TNS6001

Synchronous Step-Down Converter

Description

The TNS6001 is a high-efficiency monolithic synchronous step down DC/DC regulator using a constant frequency, current mode architecture. The device is available in an adjustable version. Supply current with no load is 70μA and drops to <1uA in shutdown. The 2.5V to 5.5V input voltage range makes the TNS6001 ideally suited for single Li-Ion battery powered applications. 100% duty cycle provides low dropout operation, extending battery life in portable systems. PWM/PFM mode operation provides very low output ripple voltage for noise sensitive applications.

Switching frequency is internally set at 2MHz, allowing the use of small surface mount inductors and capacitors. Low output voltages are easily supported with the 0.6V feedback reference voltage.

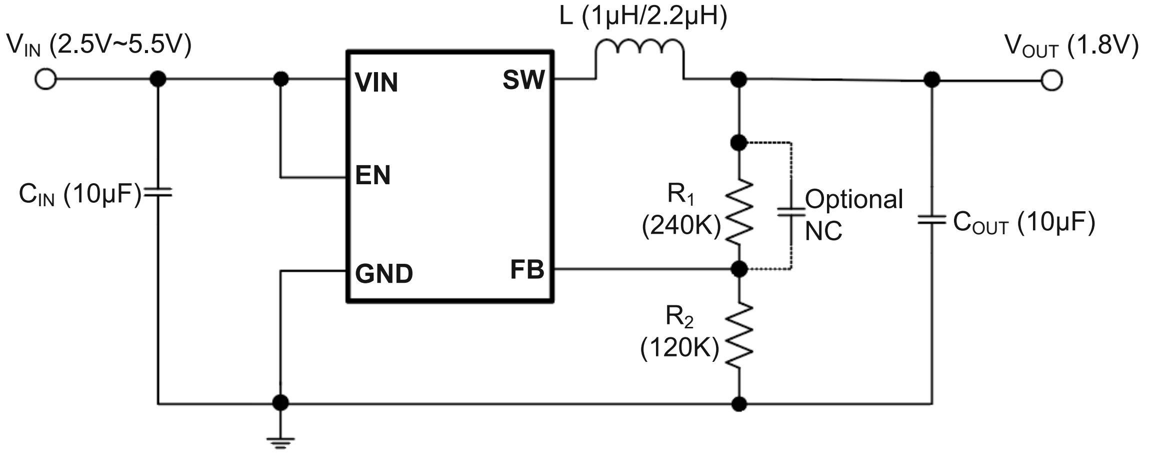
Features

- High Efficiency: Up to 96%
- 2.5V to 5.5V Input Voltage Range
- 2MHz Constant Frequency Operation
- No Schottky Diode Required
- Low Dropout Operation:100% Duty Cycle
- PFM Mode for High Efficiency in Light Load
- Low Quiescent Current: 70μA
- Over temperature Protected
- Short Circuit Protection
- Inrush Current Limit and Soft Start
- SOT-23-5 and DFN2x2C-6L Packages

Applications

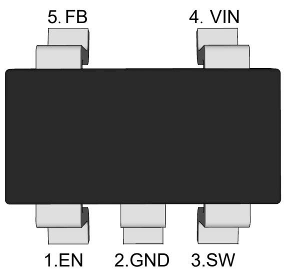
- Cellular and Smart Phones
- Wireless and DSL Modems
- Digital Still and Video Cameras

Typical Application Circuit



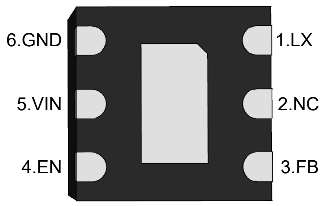
Pin Distribution

SOT-23-5



Top View

DFN2x2C-6L

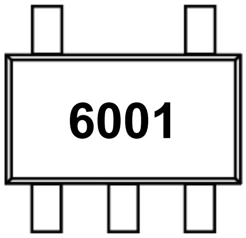
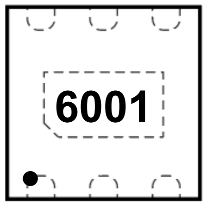


