SK6011

300mA Ultra Low Noise LDO for RF and Analog Circuits

DESCRIPTION

The SK6011 is low-power, low-dropout linear regulators, this device offers very high power supply rejection ratio (PSRR) while maintaining very low 15μA quiescent current, which makes it very suitable for RF applications.

The SK6011 uses an advanced CMOS process and a PMOS pass device to achieve fast start-up, very low noise, excellent transient response, and excellent PSRR performance.

The SK6011 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.

The SK6011 is available in DFN1×1-4L and SOT23-5L packages, which is ideal for small form factor portable equipment such as wireless handsets and PDAs.

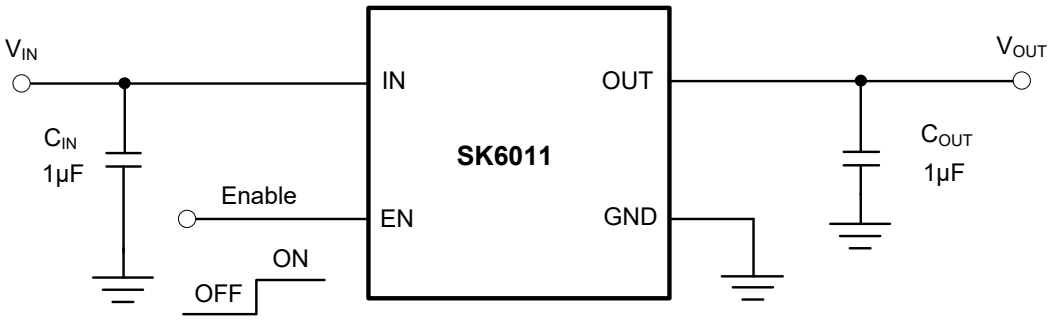
FEATURES

- Wide Input Voltage Range: 1.9V to 5.5V
- Output Voltage: 1.2V to 4.5V
- Up to 300mA Load Current
- Other Output Voltage Available on Request
- Very Low IQ: 15μA
- Low Dropout: 180mV@300mA, when V_{OUT}=3.3V
- Very High PSRR: 90dB@1kHz (load=1mA)
- Ultra Low Noise: 10μVRMS@3.3V output (load=1mA)
- Excellent Load/Line Transient Response
- Line Regulation: 0.02%/V typical
- Short-Circuit Current Limit: 60mA (Current at short mode) typical
- With Auto Discharge

APPLICATIONS

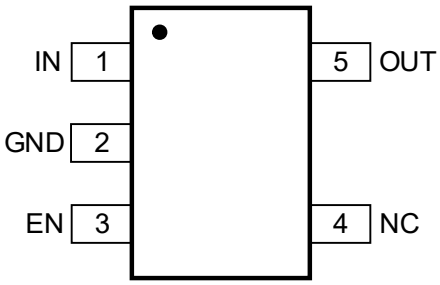
- Smart Phones and Cellular Phones
- PDAs
- MP3/MP4 Player
- Digital Still Cameras
- Portable Instrument

TYPICAL APPLICATION CIRCUITS

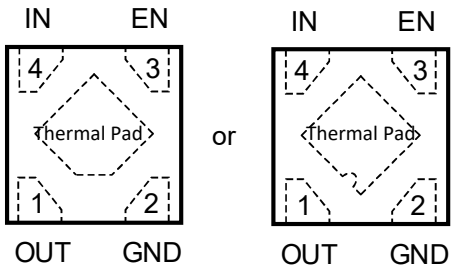


PIN CONFIGURATION

TOP VIEW



SOT23-5L



DFN1×1-4L

PIN DESCRIPTIONS

Pin No.		Symbol	Description
SOT23-5L	DFN1×1-4L		
1	4	IN	Supply input pin. Must be closely decoupled to GND with a 1μF or greater ceramic capacitor.
2	2	GND	Ground.
3	3	EN	Enable control input, active high. Do not leave EN floating.
4	-	NC	No Connection.
5	1	OUT	Output pin. Bypass a 1μF ceramic capacitor from this pin to ground.
	Thermal Pad	-	Thermal pad, connect to GND.

ORDERING INFORMATION

Part Number	Package	Packing Option
SK6011D4-XX	DFN1×1-4L	Tape and Reel, 10000
SK6011S5-XX	SOT23-5L	Tape and Reel, 3000

*XX: When expressed as 18, the output voltage is 1.8 V;
SK6011 devices are Pb-free and RoHS compliant.

