300mA Ultra-Low-Noise LDO for RF and Analog Circuits

General Description

The ET531XX family of low-dropout (LDO), low-power linear regulators offers very high power supply rejection ratio (PSRR) while maintaining very low 15μA 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 ET531XX 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 offered in a small DFN4 or SOT23-5 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~5.0V(1.2V/1.5V/1.8V/2.5V/2.8V/3.0V/3.1V/3.3V and etc)
- Up to 300mA Load Current
- Other Output Voltage Options Available on Request
- Very Low IQ: 15μA
- Low Dropout: 180mV typical@1.8V
- Very High PSRR: 80db at 1KHz
- Ultra Low Noise: 10uVrms
- Excellent Load/Line Transient Response
- Excellent Load/Line Regulation
- With Auto Discharge Function
- Package Information:

Part No.	Package	MSL
ET531XXYB	DFN4 (1×1)	Level 1
ET531XXB	SOT23-5	Level 3

Applications

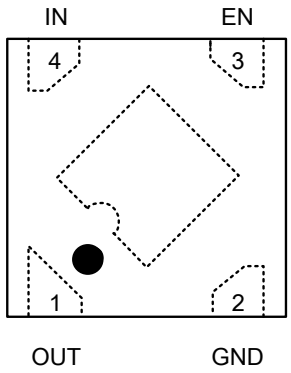
- Smart Phones and Cellular Phones
- PDAs
- MP3/MP4 Player
- Digital Still Cameras
- Portable instrument

Device Information

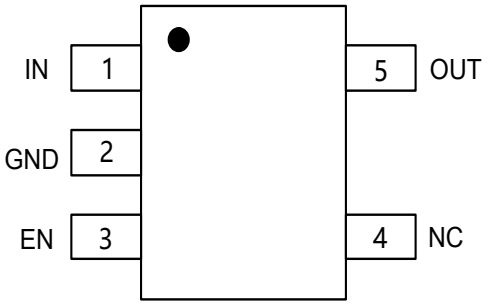
ET 531 XX X B

XX Output Voltage		**X** Package		**B** Auto-Discharging Function	
XX	Output Voltage For example, 18 is 1.8V output	Y	DFN4(1×1)	B	Auto-discharging available
		/	SOT23-5		

Pin Configuration



DFN4(1×1)



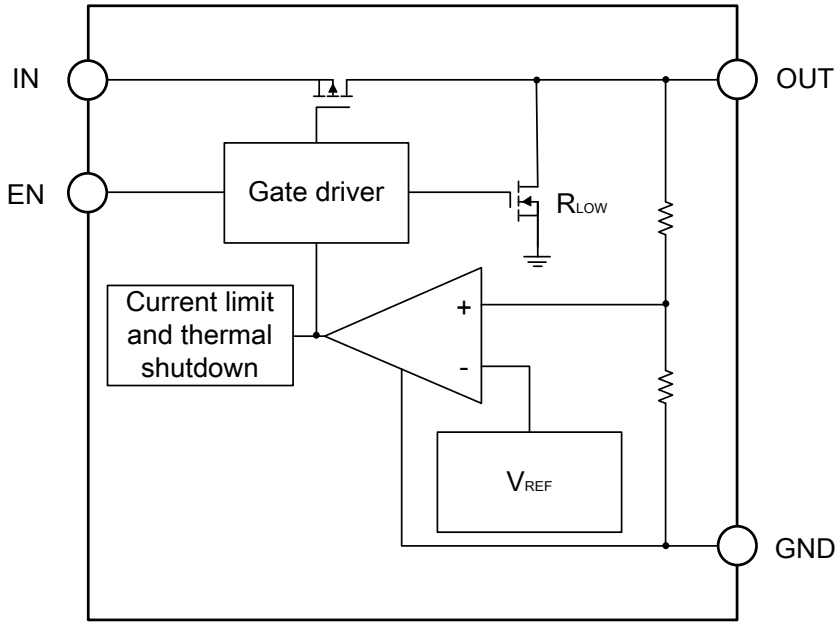
SOT23-5

Top View

Pin Function

Pin No.		Pin Name	Pin Function
DFN4	SOT23-5		
1	5	OUT	Output pin. A 1μF low-ESR capacitor should be connected to this pin to ground. An internal50Ω (typical) pull-down resistor prevents a charge remaining on OUT when the regulator is in the shutdown mode.
2	2	GND	Ground
3	3	EN	Enable control input, active high. Do not leave EN floating
4	1	IN	Supply input pin. Must be closely decoupled to GND with a 1μF or greater ceramic capacitor
-	4	Thermal Pad or NC	Thermal pad for DFN4(1×1) package, connect to GND or leave floating. Do not connect to any potential other than GND NC for SOT23-5 no connection.

