SGM2065
1A, Low Noise, Ultra-Low Dropout, Bias Rail CMOS Voltage Regulator

GENERAL DESCRIPTION

The SGM2065 is a low noise, ultra-low dropout voltage linear regulator which is designed using CMOS technology. It is capable of supplying 1A output current with typical dropout voltage of only 220mV. The operating input voltage range is from 0.8V to 5.5V and bias supply voltage range is from 2.8V to 5.5V. The output voltage range is from 0.8V to 3.5V.

Other features include logic-controlled shutdown mode, short-circuit current limit and thermal shutdown protection. The SGM2065 has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2065 is available in a Green XTDFN-1.2×1.2-6L 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: 2.8V to 5.5V**
- **Adjustable Output from 0.8V to 3.5V**
- **1A Output Current**
- **Output Voltage Accuracy: ±0.8% at +25℃**
- **Low Bias Input Current: 37μA (TYP)**
- **Low Dropout Voltage: 220mV (TYP) at 1A**
- **Low Noise: 25μV_{RMS} (TYP)**
- **Very Low Bias Shutdown Current: 0.01μA (TYP)**
- **Current Limiting and Thermal Protection**
- **Excellent Load and Line Transient Responses**
- **With Output Automatic Discharge**
- **Stable with Small Case Size Ceramic Capacitors**
- **-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

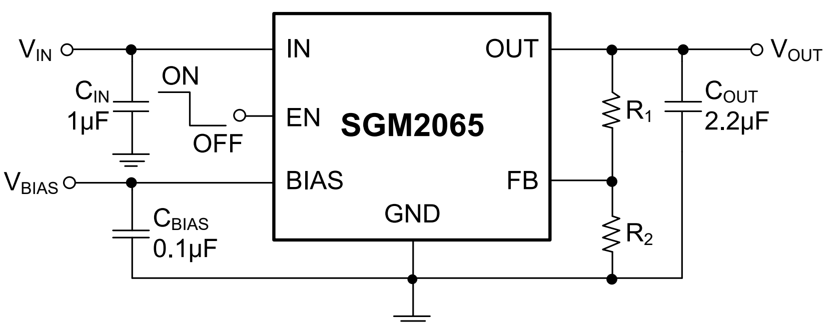


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2065-ADJ	XTDFN-1.2×1.2-6L	-40℃ to +125℃	SGM2065-ADJXXED6G/TR	3H XX	Tape and Reel, 5000

MARKING INFORMATION

NOTE: XX = Date Code.

YY — Serial Number
XX
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}... 195℃/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}..................2.8V 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.

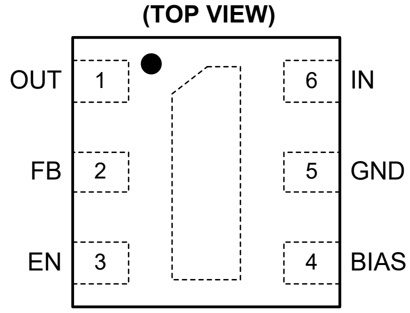
ESD SENSITIVITY CAUTION

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



XTDFN-1.2×1.2-6L

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 10μF to ensure stability. This ceramic capacitor should be placed as close as possible to OUT pin.
2	FB	Feedback Pin. Connect this pin to the midpoint of an 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 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.
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

(V_{BIAS} = 2.8V or ($V_{OUT(NOM)}$ + 2V) (whichever is greater), V_{EN} = V_{BIAS}, V_{IN} = $V_{OUT(NOM)}$ + 0.5V, I_{OUT} = 1mA, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, T_J = -40℃ to +125℃, typical values are at T_J = +25℃, unless otherwise noted.)