Bottom View

Pin Function

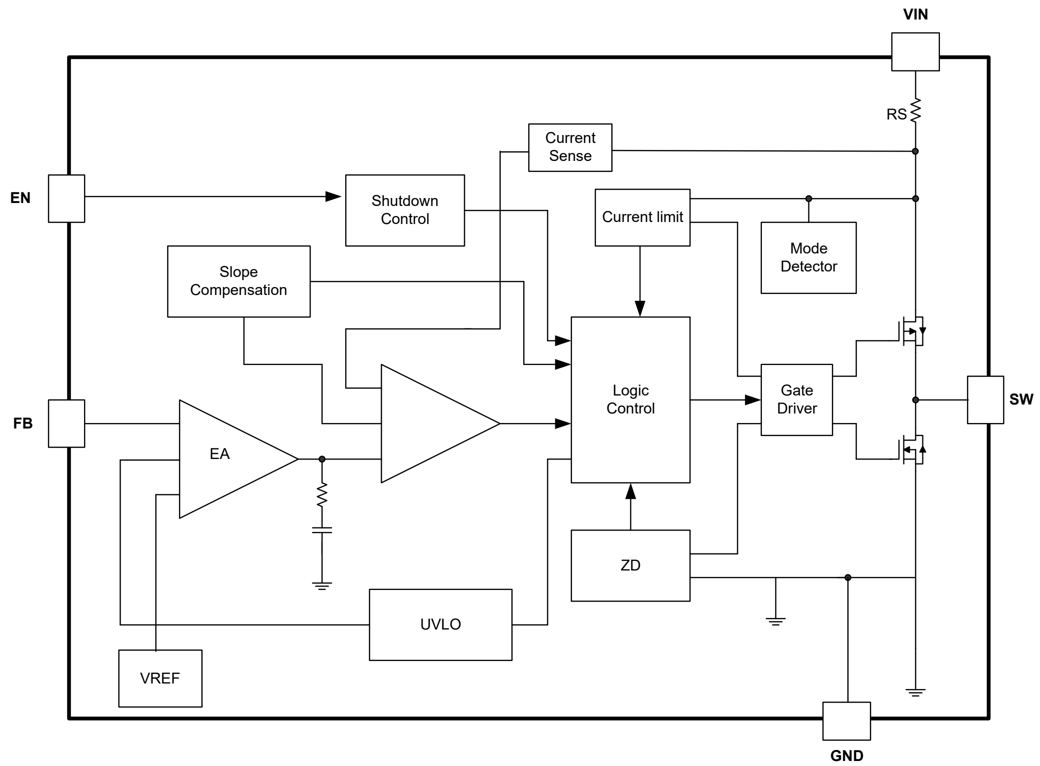
Name	Pin Function
EN	Chip Enable Pin. Drive EN above 1.5V to turn on the part.Drive EN below 0.3V to turn it off. Do not leave EN floating.
LX	Power Switch Output. It is the switch node connection to Inductor.
SW	Power Switch Output. It is the switch node connection to Inductor. This pin connects to the drains of the internal P-ch and N-ch MOSFET switches.
VIN	Power Supply Input. Must be closely decoupled to GND with a 10μF or greater ceramic capacitor.
FB	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.
NC	No Internal Connection

Ordering Information

Orderable Device	Package	Reel (inch)	Package Qty (PCS)	Eco Plan Note	MSL Level	Marking Code
TNS6001SE	SOT-23-5	7	3000	RoHS & Green	MSL3	
TNS6001DFC	DFN2x2C-6L	7	3000	RoHS & Green	MSL1	

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.

Functional Block Diagram



SOT-23-5

Absolute Maximum Ratings Note1

Ratings at 25℃ ambient temperature unless otherwise specified.