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

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	°C
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 noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		1.9		5.5	V
ΔV_{OUT}	Output Voltage Tolerance	V_{IN} = 2.8 V to 5.5 V, I_{OUT} = 1 mA to 300 mA	-2		2	%V_{OUT}
	Line Regulation	V_{IN} = 2.8 V to 5.5 V, I_{OUT} = 1 mA		0.02		%/V
	Load Regulation	I_{OUT} = 1 mA to 300 mA		15	40	mV
I_{LOAD}	Load Current		300			mA
I_{SHDN}	Input Shutdown Quiescent Current	V_{EN} = 0 V		0.2	1	μA
I_Q	Input Quiescent Current	V_{EN} = 1.2V, V_{IN} = V_{OUT} +1V, I_{OUT} = 0mA		15	25	μA
V_{DROP}	Dropout Voltage (1)	V_{OUT} = 1.8V, I_{OUT} = 300 mA		180		mV
		V_{OUT} = 3.3V, I_{OUT} = 300 mA		110		mV
I_{LMT}	Output Current Limit	R_{LOAD}=1Ω, T_A=25℃	400	600		mA
I_{SHORT}	Short Current Limit	V_{OUT} = 0 V, T_A=25℃		60		mA
PSRR(2)	Power Supply Rejection Ratio	f = 100 Hz, I_{OUT} = 1 mA		94		dB
		f = 1 kHz, I_{OUT} = 1 mA		90		dB
		f = 10 kHz, I_{OUT} = 1 mA		84		dB
		f = 100 kHz, I_{OUT} = 1 mA		71		dB
		f = 1 MHz, I_{OUT} = 1 mA		60		dB
		f = 100 Hz, I_{OUT} = 20 mA		84		dB
		f = 1 kHz, I_{OUT} = 20 mA		82		dB
		f = 10 kHz, I_{OUT} = 20 mA		75		dB
		f = 100 kHz, I_{OUT} = 20 mA		55		dB
		f = 1 MHz, I_{OUT} = 20 mA		50		dB
e_N(2)	Output Noise Voltage	BW = 10 Hz to 100 kHz, I_{OUT} = 1 mA		10		μV_{RMS}
		BW = 10 Hz to 100 kHz, I_{OUT} = 300 mA		6.5		μV_{RMS}
R_{LOW}	Output Discharge Resistance	V_{EN} = 0V, I_{OUT} = 10mA		50		Ω
V_{IL}	EN Input Logic Low Voltage	V_{IN} = 1.9 V to 5.5 V, V_{EN} falling until the output is disabled			0.4	V
V_{IH}	EN Input Logic High Voltage	V_{IN} = 1.9 V to 5.5 V, V_{EN} rising until the output is enabled	1.2			V
I_{EN}	EN Input leakage current	V_{IN} = 5.5 V ,V_{EN} = 0 V		0.01	1	μA
		V_{IN} = 5.5 V ,V_{EN} = 5.5 V		5.5		μA
T_{SHDN}	Thermal shutdown threshold(2)	T_J rising		155		°C
T_{HYS}	Thermal shutdown hysteresis(2)	T_J falling from shutdown		15		°C

ELECTRICAL CHARACTERISTICS (Continued)

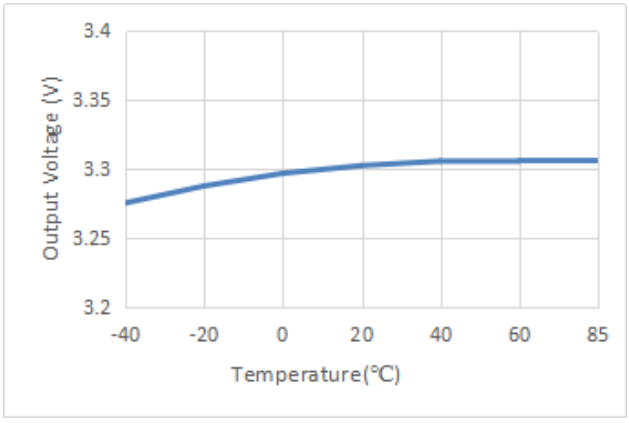
V_{IN} =V_{OUT} +1V, V_{EN} = 1.2V, I_{OUT} = 1mA, C_{IN} =1µF, C_{OUT} =1µF, T_A=25℃, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
ΔV_{OUT}(2)	Line transient	V_{IN} = (V_{OUT}) + 1 V) to (V_{OUT} + 1.6 V) in 10 µs		10		mV
		V_{IN} = (V_{OUT} + 1.6 V) to (V_{OUT} + 1 V) in 10 µs		10		mV
	Load transient	I_{OUT} = 1 mA to 300 mA in 10 µs		30		mV
		I_{OUT} = 300 mA to 1 mA in 10 µs		30		mV
Overshoot	Overshoot on start-up	Stated as percentage of $V_{OUT(SET)}$			5	%
t_{ON}	Output Turn-on Time	From V_{EN} > V_{IH} to V_{OUT} = 95% of $V_{OUT(SET)}$		70	150	µs