Block Diagram



Functional Description

Input Capacitor

A 1μF ceramic capacitor is recommended to connect between IN 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 IN 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 100mΩ, 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 1μF ceramic output capacitor can be placed up to 10cm away from the ET531XX device.

ON/OFF Input Operation

The ET531XX EN pin is internally held low by a 1MΩ resistor to GND. The ET531XX is turned on by setting the EN pin higher than V_{IH} threshold, and is turned off by pulling it lower than V_{IL} 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

The ET531XX, with PSRR of 80dB at 1KHz, is suitable for most of these applications that require high PSRR and low noise.

Output Automatic Discharge

The ET531XX output employs an internal 50Ω (typical) pull-down resistance to discharge the output when the EN pin is low, and the device is disabled.

Remote Output Capacitor Placement

The ET531XX requires at least a 1μF 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 10cm away from the LDO.

Fast Transient Response

The ET531XX'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

The ET531XX, consuming only 15μA quiescent current, provides great power saving in portable and low power applications.

Minimum Operating Input Voltage (VIN)

The ET531XX does not include any dedicated UVLO circuitry. The ET531XX internal circuitry is not fully functional until VIN is at least 1.9V. The output voltage is not regulated until VIN has reached at least the greater of 1.9V or (V_{OUT} + V_{DROP}).

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

Thermal 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 ET531XX has been designed to protect against temporary thermal overload conditions. The TSD circuitry was not intended to replace proper heat-sinking. Continuously running the ET531XX device into thermal shutdown may degrade device reliability

Absolute Maximum Ratings

Symbol	Parameters (Items)	Value	Unit
V_{IN}	IN Voltage	-0.3 to 6	V
V_{EN}	Input Voltage (EN Pin)	-0.3 to 6	V
V_{OUT}	Output Voltage	-0.3 to V_{IN}+0.3	V
P_D	Maximum Power Consumption (1)	600	mW
I_{MAX}	Maximum Load Current	300	mA
T_J	Operating Junction Temperature	-40 to 150	°C
T_{STG}	Storage Temperature	-65 to 150	°C
T_{SLOD}	Lead Temperature (Soldering, 10 sec)	300	°C
ESD	Human Body Model per ESDA/JEDEC JS-001-2017	±4000	V
	Charged Device Model per ESDA/JEDEC JS-002-2014	±1500	V

Note (1): Rating at mounting on a board (PCB board dimension: 40mm x 40mm (4layer), copper: 1OZ).

Recommended Operating Conditions

Symbol	Parameters	Rating	Unit
V_{IN}	Input Voltage	1.9 to 5.5	V
I_{OUT}	Output Current	0 to 300	mA
T_A	Operating Ambient Temperature	-40 to 85	ºC
C_{IN}	Effective Input Ceramic Capacitor Value	0.47 to 10	μF
C_{OUT}	Effective Output Ceramic Capacitor Value	0.47 to 10	μF
ESR	Input and Output Capacitor Equivalent Series Resistance (ESR)	5 to 100	mΩ

