SOT-23-5



(Top View)

DFN1x1-4L



(Bottom View)

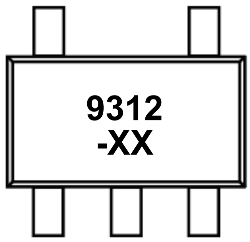
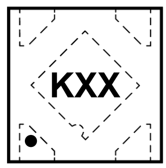
Functional Pin Description

Pin Name	Pin Function
VOUT	Output pin. A 1μF low-ESR capacitor should be connected to this pin to ground. An internal 230-Ω (typical) pull-down resistor prevents a charge remaining on VOUT when the regulator is in the shutdown mode.
GND	Ground
CE	Enable control input, active high. Do not leave EN floating
VIN	Supply input pin. Must be closely decoupled to GND with a 1μF or greater ceramic capacitor
NC	NO Connected

Ordering Information

TN9312□□□□

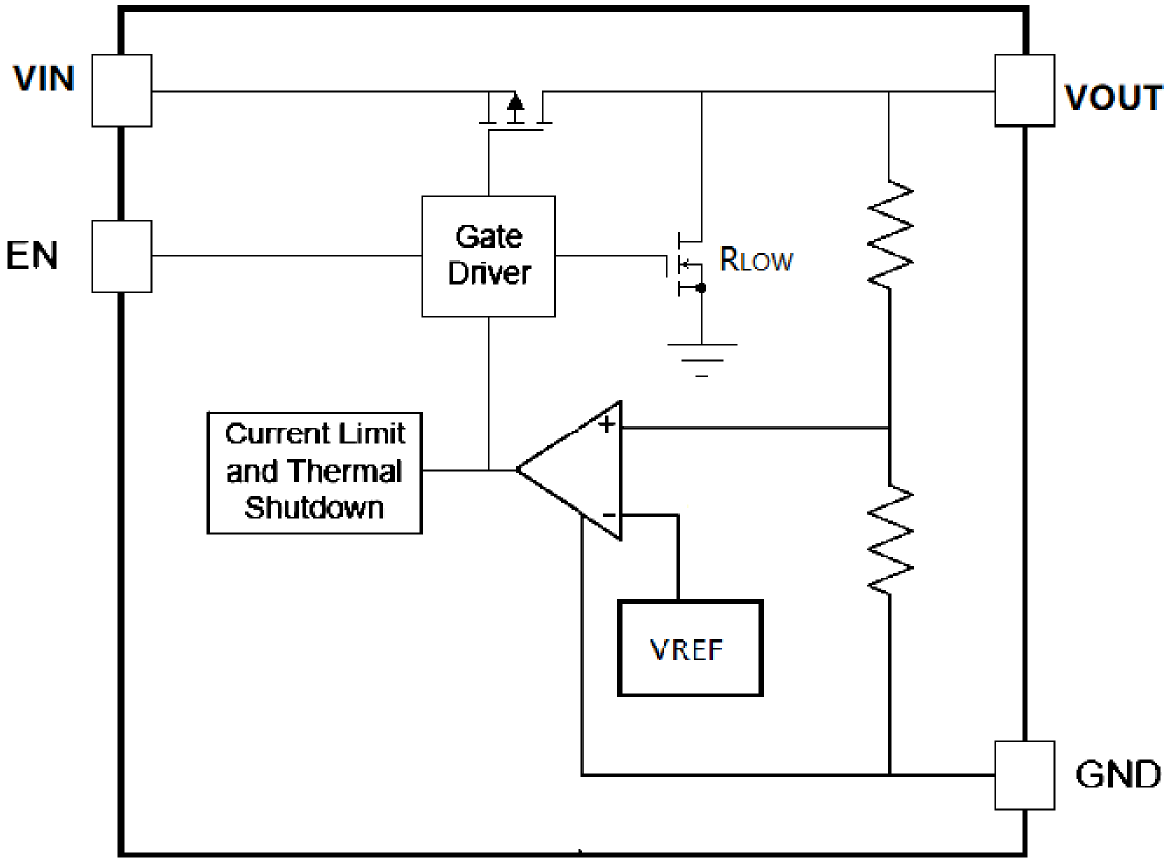
- Package Type
  SE:SOT-23-5
  DE:DFN1x1-4L
- Output Voltage
  e.g. 12:1.2V 33:3.3V 45:4.5V
- Output current tap
  L : 300mA

Orderable Device	Package	Reel (inch)	Package Qty (PCS)	Eco Plan Note1	MSL Level	Marking Code
TN9312LXXSE Note2	SOT-23-5	7	3000	RoHS & Green	MSL3	 XX:Output Voltage e.g. 3.3: 3.3V
TN9312LXXDE Note2	DFN1x1-4L	7	1000	RoHS & Green	MSL1	 K: Product Code e.g. K: PJ9312 Series XX: Output Voltage e.g. 33: 33V

Note:

1. 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.
2. XX: Output Voltage, e.g. 33: 33V

Block Diagram



Absolute Maximum Ratings

Ratings at 25℃ ambient temperature unless otherwise specified.

