SGM2038
500mA, Low Noise, Very Low Dropout Bias Rail CMOS Voltage Regulator

GENERAL DESCRIPTION

The SGM2038 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 2.5V 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 SGM2038 has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2038 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 SGM2038 is available in a Green UTDFN-1.2×1.2-4L package. It operates over an operating temperature range of -40℃ to +125℃.

FEATURES

- **Operating Input Voltage Range: 0.8V to 5.5V**
- **Operating Bias Voltage Range: 2.5V to 5.5V**
- **Fixed Outputs of 0.8V, 0.9V, 1.0V, 1.05V, 1.1V, 1.15V, 1.2V, 1.25V, 1.3V, 1.5V, 1.8V, 2.5V, 2.8V 3.0V, 3.3V, and 3.6V**
- **500mA Output Current**
- **Output Voltage Accuracy: ±0.8% at +25℃**
- **Very Low Bias Input Current: 37μA (TYP)**
- **Very Low Bias Input Current in Shutdown: 0.01μA (TYP)**
- **Low Dropout Voltage: 120mV (TYP) at 500mA**
- **Low Noise: 25μV_{RMS} (TYP)**
- **Current Limiting and Thermal Protection**
- **Excellent Load and Line Transient Responses**
- **With Output Automatic Discharge**
- **Logic Level Enable Input for ON/OFF Control**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green UTDFN-1.2×1.2-4L Package**

APPLICATIONS

Portable Equipment
Smartphone
Industrial and Medical Equipment

TYPICAL APPLICATION

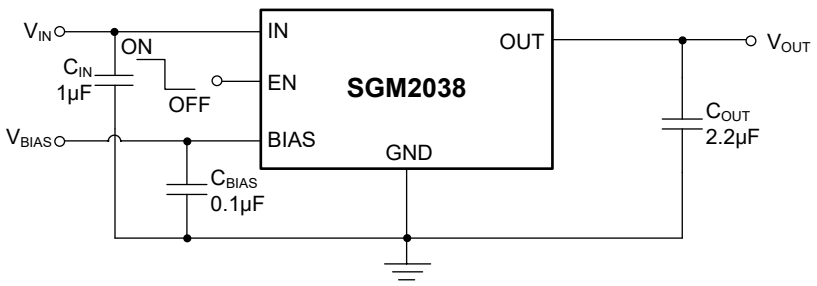


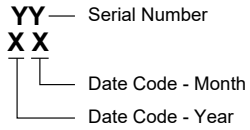
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2038-0.8	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-0.8XUDY4G/TR	38 XX	Tape and Reel, 5000
SGM2038-0.9	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-0.9XUDY4G/TR	39 XX	Tape and Reel, 5000
SGM2038-1.0	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.0XUDY4G/TR	3A XX	Tape and Reel, 5000
SGM2038-1.05	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.05XUDY4G/TR	3B XX	Tape and Reel, 5000
SGM2038-1.1	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.1XUDY4G/TR	3C XX	Tape and Reel, 5000
SGM2038-1.15	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.15XUDY4G/TR	3D XX	Tape and Reel, 5000
SGM2038-1.2	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.2XUDY4G/TR	3E XX	Tape and Reel, 5000
SGM2038-1.25	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.25XUDY4G/TR	3F XX	Tape and Reel, 5000
SGM2038-1.3	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.3XUDY4G/TR	40 XX	Tape and Reel, 5000
SGM2038-1.5	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.5XUDY4G/TR	41 XX	Tape and Reel, 5000
SGM2038-1.8	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-1.8XUDY4G/TR	42 XX	Tape and Reel, 5000
SGM2038-2.5	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-2.5XUDY4G/TR	43 XX	Tape and Reel, 5000
SGM2038-2.8	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-2.8XUDY4G/TR	44 XX	Tape and Reel, 5000
SGM2038-3.0	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-3.0XUDY4G/TR	45 XX	Tape and Reel, 5000
SGM2038-3.3	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-3.3XUDY4G/TR	46 XX	Tape and Reel, 5000
SGM2038-3.6	UTDFN-1.2×1.2-4L	-40℃ to +125℃	SGM2038-3.6XUDY4G/TR	48 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 MIN((V_{IN} + 0.3V), 6V)
Power Dissipation, P_D @ T_A = +25℃
UTDFN-1.2×1.2-4L 600mW
Package Thermal Resistance
UTDFN-1.2×1.2-4L, θ_{JA} ..... 208℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 8000V
MM 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Operating Input Voltage Range ..... 0.8V to 5.5V
Operating Bias Voltage Range ..... 2.5V to 5.5V
Enable Input Voltage Range ..... 0V 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 100μF
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.

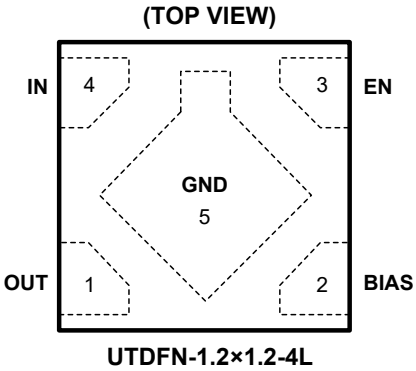
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. 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 a ceramic capacitor with effective capacitance in the range of 1μF to 100μF to ensure stability. This ceramic capacitor should be placed as close as possible to OUT pin.
2	BIAS	Bias Voltage Supply for Internal Control Circuits. This pin is monitored by internal under-voltage lockout circuit.
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	IN	Input Supply Voltage Pin. It is recommended to use a 1μF or larger ceramic capacitor from IN pin to ground to get good power supply decoupling. This ceramic capacitor should be placed as close as possible to IN pin.
5	GND	Ground.

