SGM2037H
500mA, Low Noise, Very Low Dropout Bias Rail CMOS Voltage Regulator

GENERAL DESCRIPTION

The SGM2037H is a low noise, low dropout voltage linear regulator which is designed using CMOS technology. It provides 500mA output current capability. The operating input voltage range is from 0.8V to 5.5V and bias supply voltage range is from 2.7V to 5.5V. The output voltage range is from 0.8V to 3.6V.

Other features include logic-controlled shutdown mode, short-circuit current limit and thermal shutdown protection. The SGM2037H has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2037H is suitable for application which needs low noise, fast transient response and low I_Q consumption, such as battery-powered equipment and smartphones, etc.

The SGM2037H is available in a Green XTDFN-1.2×1.2-6L package. It operates over an operating temperature range of -40℃ to +125℃.

FEATURES

- **Input Voltage Range: 0.8V to 5.5V**
- **Bias Voltage Range: 2.7V to 5.5V**
- **500mA Output Current**
- **Adjustable Output Voltage Range: 0.8V to 3.6V**
- **Output Voltage Accuracy: ±0.8% at +25℃**
- **Low Bias Input Current: 37μA (TYP)**
- **Low Dropout Voltage: 120mV (TYP) at 500mA**
- **Low Noise: 25μV_{RMS} (TYP)**
- **Shutdown Supply Current: 0.01μA (TYP)**
- **Current Limiting and Thermal Protection**
- **Excellent Load and Line Transient Responses**
- **Stable with Small Case Size Ceramic Capacitors**
- **With Output Automatic Discharge**
- **Logic Level Enable Input for ON/OFF Control**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green XTDFN-1.2×1.2-6L Package**

APPLICATIONS

Portable Equipment
Smartphone
Industrial and Medical Equipment

TYPICAL APPLICATION

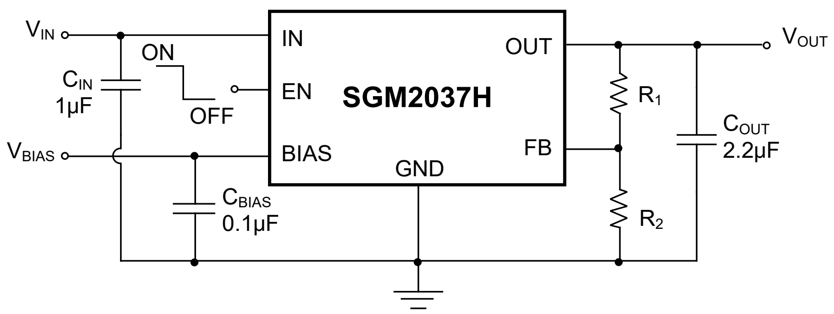


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2037H-ADJ	XTDFN-1.2×1.2-6L	-40℃ to +125℃	SGM2037H-ADJXXED6G/TR	26 XX	Tape and Reel, 5000

MARKING INFORMATION

NOTE: XX = Date Code.

XTDFN-1.2×1.2-6L

YY — Serial Number
X X
Date Code - Week
Date Code - Year

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, FB to GND .... -0.3V to Min(V_{IN} + 0.3V, 6V)
Package Thermal Resistance
XTDFN-1.2×1.2-6L, θ_{JA}... 152.5℃/W
XTDFN-1.2×1.2-6L, θ_{JB}... 99.5℃/W
XTDFN-1.2×1.2-6L, $\theta_{JC(TOP)}$ ....111.7℃/W
XTDFN-1.2×1.2-6L, $\theta_{JC(BOT)}$ .... 88.3℃/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, V_{IN}....................0.8V to 5.5V
Operating Bias Voltage Range, V_{BIAS}..................2.7V to 5.5V
BIAS Effective Capacitance, C_{BIAS} .... 0.05μF (MIN)
Input Effective Capacitance, C_{IN} .... 0.5μF (MIN)
Output Effective Capacitance, C_{OUT}.................... 1μF to 10μF
Operating Junction 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.

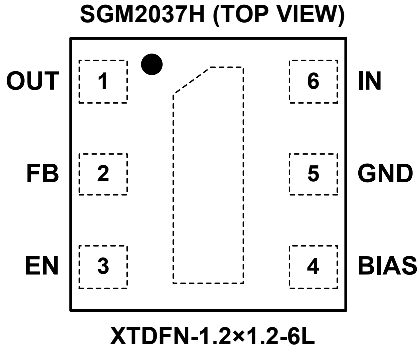
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO 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

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION



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	FB	Feedback Pin. Connect this pin to the external resistor divider to adjust the output voltage. Place the resistors as close as possible to this pin.
3	EN	Enable Pin. Drive EN high to turn on the regulator. Drive 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 Pin 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. Connect it to GND internally. Connect it to a large ground plane to maximize thermal performance. This pad is not an electrical connection point.