Parameter		Value	Unit
IN Voltage		-0.3~6	V
Other Pin Voltage		-0.3~V_{IN}+0.3	V
Maximum Load Current		Internal Limited	mA
Power Dissipation	SOT-23-5	250	mW
	DFN1x1-4L	250	mW
Thermal Resistance,Junction-to-Ambient	SOT-23-5	400	°C/W
	DFN1x1-4L	400	°C/W
Operating Junction Temperature		-40 ~ 125	°C
Storage Temperature		-65 ~ 150	°C
Lead Temperature (Soldering, 10 sec)		300°C, (10s)	--

Recommended Operating Conditions

Parameter	Value	Unit
Supply Voltage	1.9~5.5	V
Maximum Output Current	300	mA
Operating Junction Temperature	-40 ~ 125	°C

Electrical Characteristics

(V_{IN}=V_{OUT} +1.0V, V_{EN}= 1.2V, I_{OUT}=1mA, C_{IN}= 1μF, C_{OUT}= 1μF, T_A=25°C, unless otherwise stated.)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}		1.9	--	5.5	V
Output Voltage Accuracy	ΔV_{OUT}	V_{IN}=($V_{OUT(NOM)}$+1V) to 5.5V I_{OUT}=1mA to 300mA	-2	--	2	%
Line Regulation	ΔV_{LINE}	V_{IN}=($V_{OUT(NOM)}$+1V) to 5.5V I_{OUT}=1mA	--	0.02	--	%/V
Load Regulation	ΔV_{LOAD}	I_{OUT}=1mA to 300mA	--	0.001	--	%/mA
Maximum Output Current	I_{OUT}		0	--	300	mA
Quiescent Current	I_Q	V_{EN}=1.2V, V_{IN},I_{OUT}= 0V	--	12	25	μA
Dropout Voltage	V_{DROP}	I_{OUT}=100mA	--	50	--	mV
		I_{OUT}=300mA	--	180	300	mV
Shutdown Current	I_{SHDN}	Disabled, V_{EN}=0V,	--	0.2	1	μA
Standby Current	$I_{standby}$	V_{EN}=0V	--	0.2	1	μA
Current Limit	I_{Limit}		400	600	1000	mA
Power Supply Rejection Rate	PSRR	f=100 Hz, I_{OUT}=20mA	--	80	--	dB
		f=1 kHz, I_{OUT}=20mA	--	80	--	dB
		f=10 kHz, I_{OUT}=20mA	--	65	--	dB
		f=100 kHz, I_{OUT}=20mA	--	40	--	dB
Output Noise Voltage	e_N	BW=10Hz~100kHz, I_{OUT}=1mA	--	10	--	μV
		BW=10Hz~100 kHz ,I_{OUT}=300mA	--	6.5	--	μV
Output Discharge FET $R_{DS(on)}$	$R_{dischrg}$	V_{EN}<V_{IL} (output disable)	100	230	500	Ω
EN Input Logic Low Voltage	V_{ENL}	V_{IN}= 2.2V to 5.5V, V_{EN} falling until the output is disabled	--	--	0.4	V
EN Input Logic High Voltage	V_{ENH}	V_{IN}= 2.2V to 5.5V, V_{EN} rising until the output is enabled	1.2	--	--	V
EN Input leakage Current	I_{EN}	V_{IN}=5.5 ,V_{EN} = 0V	--	0.01	1	μA
		V_{IN}=5.5 ,V_{EN} = 5.5V	--	5.5	--	μA
Thermal Shutdown Threshold	T_{SHDN}	T_J Rising	--	155	--	°C
Thermal Shutdown Hysteresis	T_{HYS}	T_J Falling from shutdown	--	15	--	°C
Line Transient	ΔV_{OUT}	V_{IN}=($V_{OUT(NOM)}$+1V) to ($V_{OUT(NOM)}$+1.6V) in 10μs	--	10	--	mV
		V_{IN}=($V_{OUT(NOM)}$+1.6V) to ($V_{OUT(NOM)}$+1V) in 10μs	--	10	--	mV
Load Transient		I_{OUT}=1mA to 300mA in 10μs	--	20	--	mV
		I_{OUT}=300mA to 1mA in 10μs	--	20	--	mV
Overshoot on start-up		Stated as percentage of $V_{OUT(NOM)}$	--	--	5	%
Output Turn-on Delay Time	$T_{D(ON)}$	From V_{EN}>V_{IH} to V_{OUT}=95%of $V_{OUT(NOM)}$	--	150	250	μs