ELECTRICAL CHARACTERISTICS

(V_{BIAS} = 2.7V or ($V_{OUT(NOM)}$ + 1.6V) (whichever is greater), V_{EN} = V_{BIAS}, V_{IN} = $V_{OUT(NOM)}$ + 0.3V, I_{OUT} = 1mA, C_{IN} = 1μF, C_{BIAS} = 0.1μF, 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℃	$V_{OUT(NOM)}$ + V_{DROP_IN}		5.5	V
Operating Bias Voltage Range	V_{BIAS}		+25℃	($V_{OUT(NOM)}$ + 1.4) ≥ 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} = ($V_{OUT(NOM)}$ + 0.3V) to ($V_{OUT(NOM)}$ + 1.0V), V_{BIAS} = 2.7V or ($V_{OUT(NOM)}$ + 1.6V) to 5.5V, I_{OUT} = 1mA to 500mA	+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} = ($V_{OUT(NOM)}$ + 0.3V) 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 or ($V_{OUT(NOM)}$ + 1.6V) to 5.5V, 0.8V ≤ $V_{OUT(NOM)}$ ≤ 1.8V	+25℃		0.002	0.03	%/V
		V_{BIAS} = ($V_{OUT(NOM)}$ + 1.6V) to 5.5V, 1.8V < $V_{OUT(NOM)}$ ≤ 3.6V	+25℃		0.005	0.1	
Load Regulation	ΔV_{OUT}	I_{OUT} = 1mA to 500mA, 0.8V ≤ $V_{OUT(NOM)}$ ≤ 1.8V	+25℃		0.5	2	mV
		I_{OUT} = 1mA to 500mA, 1.8V < $V_{OUT(NOM)}$ ≤ 3.6V	+25℃		1	5	
V_{IN} Dropout Voltage (1)	V_{DROP_IN}	I_{OUT} = 150mA	+25℃		35	50	mV
		I_{OUT} = 500mA	+25℃		120	170	
V_{BIAS} Dropout Voltage (2) (3)	V_{DROP_BIAS}	I_{OUT} = 500mA	+25℃		1.2	1.5	V
Output Current Limit	I_{LIMIT}		+25℃	505	670		mA
Short Current Limit	I_{SHORT}	V_{OUT} = 0V	+25℃		340		mA
BIAS Pin Operating Current	I_{BIAS}	V_{BIAS} = 5.5V	+25℃		37	53	μA
			Full			55	
IN Pin Disable Current	I_{DIS_IN}	V_{EN} = 0V	+25℃		0.1	0.5	μA
			Full			1.6	
BIAS Pin Disable Current	I_{DIS_BIAS}	V_{EN} = 0V	+25℃		0.01	0.5	μA
			Full			2.5	
EN Pin Threshold Voltage	V_{IH}	EN input voltage high	Full	1.2			V
	V_{IL}	EN input voltage low	Full			0.25	V
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, $V_{OUT(NOM)}$ = 1.0V, I_{OUT} = 150mA, V_{IN} ≥ 1.5V	+25℃		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	+25℃		76		
Output Voltage Noise	e_n	V_{IN} = $V_{OUT(NOM)}$ + 0.5V, $V_{OUT(NOM)}$ = 1.0V, f = 10Hz to 100kHz	+25℃		25		μV_{RMS}
Output Discharge Resistance	R_{DIS}	V_{EN} = 0V, V_{OUT} = 0.5V	+25℃		120		Ω
Thermal Shutdown Temperature	T_{SHDN}				160		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				20		℃

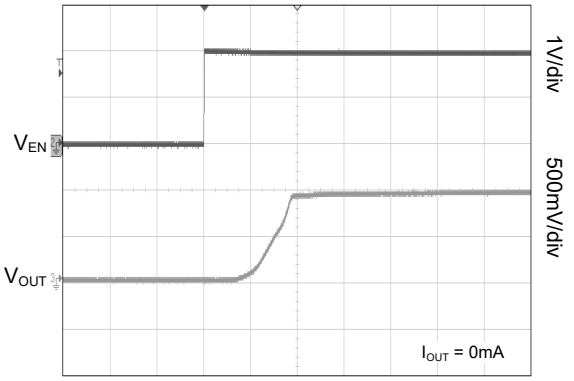
NOTES:

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 VIN and BIAS pins are connected together and V_{OUT} falls to 95% × $V_{OUT(NOM)}$.
3. For output voltages lower than 1.5V, V_{BIAS} dropout voltage is not applicable because the minimum bias supply voltage is 2.5V.