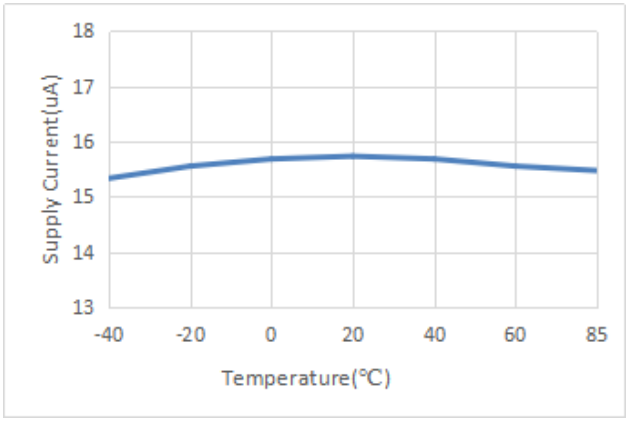
Note: (2) Guaranteed by design and characterization. not a FT item.

TYPICAL CHARACTERISTICS

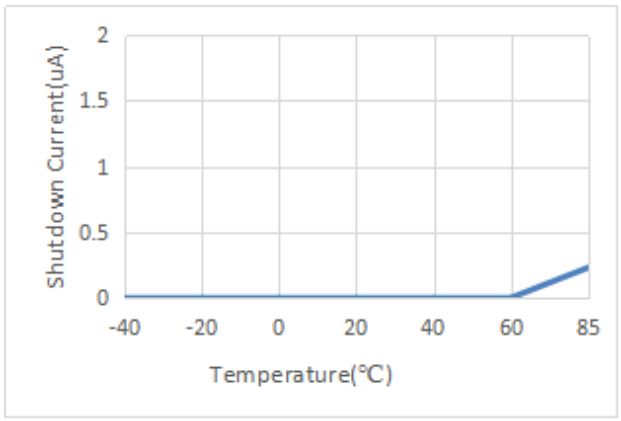
(V_{IN} =4.3V, V_{OUT}=3.3V, I_{OUT}=1mA, C_{IN} =Ceramic 1.0μF, C_{OUT}=Ceramic 1.0μF, unless otherwise noted.)