Functional Description

Input Capacitor

A 1μF ceramic capacitor is recommended to connect between VIN and GND pins to decouple input power supply glitch and noise. The amount of the capacitance may be increased without limit. This input capacitor must be located as close as possible to the device to assure input stability and less noise. For PCB layout, a wide copper trace is required for both VIN and GND. The input capacitor should be at least equal to, or greater than, the output capacitor for good load transient performance。

Output Capacitor

An output capacitor is required for the stability of the LDO. The recommended output capacitance is from 1μF to 10μF, Equivalent Series Resistance (ESR) is from 5mΩ to 500mΩ, and temperature characteristics are X7R or X5R. Higher capacitance values help to improve load/line transient response. The output capacitance may be increased to keep low undershoot/overshoot. Place output capacitor as close as possible to OUT and GND pins. With a reasonable PCB layout, the single 1-μF ceramic output capacitor can be placed up to 10 cm away from the TN9312 device.

ON/OFF Input Operation

The TN9312 EN pin is internally held low by a 1-MΩ resistor to GND. The TN9312 is turned on by setting the EN pin higher than VIH threshold, and is turned off by pulling it lower than VIL threshold. If this feature is not used, the EN pin should be tied to IN pin to keep the regulator output on at all time.

High PSRR and Low Noise

RF circuits such as LNA (low-noise amplifier), up/down-converter, mixer, PLL, VCO, and IF stage, require low noise and high PSRR LDOs. The temperature-compensated crystal oscillator circuit requires very high PSRR at RF power amplifier burst frequency. For instance, minimum 65dB PSRR at 217Hz is recommended for the GSM handsets.

In order to provide good audio quality, the audio power supply for hand-free, game, MP3, and multimedia applications in cellular phones, require low-noise and high PSRR at audio frequency range (20Hz-20kHz).

The TN9312, with PSRR of 82dB at 1KHz, is suitable for most of these applications that require high PSRR and low noise.

Output Automatic Discharge

The TN9312 output employs an internal 230-Ω (typical) pulldown resistance to discharge the output when the EN pin is low, and the device is disabled.

Remote Output Capacitor Placement

The TN9312 requires at least a 1-μF capacitor at the OUT pin, but there are no strict requirements about the location of the capacitor in regards the OUT pin. In practical designs, the output capacitor may be located up to 10 cm away from the LDO.

Fast Transient Response

Fast transient response LDOs can also extend battery life. TDMA-based cell phone protocols such as Global System for Mobile Communications (GSM) have a transmit/receive duty factor of only 12.5 percent, enabling power savings by putting much of the baseband circuitry into standby mode in between transmit cycles. In baseband circuits, the load often transitions virtually instantaneously from 100μA to 100mA. To meet this load requirement, the LDO must react very quickly without a large voltage drop or overshoot — a requirement that cannot be met with conventional, general-purpose LDOs.

The TN9312's fast transient response from 0 to 300mA provides stable voltage supply for fast DSP and GSM chipset with fast changing load.

Low Quiescent Current

Cellular phone baseband internal digital circuits typically operate all the time. That requires LDO stays on at all times. However, in the standby mode, the microprocessor consumes only around 100~300μA. Since the phone stays in standby for the longest percentage of time, using a 12μA quiescent current LDO, instead of 100μA, saves 88μA and can substantially extends the battery standby time.

The TN9312, consuming only 12 μ A quiescent current, provides great power saving in portable and low power applications.

Minimum Operating Input Voltage (VIN)

The TN9312 does not include any dedicated UVLO circuitry. The TN9312 internal circuitry is not fully functional until VIN is at least 1.9 V. The output voltage is not regulated until VIN has reached at least the greater of 1.9 V or (VOUT + VDO).

Current Limit Protection

When output current at the OUT pin is higher than current limit threshold or the OUT pin is short-circuiting to GND, the current limit protection will be triggered and clamp the output current to approximately 500mA to prevent over-current and to protect the regulator from damage due to overheating.