ELECTRICAL CHARACTERISTICS

(T_J = -40℃ to +125℃, typical values are at T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 0.3V, V_{BIAS} = 2.7V or ($V_{OUT(NOM)}$ + 1.6V) (whichever is greater), V_{EN} = V_{BIAS}, I_{OUT} = 1mA, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.) [1]

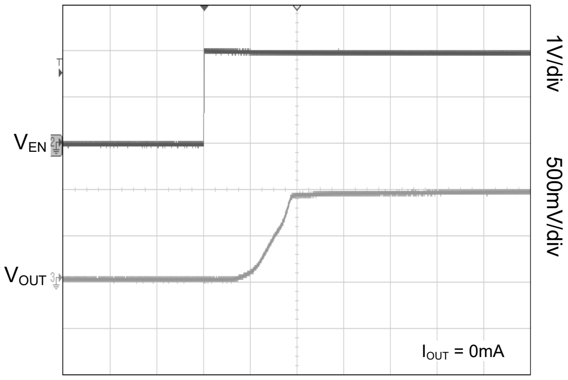
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Input Voltage Range	V_{IN}		$V_{OUT(NOM)}$ + V_{DROP_IN}		5.5	V
Operating Bias Voltage Range	V_{BIAS}		2.7		5.5	V
Under-Voltage Lockout Thresholds	V_{UVLO}	V_{BIAS} rising		1.6	2.6	V
		Hysteresis		0.2		
Feedback Voltage	V_{FB}	V_{OUT} = V_{FB}, I_{OUT} = 1mA to 500mA		0.8		V
Output Voltage Accuracy	V_{OUT}	V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) to ($V_{OUT(NOM)}$ + 1V), V_{BIAS} = 2.7V or ($V_{OUT(NOM)}$ +1.6V) to 5.5V, I_{OUT} = 1mA to 500mA; T_J = +25℃	-0.8		0.8	%
		T_J = -40℃ to +125℃	-1.5		1.5	
V_{IN} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$	V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) to 5.5V		0.002	0.05	%/V
V_{BIAS} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{BIAS} \times V_{OUT}}$	V_{BIAS} = 2.7V or ($V_{OUT(NOM)}$ +1.6V) to 5.5V, 0.8V ≤ $V_{OUT(NOM)}$ ≤ 1.8V		0.002	0.05	%/V
		V_{BIAS} = ($V_{OUT(NOM)}$ + 1.6V) to 5.5V, 1.8V < $V_{OUT(NOM)}$ ≤ 3.6V		0.005	0.2	
Load Regulation	ΔV_{OUT}	I_{OUT} = 1mA to 500mA, T_J = +25℃; 0.8V ≤ $V_{OUT(NOM)}$ ≤ 1.8V		0.5	2	mV
		1.8V < $V_{OUT(NOM)}$ ≤ 3.6V		1	5	
V_{IN} Dropout Voltage [1]	V_{DROP_IN}	I_{OUT} = 150mA		35	65	mV
		I_{OUT} = 500mA		120	220	
V_{BIAS} Dropout Voltage [1, 2]	V_{DROP_BIAS}	I_{OUT} = 500mA		1.2	1.6	V
Output Current Limit	I_{LIM}	T_J = +25℃	505	670		mA
Short-Circuit Current Limit	I_{SHORT}	V_{OUT} = 0V		340		mA
FB Pin Input Current	I_{FB}		-100		100	nA
BIAS Pin Operating Current	I_{BIAS}	V_{BIAS} = 5.5V		37	58	μA
IN Pin Disable Current	I_{DIS_IN}	V_{EN} = 0V, T_J = +25℃		0.1	1.2	μA
		V_{EN} = 0V			2	
BIAS Pin Disable Current	I_{DIS_BIAS}	V_{EN} = 0V, T_J = +25℃		0.01	1	μA
		V_{EN} = 0V			2.8	
EN Pin Threshold Voltage	V_{IH}	EN input voltage high	1.2			V
	V_{IL}	EN input voltage low			0.25	V
EN Pin Pull-Down Resistance	R_{EN}		270	580	880	kΩ
Turn-On Time	t_{ON}	From assertion of V_{EN} to V_{OUT} = 90% × $V_{OUT(NOM)}$		100		μs
V_{IN} Power Supply Rejection Ratio	PSRR	V_{IN} to V_{OUT}, f = 1kHz, $V_{OUT(NOM)}$ = 1.0V, I_{OUT} = 150mA, V_{IN} ≥ 1.5V		71		dB
V_{BIAS} Power Supply Rejection Ratio		V_{BIAS} to V_{OUT}, f = 1kHz, $V_{OUT(NOM)}$ = 1.0V, I_{OUT} = 150mA, V_{IN} ≥ 1.5V		76		
Output Voltage Noise	e_n	V_{IN} = $V_{OUT(NOM)}$ + 0.5V, $V_{OUT(NOM)}$ = 1.05V, f = 10Hz to 100kHz		25		$μV_{RMS}$
Output Discharge Resistance	R_{DIS}	V_{EN} = 0V, V_{OUT} = 0.5V	50	120	220	Ω
Thermal Shutdown Temperature	T_{SHDN}			160		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}			20		℃

NOTES:
1. V_{IN} dropout voltage is defined as the difference between V_{IN} and V_{OUT} when V_{OUT} falls to 95% × $V_{OUT(NOM)}$.
2. V_{BIAS} dropout voltage refers to V_{BIAS} - V_{OUT} when the IN and BIAS pins are connected together and V_{OUT} falls to 95% × $V_{OUT(NOM)}$. For output voltages below 1.5V, V_{BIAS} dropout voltage does not apply due to a minimum bias operating voltage of 2.7V.