Electrical Characteristics

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

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		1.9		5.5	V
V_{OUT}	Output Voltage Range		1.2		5.0	V
ΔV_{OUT}	Output Voltage Tolerance	V_{IN}=($V_{OUT(NOM)}$+1V) to 5.5V I_{OUT}=1mA to 300mA	-2		2	%
	Line Regulation	V_{IN}=(V_{OUT}+1V) to 5.5V,I_{OUT}=1mA		0.02		%/V
	Load Regulation	I_{OUT}=1mA to 300mA		15	40	mV
I_{LOAD}	Load Current		300			mA
I_{Q_OFF}	Input Shutdown Quiescent Current	V_{EN}=0V		0.2	1	uA
I_{Q_ON}	Input Quiescent Current /Channel	V_{EN}=1.2V, V_{IN}=V_{OUT} +1V I_{OUT}= 0mA		15	25	uA
		V_{EN}=1.2V, V_{IN}=V_{OUT} +1V I_{OUT}= 300mA		250	425	uA
V_{DROP}	Dropout Voltage	V_{OUT}=1.2V, I_{OUT}=300mA			700	mV
		V_{OUT}=1.8V,I_{OUT}=300mA		180		mV
		V_{OUT}=2.8V,I_{OUT}=300mA		135		mV
		V_{OUT}=3.3V,I_{OUT}=300mA		110		mV
I_{LIMIT}	Current Limit	R_{LOAD}=1Ω, T_A=25°C	400	600	1000	mA
I_{SHORT}	Short Current Limit	V_{OUT}=0V, T_A=25°C		60		mA
PSRR[(2)]	Power Supply Rejection Ratio	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
e_N[(2)]	Output Noise Voltage	BW=10 Hz to 100 kHz, I_{OUT}=1mA		10		uV_{RMS}
		BW=10 Hz to 100 kHz, I_{OUT}=300mA		6.5		uV_{RMS}
R_{LOW}	Output Discharge FET Rdson	V_{EN}=0V, I_{OUT}=10mA		50		Ω
V_{IL}	EN Input Logic Low Voltage	V_{IN}= 1.9V to 5.5V, V_{EN} falling until the output is disabled			0.4	V
V_{IH}	EN Input Logic High Voltage	V_{IN}= 1.9 V to 5.5V, V_{EN} rising until the output is enabled	1.2			V
I_{EN}	EN Input Leakage current	V_{IN}=5.5V, V_{EN} = 0V		0.01	1	uA
		V_{IN}=5.5V, V_{EN} = 5.5V		5.5		uA

Electrical Characteristics (Continued)

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

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
TRANSIENT CHARACTERISTICS						
ΔV_{OUT}[(2)]	Line transient	V_{IN}=(V_{OUT}+1V) to (V_{OUT}+1.6V) in 10us		10		mV
		V_{IN}=(V_{OUT}+1.6V) to (V_{OUT}+1V) in 10us		10		mV
	Load transient	I_{OUT}=1mA to 300mA in 10us		30		mV
		I_{OUT}=300mA to 1mA in 10us		30		mV
	Overshoot on start-up	Stated as percentage of $V_{OUT(NOM)}$			5	%
t_{ON}	Output Turn-on Time	From V_{EN}> V_{IH} to V_{OUT} = 95% of $V_{OUT(NOM)}$		70	150	us
T_{SHDN}	Thermal Shutdown threshold[(2)]	T_J rising		160		°C
T_{HYS}	Thermal Shutdown Hysteresis[(2)]	T_J falling from shutdown		15		°C

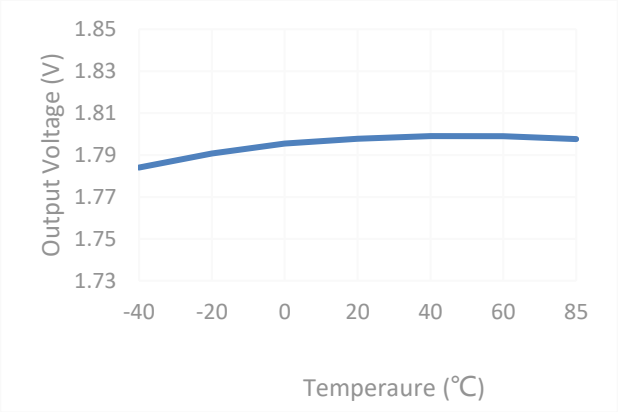
Note (2). Guaranteed by design and characterization. not a FT item.

Typical Characteristics

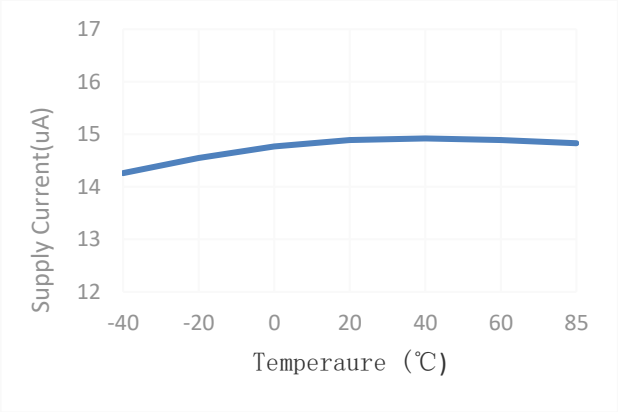
VOLTAGE VERSION 1.8V

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

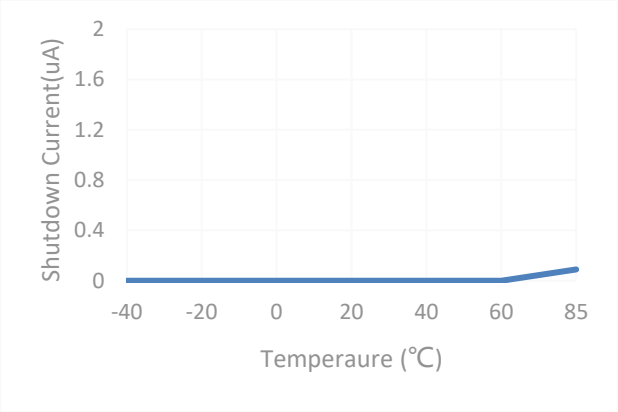
(V_{IN} =2.8V, I_{OUT}=1mA, C_{IN} =Ceramic 1.0μF, C_{OUT}=Ceramic 1.0μF)



