SGM2037S
Fast Load Transient Response, 600mA, Low Noise, CMOS LDO with Bias Rail

GENERAL DESCRIPTION

The SGM2037S is a low noise, low dropout voltage linear regulator which is designed using CMOS technology. It provides 600mA output current capability. The operating input voltage range is from 0.9V to 5.5V and bias supply voltage range is from 2.5V to 5.5V. The fixed output voltage is 0.9V.

Other features include logic-controlled shutdown mode, short-circuit current limit and thermal shutdown protection. The SGM2037S has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2037S is suitable for applications which need low noise, fast transient response and low I_Q consumption, such as battery-powered equipment and smartphones, etc.

The SGM2037S is available in a Green UTDFN-1.2×1.2-6L package. It operates over an ambient temperature range of -40℃ to +125℃.

FEATURES

- **600mA Nominal Output Current**
- **Input Voltage Range: 0.9V to 5.5V**
- **Bias Voltage Range: 2.5V to 5.5V**
- **0.9V Fixed Output Voltage**
- **Low Dropout Voltage: 140mV (TYP) at 600mA**
- **Very Low Bias Input Current: 98μA (TYP)**
- **Very Low Bias Input Current in Shutdown: 0.01μA (TYP)**
- **Low Noise: 20μV_{RMS} (TYP)**
- **Over-Current and Over-Temperature Protections**
- **Fast Load Transient Response**
- **Logic Level Enable Input for ON/OFF Control**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green UTDFN-1.2×1.2-6L Package**

APPLICATIONS

Portable Equipment
Smartphone
Industrial and Medical Equipment

TYPICAL APPLICATION

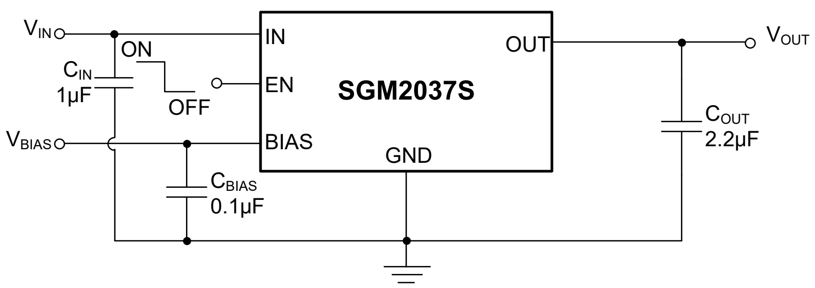


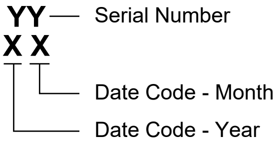
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2037S-0.9	UTDFN-1.2×1.2-6L	-40℃ to +125℃	SGM2037S-0.9XUDX6G/TR	4B XX	Tape and Reel, 5000

MARKING INFORMATION

NOTE: XX = Date Code.



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

IN, BIAS, EN to GND .... -0.3V to 6V
OUT to GND .... -0.3V to (V_{IN} + 0.3V)
Power Dissipation, P_D @ T_A = +25℃
UTDFN-1.2×1.2-6L 612mW
Package Thermal Resistance
UTDFN-1.2×1.2-6L, θ_{JA} .... 204℃/W
Junction Temperature .... +150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃
ESD Susceptibility
HBM 8000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Operating Input Voltage Range .... 0.9V to 5.5V
Operating Bias Voltage Range .... 2.5V to 5.5V
BIAS Effective Capacitance, C_{BIAS} .... 0.1μF (MIN)
Input Effective Capacitance, C_{IN} .... 0.5μF (MIN)
Output Effective Capacitance, C_{OUT} .... 1μF to 10μF
Operating Temperature Range .... -40℃ to +125℃

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

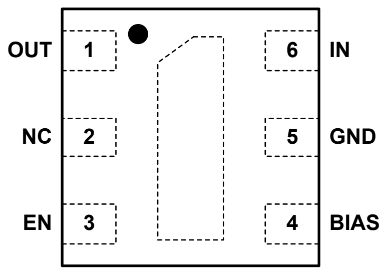
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. It 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 even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