TYPICAL PERFORMANCE CHARACTERISTICS

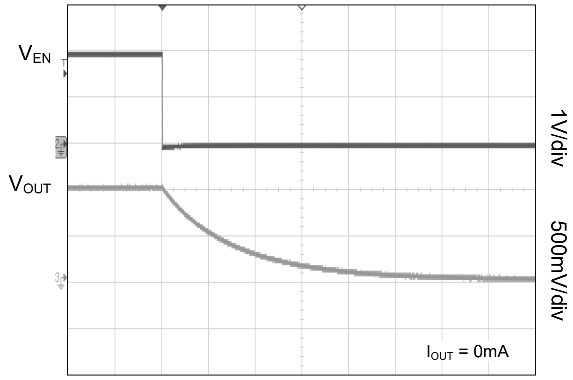
T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 1.0V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

Turn-On Speed with EN Pin



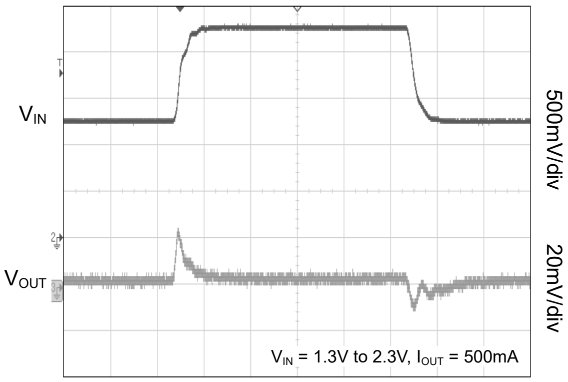
Time (50μs/div)

Turn-Off Speed with EN Pin



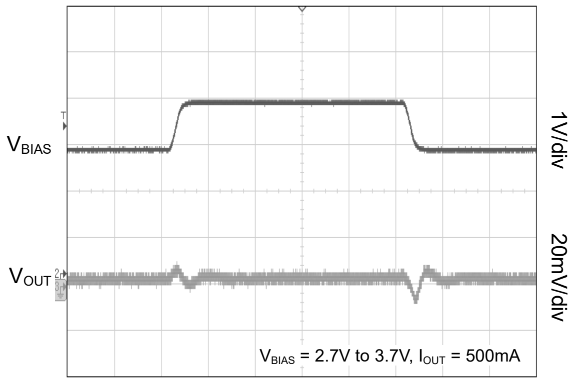
Time (200μs/div)

V_{IN} Line Transient Response



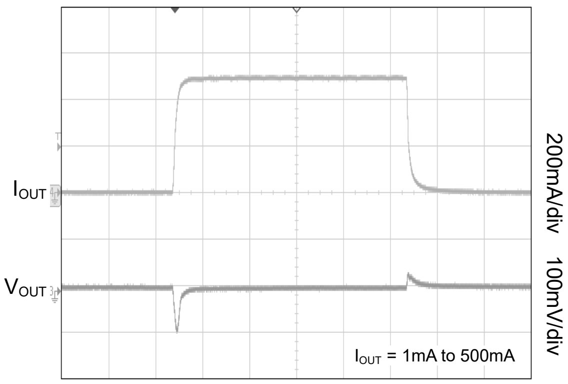
Time (10μs/div)

V_{BIAS} Line Transient Response



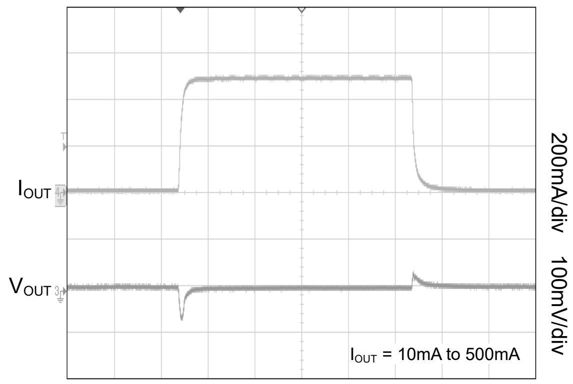
Time (20μs/div)

Load Transient Response



Time (50μs/div)

Load Transient Response

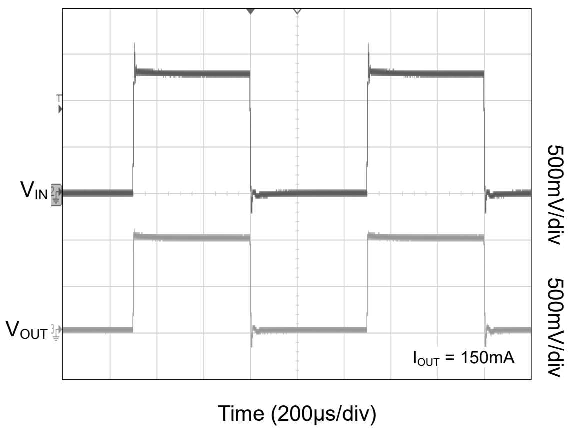


Time (50μs/div)

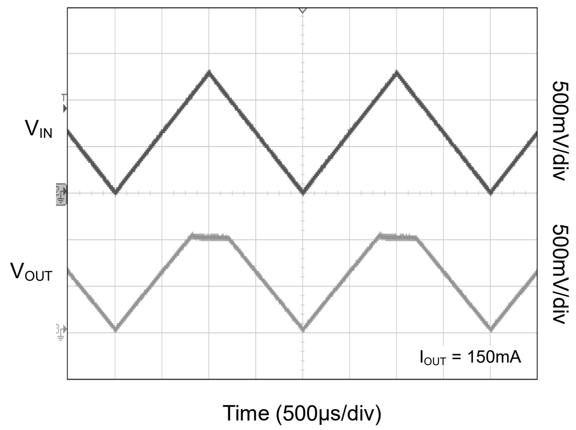
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 1.0V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

