SGM2046
1.2A, Low Noise, Ultra-Low Dropout Bias Rail CMOS Voltage Regulator

GENERAL DESCRIPTION

The SGM2046 is a 1.2A, low noise, ultra-low dropout linear regulator equipped with NMOS pass transistor and a separate bias supply voltage (V_{BIAS}). The device provides very stable, accurate output voltage with low noise suitable for space constrained, noise sensitive applications. In order to optimize performance for battery operated portable applications, the SGM2046 features low I_Q consumption.

The SGM2046 is available in a Green WLCSP-0.8×1.2-6B-B package. It operates over an operating temperature range of -40℃ to +125℃.

APPLICATIONS

Battery-Powered Equipment
Smartphones and Tablets
Cameras, DVRs, STB and Camcorders

FEATURES

- **Input Voltage Range: 0.5V to 5.5V**
- **Bias Voltage Range: 2.5V to 5.5V**
- **Adjustable Output Voltage Range: 0.5V to 3.3V**
- **Low Dropout Voltage: 50mV (TYP) at 1A**
- **Very Low Bias Input Current: 35μA (TYP)**
- **Very Low Bias Input Current in Disable Mode: 0.1μA (TYP)**
- **Low Noise: 29μV_{RMS} (TYP)**
- **Over-Current Protection**
- **Over-Temperature Protection**
- **Fast Load Transient Response**
- **Logic Level Enable Input for ON/OFF Control**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green WLCSP-0.8×1.2-6B-B Package**

TYPICAL APPLICATION

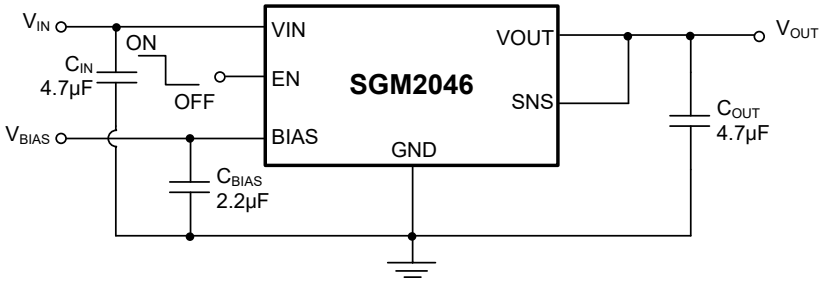


Figure 1. Fixed Voltage Typical Application Circuit

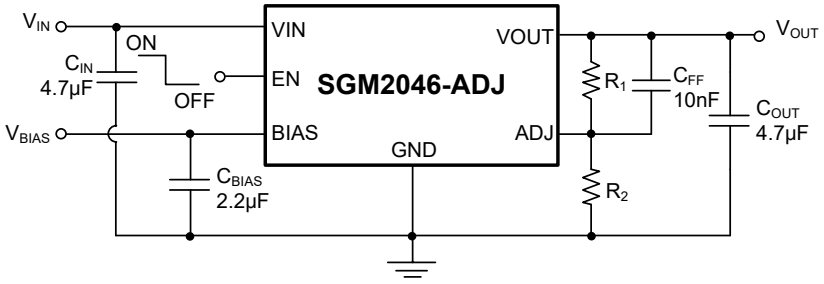


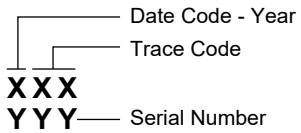
Figure 2. Adjustable Voltage Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	V_{OUT} (V)	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2046-0.75	0.75	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-0.75XG/TR	XXX OPC	Tape and Reel, 5000
SGM2046-0.8	0.8	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-0.8XG/TR	XXX OPD	Tape and Reel, 5000
SGM2046-0.85	0.85	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-0.85XG/TR	XXX OPE	Tape and Reel, 5000
SGM2046-1.0	1.0	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-1.0XG/TR	XXX OPF	Tape and Reel, 5000
SGM2046-1.05	1.05	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-1.05XG/TR	XXX OR0	Tape and Reel, 5000
SGM2046-1.1	1.1	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-1.1XG/TR	XXX OR1	Tape and Reel, 5000
SGM2046-1.15	1.15	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-1.15XG/TR	XXX OR2	Tape and Reel, 5000
SGM2046-1.2	1.2	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-1.2XG/TR	XXX OR3	Tape and Reel, 5000
SGM2046-1.8	1.8	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-1.8XG/TR	XXX OR4	Tape and Reel, 5000
SGM2046-2.8	2.8	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-2.8XG/TR	XXX OR5	Tape and Reel, 5000
SGM2046-3.0	3.0	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-3.0XG/TR	XXX OR6	Tape and Reel, 5000
SGM2046-3.3	3.3	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-3.3XG/TR	XXX OR7	Tape and Reel, 5000
SGM2046-ADJ	Adjustable	WLCSP-0.8×1.2-6B-B	-40℃ to +125℃	SGM2046-ADJXG/TR	XXX OR8	Tape and Reel, 5000