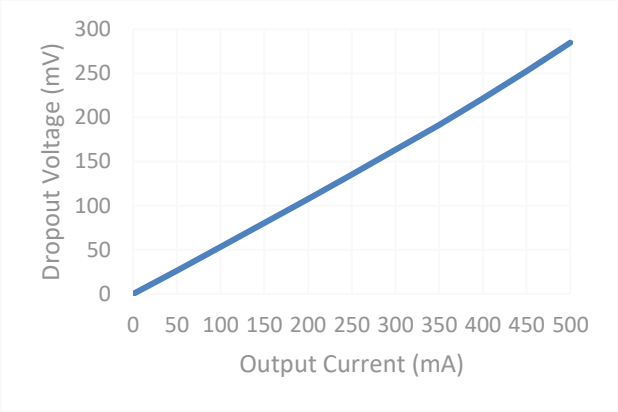
Output Voltage vs. Temperature



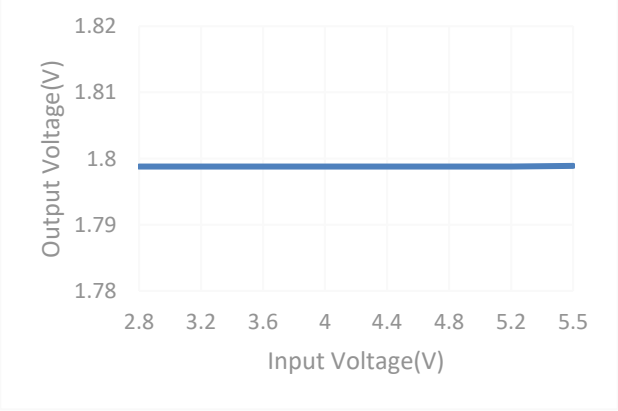
Supply Current vs. Temperature



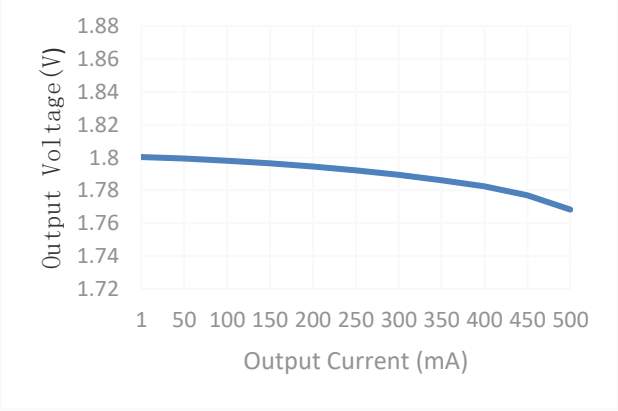
Shutdown Current VS Temperature



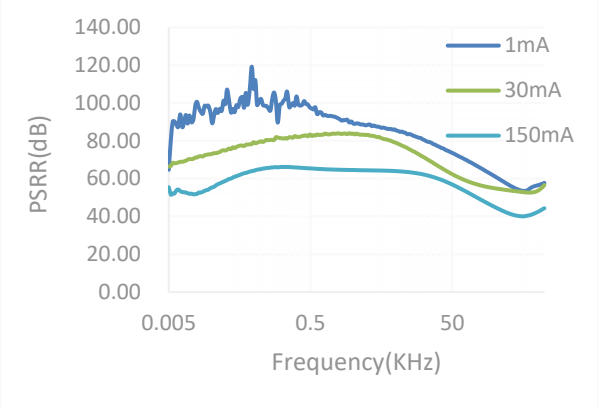
Dropout Voltage vs. Output Current



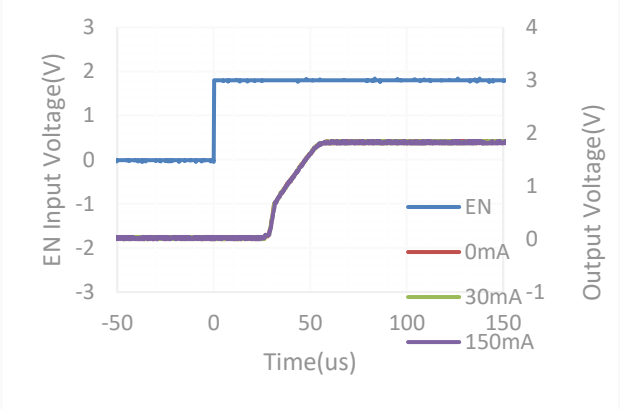