TYPICAL PERFORMANCE CHARACTERISTICS

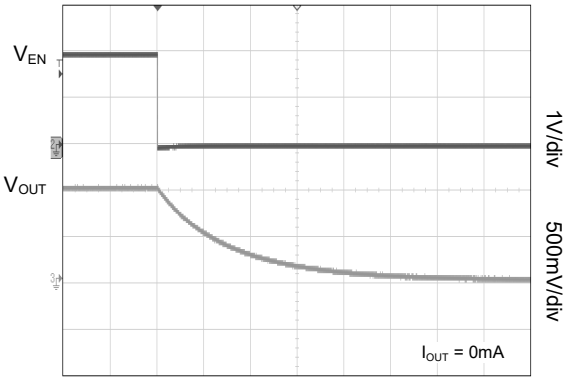
T_A = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 1.0V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

Turn-On Speed with EN Pin



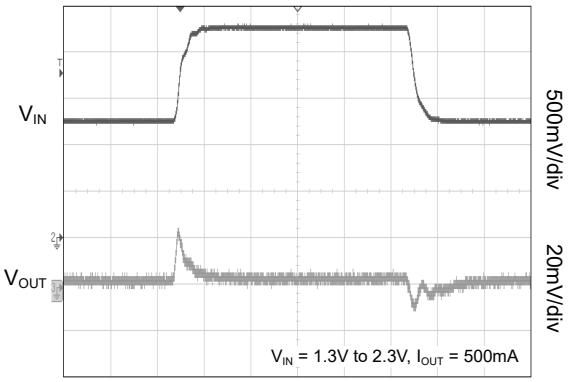
Time (50μs/div)

Turn-Off Speed with EN Pin



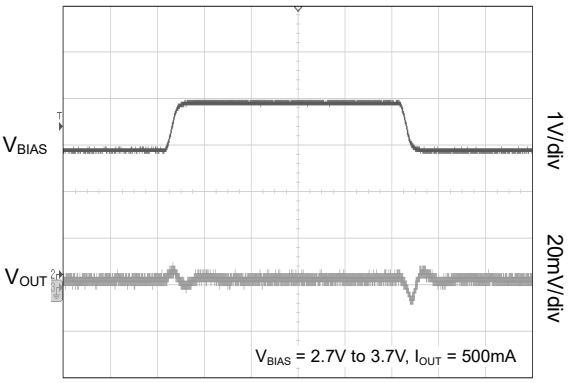
Time (200μs/div)

V_{IN} Line Transient Response



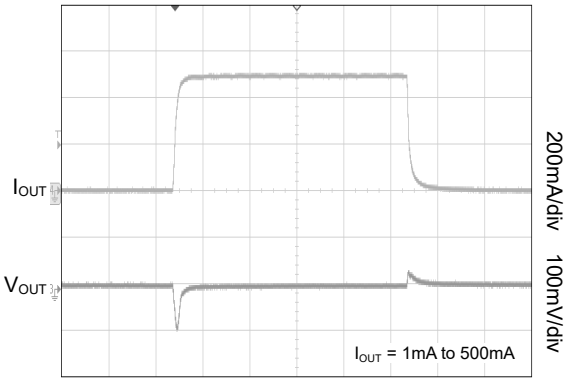
Time (10μs/div)

V_{BIAS} Line Transient Response



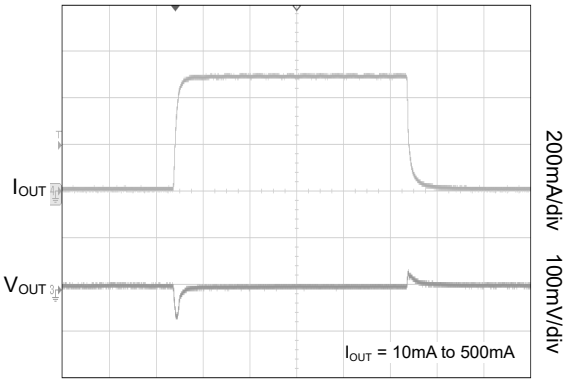
Time (20μs/div)

Load Transient Response



Time (50μs/div)

Load Transient Response

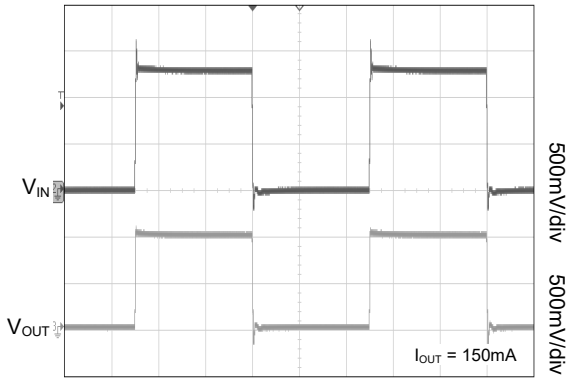


Time (50μs/div)