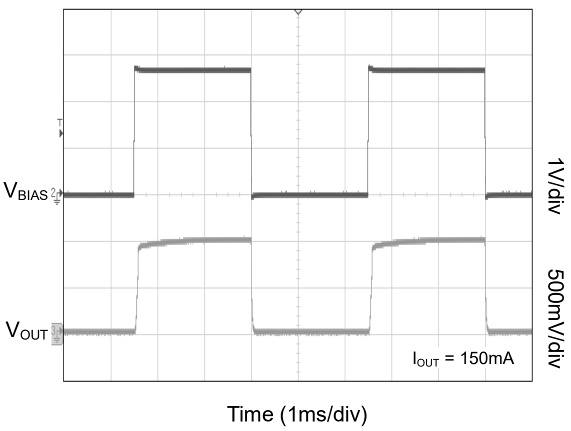
V_{IN} Power-Up/Power-Down Output Waveform



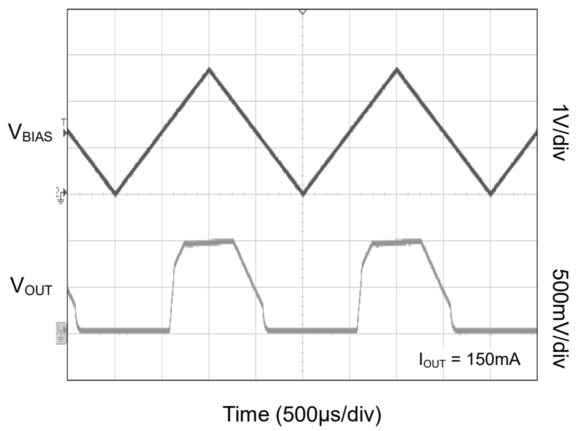
V_{IN} Power Ramp-Up/Ramp-Down Output Waveform



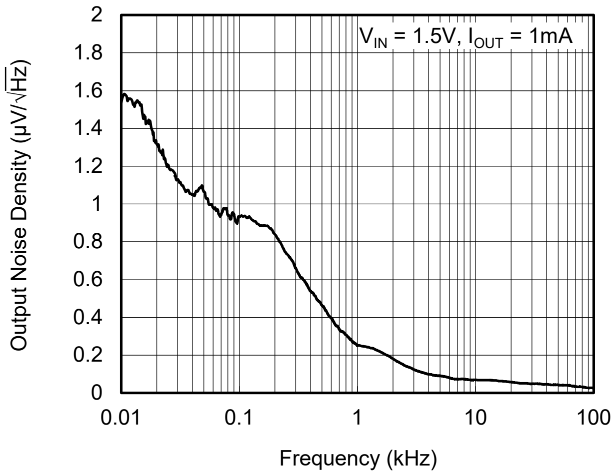
V_{BIAS} Power-Up/Power-Down Output Waveform



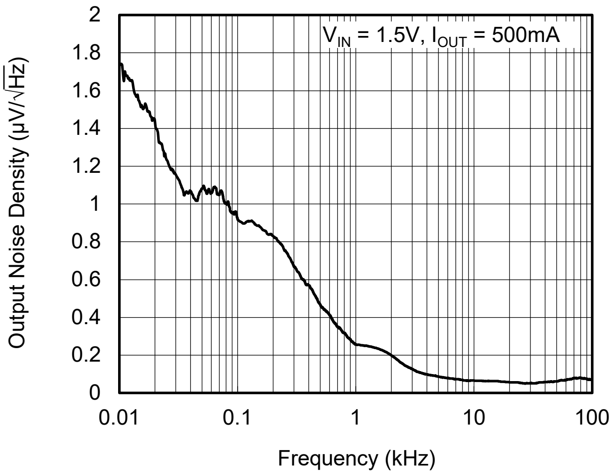
V_{BIAS} Power Ramp-Up/Ramp-Down Output Waveform