Output Voltage VS Input Voltage



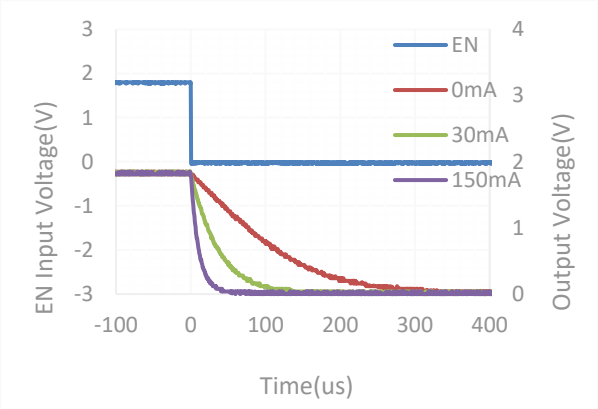
Output Voltage VS Output Current



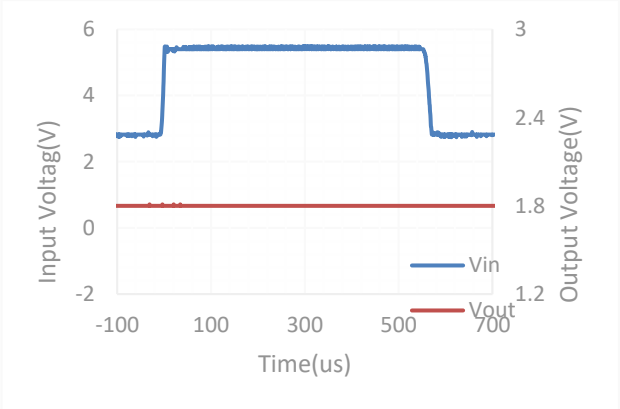
PSRR VS I_{OUT}



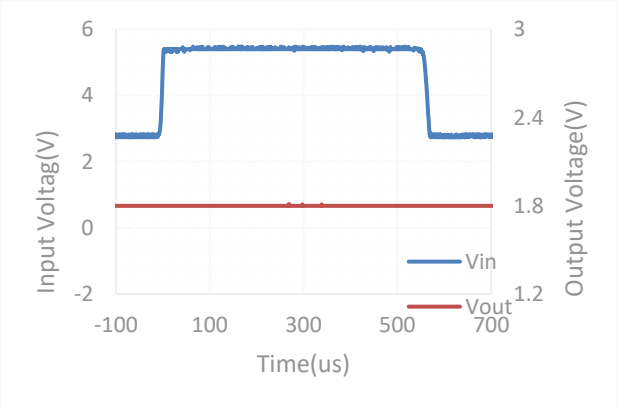
Turn On Speed VS EN Voltage



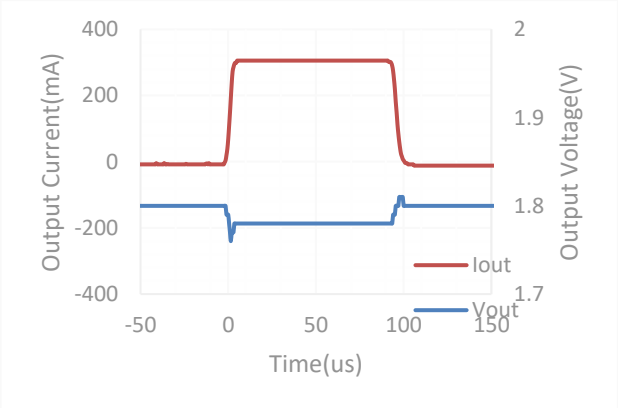
Turn Off Speed VS EN Voltage



Input Transient Response(I_{OUT}=1mA)