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

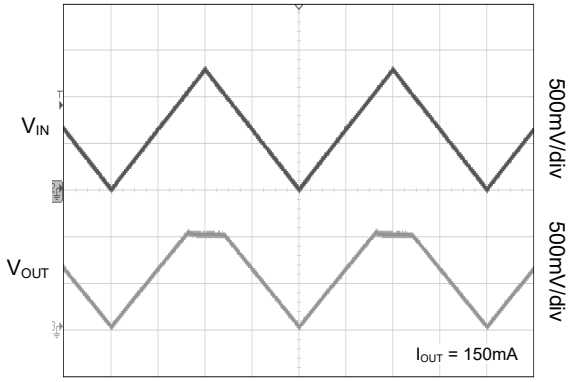
T_A = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.7V, $V_{OUT(NOM)}$ = 1.0V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

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



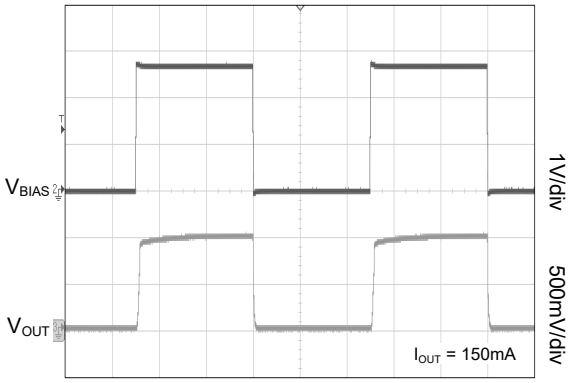
Time (200μs/div)

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



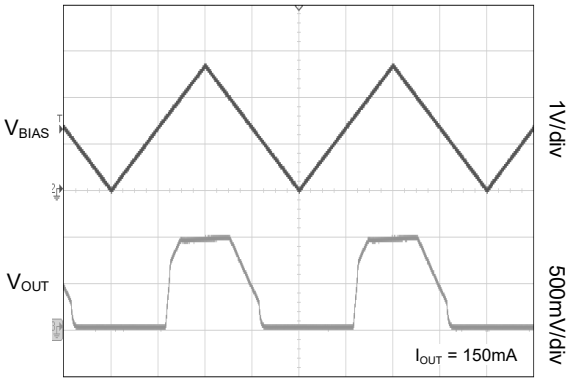
Time (500μs/div)

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



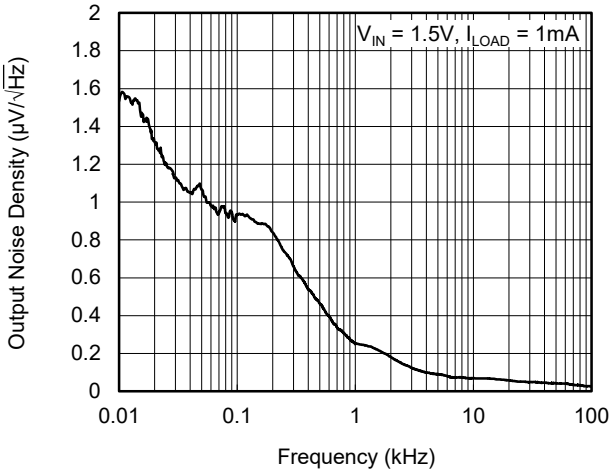
Time (1ms/div)

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

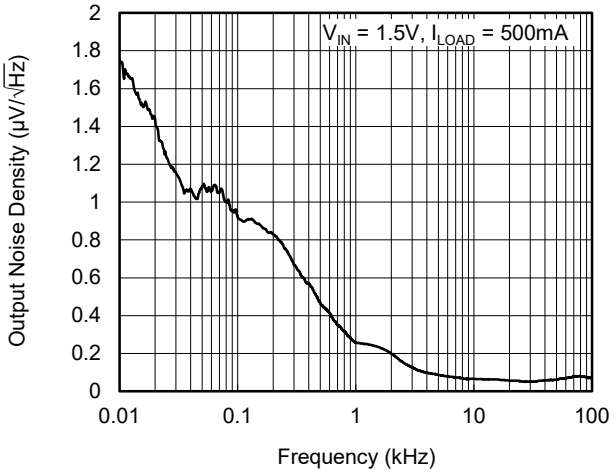


Time (500μs/div)