Output Noise Density vs. Frequency

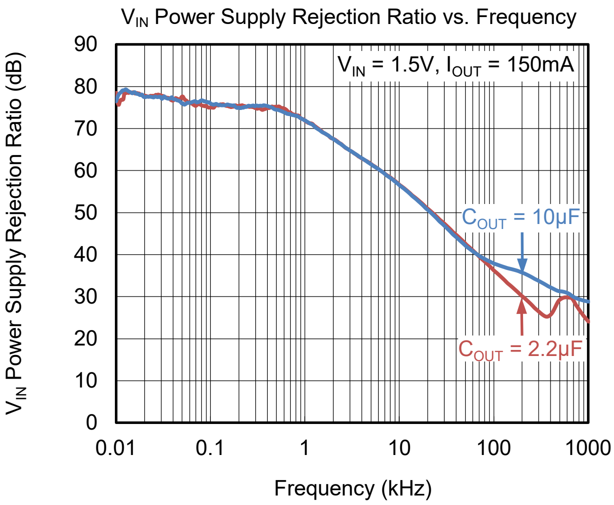


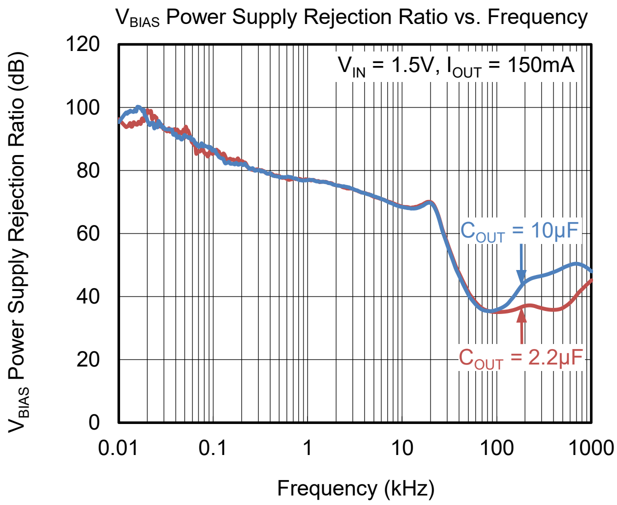
Output Noise Density vs. Frequency

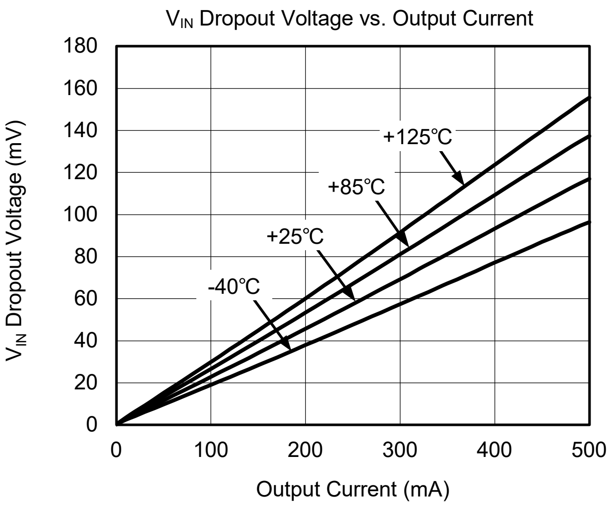


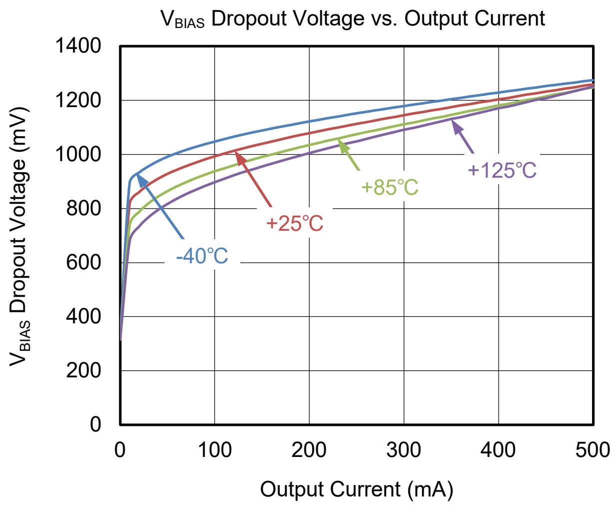
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

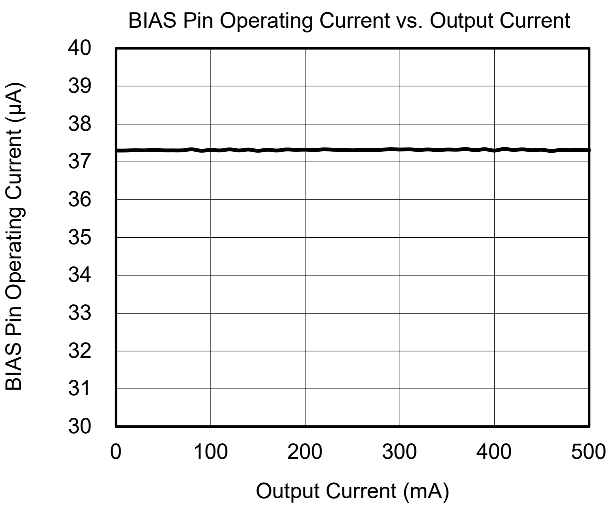
T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 1.0V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