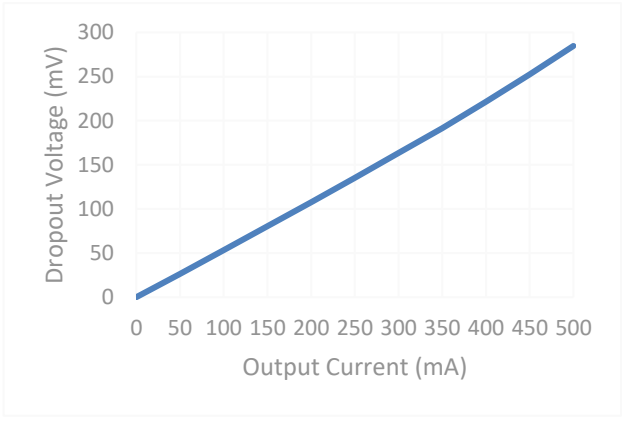
Output Voltage *vs.* Temperature



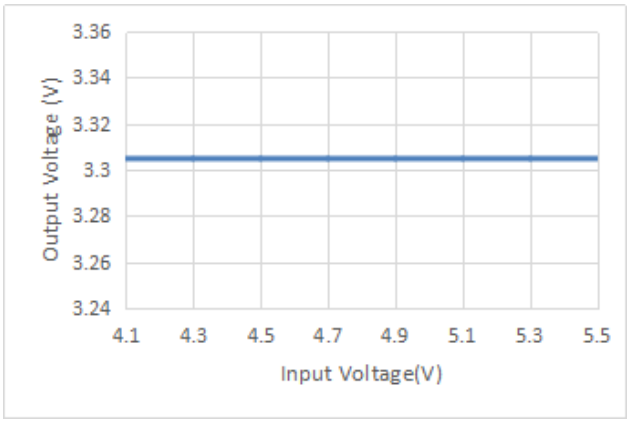
Supply Current *vs.* Temperature



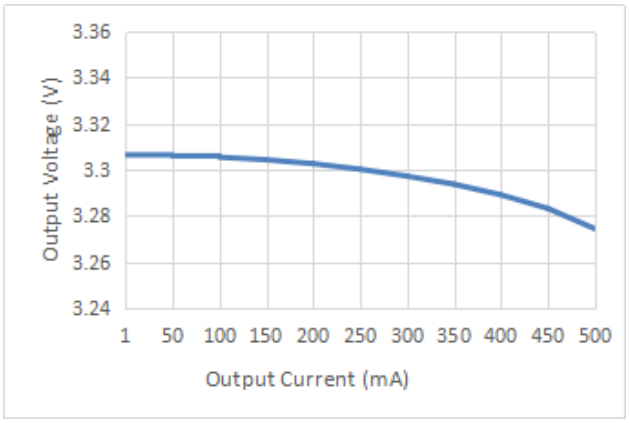
Shutdown Current *vs.* Temperature



Dropout Voltage *vs.* Output Current



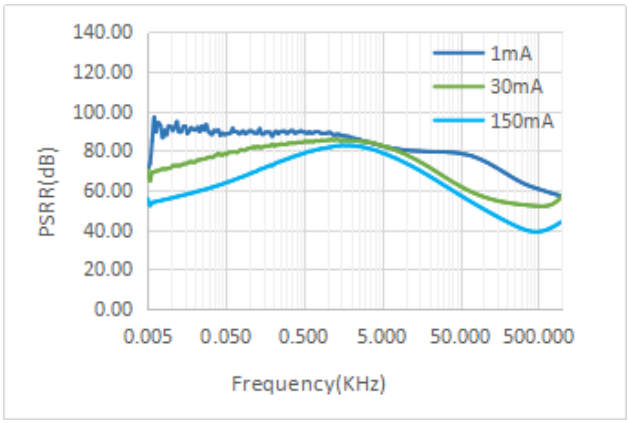
Output Voltage *vs.* Input Voltage



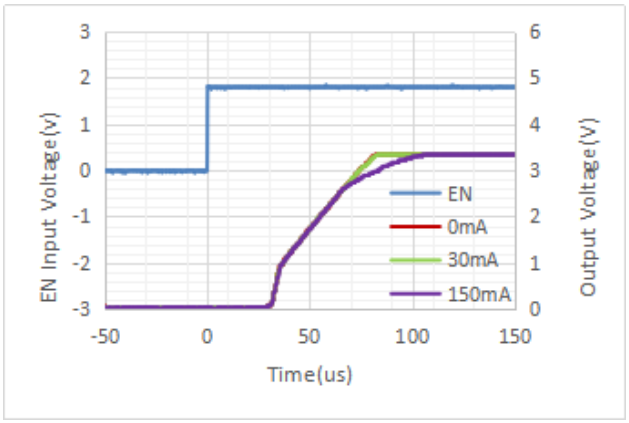
Output Voltage *vs.* Output Current

TYPICAL CHARACTERISTICS (Continued)

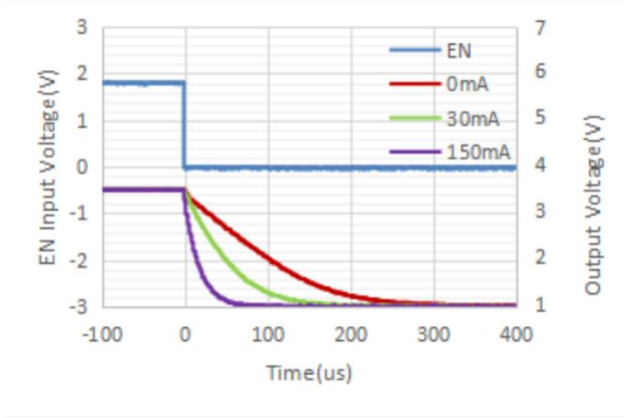
(V_{IN} =4.3V, V_{OUT}=3.3V, I_{OUT}=1mA, C_{IN} =Ceramic 1.0μF, C_{OUT}=Ceramic 1.0μF, unless otherwise noted.)



