PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM40659	WLCSP-1.30×0.94-6B	-40℃ to +85℃	SGM40659YG/TR	6C XX	Tape and Reel, 3000
SGM40660	WLCSP-1.30×0.94-6B	-40℃ to +85℃	SGM40660YG/TR	6E XX	Tape and Reel, 3000
SGM40661	WLCSP-1.30×0.94-6B	-40℃ to +85℃	SGM40661YG/TR	4A XX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XX = Date Code.

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

Input Voltage Range, IN .... -0.3V to 28V
Output Voltage Range, OUT.....................-0.3V to V_{IN} + 0.3V
OVLO Pin, OVLO.. -0.3V to 7V
Continuous Current, IN, OUT Current................................4A
Package Thermal Resistance
WLCSP-1.30×0.94-6B, θ_{JA} .... 110℃/W
Junction Temperature..+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility
HBM... 4000V
MM... 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range ....2.7V to 20V
Input to Output Continuous Current 3A
Output Capacitance Range................................Up to 100μF
Operating Temperature Range ....-40℃ to +85℃

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 by ESD if you don't pay attention to ESD protection. 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 very small parametric changes could cause the device not to meet its published specifications.

DISCLAIMER

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

PIN CONFIGURATION

(TOP VIEW)

WLCSP-1.30×0.94-6B
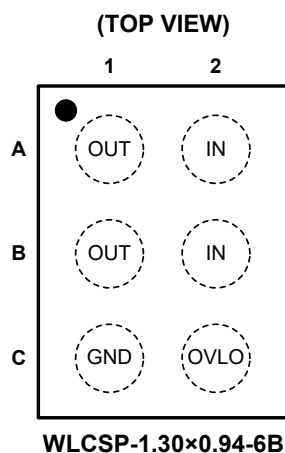
PIN DESCRIPTION

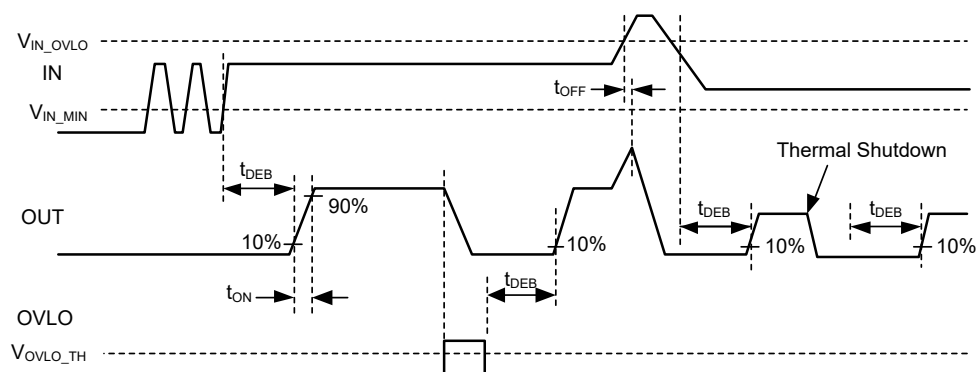| PIN	NAME	FUNCTION
A1, B1	OUT	Output Voltage.
A2, B2	IN	Input Voltage. Bypass IN with a 0.1µF capacitor as close as possible to the device.
C1	GND	Ground.
C2	OVLO	External OVLO Adjustment. Connect OVLO to GND when using the internal threshold. Connect a resistor-divider to OVLO to set a different OVLO threshold.