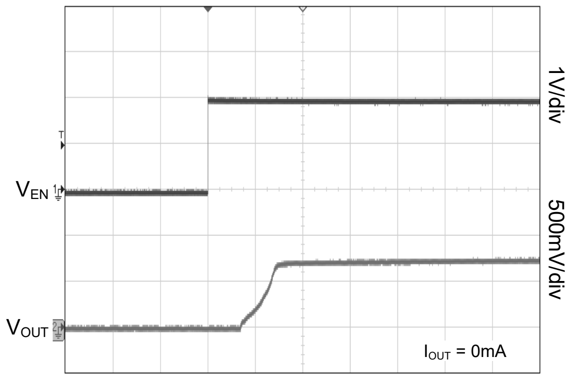
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Operating Input Voltage Range	V_{IN}			$V_{OUT(NOM)}$ + V_{DROP_IN}		5.5	V
Operating Bias Voltage Range	V_{BIAS}			2.8		5.5	V
Under-Voltage Lockout Thresholds	V_{UVLO}	V_{BIAS} rising			1.6	2.6	V
		Hysteresis			0.2		
Feedback Voltage	V_{FB}	V_{OUT} = V_{FB}, I_{OUT} = 1mA to 1000mA	T_J = +25℃	0.7936	0.8	0.8064	V
			T_J = -40℃ to +125℃	0.784		0.816	
Output Voltage Accuracy	V_{OUT}	V_{IN} = ($V_{OUT(NOM)}$ + 0.5V) to 5.5V, V_{BIAS} = 2.8V or ($V_{OUT(NOM)}$ +2V) (whichever is greater) to 5.5V, I_{OUT} = 1mA to 1000mA	T_J = +25℃	-0.8		0.8	%
			T_J = -40℃ to +125℃	-2		2	
V_{IN} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$	V_{IN} = ($V_{OUT(NOM)}$ + 0.5V) to 5.5V			0.002	0.05	%/V
V_{BIAS} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{BIAS} \times V_{OUT}}$	V_{BIAS} = 2.8V or ($V_{OUT(NOM)}$ +2V) (whichever is greater) to 5.5V			0.002	0.05	%/V
Load Regulation	ΔV_{OUT}	I_{OUT} = 1mA to 1000mA	T_J = +25℃		0.8	4	mV
			T_J = -40℃ to +125℃			12	
V_{IN} Dropout Voltage (1)	V_{DROP_IN}	I_{OUT} = 500mA			110	200	mV
		I_{OUT} = 1000mA			220	400	
V_{BIAS} Dropout Voltage (1, 2)	V_{DROP_BIAS}	I_{OUT} = 500mA			1.2	1.6	V
		I_{OUT} = 1000mA			1.5	2	
Output Current Limit	I_{LIMIT}	T_J = +25℃		1	1.3		A
Short-Circuit Current Limit	I_{SHORT}	V_{OUT} = 0V			0.4		A
FB Pin Input Current	I_{FB}	V_{FB} = 0.9V		-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
			T_J = -40℃ to +125℃			2	
BIAS Pin Disable Current	I_{DIS_BIAS}	V_{EN} = 0V	T_J = +25℃		0.01	1	μA
			T_J = -40℃ to +125℃			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, $V_{OUT(NOM)}$ = 1V, I_{OUT} = 150mA, V_{IN} ≥ 1.5V			71		dB
V_{BIAS} Power Supply Rejection Ratio		V_{BIAS} to V_{OUT}, f = 1kHz, $V_{OUT(NOM)}$ = 1V, I_{OUT} = 150mA, V_{IN} ≥ 1.5V			76		
Output Voltage Noise	e_n	V_{IN} = $V_{OUT(NOM)}$ + 0.5V, $V_{OUT(NOM)}$ = 1V, f = 10Hz to 100kHz			25		$μV_{RMS}$
Output Discharge Resistance	R_{DIS}	V_{EN} = 0V, V_{OUT} = 0.5V		50	135	220	Ω
Thermal Shutdown Temperature	T_{SHDN}				160		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				20		℃

NOTES:
1. The dropout voltage is defined as the difference between V_{IN} and V_{OUT} when V_{OUT} falls to 95% × $V_{OUT(NOM)}$.
2. The V_{BIAS} dropout voltage is not suitable for output voltages below 1.3V because the minimum bias operating voltage is 2.8V.

TYPICAL PERFORMANCE CHARACTERISTICS

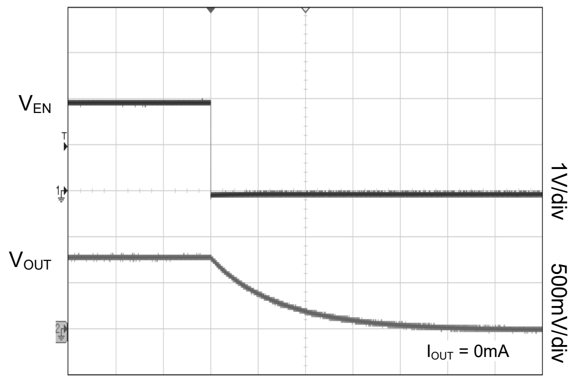
T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.8V, $V_{OUT(NOM)}$ = 0.8V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

Turn-On Speed with EN Pin



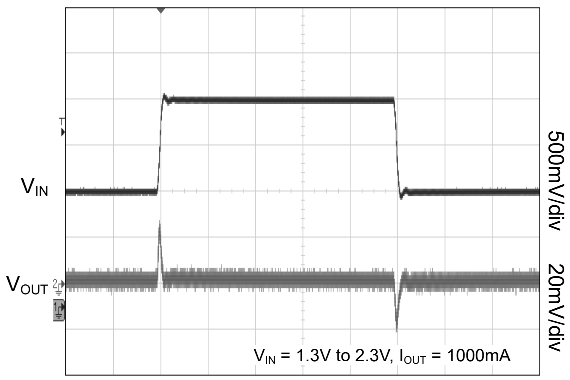
Time (50μs/div)

Turn-Off Speed with EN Pin



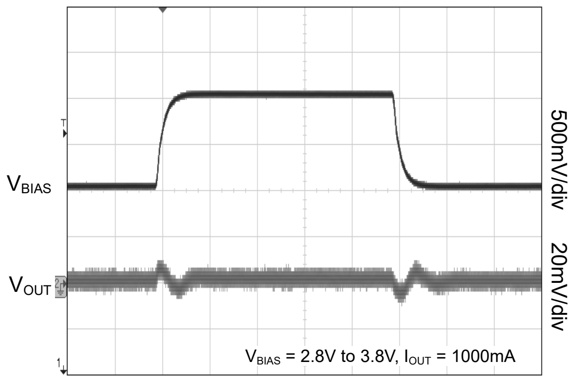
Time (200μs/div)