We reserve the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION



UTDFN-1.2×1.2-6L

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	OUT	Regulated Output Voltage Pin. It is recommended to use output capacitor with effective capacitance in the range of 1μF to 10μF.
2	NC	No Connection.
3	EN	Enable Pin. Driving EN high to turn on the regulator. Driving EN low to turn off the regulator. The EN pin has an internal pull-down resistance which ensures that the device is turned off when the EN pin is floated.
4	BIAS	Bias Voltage Supply for Internal Control Circuits. This pin is monitored by internal under-voltage lockout circuit.
5	GND	Ground.
6	IN	Input Voltage Supply Pin.
Exposed Pad	–	Exposed Pad. Exposed pad is internally connected to GND. Connect it to a large ground plane to maximize thermal performance; not intended as an electrical connection point.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 1.2V, V_{EN} = V_{BIAS} = 2.7V, I_{OUT} = 1mA, C_{IN} = 1μF, C_{BIAS} = 0.1μF and C_{OUT} = 2.2μF, Full = -40℃ to +125℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Operating Input Voltage Range	V_{IN}		+25℃	0.9		5.5	V
Operating Bias Voltage Range	V_{BIAS}		+25℃	2.5		5.5	V
Under-Voltage Lockout Threshold	V_{UVLO}	V_{BIAS} rising	+25℃		1.6		V
		Hysteresis	+25℃		0.2		
Output Voltage Accuracy	V_{OUT}	V_{IN} = 1.2V to 1.9V, V_{BIAS} = 2.7V to 5.5V, I_{OUT} = 1mA to 600mA	+25℃	-0.8		0.8	%
			Full	-1.5		1.5	
V_{IN} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$	V_{IN} = 1.2V to 5.5V	+25℃		0.002	0.03	%/V
V_{BIAS} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{BIAS} \times V_{OUT}}$	V_{BIAS} = 2.7V to 5.5V	+25℃		0.002	0.03	%/V
Load Regulation	ΔV_{OUT}	I_{OUT} = 1mA to 600mA	+25℃		0.5	2	mV
V_{IN} Dropout Voltage (1)	V_{DROP_IN}	I_{OUT} = 150mA	+25℃		35	50	mV
		I_{OUT} = 600mA	+25℃		140	200	
Output Current Limit	I_{LIM}		+25℃	1000	1400		mA
Short Current Limit	I_{SHORT}	V_{OUT} = 0V	+25℃		400		mA
BIAS Pin Operating Current	I_{BIAS}	V_{BIAS} = 5.5V	+25℃		98	130	μA
			Full			145	
BIAS Pin Disable Current	I_{DIS_BIAS}	V_{EN} = 0V	+25℃		0.01	0.5	μA
			Full			2.5	
IN Pin Disable Current	I_{DIS_IN}	V_{EN} = 0V	+25℃		0.05	0.5	μA
			Full			1.6	
EN Pin Threshold Voltage	V_{IH}	EN input voltage high	Full	1.2			V
	V_{IL}	EN input voltage low	Full			0.25	
EN Pin Pull-Down Resistance	R_{EN}		+25℃		580		kΩ
Turn-On Time	t_{ON}	From assertion of V_{EN} to V_{OUT} = 90%$V_{OUT(NOM)}$	+25℃		100		μs
V_{IN} Power Supply Rejection Ratio	PSRR	V_{IN} to V_{OUT}, f = 1kHz, I_{OUT} = 150mA, V_{IN} ≥ 1.4V	+25℃		76		dB
V_{BIAS} Power Supply Rejection Ratio		V_{BIAS} to V_{OUT}, f = 1kHz, I_{OUT} = 150mA, V_{IN} ≥ 1.4V	+25℃		76		
Output Voltage Noise	e_n	V_{IN} = 1.4V, f = 10Hz to 100kHz	+25℃		20		μV_{RMS}
Output Discharge Resistance	R_{DISCH}	V_{EN} = 0V, V_{OUT} = 0.5V	+25℃		120		Ω
Thermal Shutdown Temperature	T_{SHDN}				160		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				20		℃

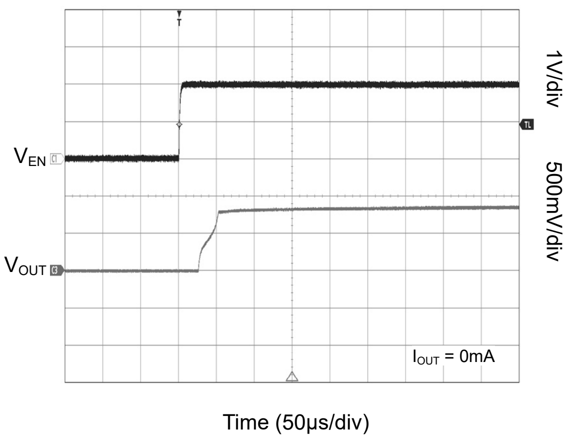
NOTE:

1. Dropout voltage is characterized when V_{OUT} falls 5% below $V_{OUT(NOM)}$.

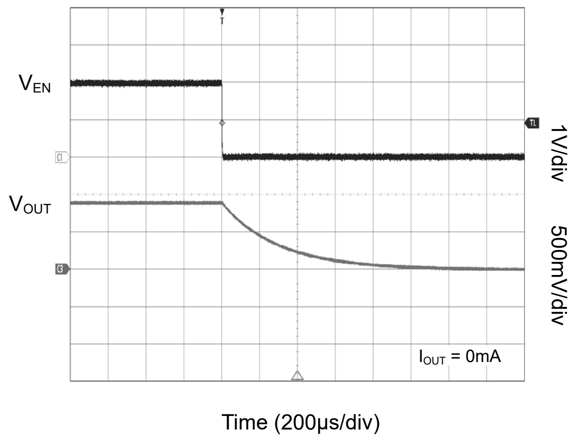
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25°C, V_{IN} = 1.2V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 0.9V, C_{IN} = 1μF, C_{BIAS} = 0.1μF and C_{OUT} = 2.2μF, unless otherwise noted.