MARKING INFORMATION

NOTE: X = Date Code. XX = Trace 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

Supply Input Voltage Range, V_{IN} ..... -0.3V to 6V
All Other Pins to GND ..... -0.3V to 6V
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃

RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range, V_{IN} ..... 0.5V to 5.5V
Supply Voltage Range, V_{BIAS} ..... 2.5V to 5.5V
BIAS Capacitance, C_{BIAS} ..... 1μF (MIN)
Input Capacitance, C_{IN} ..... 2.2μF (MIN)
Output Capacitance, C_{OUT} ..... 2.2μF to 47μF
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.

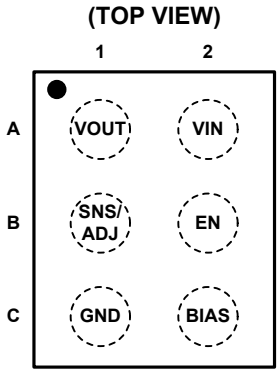
ESD SENSITIVITY CAUTION

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



WLCSP-0.8×1.2-6B-B

PIN DESCRIPTION

PIN	NAME	
A1	VOUT	Regulated Output Voltage. It is recommended to use an output capacitor with effective capacitance in the range of 2.2μF to 47μF.
A2	VIN	
B1	SNS	Output Voltage Sensing Input (fixed voltage version only). Connect to VOUT on the PCB to output the voltage corresponding to the part version.
	ADJ	Adjustable Output Voltage Feedback Input (adjustable voltage version only).
B2	EN	Chip Enable (active high). Pulling this pin below 0.4V turns the regulator off, reducing the quiescent current to a fraction of its operating value. This pin must not be left floating, please connect it to BIAS if not used.
C1	GND	Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.
C2	BIAS	Bias Input Pin. Providing input voltage for internal control circuitry.