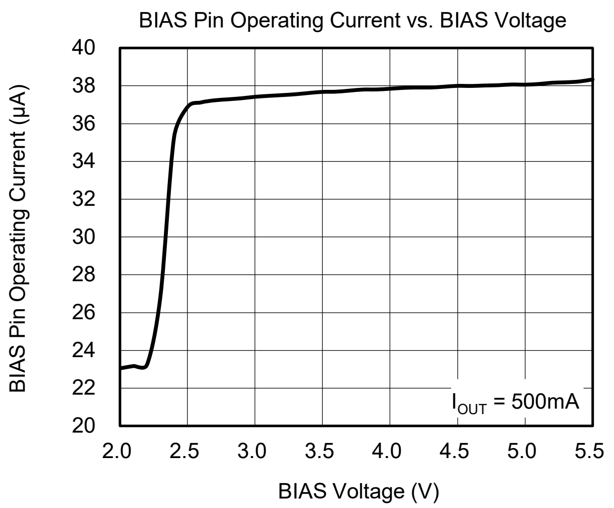






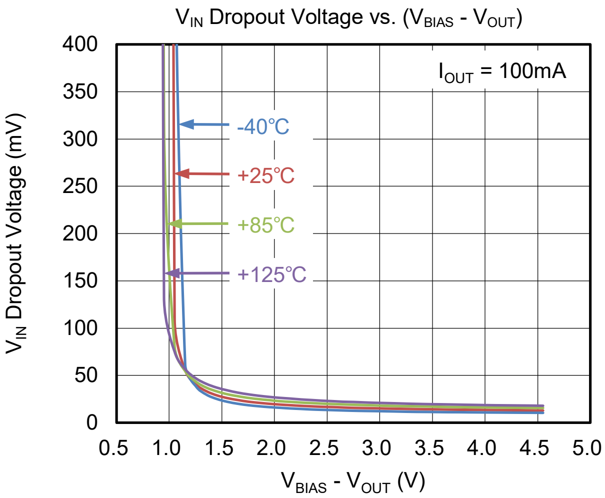


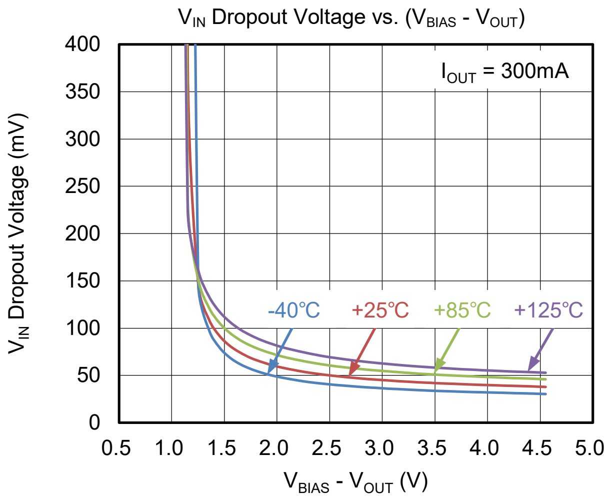


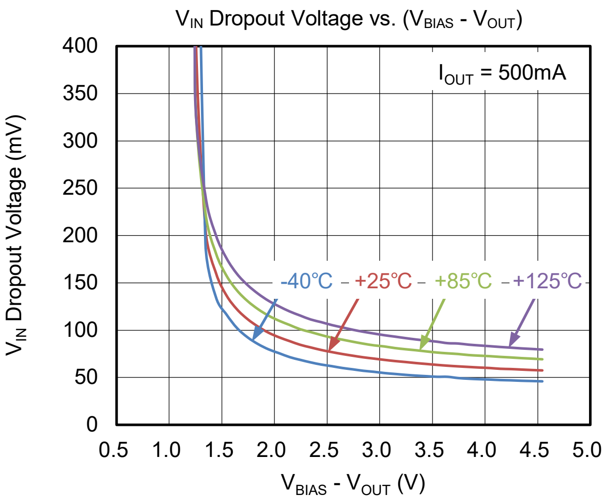


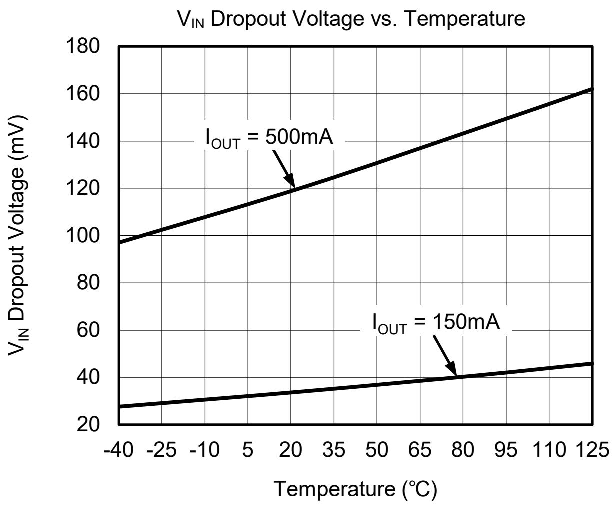
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 1.0V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.









FUNCTIONAL BLOCK DIAGRAM

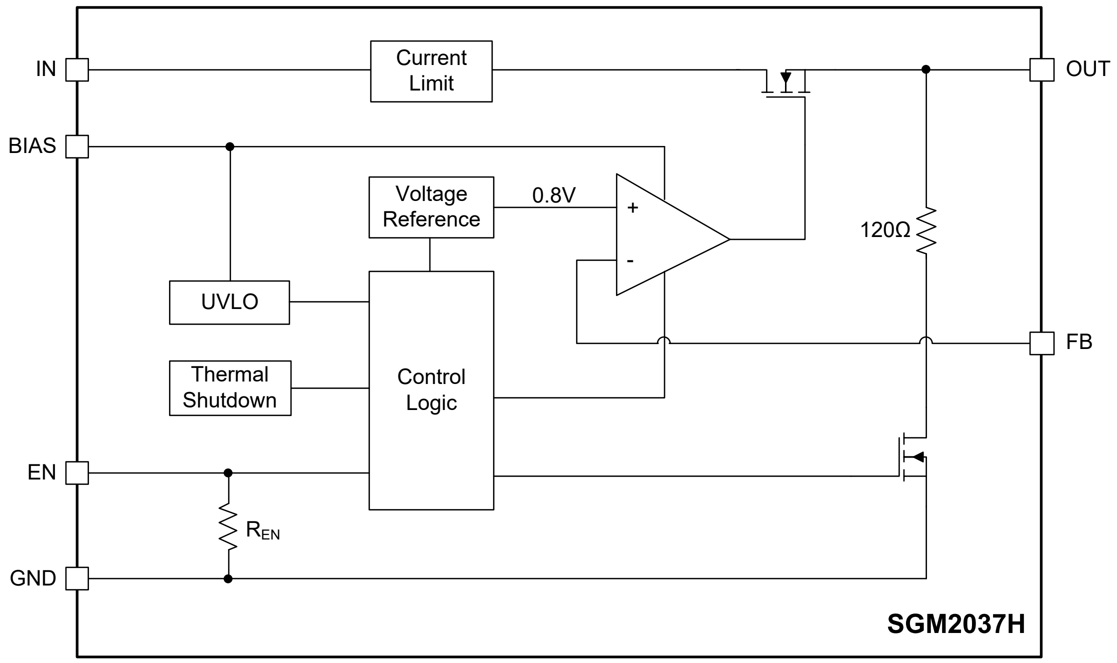


Figure 2. Block Diagram

APPLICATION INFORMATION

The SGM2037H is a low noise, fast transient response high performance LDO, it consumes only 37μA (TYP) quiescent current and provides 500mA output current. The SGM2037H provides the protection function for output overload, output short- circuit condition and overheating.