Parameter	Symbol	Rating	Unit
Input Voltage	V_{IN}	-0.3~7.0	V
Voltage at EN Pin	V_{EN}	-0.3~6.0	V
Voltage at SW Pin	V_{SW}	-0.3~(V_{IN}+0.3V)	V
Peak SW Sink and Source Current	--	2.2	A
Power Dissipation (T_A=25°C) Note2	P_D	0.5	W
Thermal Resistance,Junction-to-Ambient Note3	$R_{θJA}$	170	°C/W
Thermal Resistance,Junction-to-Case Note3	$R_{θJC}$	75	°C/W
Junction Temperature	T_J	-40 to +165	°C
Package Lead Soldering Temperature and Time	T_L	260°C, 10S	--
Storage Temperature Range	T_{STG}	-65 to +150	°C

Note: 1.Exceeding these ratings may damage the device.

2.The maximum allowable power dissipation is a function of the maximum junction temperature TJ(MAX), the junction-to-ambient thermal resistance θJA, and the ambient temperature TA. The maximum allowable continuous power dissipation at any ambient temperature is calculated by PD(MAX)=(TJ(MAX)-TA)/RθJA. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.

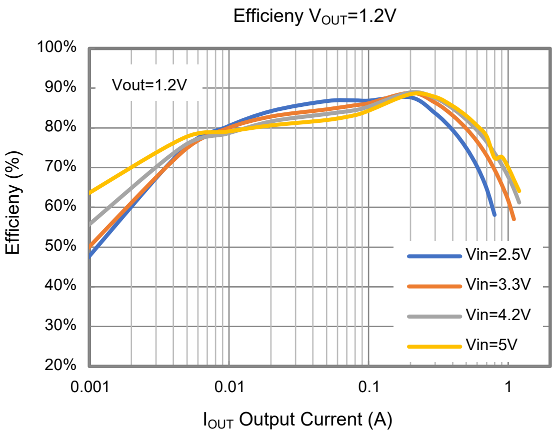
3.Measured on JESD51-7, 4-layer PCB.

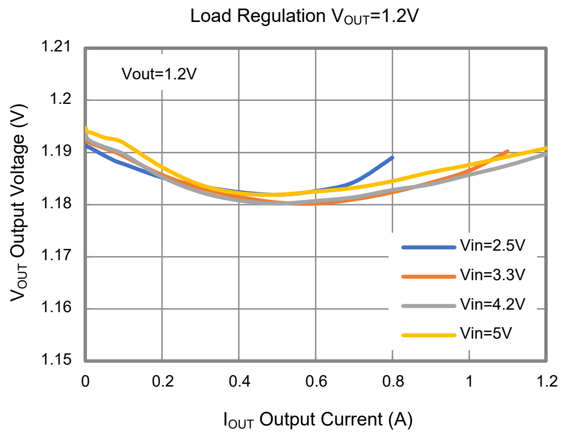
Electrical Characteristics

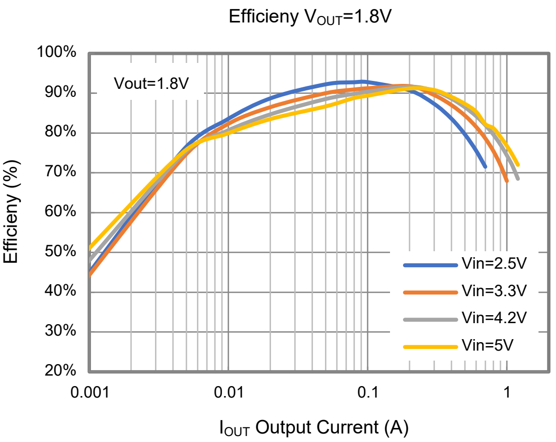
(T_J=25℃ , unless otherwise noted.)