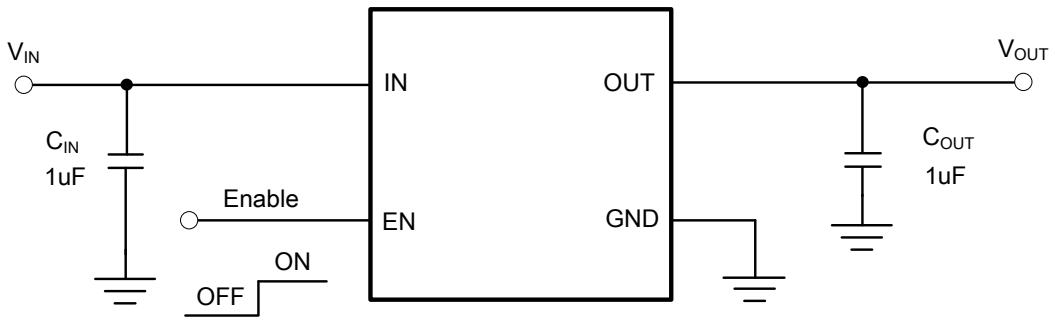


Input Transient Response(I_{OUT}=30mA)

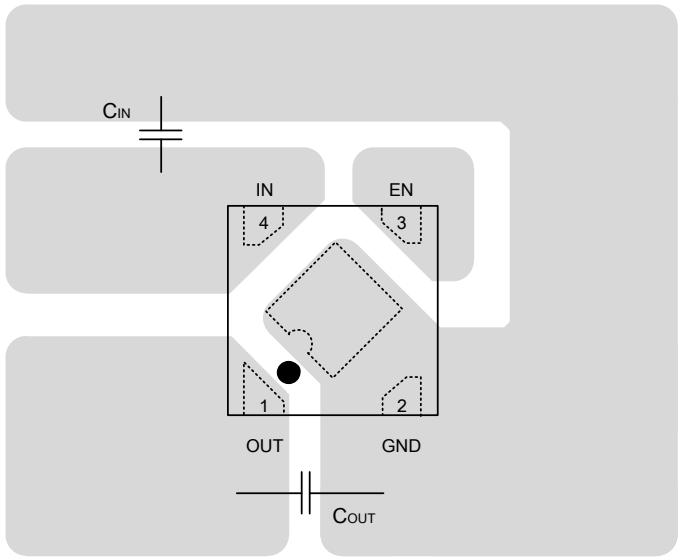


Load Transient Response

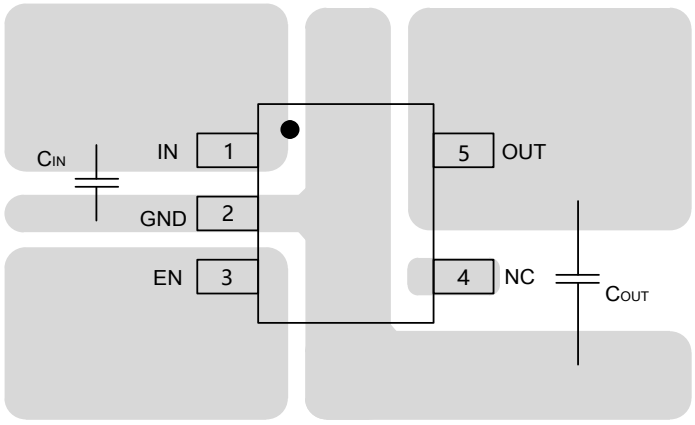
Application Circuits



PCB Layout Guide



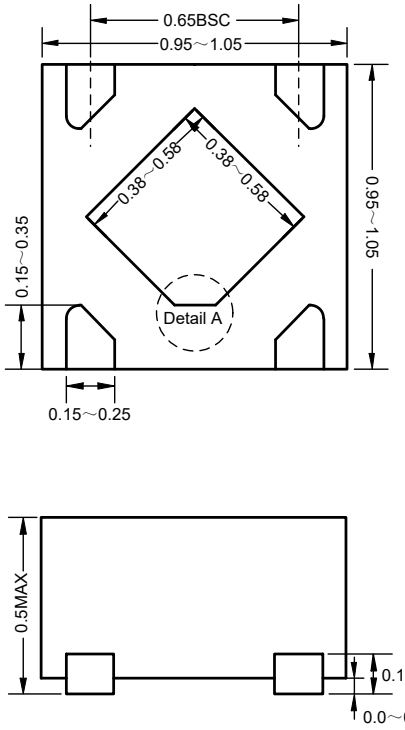