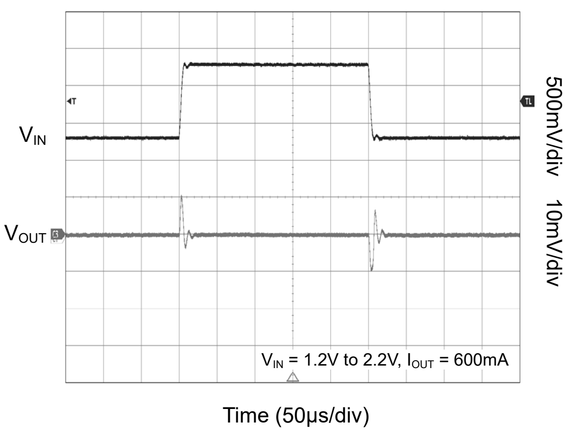
Turn-On with EN Pin



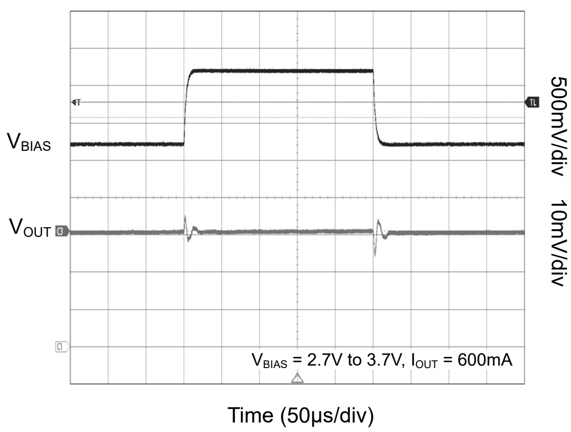
Turn-Off with EN Pin



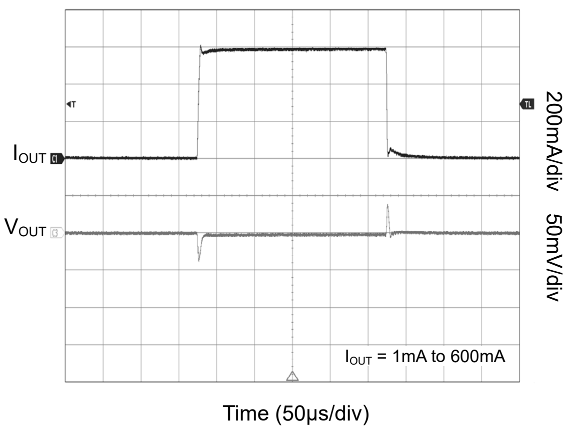
V_{IN} Line Transient Response



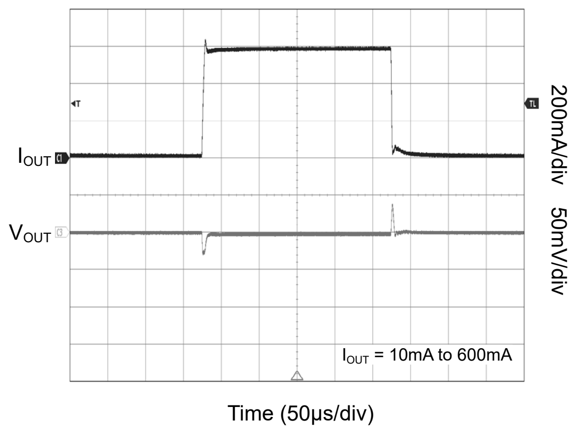
V_{BIAS} Line Transient Response



Load Transient Response



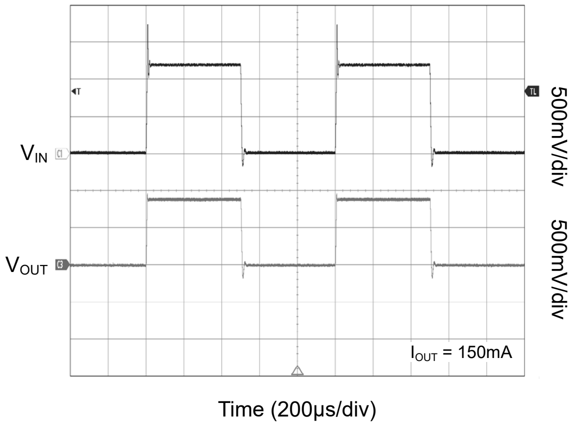
Load Transient Response



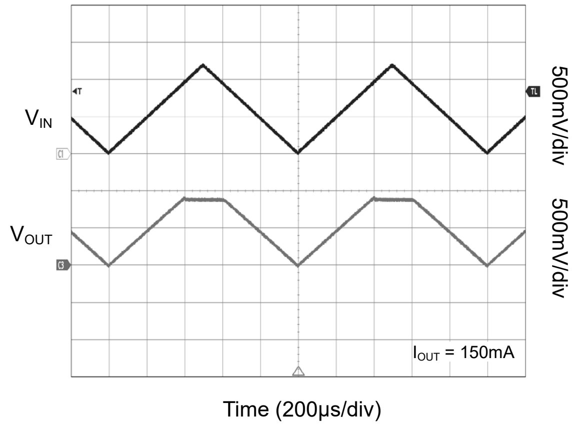
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_{IN} = 1.2V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 0.9V, C_{IN} = 1μF, C_{BIAS} = 0.1μF and C_{OUT} = 2.2μF, unless otherwise noted.