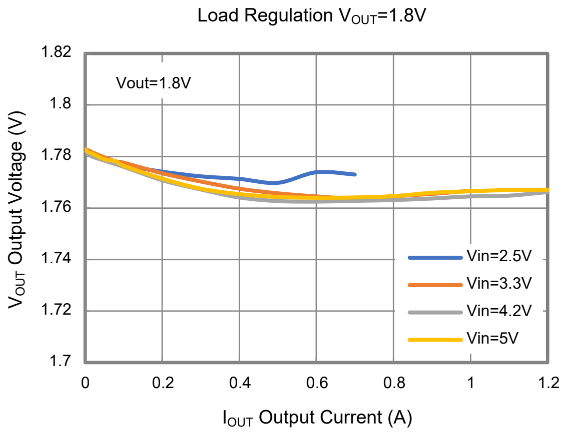
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}		2.5	--	5.5	V
Overvoltage Voltage	V_{OVP}	Input overvoltage threshold	--	6.1	--	V
Feedback Voltage	V_{FB}	No load	588	600	612	mV
Under Voltage Lock Out	V_{UVLO}		2.1	2.3	2.5	V
UVLO hysteresis	V_{UVLO_H}		0.1	0.2	0.3	V
No load supply current a V_{IN}	--		--	70	120	μA
Shutdown Supply Current	I_{SHUT}	V_{EN}=0V	--	0.1	1	μA
Efficiency	--	I_{LOAD}=0.6A	85	90	--	%
Line Regulation	$\triangle V_{Line}$	I_{LOAD}=300mA	--	0.1	0.2	%/V
Load Regulation	$\triangle V_{Load}$	I_{LOAD}=0A~1A	--	0.1	0.2	%/A
Switching Frequency	f_{SW}	V_{FB}=5V	1.6	2	2.4	MHz
Maximum Duty Cycle	D_{Max}		--	100	--	%
EN Minimum High Level	V_{EN_H}		1	--	--	V
EN Maximum Low Level	V_{EN_L}		--	--	0.3	V
Peak Current Limit	--		1.4	1.8	2.2	A
SW Leakage Current	--	V_{IN}= 6V, V_{SW}= 0 or 6V, EN=0	--	--	10	μA
OTP	--		135	150	165	°C
OTP Hystersis	--		20	30	40	°C
NMOS Switch On Resistance	R_{ON}	I_{SW}=100mA	--	250	250	mΩ
PMOS Switch On Resistance			--	350	350	mΩ