Output Noise Density vs. Frequency



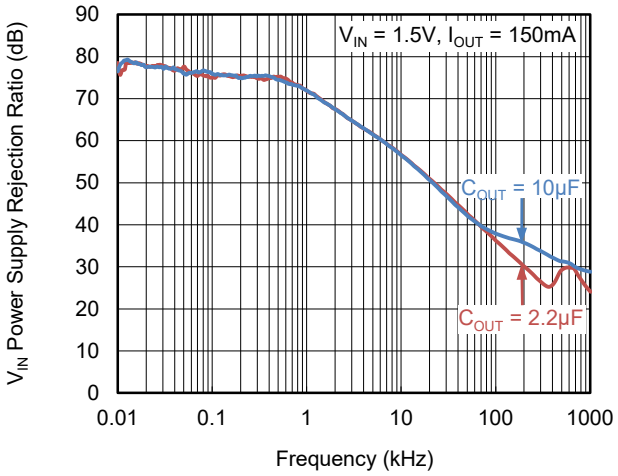
Output Noise Density vs. Frequency



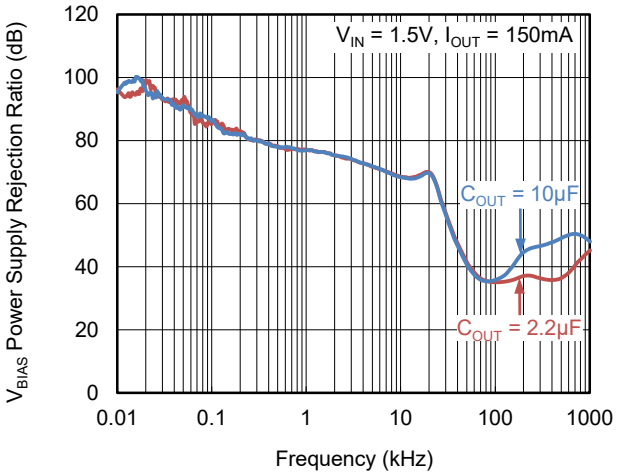
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +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.

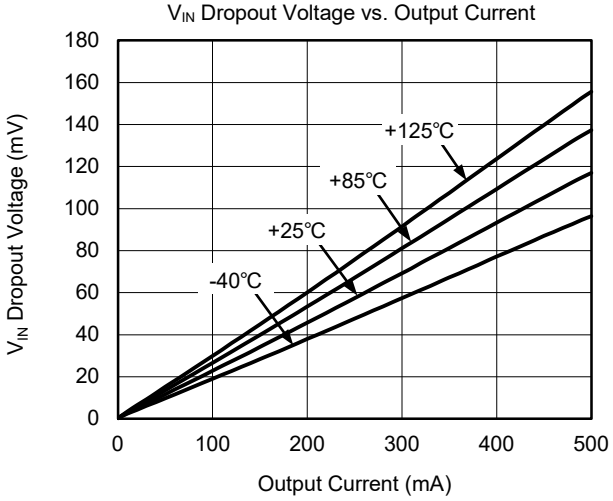
V_{IN} Power Supply Rejection Ratio vs. Frequency



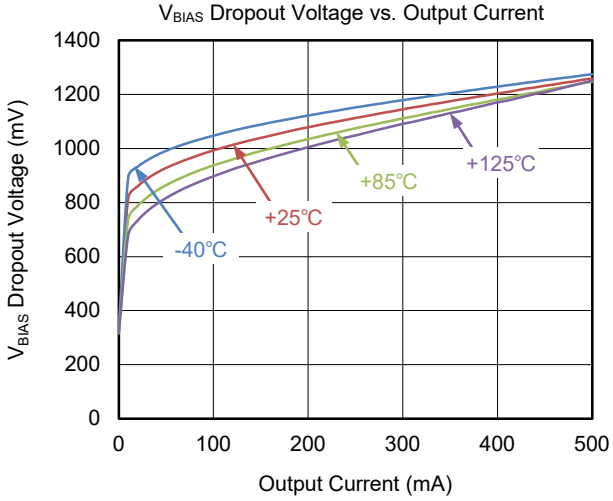
V_{BIAS} Power Supply Rejection Ratio vs. Frequency



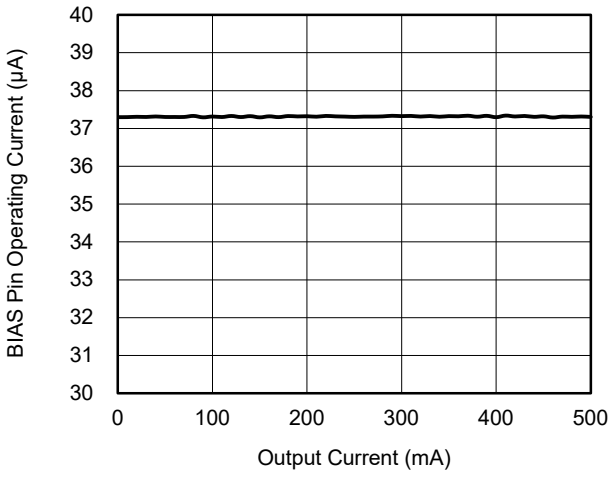
V_{IN} Dropout Voltage vs. Output Current



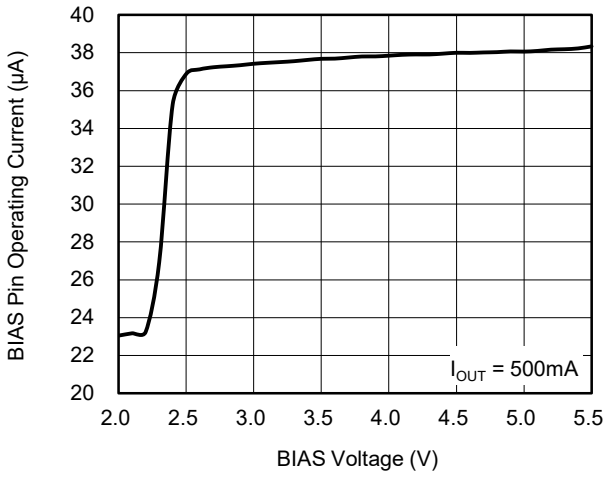
V_{BIAS} Dropout Voltage vs. Output Current