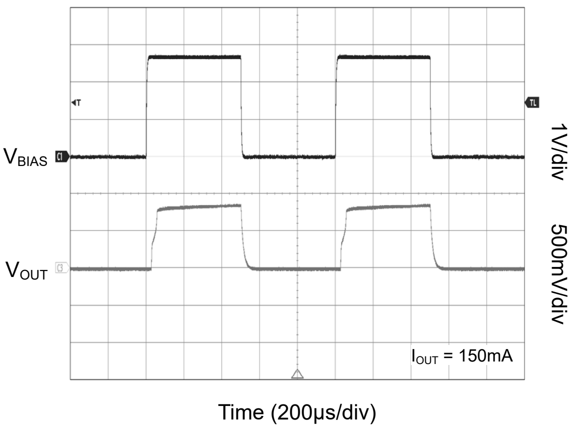
V_{IN} Power-Up/Power-Down Output Waveform



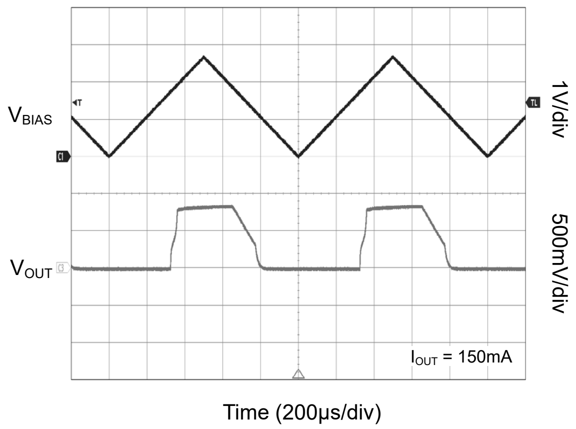
V_{IN} Power Ramp-Up/Ramp-Down Output Waveform



V_{BIAS} Power-Up/Power-Down Output Waveform



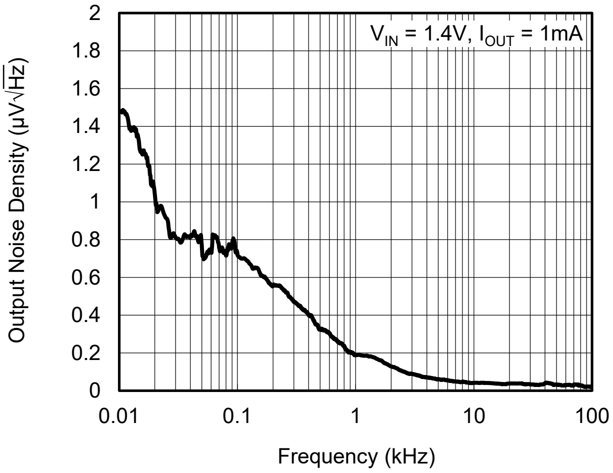
V_{BIAS} Power Ramp-Up/Ramp-Down Output Waveform



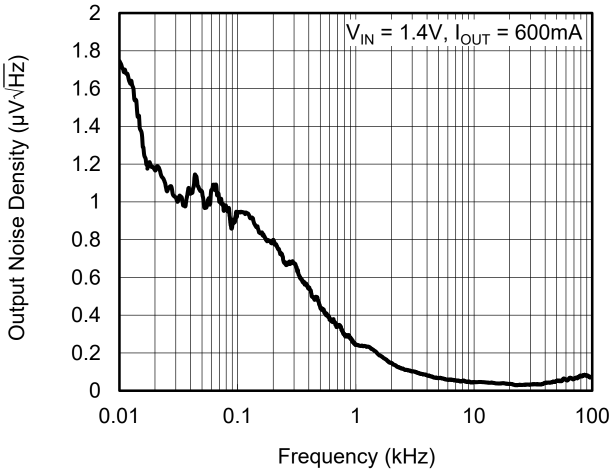
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_{IN} = 1.2V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 0.9V, C_{IN} = 1μF, C_{BIAS} = 0.1μF and C_{OUT} = 2.2μF, unless otherwise noted.