ELECTRICAL CHARACTERISTICS

(T_J = -40℃ to +125℃, typical values are at T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 0.3V, V_{BIAS} = 2.5V or ($V_{OUT(NOM)}$ + 1.6V), whichever is greater, V_{EN} = 1V, I_{OUT} = 1mA, C_{IN} = C_{OUT} = 4.7μF and C_{BIAS} = 2.2μF, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Input Voltage Range	V_{IN}		$V_{OUT(NOM)}$ + V_{DROP_VIN}		5.5	V
Operating Bias Voltage Range	V_{BIAS}		($V_{OUT(NOM)}$ + 1.6) ≥ 2.5		5.5	V
Under-Voltage Lockout	UVLO	V_{BIAS} rising		1.65		V
		Hysteresis		0.3		V
Reference Voltage	V_{REF}	SGM2046-ADJ		0.5		V
V_{IN} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$	V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) to 5.5V		0.001		%/V
V_{BIAS} Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{BIAS} \times V_{OUT}}$	V_{BIAS} = 2.5V or ($V_{OUT(NOM)}$ + 1.6V) to 5.5V		0.005		%/V
Load Regulation	ΔV_{OUT}	I_{OUT} = 1mA to 1.2A		1		mV
V_{IN} Dropout Voltage	V_{DROP_VIN}	I_{OUT} = 1A		50		mV
V_{BIAS} Dropout Voltage (1, 2)	V_{DROP_BIAS}	I_{OUT} = 1A, V_{IN} = V_{BIAS}		1.05		V
Output Current Limit	I_{LIM}	V_{OUT} = 90% × $V_{OUT(NOM)}$		2		A
Short Current Limit	I_{SHORT}	V_{OUT} = 0V		1		A
ADJ Pin Operating Current	I_{ADJ}			0.1		nA
Bias Pin Quiescent Current	I_{BIAS}	V_{BIAS} = 5.5V		35		μA
Bias Pin Shutdown Current	$I_{BIAS(DIS)}$	V_{EN} = 0V		0.1		μA
VIN Pin Shutdown Current	$I_{VIN(DIS)}$	V_{EN} = 0V		0.1		μA
EN Input Voltage	V_{IH}	Logic high, T_J = +25℃	1			V
	V_{IL}	Logic low, T_J = +25℃			0.4	V
EN Pull-Down Current	I_{EN}	V_{EN} = 5.5V, V_{BIAS} = 5.5V		0.26		μA
Turn-On Time	t_{ON}	From assertion of V_{EN} to V_{OUT} = 98% × $V_{OUT\ (NOM)}$, $V_{OUT(NOM)}$ = 1.15V		150		μs
Power Supply Rejection Ratio	PSRR_V_{IN}	V_{IN} to V_{OUT}, f = 1kHz, $V_{OUT(NOM)}$ = 1.15V, I_{OUT} = 150mA, V_{IN} ≥ 1.65V		68		dB
	PSRR_V_{BIAS}	V_{BIAS} to V_{OUT}, f = 1kHz, $V_{OUT(NOM)}$ = 1.15V, I_{OUT} = 150mA, V_{IN} ≥ 1.65V		80		dB
Output Noise Voltage	e_n	$V_{OUT(NOM)}$ = 1.15V, V_{IN} = 1.65V, f = 10Hz to 100kHz		29		μV_{RMS}
Output Discharge Pull-Down	R_{DISCH}	V_{EN} = 0V, V_{OUT} = 0.5V		80		Ω
Thermal Shutdown Temperature	T_{SHDN}			160		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}			20		℃

NOTES:

1. Dropout voltage is characterized when V_{OUT} falls 3% below $V_{OUT(NOM)}$.
2. For output voltages below 1.5V, V_{BIAS} dropout voltage does not apply due to a minimum bias operating voltage of 2.5V.