The SGM2037H is suitable for application which has noise sensitive circuit such as battery-powered equipment and smartphones.

Input Capacitor Selection (C_{IN} and C_{BIAS})

The input decoupling capacitor should be placed as close as possible to the IN pin and BIAS pin to ensure the device stability. C_{IN} = 1μF and C_{BIAS} = 0.1μF or larger X7R or X5R ceramic capacitors are selected to get good dynamic performance.

When V_{IN} is required to provide large current instantaneously, 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. For C_{OUT} with larger capacitance, it is recommended to choose the larger capacitance C_{IN}.

Output Capacitor Selection (C_{OUT})

The output capacitor should be placed as close as possible to the OUT pin. 2.2μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance. The minimum effective capacitance of C_{OUT} that SGM2037H 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. Additionally, C_{OUT} with larger capacitance and lower ESR will help increase the high frequency PSRR and improve the load transient response.

Enable Operation

The SGM2037H 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. There is no current flowing from IN to OUT pins. 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 output voltage is regulated to the expected value and the automatic discharge transistor is turned off.

Adjustable Regulator

The output voltage of the SGM2037H can be adjusted from 0.8V to 3.6V. The FB pin will be connected to two external resistors as shown in Figure 3. The output voltage is determined by the following equation:

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_1}{R_2}\right) \quad (1)$$

where:

V_{OUT} is output voltage and V_{FB} is the internal voltage reference, V_{FB} = 0.8V. Choose R_2 = 40kΩ to maintain a 20μA minimum load.

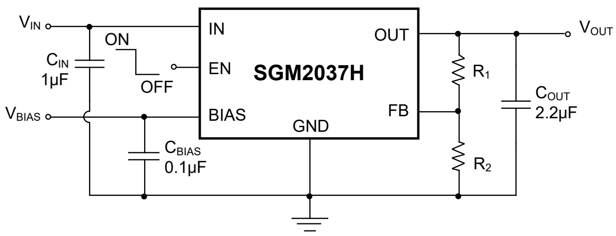


Figure 3. Adjustable Output Voltage Application

Dropout Voltage

The SGM2037H 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 the output voltage is lower than 1.5V, V_{BIAS} dropout voltage is not applicable because the minimum bias operating voltage is 2.7V.

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 overload events happen, the output current is internally limited to 750mA (TYP). When the OUT pin is shorted to ground, the short-circuit protection will limit the output current to 340mA (TYP).

APPLICATION INFORMATION (continued)

Thermal Shutdown

When the die temperature exceeds the threshold value of thermal shutdown, the SGM2037H will be in shutdown state and it will remain in this state until the die temperature decreases to +140℃.

Power Dissipation (P_D)

Power dissipation (P_D) of the SGM2037H can be calculated by the equation $P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$. The maximum allowable power dissipation ($P_{D(MAX)}$) of the SGM2037H is affected by many factors, including the difference between junction temperature and ambient temperature ($T_{J(MAX)} - T_A$), package thermal resistance from the junction to the ambient environment (θ_{JA}), the rate of ambient airflow and PCB layout. $P_{D(MAX)}$ can be approximated by the following equation:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A)/\theta_{JA} \quad (2)$$

The power dissipation must be less than 1.5W for the device protection. For example, when output is short to GND, the short current is about 0.5A and the input voltage must be less than 3V, otherwise the SGM2037H may be damaged.

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 SGM2037H. 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 SGM2037H.

TYPICAL APPLICATION CIRCUIT

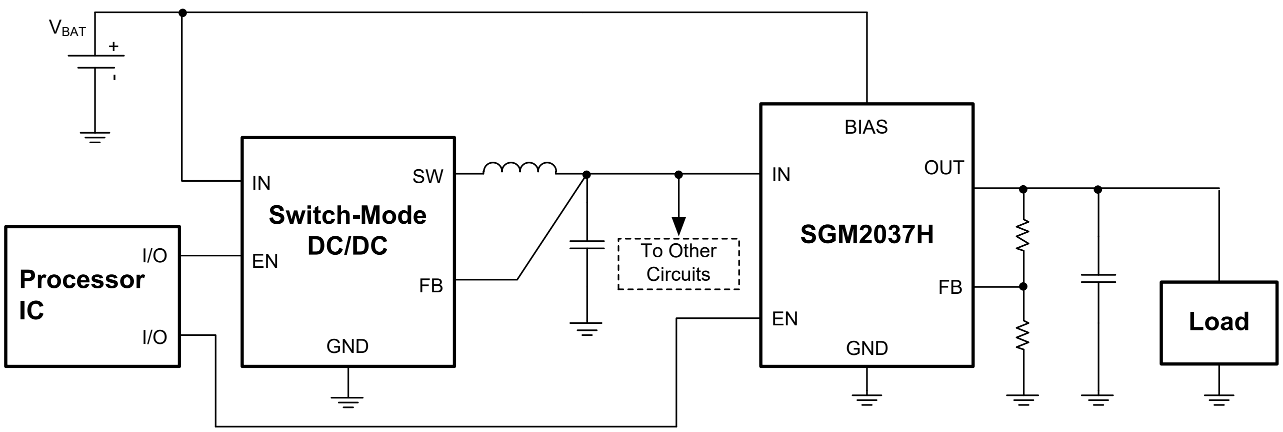


Figure 4. Used as DC/DC Post Regulator

REVISION HISTORY

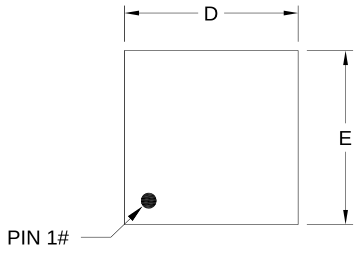
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