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SEPTEMBER 2018

3

ELECTRICAL CHARACTERISTICS

(V_{IN} = 2.5V to 28V, C_{IN} = 0.1µF, Full = -40℃ to +85℃, typical values are at V_{IN} = 5V, I_{IN} ≤ 3A, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
INPUT OPERATION							
Input Voltage Range	V_{IN}			2.5		28	V
Input Supply Current	I_{IN}	V_{IN} = 5V				140	µA
Under-Voltage Lockout Threshold	V_{IN_UVLO}	V_{IN} rising			2.4		V
Under-Voltage Lockout Hysteresis	V_{UVLO_HYS}				0.2		V
OVER-VOLTAGE PROTECTION							
Internal Over-Voltage Trip Level	V_{IN_OVLO}	V_{IN} rising	SGM40659	15.07	15.61	16.14	V
			SGM40660	6.60	6.80	7.00	
			SGM40661	5.75	5.94	6.12	
		V_{IN} falling	SGM40659	14.22	14.76		
			SGM40660	6.24	6.47		
			SGM40661	5.45	5.66		
OVLO Preset Threshold Range	V_{OVLO_TH}			1.183	1.213	1.242	V
Adjustable OVLO Threshold Range				4		20	V
External OVLO Select threshold	V_{OVLO_SELECT}			0.24	0.27	0.31	V
Switch On-Resistance	R_{ON}	V_{IN} = 5V, I_{OUT} = 0.5A, T_A = +25℃			27	45	mΩ
OVLO Input Leakage Current	I_{OVLO}	V_{OVLO} = 1.3V		-100		100	nA
TIMING CHARACTERISTICS							
Debounce Time	t_{DEB}	Time from V_{IN} > 2.5V to the time V_{OUT} starts rising			15		ms
Switch Turn-On Time	t_{ON}	V_{IN} = 5V, R_L = 100Ω, C_{LOAD} = 100µF, V_{OUT} from 10%, V_{IN} to 90% V_{IN}			2		ms
Switch Turn-Off Time	t_{OFF}	V_{IN} > V_{OVLO} to V_{OUT} = 80% of V_{IN}, R_L = 100Ω, V_{IN} rising at 2V/µs			80		ns
THERMAL SHUTDOWN							
Thermal Shutdown					150		℃
Thermal Shutdown Hysteresis					60		℃

TIMING DIAGRAM

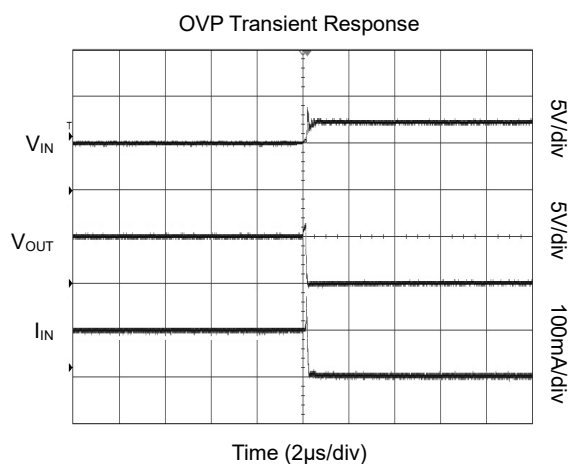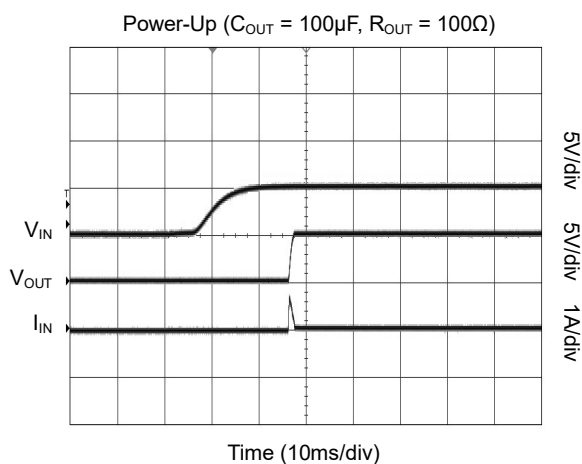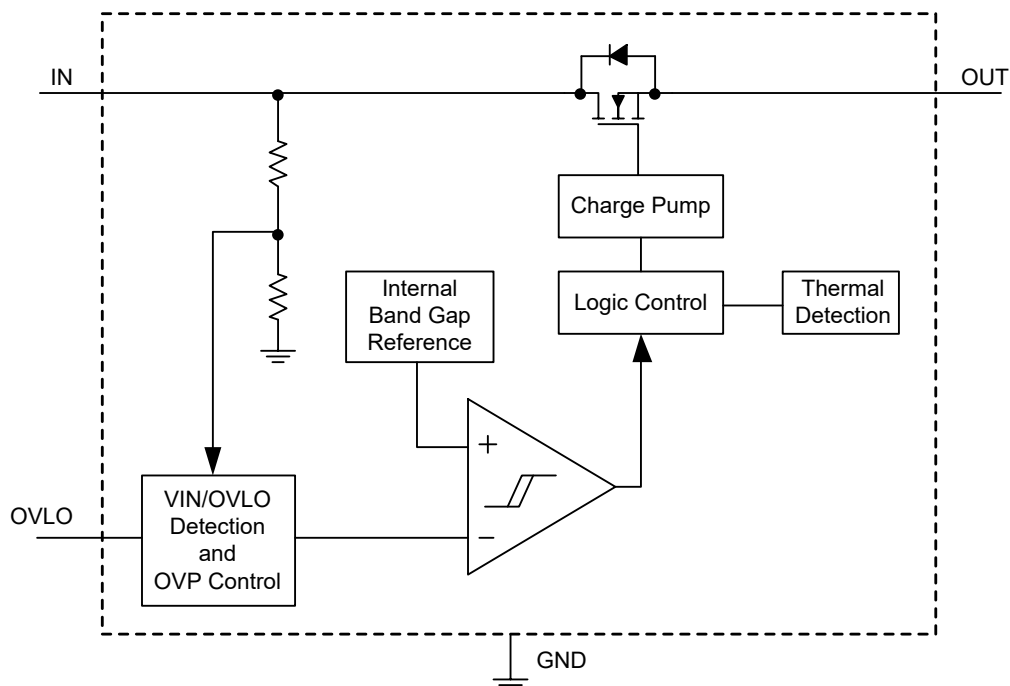NOTE: Waveforms are not to scale.