BIAS Pin Operating Current vs. Output Current



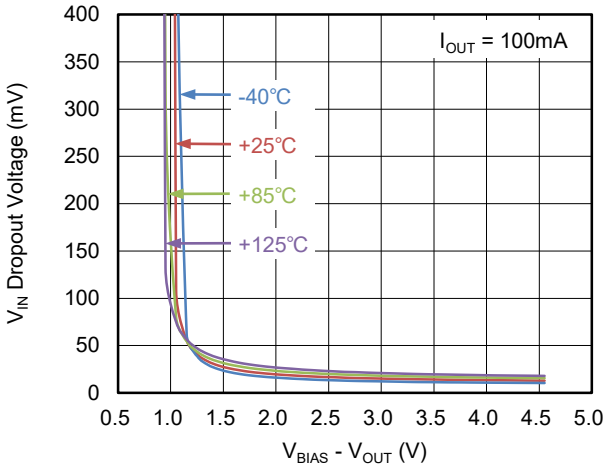
BIAS Pin Operating Current vs. BIAS Voltage



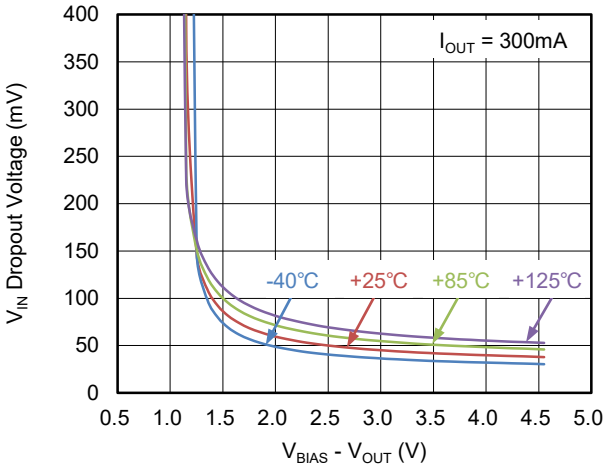
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +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.

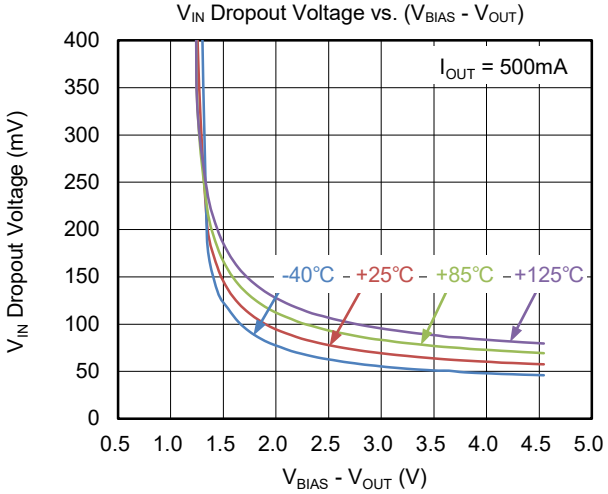
V_{IN} Dropout Voltage vs. (V_{BIAS} - V_{OUT})



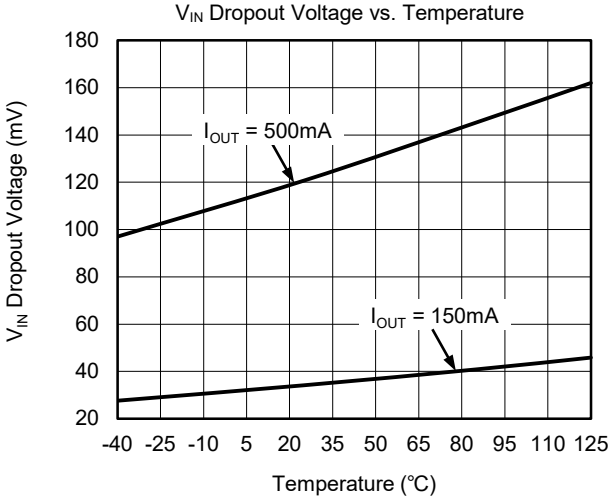
V_{IN} Dropout Voltage vs. (V_{BIAS} - V_{OUT})



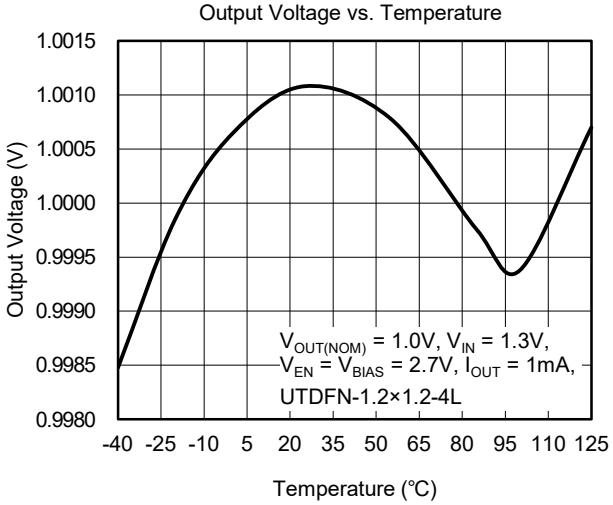
V_{IN} Dropout Voltage vs. (V_{BIAS} - V_{OUT})