Thermal Overload Protection

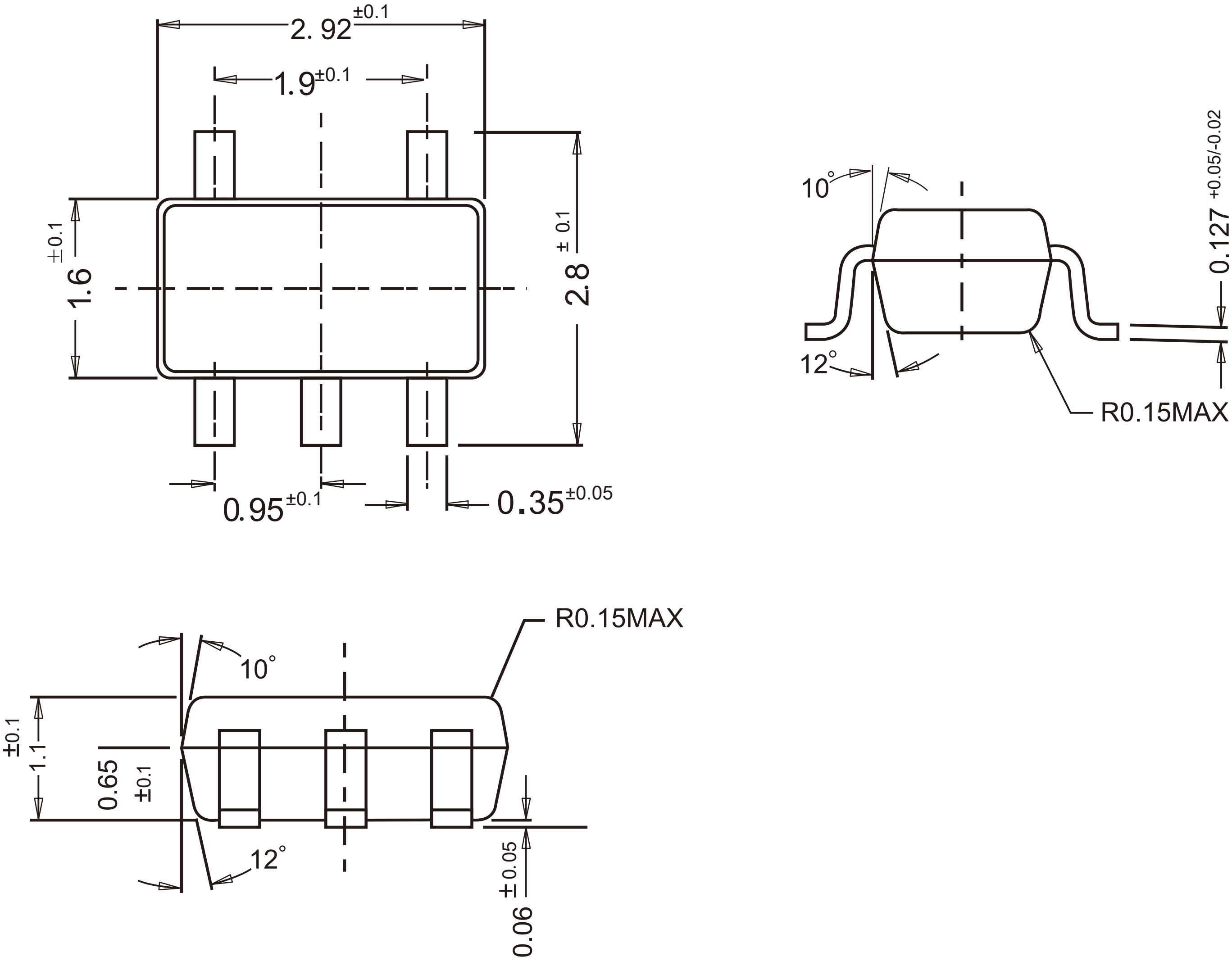
Termal shutdown disables the output when the junction temperature rises to approximately 155°C which allows the device to cool. When the junction temperature cools to approximately 140°C, the output circuitry enables. Based on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This thermal cycling limits the dissipation of the regulator and protects it from damage as a result of overheating.

The thermal shutdown circuitry of the TN9312 has been designed to protect against temporary thermal overload conditions. The TSD circuitry was not intended to replace proper heat-sinking. Continuously running the TN9312 device into thermal shutdown may degrade device reliability .