V_{IN} Line Transient Response



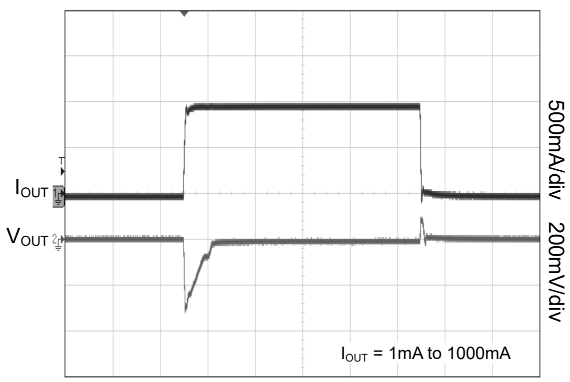
Time (50μs/div)

V_{BIAS} Line Transient Response



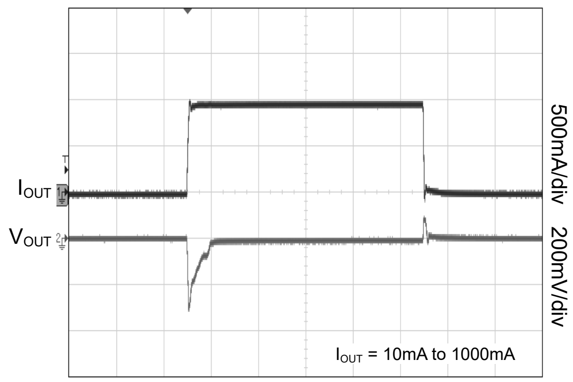
Time (20μs/div)

Load Transient Response



Time (50μs/div)

Load Transient Response

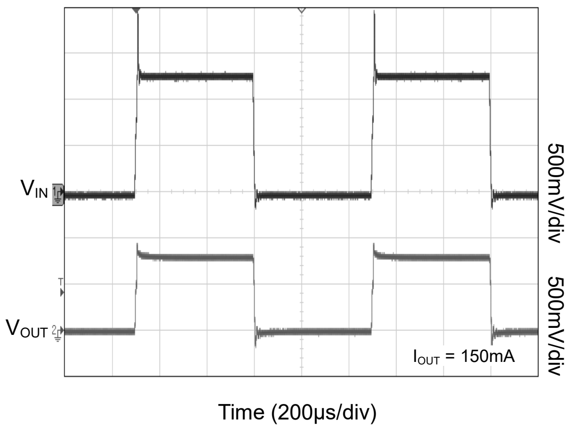


Time (50μs/div)

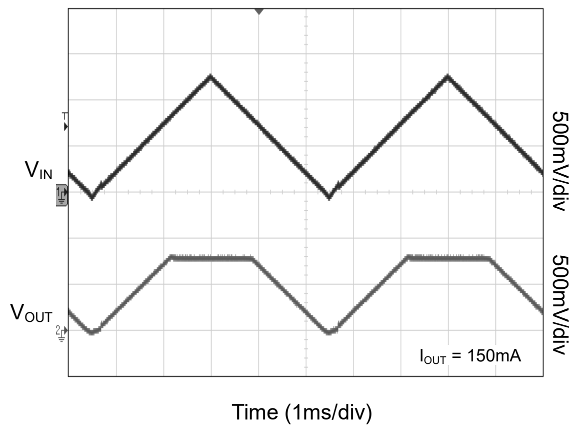
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.8V, $V_{OUT(NOM)}$ = 0.8V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

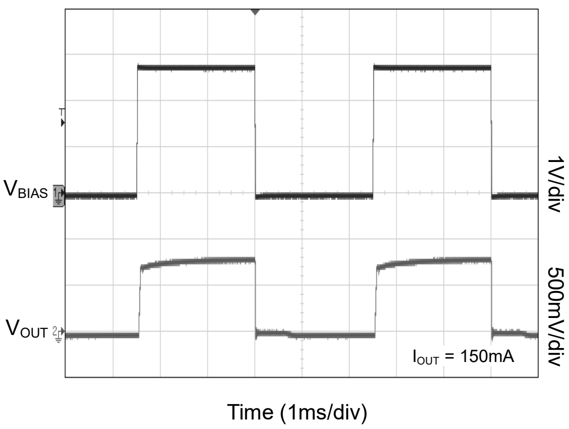
V_{IN} Power-Up/Power-Down Output Waveform