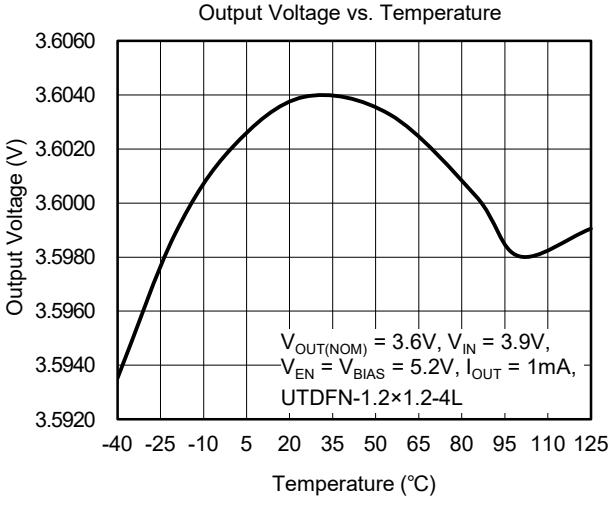
V_{IN} Dropout Voltage vs. Temperature



Output Voltage vs. Temperature



Output Voltage vs. Temperature



FUNCTIONAL BLOCK DIAGRAM

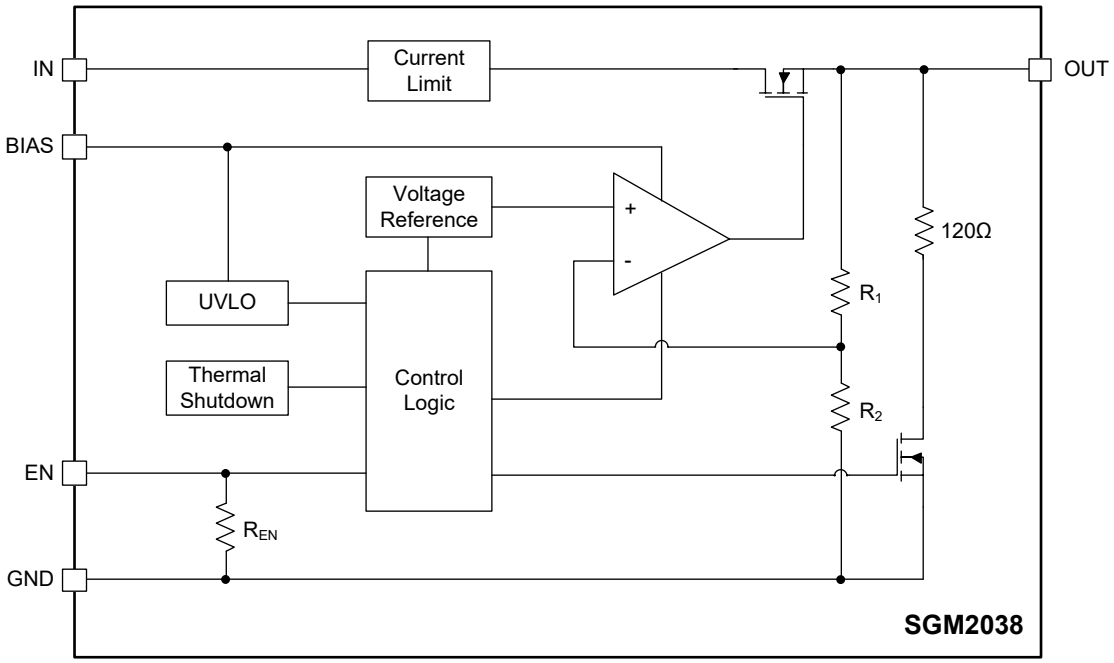


Figure 2. Block Diagram

APPLICATION INFORMATION

The SGM2038 is a low noise high performance LDO with fast transient response. It consumes only 37μA (TYP) quiescent current and provides 500mA output current. The SGM2038 provides protection functions for output overload, output short-circuit condition and overheating.

The SGM2038 is suitable for applications which need noise sensitive circuit such as battery-powered equipment and smartphones.

Input and Bias Capacitors (C_{IN}, C_{BIAS})

The input decoupling capacitor and bias capacitor should be placed as close as possible to the IN pin and BIAS pin for ensuring the device stability. C_{IN} = 1μF/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.

Output Capacitor (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 SGM2038 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 EN pin of the SGM2038 is used 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 SGM2038 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 2.5V.

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.

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 SGM2038. 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 SGM2038.

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.

Output Current Limit and Short-Circuit Protection

When an overload event happens, the output current is internally limited to 670mA (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

The SGM2038 can detect the temperature of die. When the die temperature exceeds the threshold value of thermal shutdown, the SGM2038 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 SGM2038. 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. The power dissipation needs to be less than 1.5W when thermal protection occurs.

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 SGM2038 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.