Package Outline

SOT-23-5

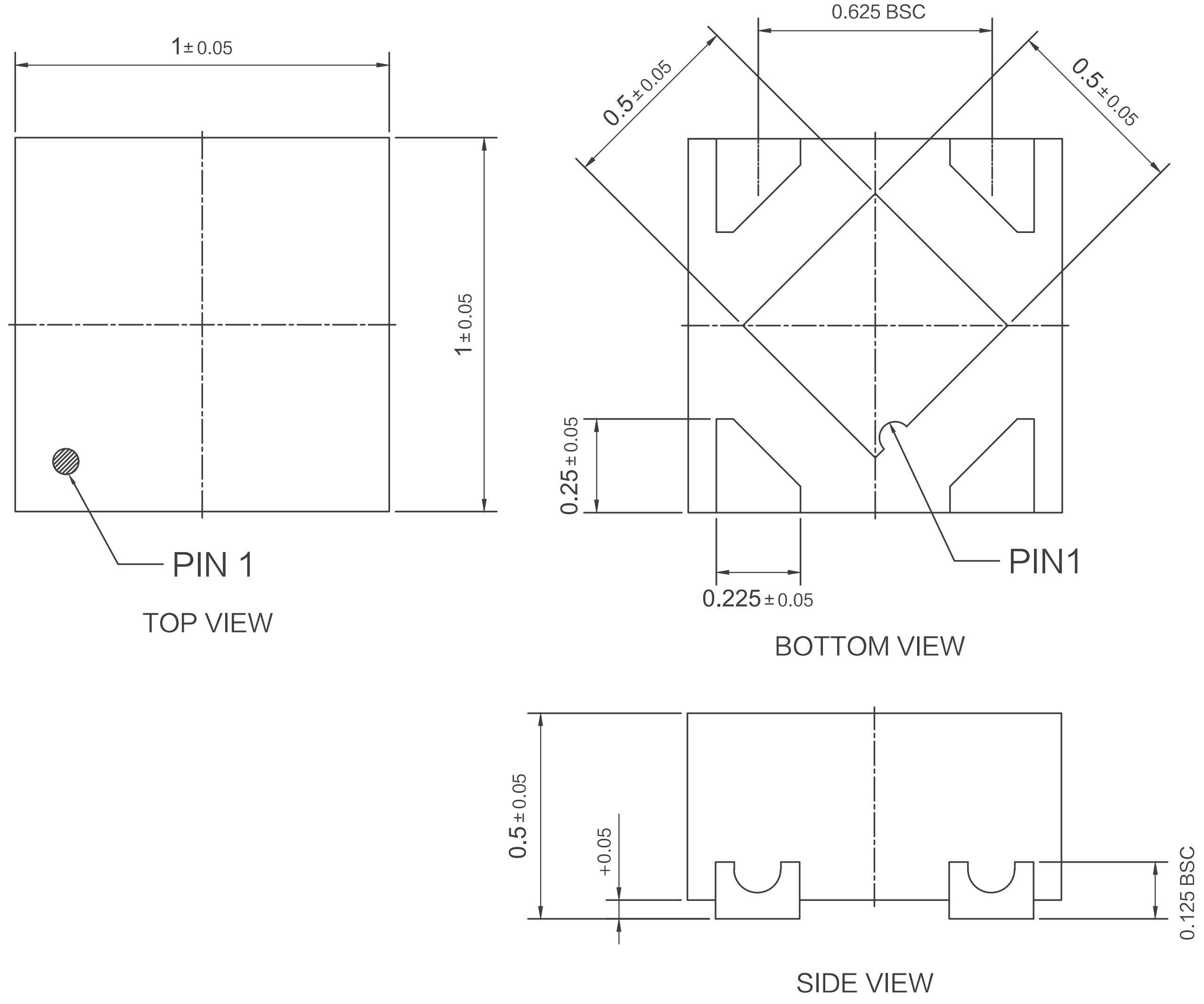
Dimensions in mm



Package Outline

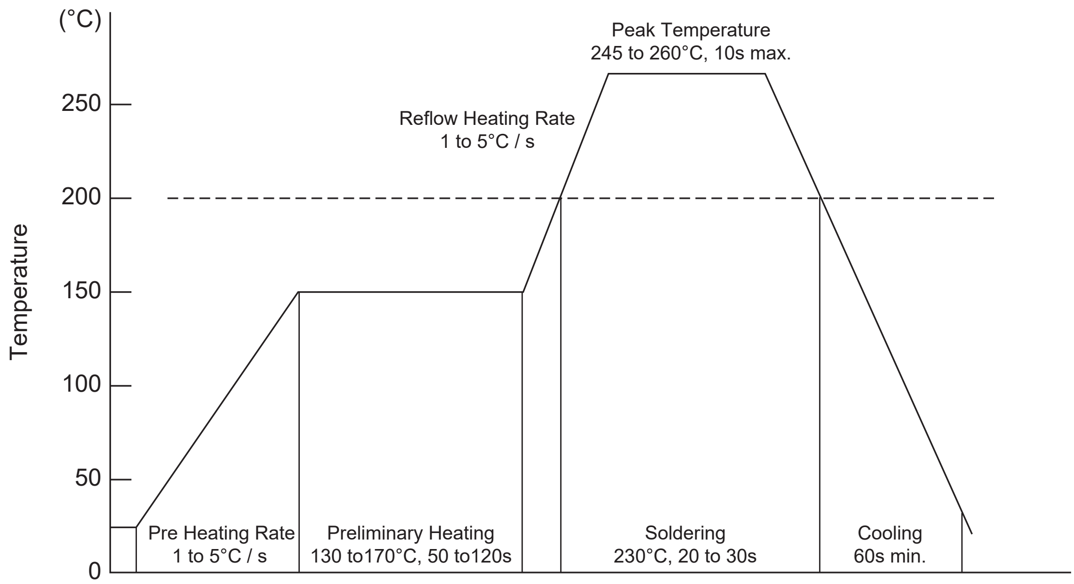
DFN1x1-4L

Dimensions in mm



Conditions of Soldering and Storage

◆ **Recommended condition of reflow soldering**



Recommended peak temperature is over 245°C. If peak temperature is below 245°C, you may adjust the following parameters:

- Time length of peak temperature (longer)
- Time length of soldering (longer)
- Thickness of solder paste (thicker)

◆ **Conditions of hand soldering**

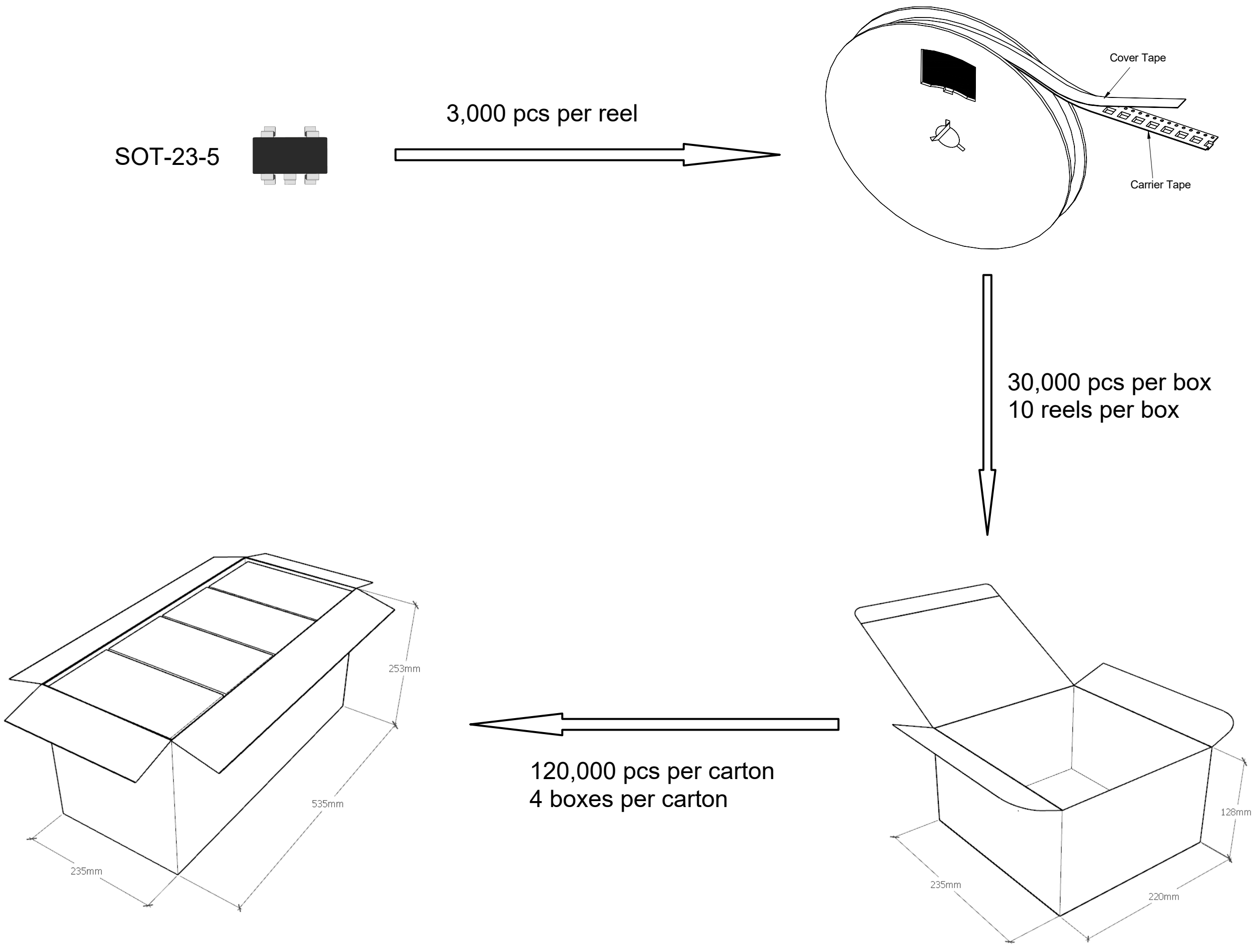
- Temperature: 300°C
- Time: 3s max.
- Times: one time