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



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



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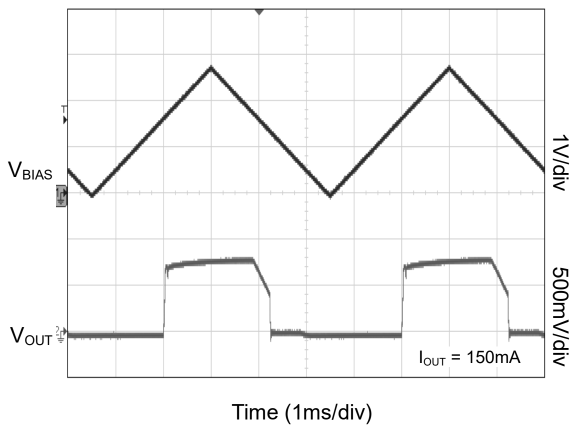
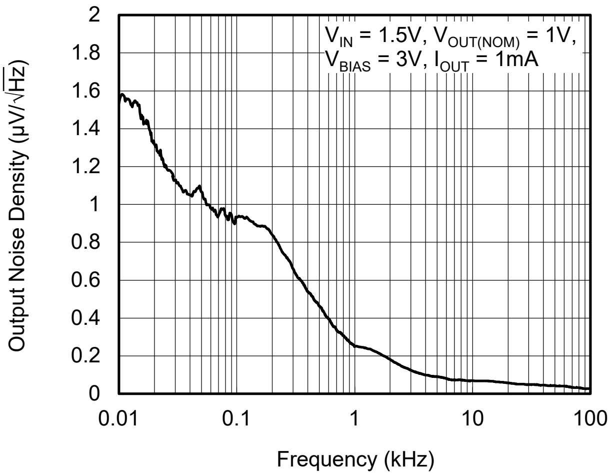


Output Noise Density vs. Frequency



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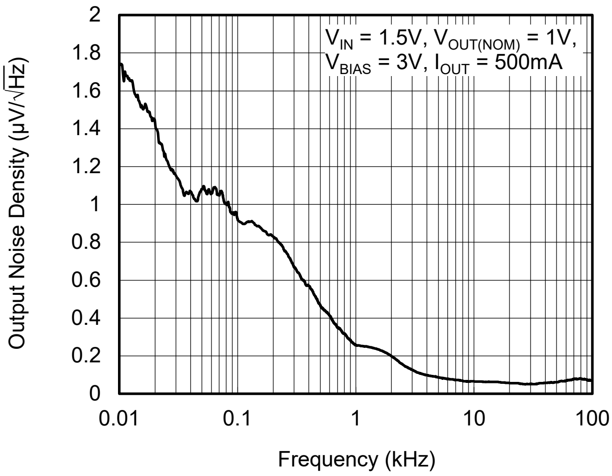
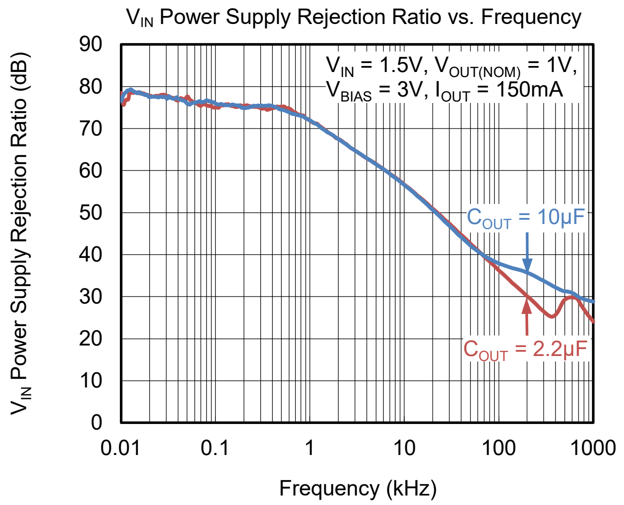
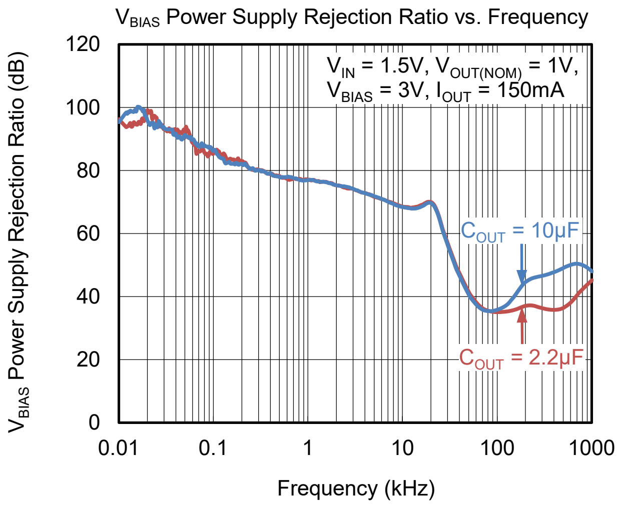
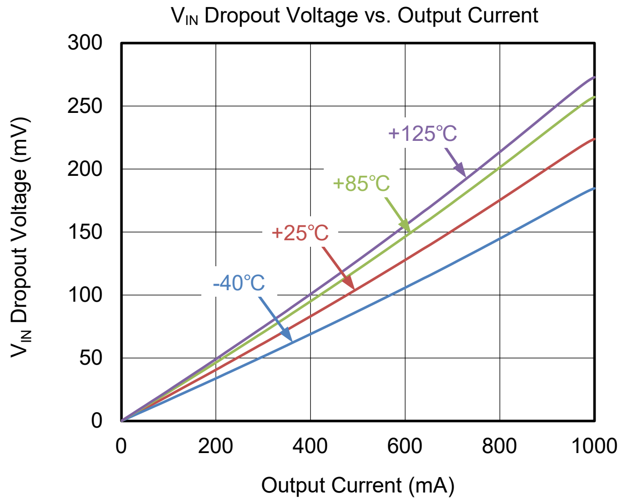