FUNCTIONAL BLOCK DIAGRAM

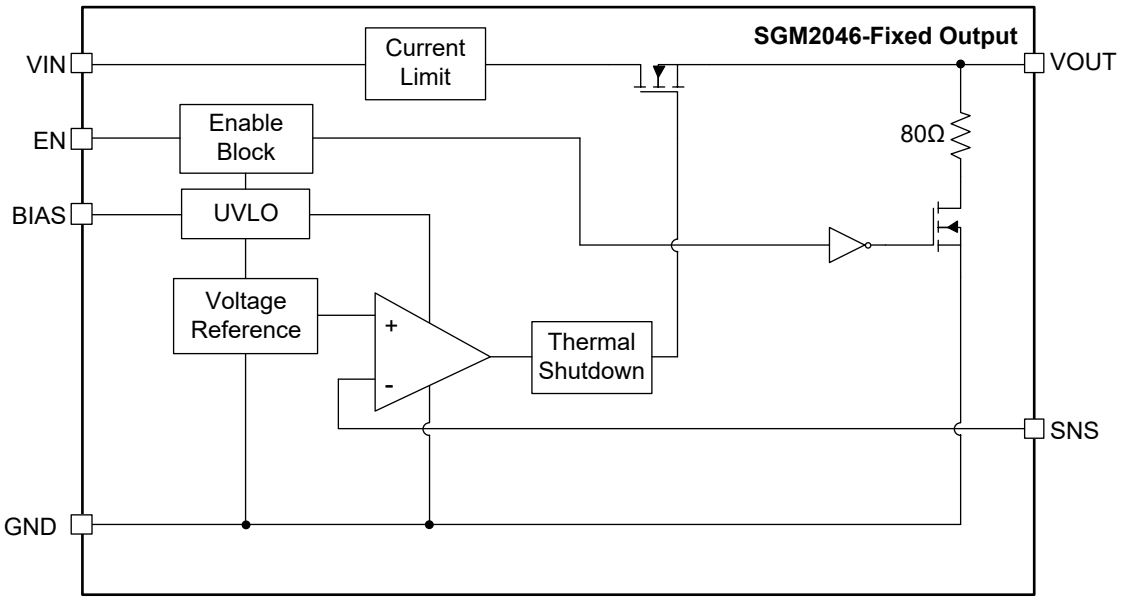


Figure 3. Fixed Output Voltage Internal Block Diagram

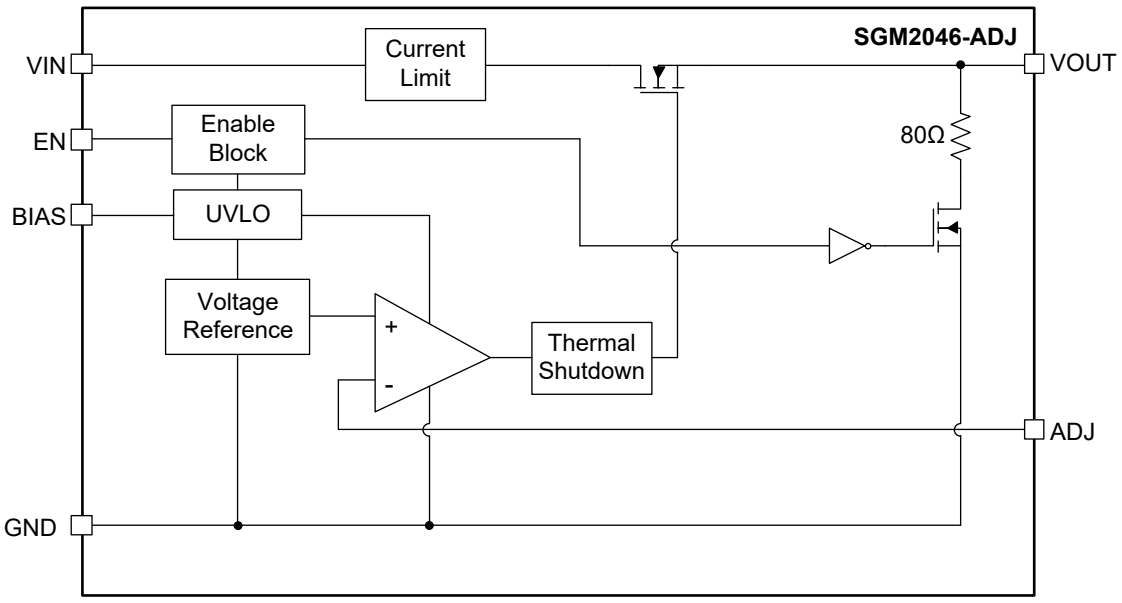


Figure 4. Adjustable Output Voltage Internal Block Diagram

APPLICATION INFORMATION

The SGM2046 is a low voltage, low dropout linear regulator with input voltage V_{IN} from 0.5V to 5.5V, V_{BIAS} from 2.5V to 5.5V and adjusted output voltage from 0.5V to (V_{IN} - V_{DROP}).

The SGM2046 is using NMOS pass transistor for output voltage regulation from V_{IN} voltage. The separated bias voltage (V_{BIAS}) power the low current internal control circuit for applications requiring low input voltage and ultra-low dropout voltage. In steady-state operation, the feedback voltage is regulated to the reference voltage by the internal regulator. When the feedback voltage signal is less than the reference, the output current passes through the power MOSFET will be increased. The extra amount of the current is sent to the output until the voltage level of ADJ pin returns to the reference. On the other hand, if the feedback voltage is higher than the reference voltage, the power MOSFET current is decreased. The excess charge at the output can be released by the loading current.

Output Voltage Setting

For the SGM2046-ADJ, the voltage on the ADJ pin sets the output voltage and is determined by the values of R_1 and R_2. The values of R_1 and R_2 can be calculated for any voltage using the equation:

$$V_{OUT} = 0.5V \times \left(\frac{R_1 + R_2}{R_2} \right)$$

Using lower values for R_1 and R_2 is recommended to reduce the noise injected from the ADJ pin. Note that R_1 is connected from the VOUT pin to the ADJ pin and R_2 is connected from the ADJ pin to GND.