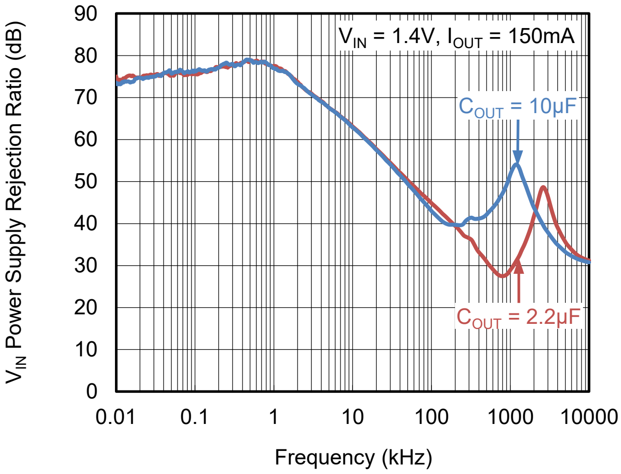
Output Noise Density vs. Frequency



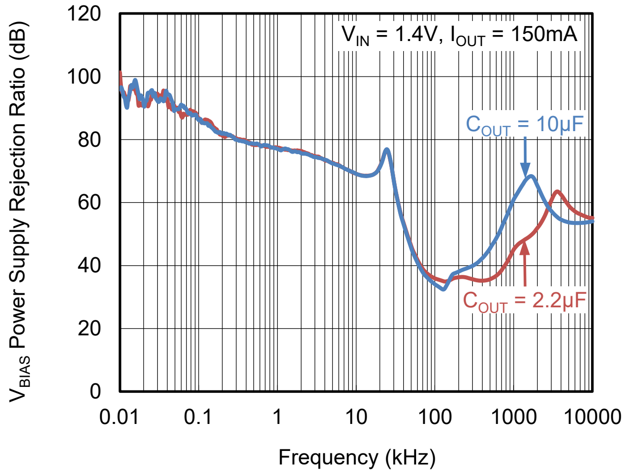
Output Noise Density vs. Frequency



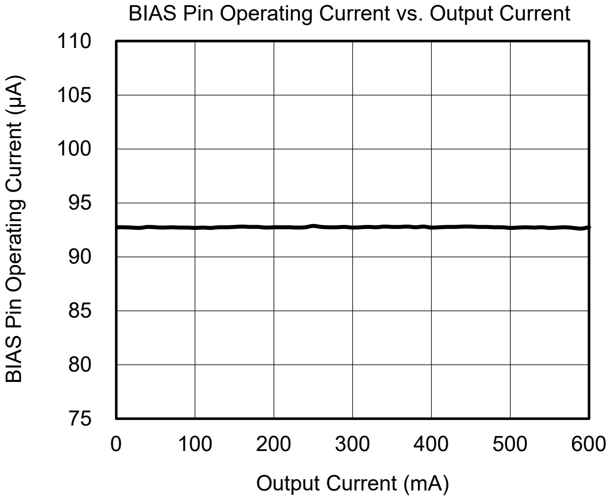
V_{IN} Power Supply Rejection Ratio vs. Frequency



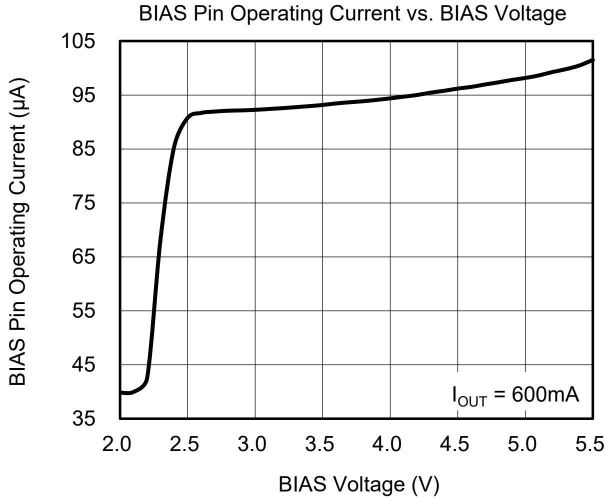
V_{BIAS} Power Supply Rejection Ratio vs. Frequency



BIAS Pin Operating Current vs. Output Current

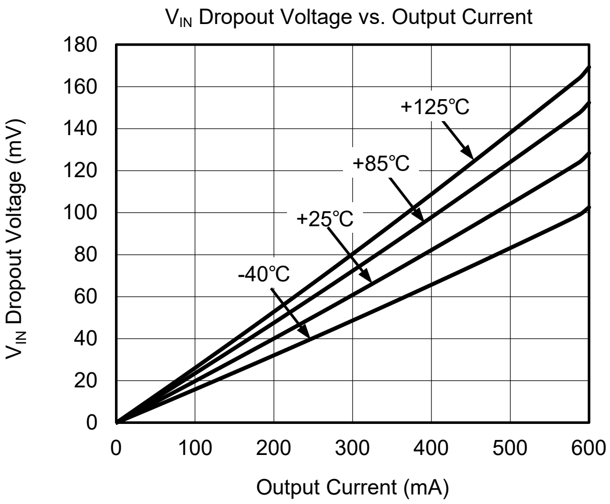


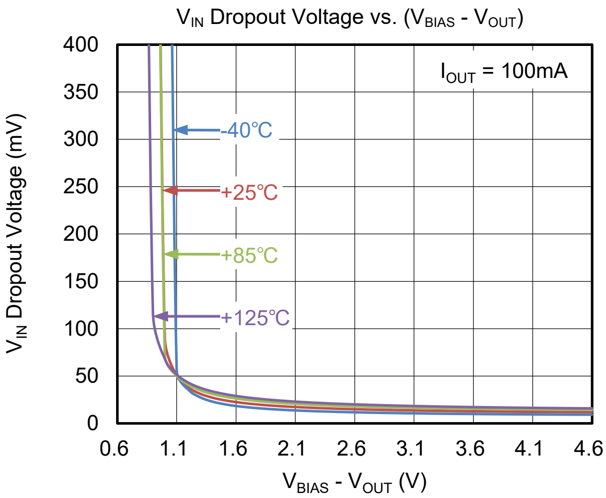
BIAS Pin Operating Current vs. BIAS Voltage