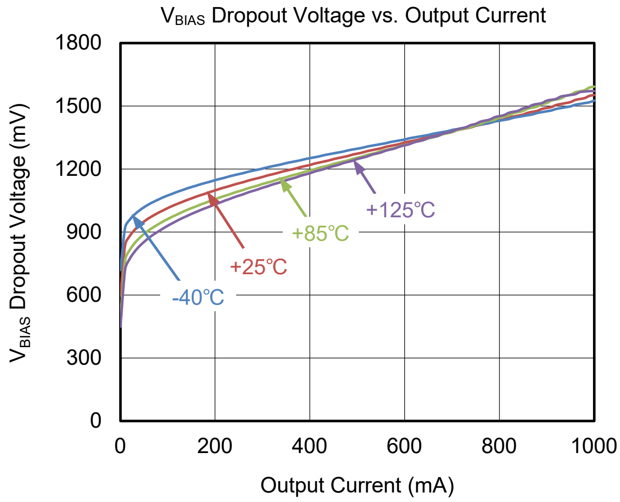
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

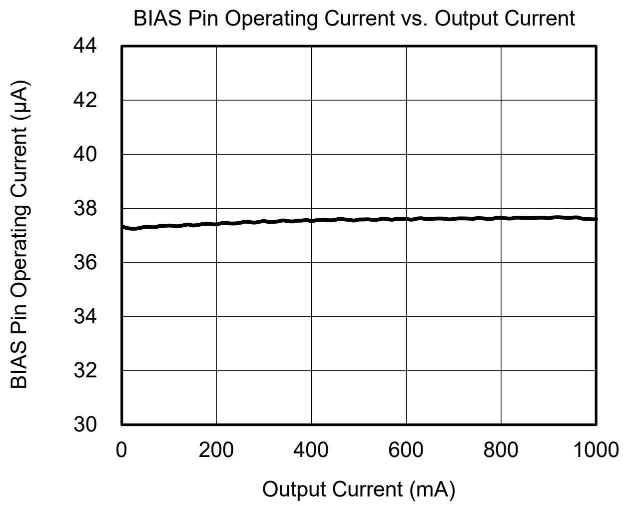
T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.8V, $V_{OUT(NOM)}$ = 0.8V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.

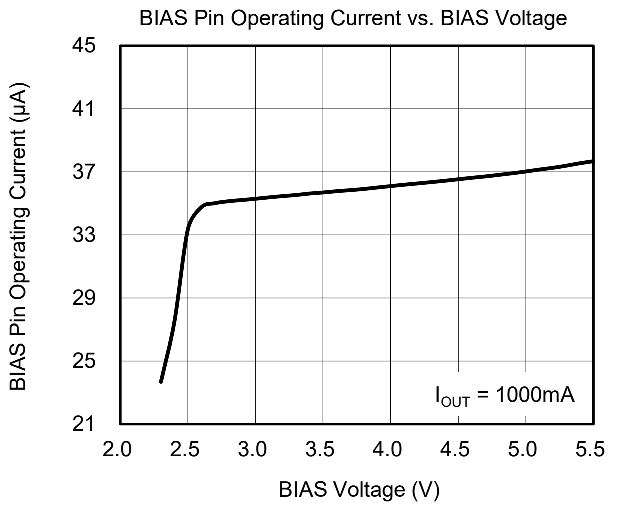






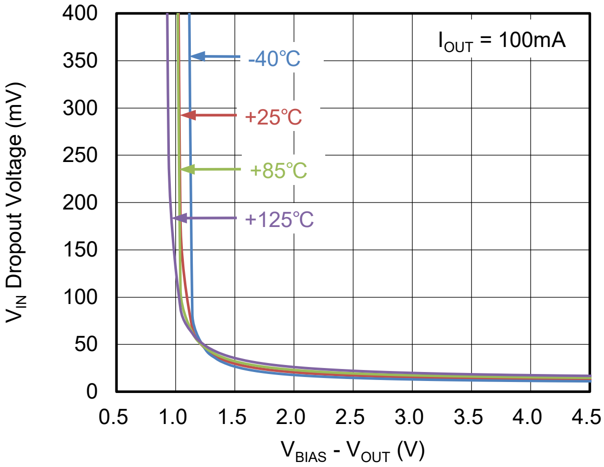




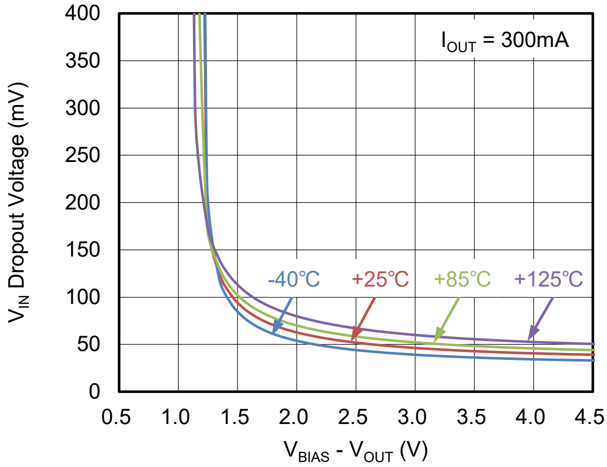


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = 1.3V, V_{EN} = V_{BIAS} = 2.8V, $V_{OUT(NOM)}$ = 0.8V, C_{IN} = 1μF, C_{BIAS} = 0.1μF, C_{OUT} = 2.2μF, unless otherwise noted.