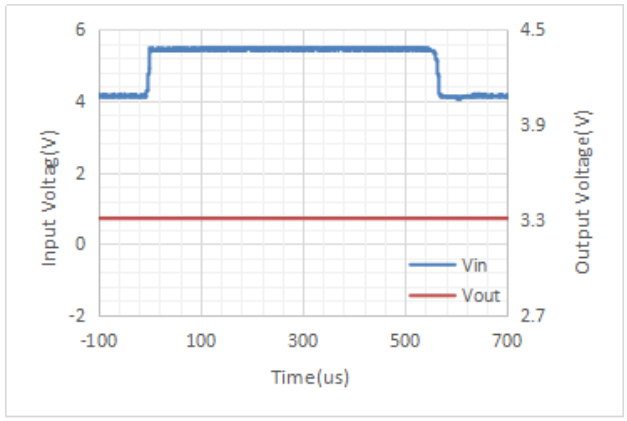
PSRR *vs.* I_{OUT}



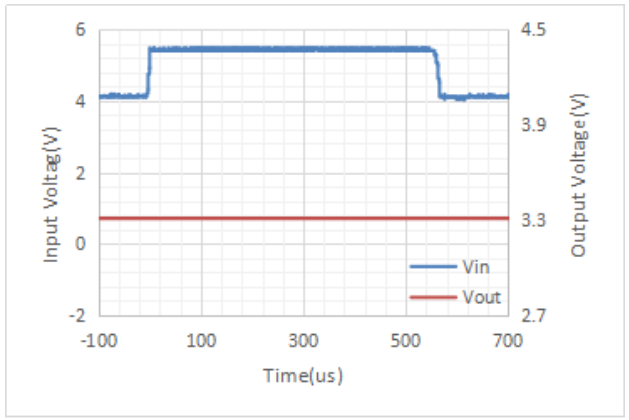
Turn On Speed *vs.* EN Voltage



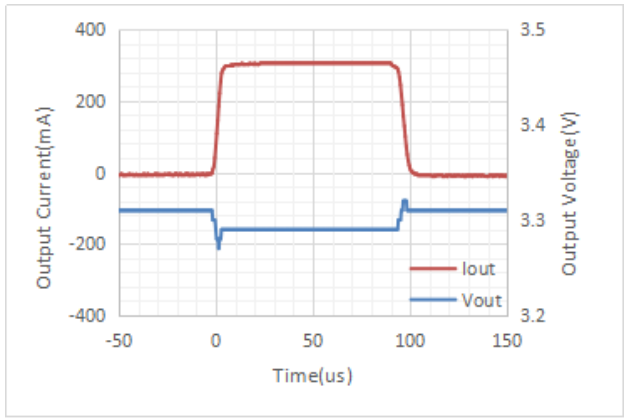
Turn Off Speed *vs.* EN Voltage



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

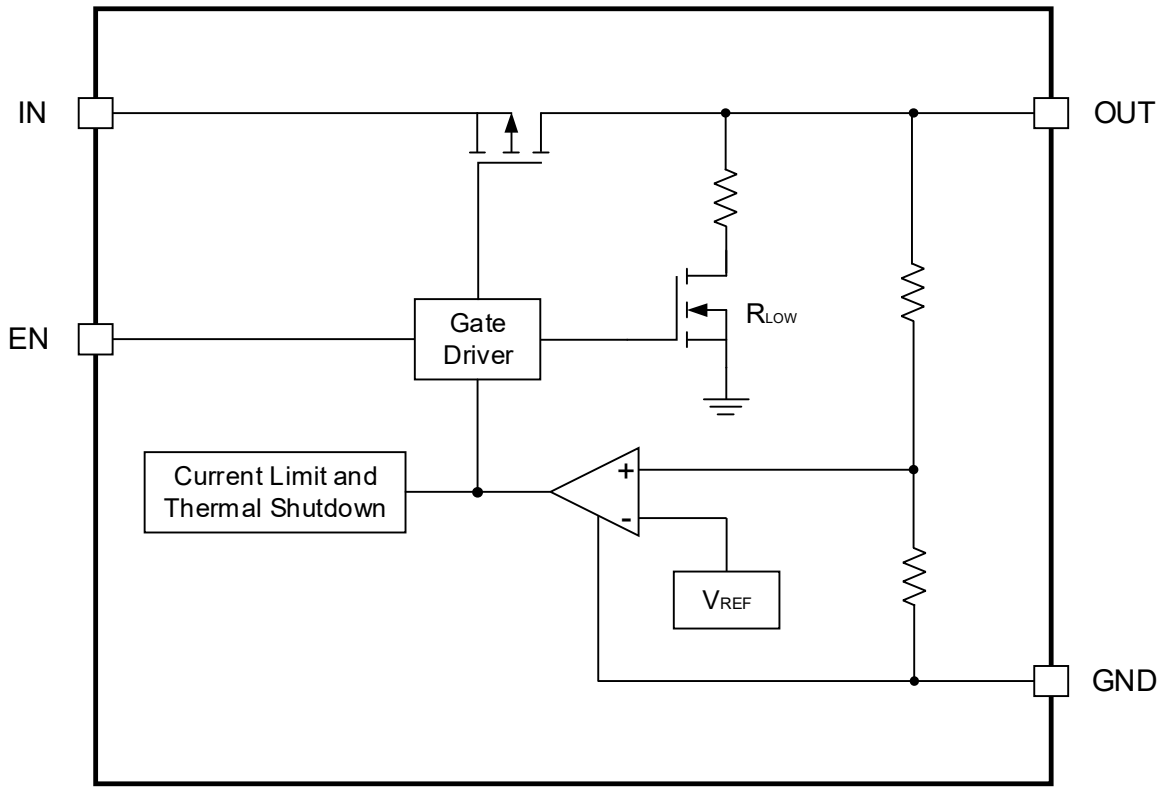


Input Transient Response (I_{OUT}=30mA)



Load Transient Response

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 SK6011 device.

ON/OFF Input Operation

The SK6011 EN pin is internally held low by a 1MΩ resistor to GND. The SK6011 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

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 to 20kHz). The SK6011, with PSRR around 80dB at 1 kHz, is suitable for most of these applications that require high PSRR and low noise.

Output Automatic Discharge

The SK6011 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 SK6011 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