◆ **Storage conditions**

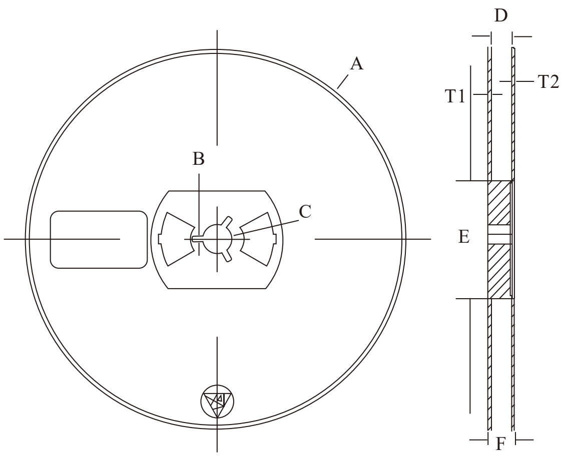
- **Temperature**
  5 to 40°C
- **Humidity**
  30 to 80% RH
- **Recommended period**
  One year after manufacturing

Package Specifications

- The method of packaging



- **reel data**

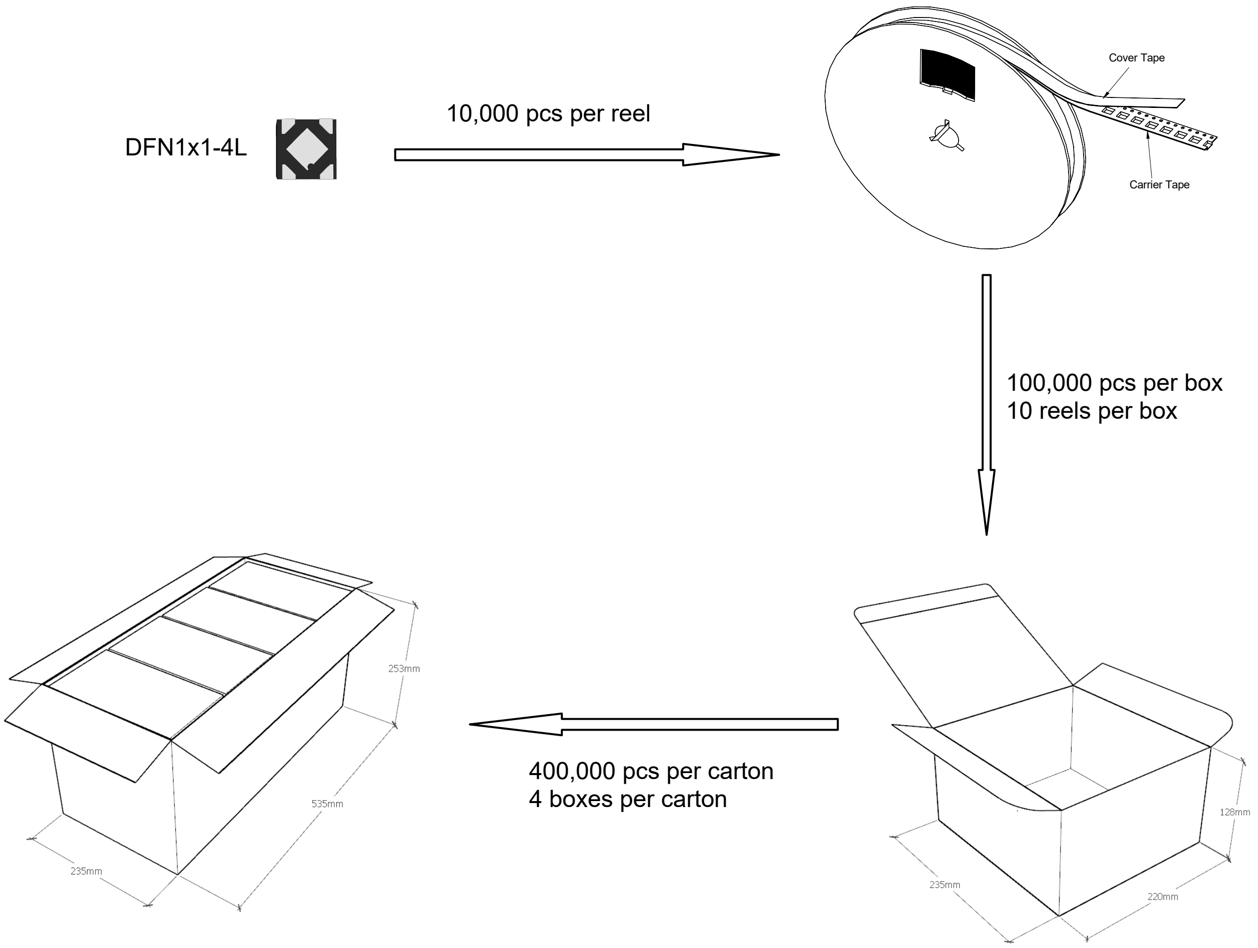


Reel (7")