Dropout Voltage

There are two power supply inputs V_{IN} and V_{BIAS} and only one output V_{OUT} for the SGM2046, the dropout voltage with these two different inputs also has different definitions. V_{IN} dropout voltage is the voltage difference between VIN and VOUT pins when V_{OUT} starts to decrease while reduce V_{IN} level (for this condition, V_{BIAS} needs high enough as specific value published in Electrical Characteristics table). V_{BIAS} dropout voltage is the voltage difference between V_{BIAS} and V_{OUT} while VIN and BIAS pins are connected together and V_{OUT} starts to decrease.

C_{IN} and C_{OUT} Selection

The SGM2046 is designed specifically to work with low ESR ceramic output capacitor for space saving and performance consideration. Using a ceramic capacitor with effective capacitance range from 2.2μF to 47μF on the SGM2046 output ensures stability. The input capacitor must be located at a distance of no more than 0.5 inch from the VIN pin of the chip. However, a capacitor with larger value and lower ESR (Equivalent Series Resistance) is recommended since it will provide better PSRR and line transient response. Any good quality ceramic capacitor can be used, C_{IN} = 4.7μF and C_{BIAS} = 2.2μF or greater are recommended.

Chip Enable Operation

The SGM2046 goes into sleep mode when the EN pin is in a logic low condition. In this condition, the pass transistor, error amplifier and band gap are all turned off to reduce the supply current to only 0.1μA (TYP).

Consideration should be taken in the power on sequence, it is mandatory to ensure V_{BIAS} > V_{OUT} + 1.6V before both V_{EN} > V_{IH} and V_{IN} > V_{OUT} + 0.1V. The BIAS pin supplies voltage for the LDO control circuit and powering up V_{BIAS} first will ensure turn-on time (t_{ON}) and output voltage accuracy (V_{OUT}) to follow datasheet specification.

Figure 5 also shows the use of an RC-delay circuit that holds off V_{EN} until V_{BIAS} has ramped up to target value. This technique can also be used to drive the EN pin from the VIN pin. An external control signal can also be used to enable the device after V_{IN} and V_{BIAS} are present.

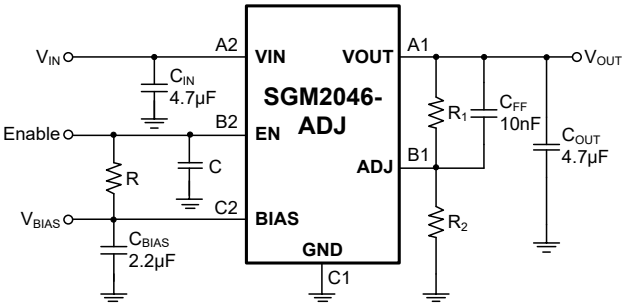


Figure 5. Soft-Start Delay Using an RC Circuit to Enable the Device

APPLICATION INFORMATION (continued)

Current Limit

The SGM2046 continuously monitors the output current to protect the pass transistor against abnormal operations. When an overload or short circuit is encountered, the current limit circuitry controls the pass transistor's gate voltage to limit the output within the predefined range.

Over-Temperature Protection (OTP)

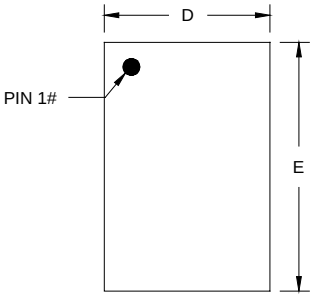
The SGM2046 has an over-temperature protection. When the device triggers the OTP, the device shuts down until the temperature back to normal state.

Thermal Protection

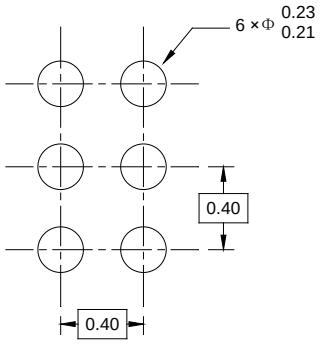
Internal thermal shutdown (TSD) circuitry is provided to protect the integrated circuit in the event that the maximum junction temperature is exceeded. When TSD is activated, the regulator output turns off. When cooling down below the low temperature threshold, device output is activated again. This TSD feature is provided to prevent failures from accidental overheating.