DFN4

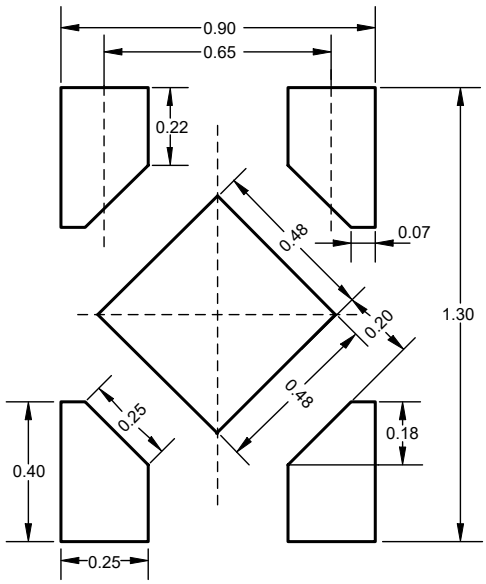


SOT23-5

Package Dimension

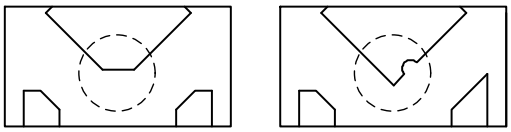
DFN4





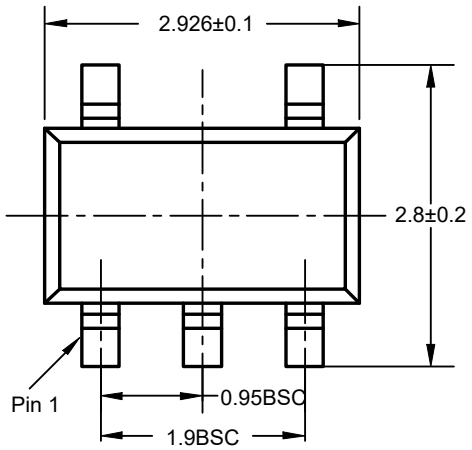
Recommended Land Pattern

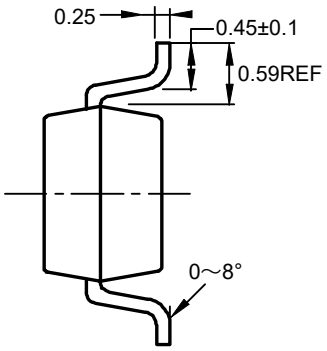
Detail A: (PIN1 shape)