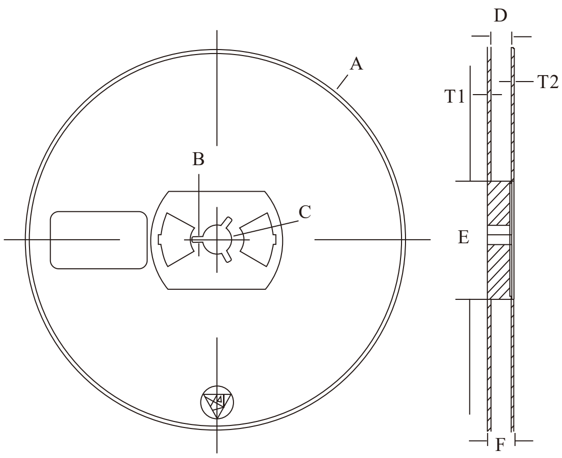
Symbol	Value (unit: mm)
A	Ø 177.8±1
B	2.7±0.2
C	Ø 13.5±0.2
E	Ø 54.5±0.2
F	12.3±0.3
D	9.6+2/-0.3
T1	1.0±0.2
T2	1.2±0.2

Package Specifications

- The method of packaging



◆ Embossed reel data



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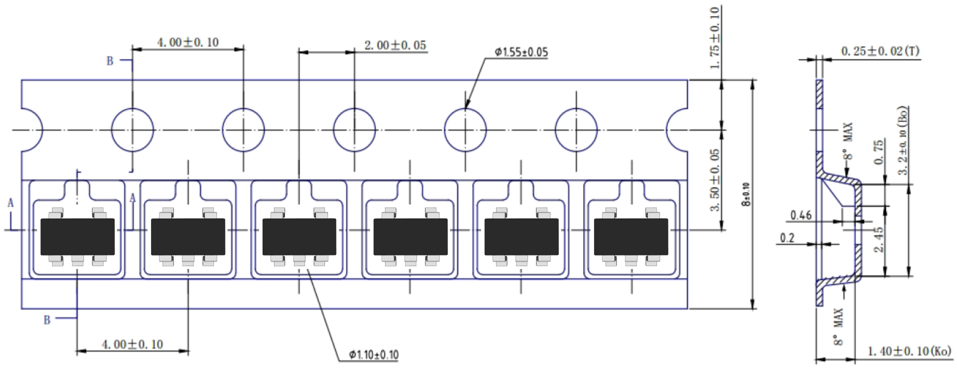
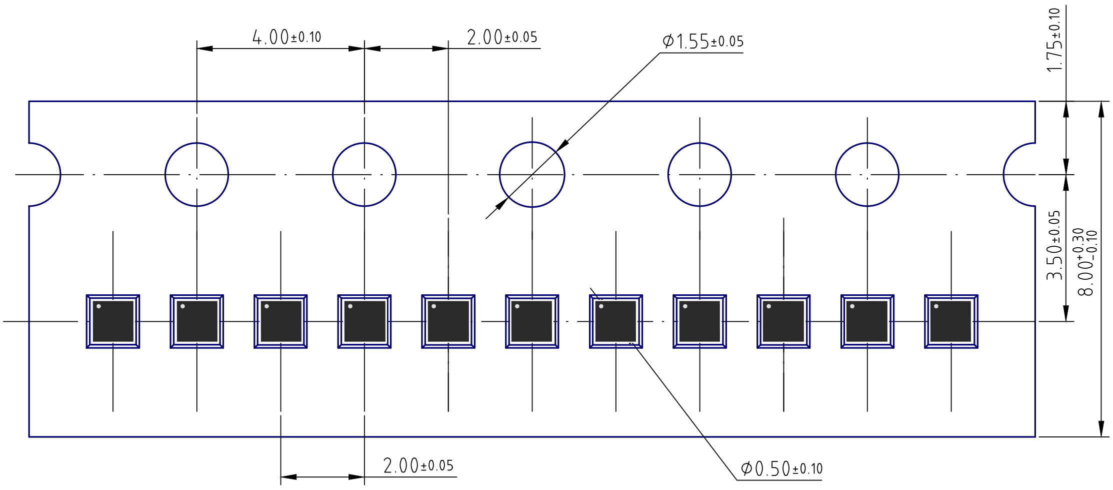
F	12.3±0.3
D	9.6+2/-0.3
T1	1.0±0.2
T2	1.2±0.2

◆ **Embossed tape data**

SOT-23-5



DFN1x1-4L



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.

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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.

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