PACKAGE OUTLINE DIMENSIONS

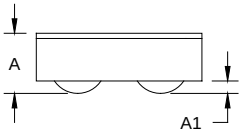
WLCSP-0.8×1.2-6B-B



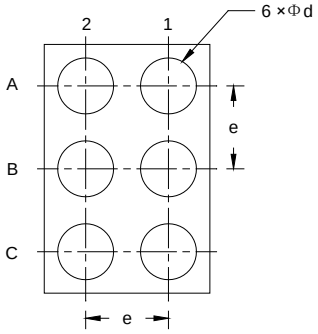
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



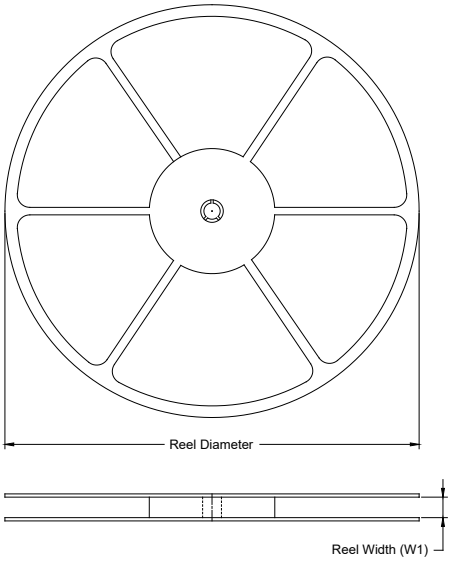
BOTTOM VIEW

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.262	0.290	0.318
A1	0.050	0.060	0.070
D	0.780	0.805	0.830
E	1.180	1.205	1.230
d	0.250	0.270	0.290
e	0.400 BSC		

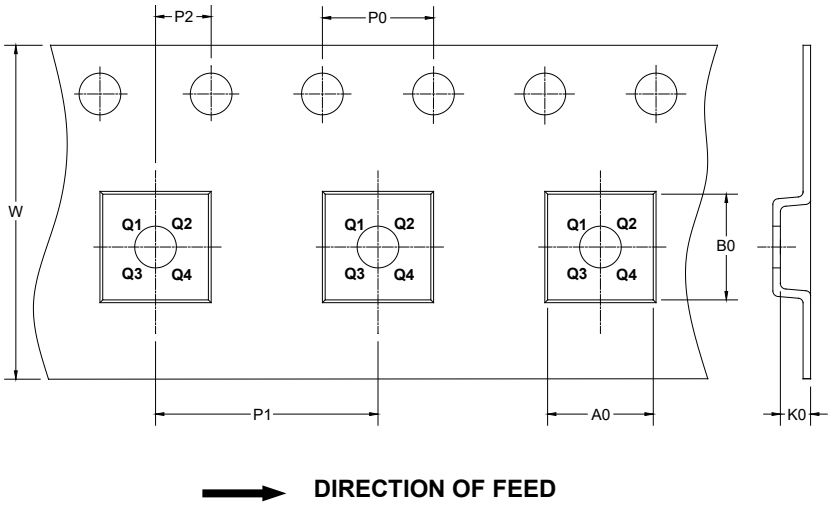
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



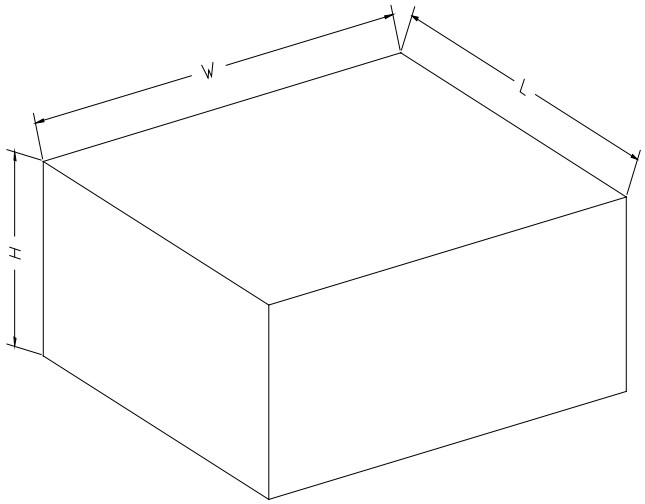
NOTE: The picture is only for reference. Please make the object as the standard.

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
WLCSP-0.8×1.2-6B-B	7″	9.5	0.90	1.30	0.42	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