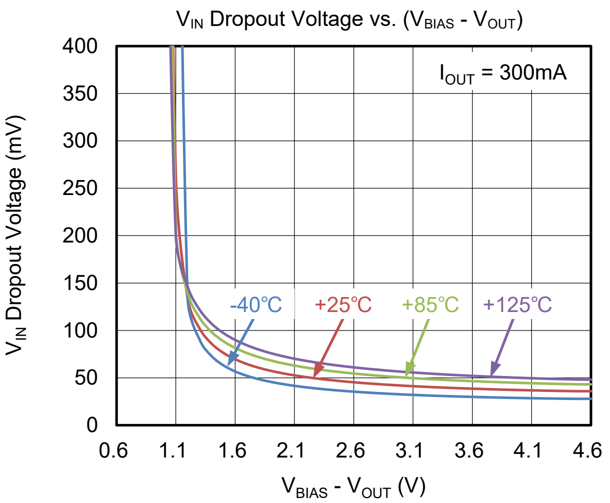


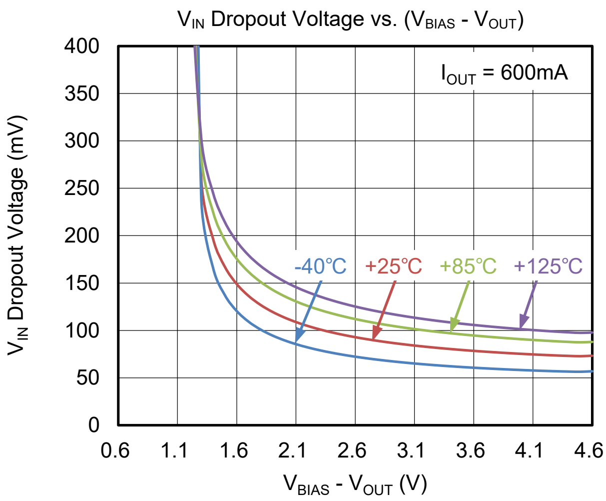
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

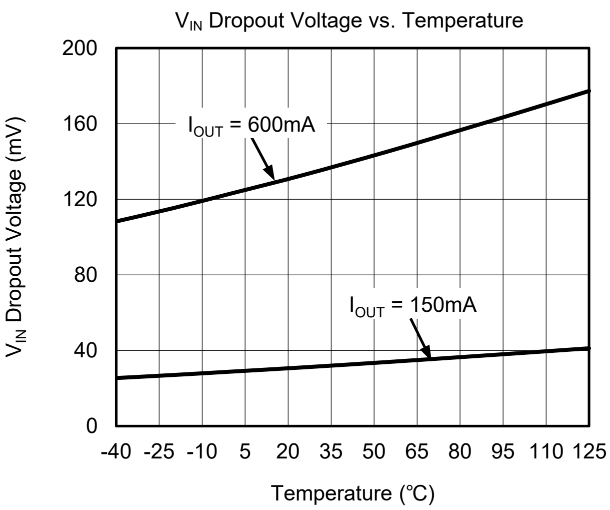
T_A = +25℃, V_{IN} = 1.2V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 0.9V, C_{IN} = 1μF, C_{BIAS} = 0.1μF and C_{OUT} = 2.2μF, unless otherwise noted.