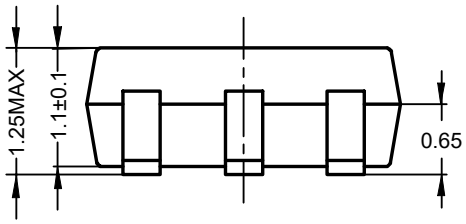


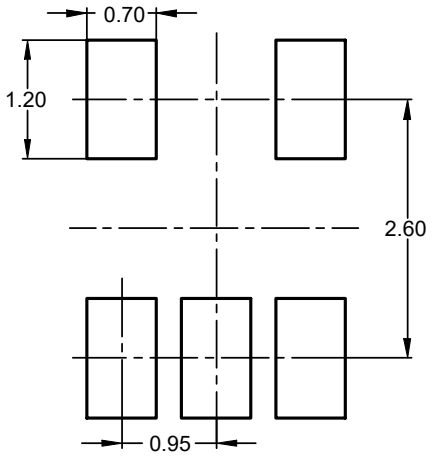
Unit: mm

SOT23-5







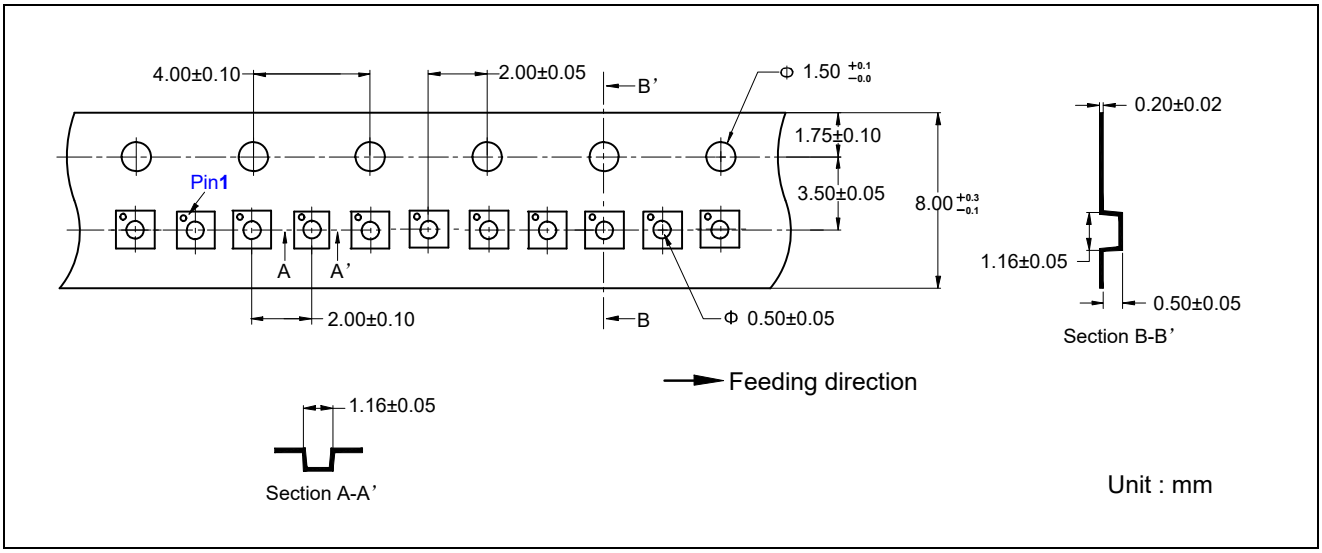


Recommended Land Pattern

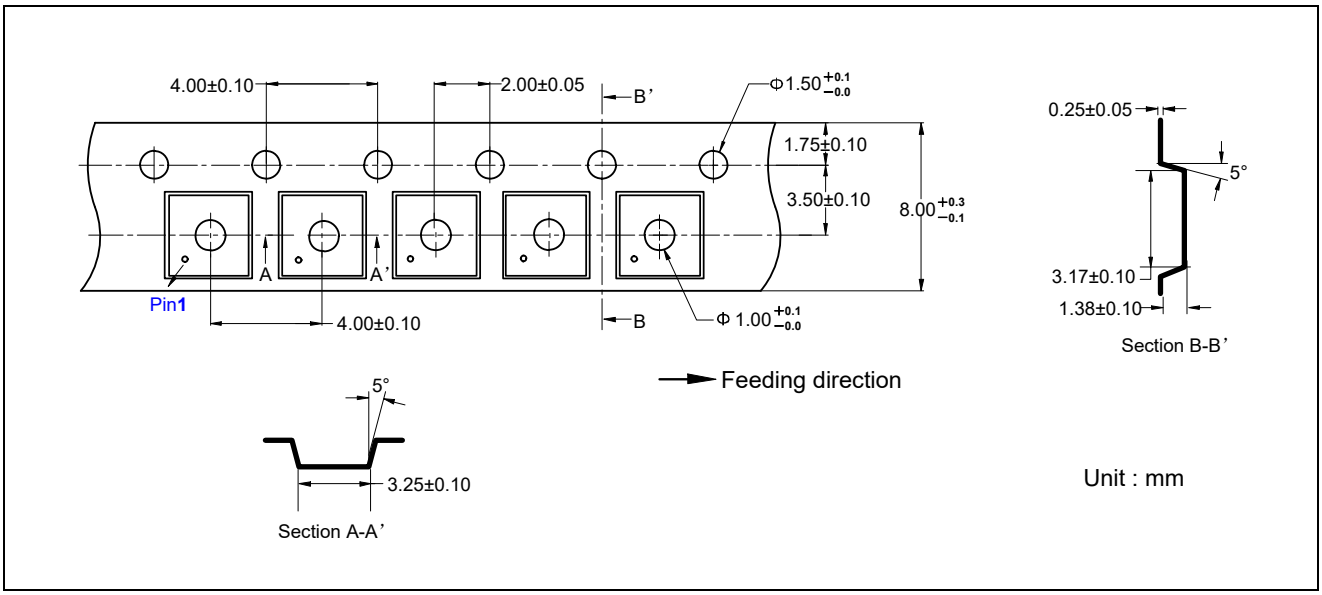
Unit: mm

Tape Information

DFN4 (1mm × 1mm)



SOT23-5



Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2018-06-27	Original Version	Liu Yi Guo	Liu Yi Guo	Liu Jia Ying
1.1	2018-12-12	Update EC table	Liu Yi Guo	Liu Yi Guo	Liu Jia Ying
1.2	2022-08-24	Update Typeset	Yang Xiao Xu	Liu Yi Guo	Yang Xiao Xu
1.3	2023-10-11	Update package picture	Shibo	Liu Yi Guo	Yang Xiao Xu