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



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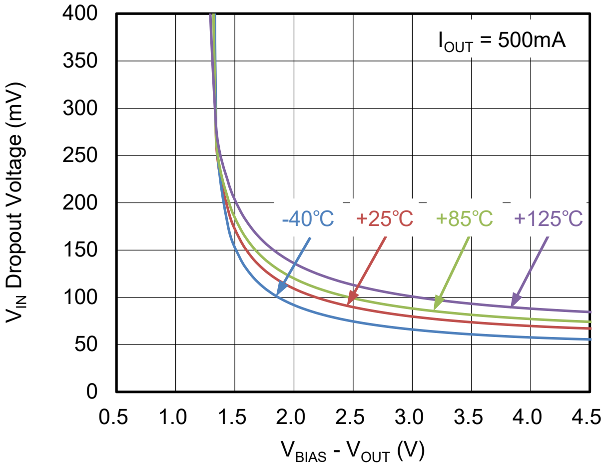

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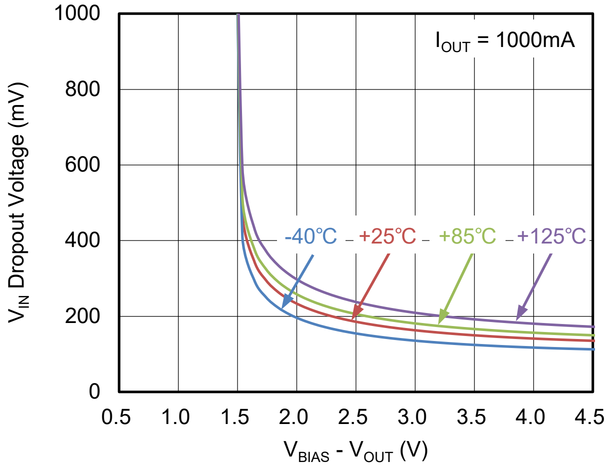

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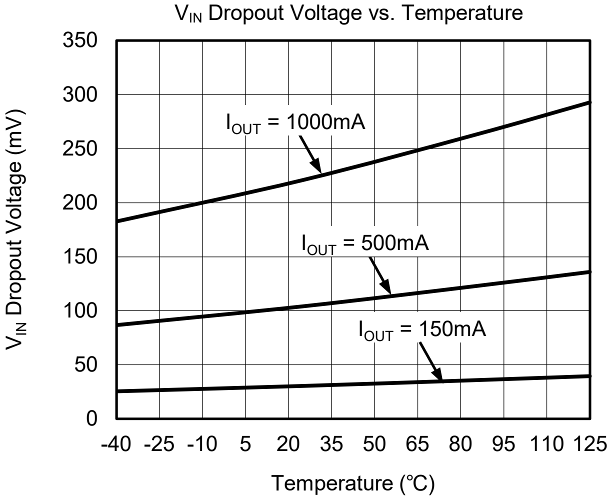
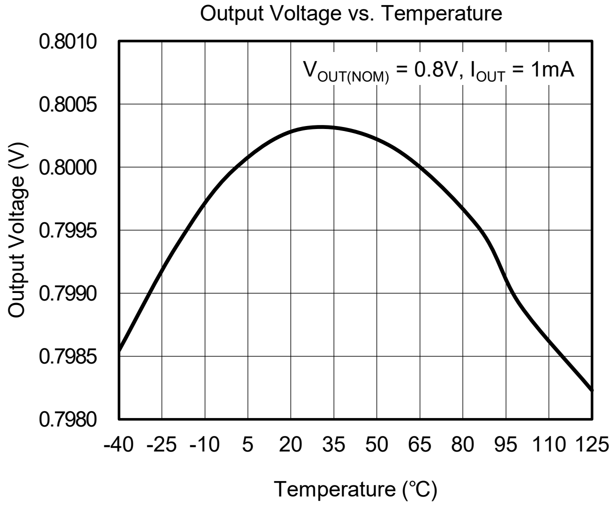