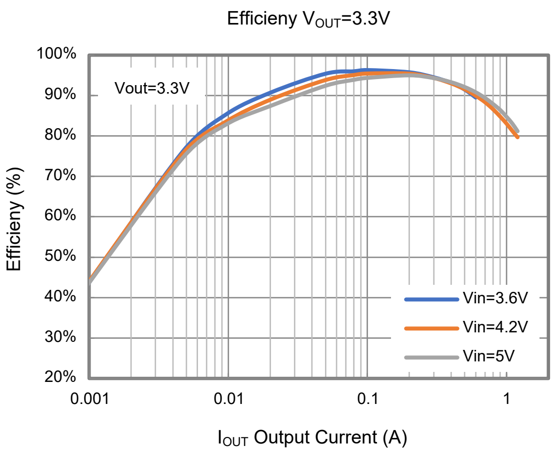
Typical Electrical Curves

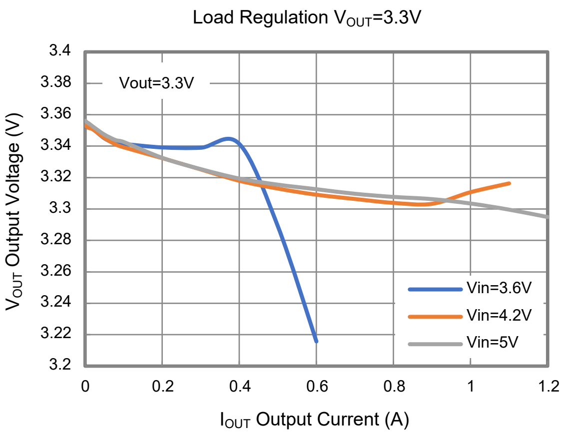


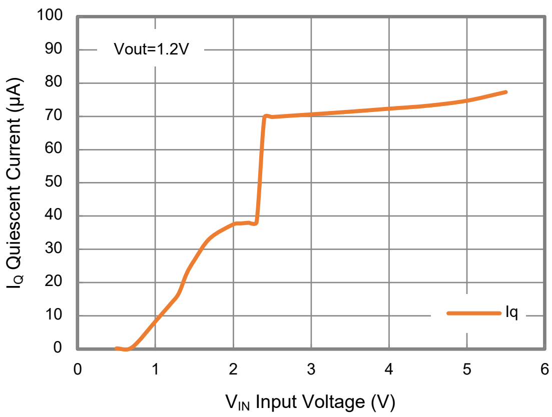


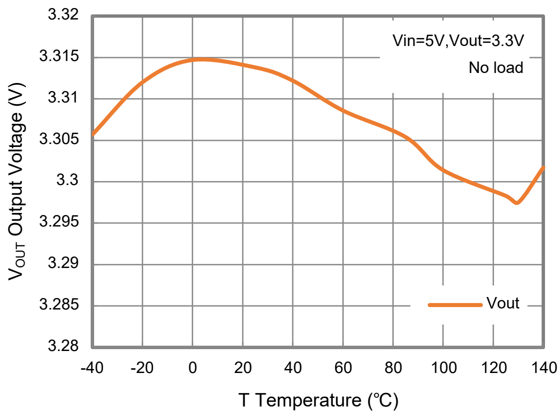




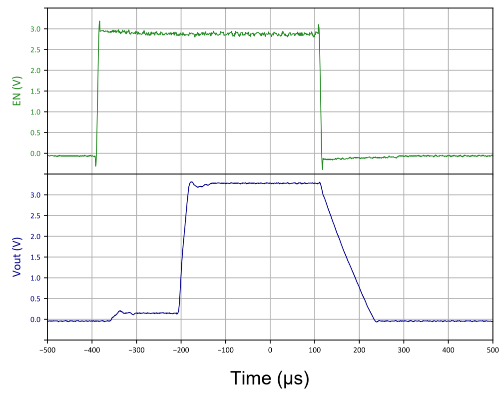




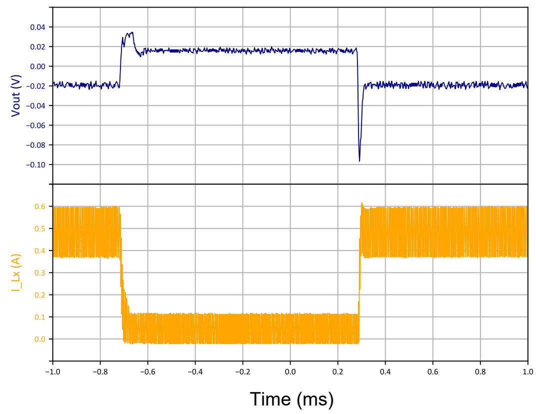




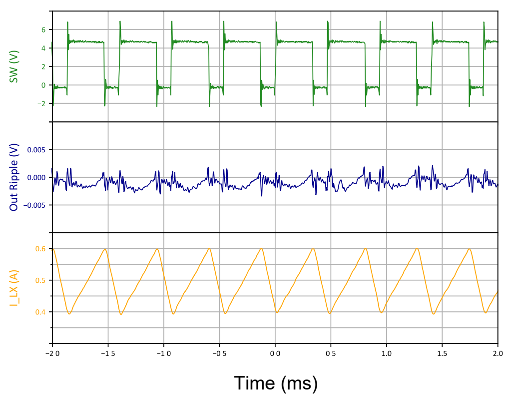
EN ON_OFF, V_{IN}=5V,V_{OUT}=3.3V,I_{OUT}=0.5A



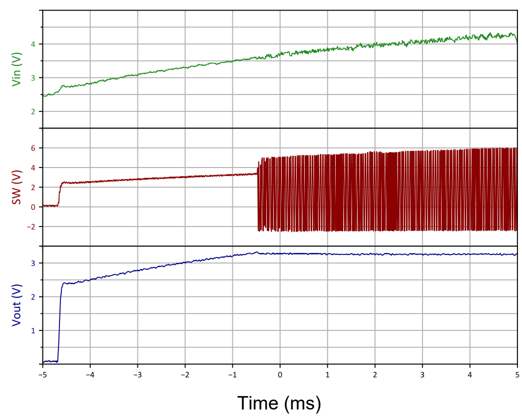
Load Transient, V_{IN}=5V,V_{OUT}=3.3V,I_{OUT}=0.01~0.5A