REVISION HISTORY

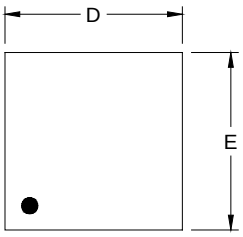
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

JULY 2022 – REV.A to REV.A.1	Page
Updated Recommended Operating Conditions	3

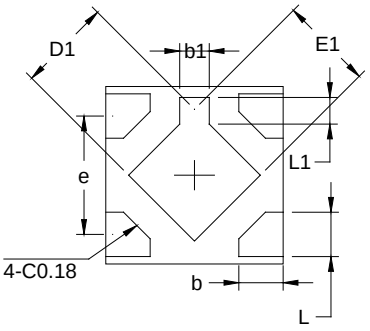
Changes from Original (SEPTEMBER 2018) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

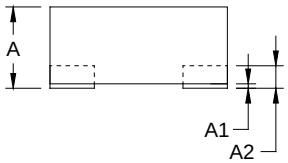
UTDFN-1.2×1.2-4L



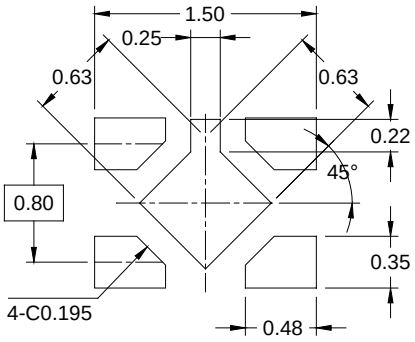
TOP VIEW



BOTTOM VIEW



SIDE VIEW



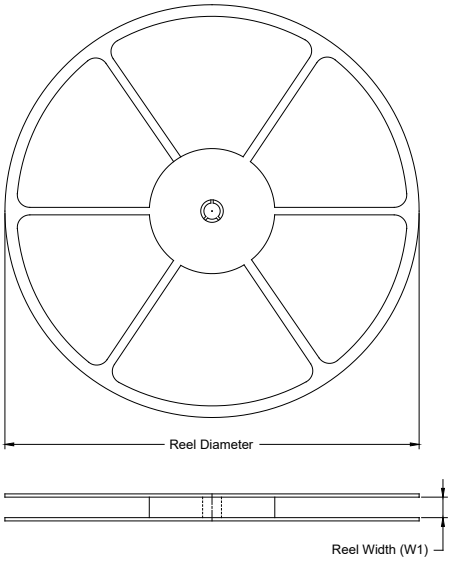
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.500	0.550	0.600
A1			0.050
A2	0.152 REF		
e	0.800 BSC		
D	1.150	1.200	1.250
E	1.150	1.200	1.250
D1	0.580	0.630	0.680
E1	0.580	0.630	0.680
b	0.250	0.300	0.350
b1	0.150	0.200	0.250
L	0.250	0.300	0.350
L1	0.130	0.180	0.230

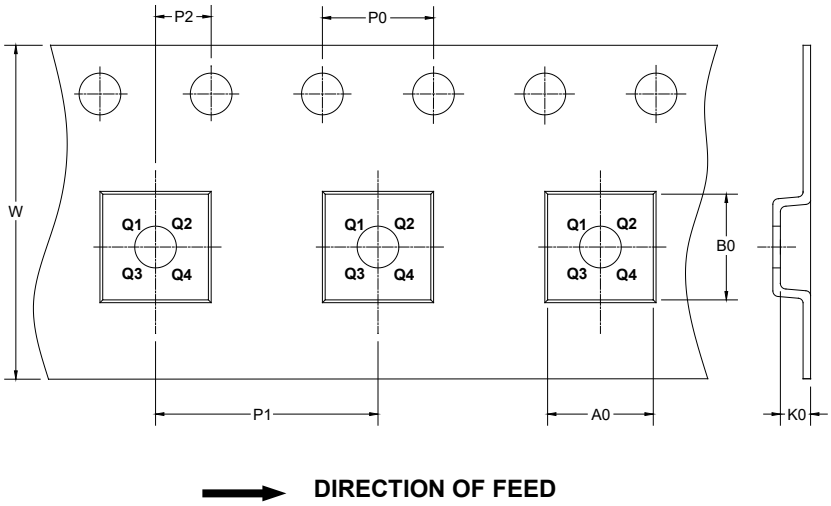
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



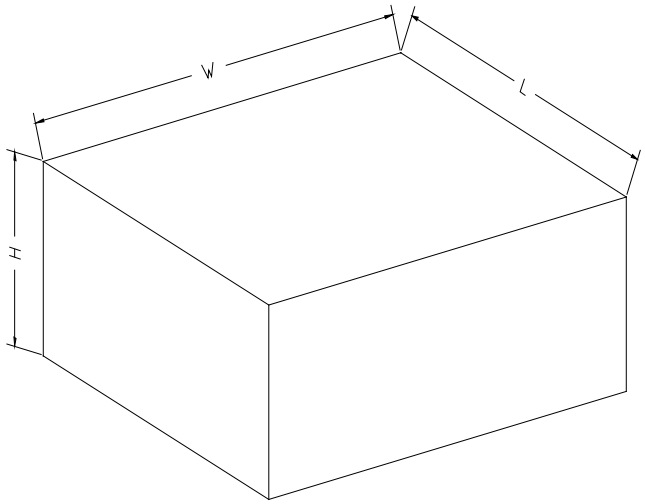
NOTE: The picture is only for reference. Please make the object as the standard.

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
UTDFN-1.2×1.2-4L	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