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%, 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 SK6011'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 SK6011 consuming only 15μA quiescent current, provides great power saving in portable and low power applications.

Minimum Operating Input Voltage (V_{IN})

The SK6011 does not include any dedicated UVLO circuitry. The SK6011 internal circuitry is not fully functional until V_{IN} is at least 1.9V. The output voltage is not regulated until V_{IN} 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-circuit 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 (TSD)

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.

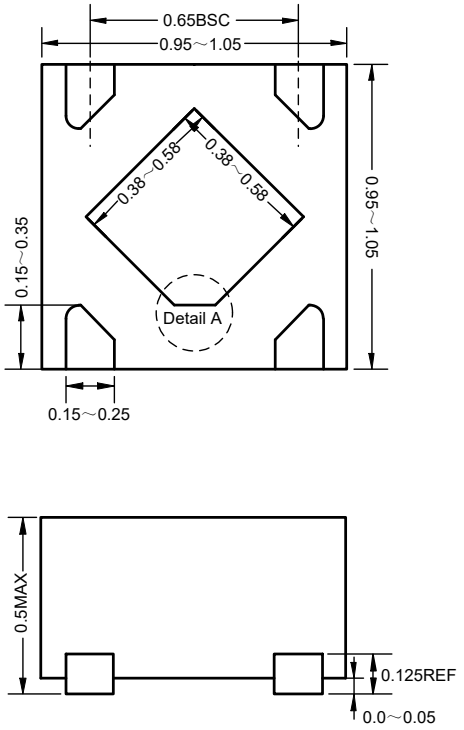
The thermal shutdown circuitry of the SK6011 has been designed to protect against temporary thermal overload conditions. The TSD circuitry was not intended to replace proper heat-sinking. Continuously running the SK6011 device into thermal shutdown may degrade device reliability.