V_{IN} Dropout Voltage vs. Temperature



Output Voltage vs. Temperature

FUNCTIONAL BLOCK DIAGRAM

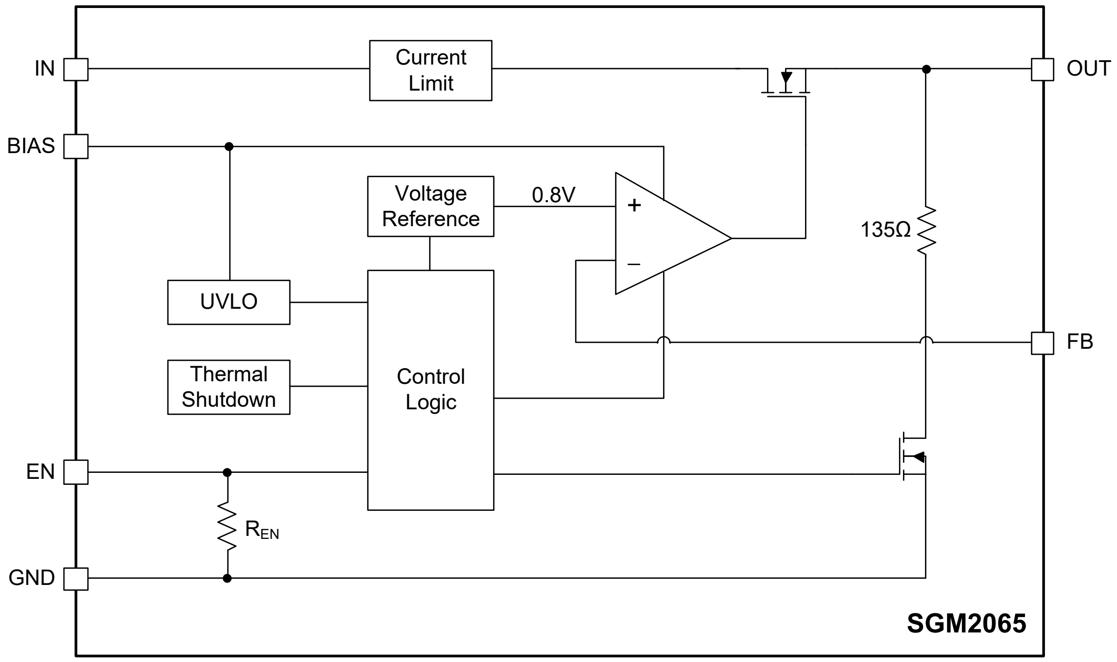


Figure 2. Block Diagram

APPLICATION INFORMATION

The SGM2065 is a low noise, ultra-low dropout LDO and provides 1A output current. These features make the device a reliable solution to solve many challenging problems in the generation of clean and accurate power supply. The high performance also makes the SGM2065 useful in a variety of applications. The SGM2065 provides protection functions for output overload, output short-circuit condition and overheating.

The SGM2065 is suitable for applications which have noise sensitive circuit such as battery-powered equipment and smartphones.

The SGM2065 provides an EN pin as an external chip enable control to enable/disable the device. When the regulator is in shutdown state, the shutdown current consumes as low as 0.01μA (TYP).

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 SGM2065 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.

Dropout Voltage

The SGM2065 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 1.3V, V_{BIAS} dropout voltage does is not applicable because the minimum bias operating voltage is 2.8V.

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.

Adjustable Regulator

The output voltage of the SGM2065 can be adjusted from 0.8V to 3.5V. 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.

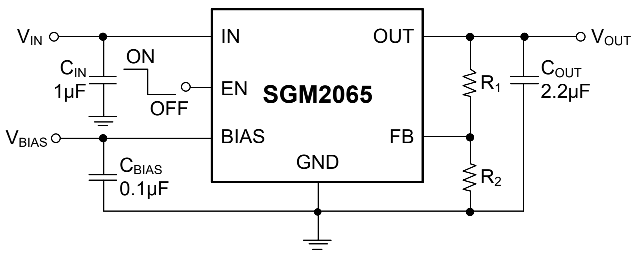


Figure 3. Adjustable Output Voltage Application

Enable Operation

The EN pin of the SGM2065 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, 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 135Ω (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.

APPLICATION INFORMATION (continued)

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 SGM2065. 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 SGM2065.

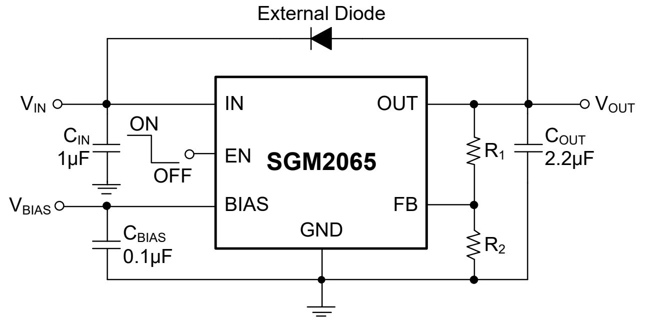


Figure 4. Reverse Protection Reference Design

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.

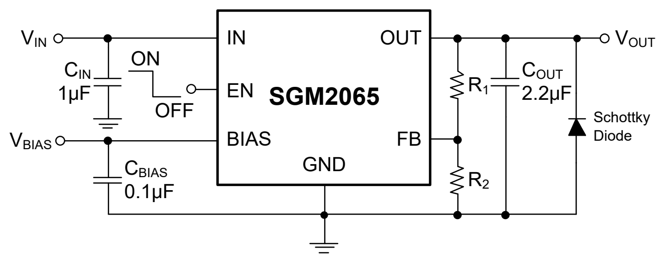


Figure 5. Negatively Biased Output Application

Output Current Limit and Short-Circuit Protection

When overload events happen, the output current is internally limited to 1.3A (TYP). When the OUT pin is shorted to ground, the short-circuit protection will limit the output current to 0.4A (TYP).