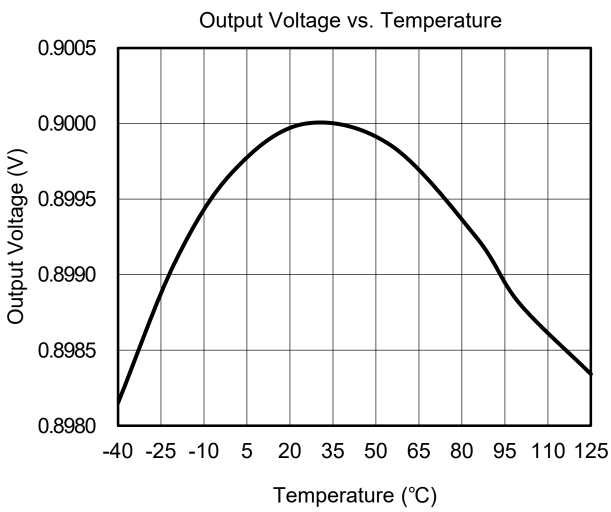












FUNCTIONAL BLOCK DIAGRAM

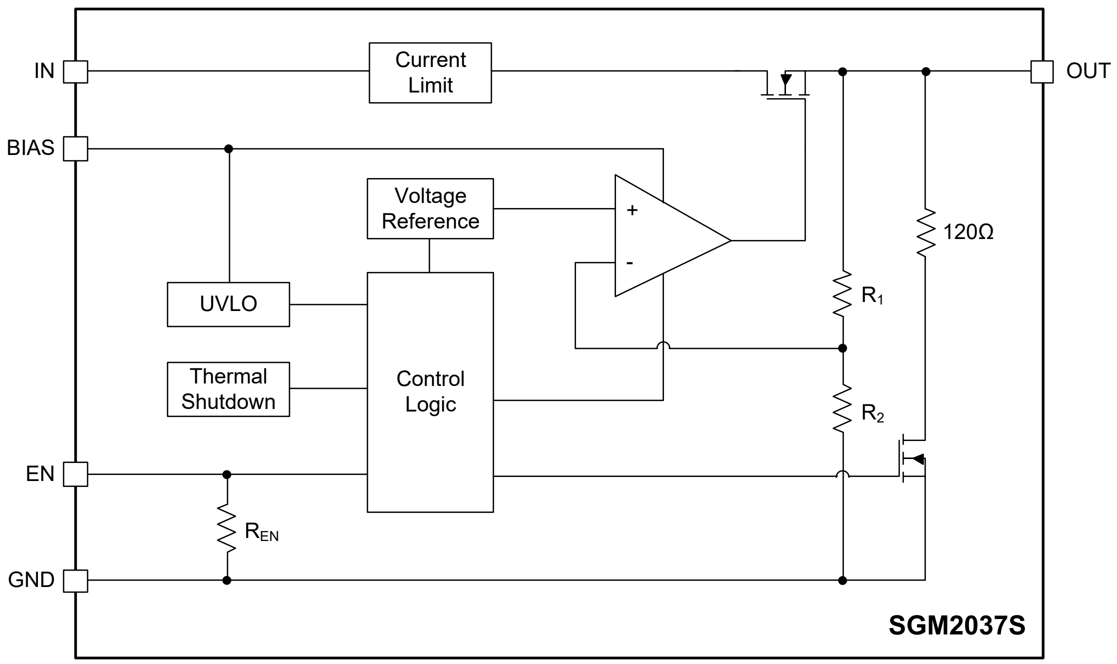


Figure 2. Block Diagram

TYPICAL APPLICATION CIRCUIT

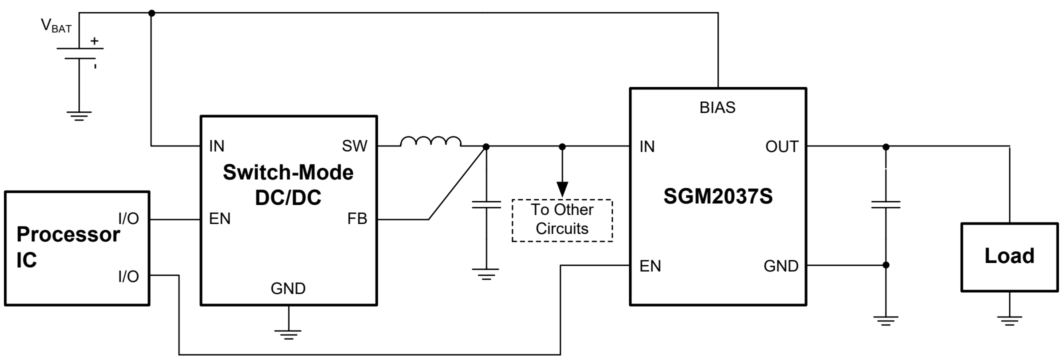


Figure 3. Used as DC/DC Post Regulator

APPLICATION INFORMATION

The SGM2037S is a low noise high performance LDO with fast transient response. It consumes only 98μA (TYP) quiescent current and provides 600mA output current. The SGM2037S provides protection functions for output overload, output short-circuit condition and overheating.

The SGM2037S is suitable for applications which need noise sensitive circuit such as battery-powered equipment and smartphones.

Input Capacitor Selection (C_{IN})

The input decoupling capacitor is necessary to connect as close as possible to the IN pin for ensuring the device stability. A 1μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance.

When V_{IN} is required to instantaneously provide large current, a large effective input capacitor is required. Multiple input capacitors can limit the input tracking inductance. Adding more input capacitors is available to restrict the ringing and to keep it below the device absolute maximum ratings.

Output Capacitor Selection (C_{OUT})

The output decoupling capacitor should be located as close as possible to the OUT pin. A 1μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance. The minimum effective capacitance of C_{OUT} that SGM2037S can remain stable is 1μF. For ceramic capacitor, temperature, DC bias and package size will change the effective capacitance, so enough margin of C_{OUT} must be considered in design. Larger capacitance and lower ESR C_{OUT} will help improve the load transient response and increase the high frequency PSRR.

Enable Operation

The SGM2037S uses the EN pin to enable/disable the device and to deactivate/activate the output automatic discharge function.

When the EN pin voltage is lower than 0.25V, the device is in shutdown state, and there is no current flowing from IN to OUT pin. In this state, the automatic discharge transistor is active to discharge the output voltage through a 120Ω (TYP) resistor.

When the EN pin voltage is higher than 1.2V, the device is in active state. The input voltage is regulated to the output voltage and the automatic discharge transistor is turned off.

Dropout Voltage

The SGM2037S specifies two dropout voltages because there are two power supplies V_{IN} and V_{BIAS} and one V_{OUT} regulator output. V_{IN} dropout voltage is defined as the difference between V_{IN} and V_{OUT} when V_{OUT} falls 5% below $V_{OUT(NOM)}$.

When V_{OUT} begins to decrease and V_{BIAS} is high enough, the V_{IN} dropout voltage equals to V_{IN} - V_{OUT}. V_{BIAS} dropout voltage refers to V_{BIAS} - V_{OUT} when the IN and BIAS pins are connected together and V_{OUT} begins to decrease.

Output Current Limit and Short-Circuit Protection

When an overload event happens, the output current is internally limited to 1.4A (TYP). When the OUT pin is shorted to ground, the short-circuit protection will limit the output current to 400mA (TYP).

Thermal Shutdown

The SGM2037S can detect the temperature of die. When the die temperature exceeds the threshold value of thermal shutdown, the SGM2037S will be in shutdown state and it will remain in this state until the die temperature decreases to +140℃.

Power Dissipation (P_D)

Thermal protection limits power dissipation in the SGM2037S. When power dissipation on pass element ($P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$) is too much and the operating junction temperature exceeds +160℃, the OTP circuit starts the thermal shutdown function and turns the pass element off.

Therefore, thermal analysis for the chosen application is important to guarantee reliable performance over all conditions. To guarantee reliable operation, the junction temperature of the SGM2037S must not exceed 125℃.

The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction temperature and ambient temperature. The maximum power dissipation can be approximated using the following equation:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA} \quad (1)$$

where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction -to-ambient thermal resistance.

APPLICATION INFORMATION (continued)

Negatively Biased Output

When the output voltage is negative, the chip may not start up due to parasitic effects. Ensure that the output is greater than -0.3V under all conditions. If negatively biased output is excessive and expected in the application, a Schottky diode can be added between the OUT pin and GND pin.