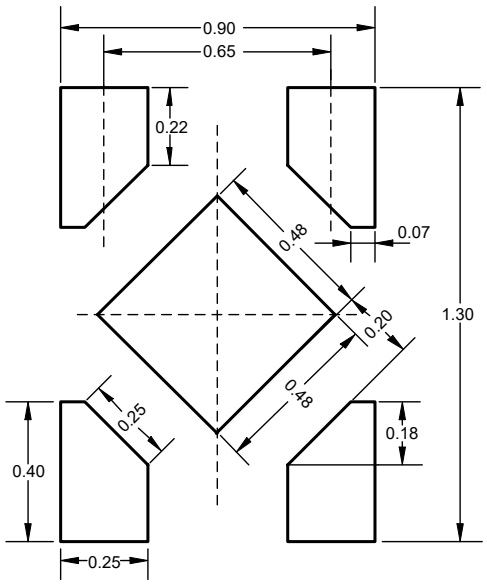
Caution

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SUNTEK recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

SUNTEK reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact SUNTEK sales office to get the latest datasheet.

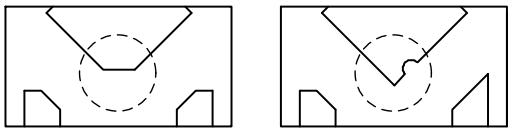
PACKAGE DIMENSIONS: DFN1x1-4L





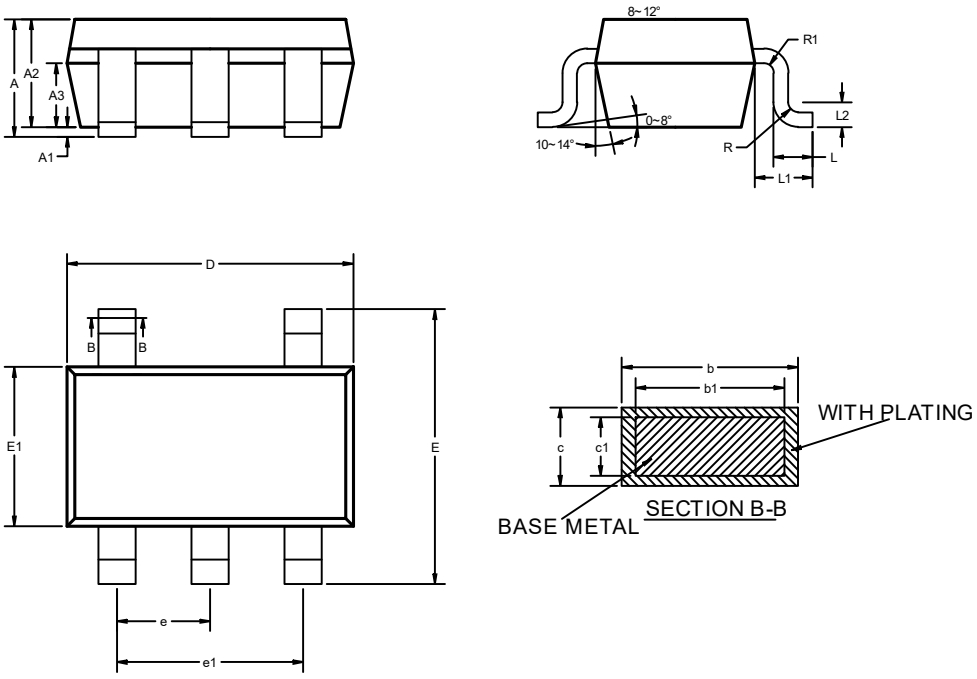
Recommended Land Pattern

Detail A: (PIN1 shape)



Unit: mm

PACKAGE DIMENSIONS: SOT23-5L



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	—	—	1.250
A1	0	—	0.150
A2	1.000	1.100	1.200
A3	0.600	0.650	0.700
b	0.360	—	0.450
b1	0.350	0.380	0.410
c	0.140	—	0.200
c1	0.140	0.150	0.160
D	2.826	2.926	3.026
E	2.600	2.800	3.000
E1	1.526	1.626	1.726
e	0.900	0.950	1.000
e1	1.800	1.900	2.000
L	0.300	0.400	0.500
L1	0.590REF		
L2	0.250BSC		
R	0.050	—	0.200
R1	0.050	—	0.200