Thermal Shutdown

The SGM2065 can detect the temperature of die. When the die temperature exceeds the threshold value of thermal shutdown, the SGM2065 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 SGM2065. When power dissipation on pass element (P_D = (V_{IN} - V_{OUT}) × 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 SGM2065 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:

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

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.

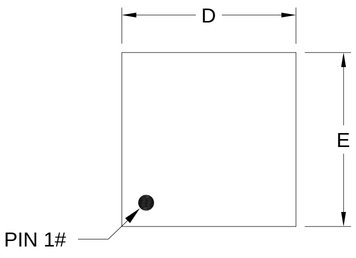
REVISION HISTORY

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

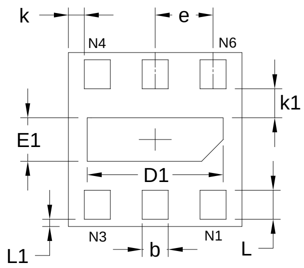
Changes from Original (JUNE 2022) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

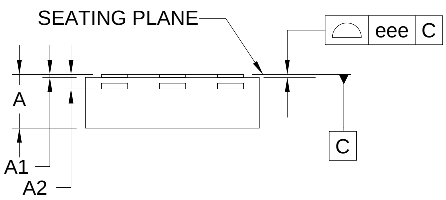
XTDFN-1.2×1.2-6L



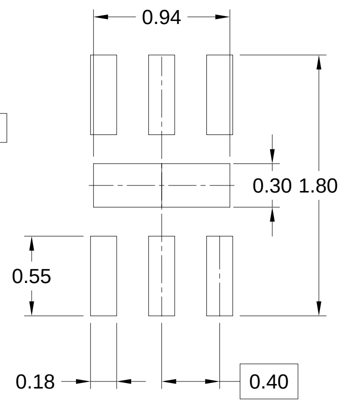
TOP VIEW



BOTTOM VIEW



SIDE VIEW



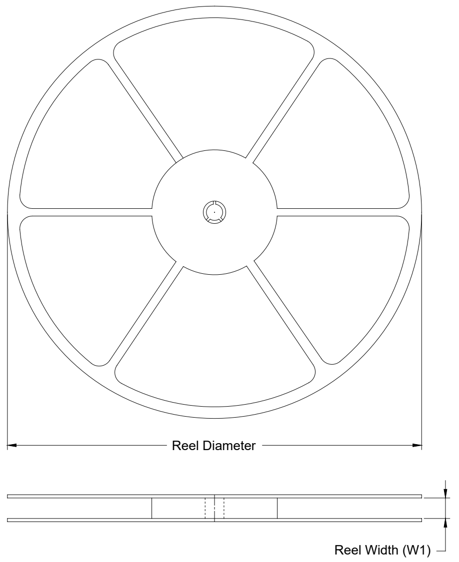
RECOMMENDED LAND PATTERN (Unit: mm)

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		

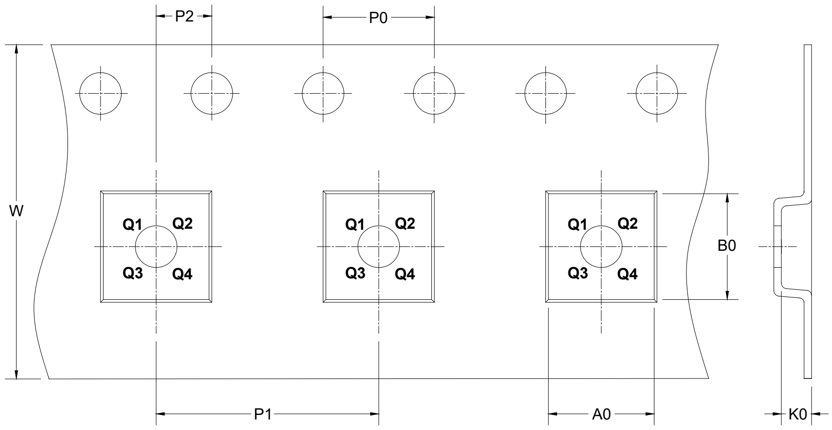
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

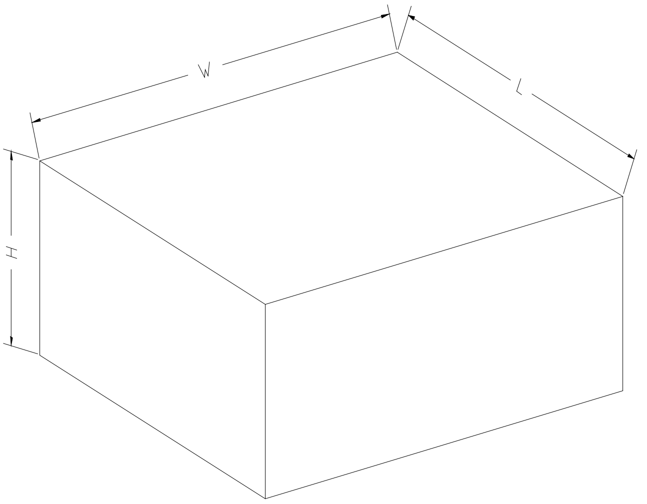
NOTE: The picture is only for reference. Please make the object as the standard.

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
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