APRIL 2024 – REV.A to REV.A.1	Page
Updated Package Thermal Resistance	2

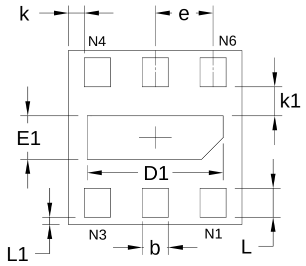
Changes from Original (DECEMBER 2021) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

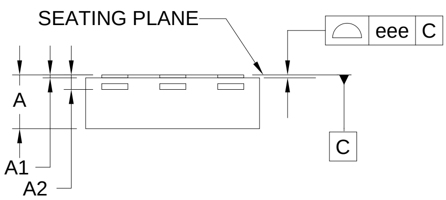
XTDFN-1.2×1.2-6L



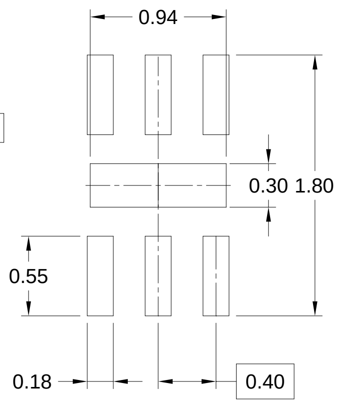
TOP VIEW



BOTTOM VIEW



SIDE VIEW



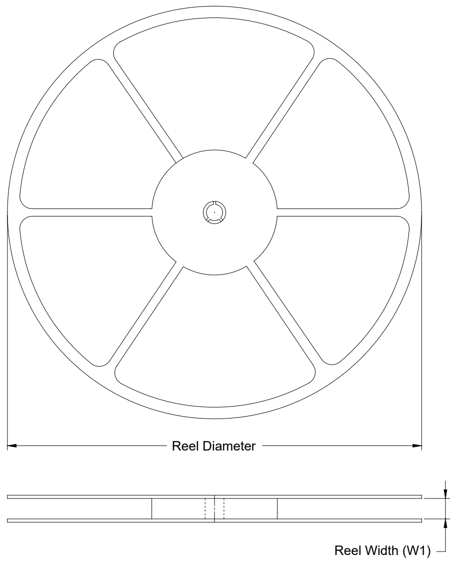
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.340	0.370	0.400
A1	0.000	-	0.050
A2	0.100 REF		
b	0.130	0.180	0.230
D	1.100	1.200	1.300
E	1.100	1.200	1.300
D1	0.890	0.940	0.990
E1	0.250	0.300	0.350
e	0.300	0.400	0.500
k	0.110 REF		
k1	0.150	0.200	0.250
L	0.150	0.200	0.250
L1	0.000	0.050	0.100
eee	0.080		

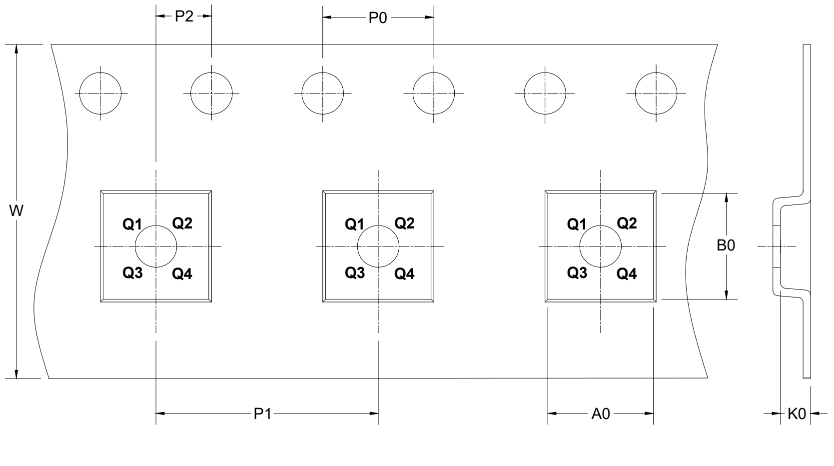
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



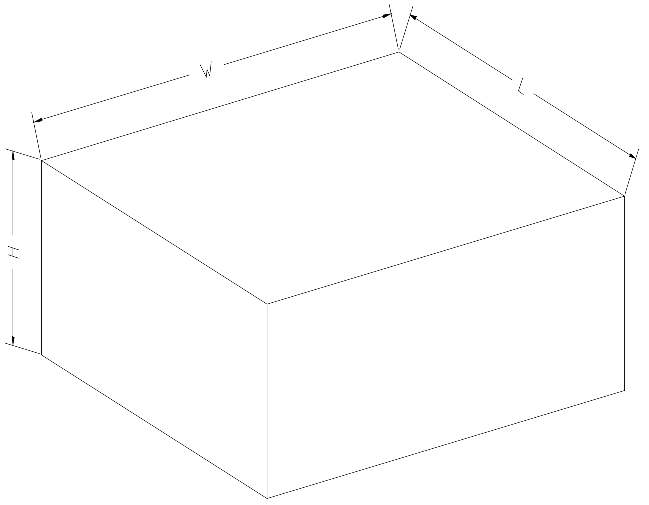
NOTE: The picture is only for reference. Please make the object as the standard.

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
XTDFN-1.2×1.2-6L	7″	9.5	1.37	1.37	0.55	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