Reverse Current Protection

The NMOS power transistor has an inherent body diode, this body diode will be forward biased when V_{OUT} > V_{IN}. When V_{OUT} > V_{IN}, the reverse current flowing from the OUT pin to the IN pin will damage the SGM2037S. If V_{OUT} > (V_{IN} + 0.3V) is expected in the application, one external Schottky diode will be added between the OUT pin and IN pin to protect the SGM2037S.

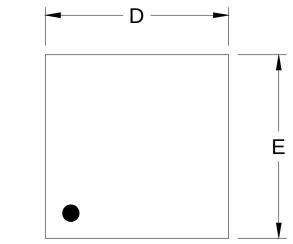
REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

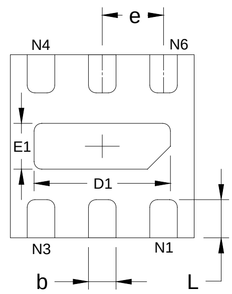
Changes from Original (MAY 2019) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

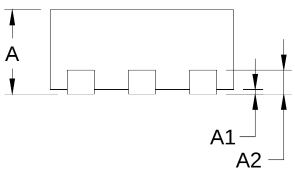
UTDFN-1.2×1.2-6L



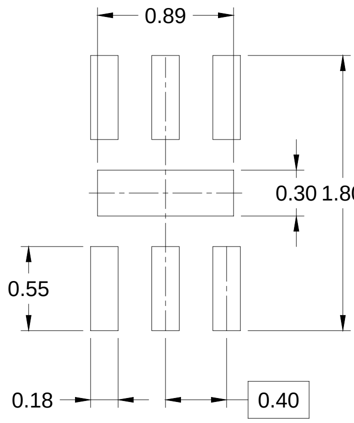
TOP VIEW



BOTTOM VIEW



SIDE VIEW

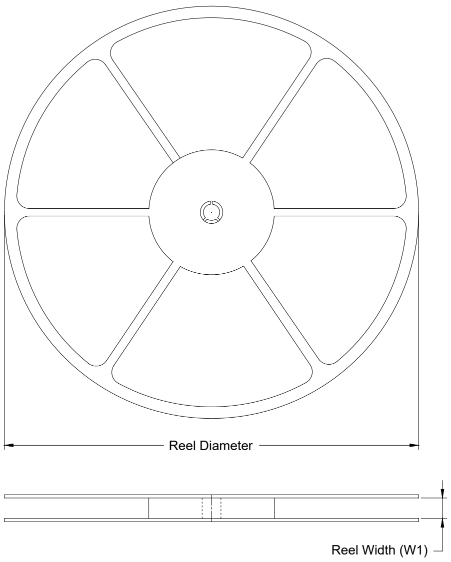


RECOMMENDED LAND PATTERN (Unit: mm)

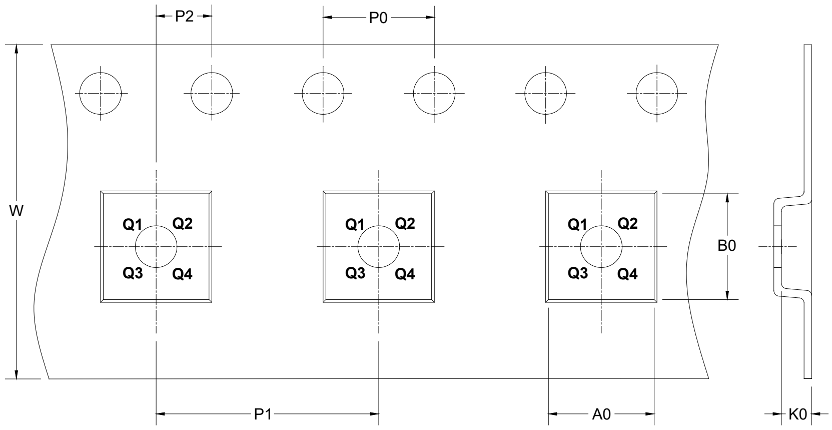
Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.500	0.550	0.600
A1			0.050
A2	0.152 REF		
e	0.400 BSC		
D	1.150	1.200	1.250
E	1.150	1.200	1.250
D1	0.840	0.890	0.940
E1	0.250	0.300	0.350
b	0.130	0.180	0.230
L	0.200	0.250	0.300

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

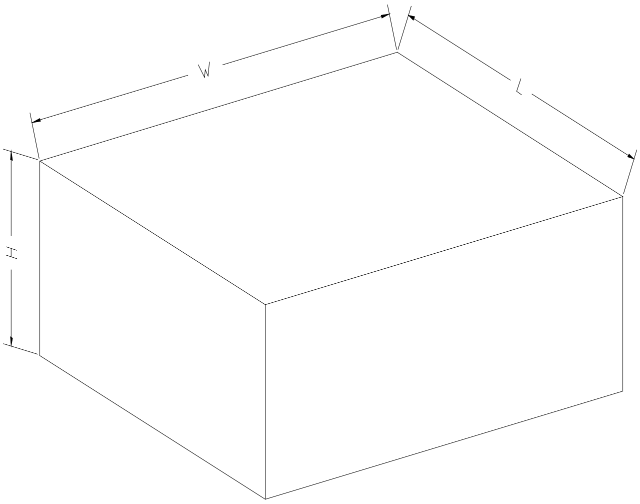
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
UTDFN-1.2×1.2-6L	7″	9.0	1.35	1.35	0.73	4.0	4.0	2.0	8.0	Q1

DD0001

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″ (Option)	368	227	224	8
7″	442	410	224	18

DD0002