Operation Wavefrom, V_{IN}=5V,V_{OUT}=3.3V,I_{OUT}=0.5A



Power ON, V_{IN}=5V,V_{OUT}=3.3V,I_{OUT}=0.5A



Function Description

The TNS6001 uses a constant frequency, current mode step-down architecture. Both the main (P-channel MOSFET) and synchronous (N-channel MOSFET) switches are internal. During normal operation, the internal top power MOSFET is turned on each cycle when the oscillator sets the RS latch, and turned off when the current comparator, ICOMP, resets the RS latch. The peak inductor current at which ICOMP resets the RS latch, is controlled by the output of error amplifier EA. When the load current increases, it causes a slight decrease in the feedback voltage, FB, relative to the 0.6V reference, which in turn, causes the EA amplifier's output voltage to increase until the average inductor current matches the new load current. While the top MOSFET is off, the bottom MOSFET is turned on until either the inductor current starts to reverse, as indicated by the current reversal comparator IRCMP, or the beginning of the next clock cycle.

Application Information

Setting the Output Voltage

In the adjustable version, the output voltage is set by a resistive divider according to the following formula:

$$R_2 = R_1/(V_{OUT}/V_{FB}-1)$$

The external resistive divider is connected to the output, allowing remote voltage sensing as shown in on page1

Inductor Selection

For most designs, the TNS6001 operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = [V_{OUT}*(V_{IN}-V_{OUT})]/(V_{IN}*\triangle I_L*f_{osc})$$

Where $\triangle I_L$ is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

Input Capacitor Selection

THigher values, lower cost ceramic capacitors are now becoming available in smaller case sizes. Their high ripple current, high voltage rating and low ESR make them ideal for switching regulator applications. Because the TNS6001's control loop does not depend on the output capacitor's ESR for stable operation, ceramic capacitors can be used freely to achieve very low output ripple and small circuit size. However, care must be taken when ceramic capacitors are used at the input and the output. When a ceramic capacitor is used at the input and the power is supplied by a wall adapter through long wires, a load step at the output can induce ringing at the input, VIN. At best, this ringing can couple to the output and be mistaken as loop instability. At worst, a sudden inrush of current through the long wires can potentially cause a voltage spike at VIN, large enough to damage the part. When choosing the input and output ceramic capacitors, choose the X5R or X7R dielectric formulations. These dielectrics have the best temperature and voltage characteristics of all the ceramics for a given value and size.

PCB Layout Checklist

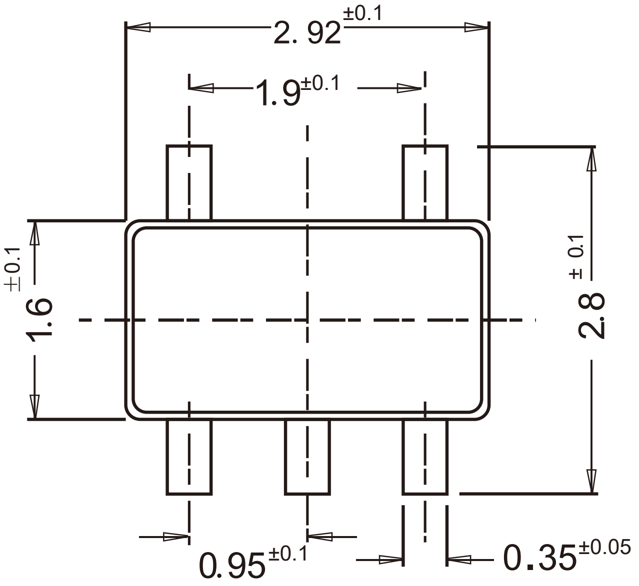
When laying out the printed circuit board, the following checking should be used to ensure proper operation of the TNS6001. Check the following in your layout:

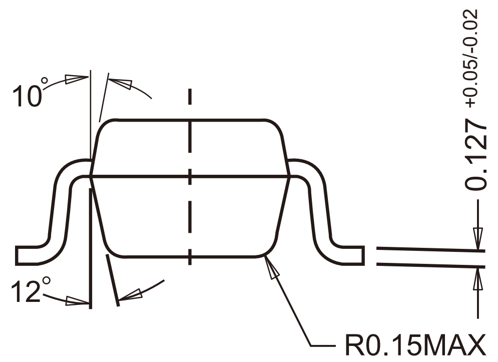
1. The power traces, consisting of the GND trace, the SW trace and the VIN trace should be kept short, direct and wide.
2. Place the Cin to TNS6001's Vin and GND pins as closely as possible. This capacitor provides the AC current to the internal power MOSFETs.
3. Better to make a star connection of ground node for Cin, TNS6001's ground and Cout.
4. Keep the switching node, SW, away from the sensitive feedback node.
5. Keep the (-) terminal of Cin and Cout as close as possible, to minimize current loop area for EMI concern.

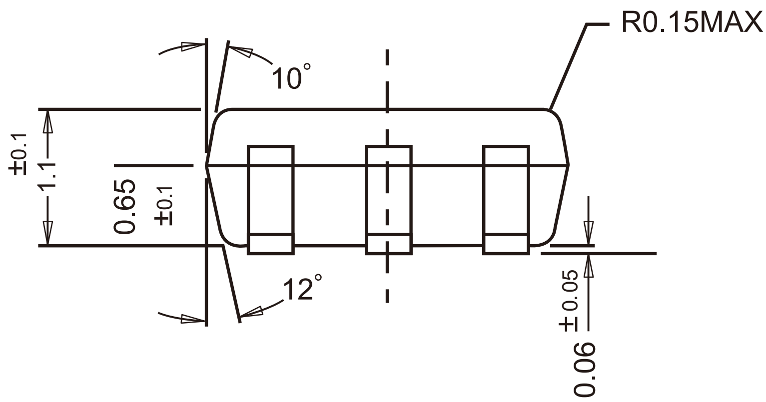
Package Outline

SOT-23-5

Dimensions in mm



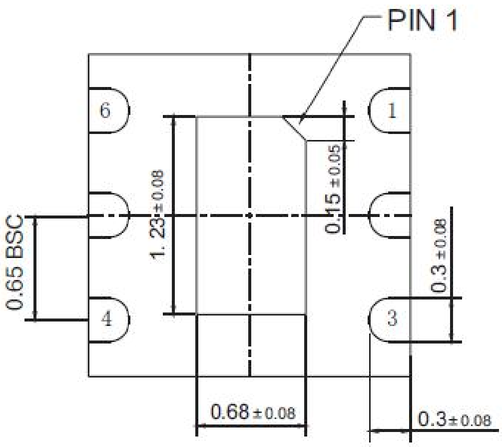




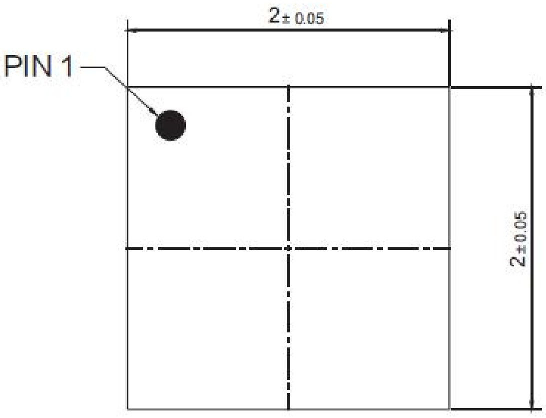
Package Outline

DFN2x2C-6L

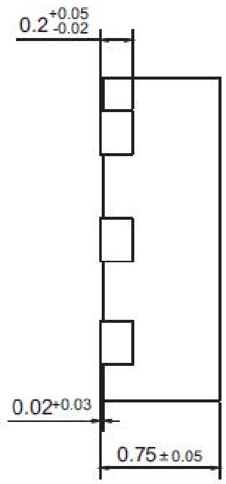
Dimensions in mm



BOTTOM VIEW



TOP VIEW



SIDE VIEW

Contact Information

TANI website: **http://www.tanisemi.com** Email:tani@tanisemi.com

For additional information, please contact your local Sales Representative.

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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