Figure 2. Timing Diagram

SGM40659
SGM40660/SGM40661   Adjustable Over-Voltage Protection Switches

TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, V_{IN} = 5V, OVLO pin = GND, C_{IN} = 0.1µF and C_{OUT} = 1µF, unless otherwise specified.

Power-Up (C_{OUT} = 100µF, R_{OUT} = 100Ω)

Time (10ms/div)

OVP Transient Response

Time (2µs/div)

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5

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FUNCTIONAL BLOCK DIAGRAM

Figure 3. Block Diagram

DETAILED DESCRIPTION

The SGM40659/60/61 are inserted between the power supply or charger source and the load to be protected. The SGM40659/60/61 consist of a slew-rate controlled, low resistance OVP switch, under-voltage lockout protection (UVLO), and over-voltage monitor and protection (OVLO).

The SGM40659/60/61 over-voltage protection devices feature a low on-resistance (R_{ON}) internal FET and protect low voltage systems against voltage faults up to +28V_{DC}. If the input voltage exceeds the over-voltage threshold, the internal FET is turned off to prevent damage to downstream components. A 15ms (TYP) debounce time built into the device prevents false turn-on of the internal FET during startup.

In normal operation the OVP switch acts as a slew-rate controlled load switch, connecting and disconnecting the power supply from IN to OUT. A low resistance N-channel MOSFET is used to minimize the voltage drop between the voltage source and the load and to reduce power dissipation.

When the voltage at the input exceeds the programmed over-voltage trip point, the device immediately turns off the internal switch disconnecting the load from the abnormal voltage, preventing damage to downstream components.

In the event that the power dissipation causes the chip temperature to exceed its maximum temperature setting, the SGM40659/60/61 will switch off protecting the device. Once the chip temperature has cooled to below the hysteresis temperature, SGM40659/60/61 will re-initiate. Should the over-temperature condition persist, then SGM40659/60/61 will continue to thermally cycle on and off, until the input power is removed.

USB On-The-Go (OTG) Operation
When used in an OTG application the SGM40659/60/61 can provide power from OUT to IN. Initially, the OTG voltage applied at OUT will forward-bias the power switch bulk diode and present a voltage drop of approximately 0.7V between OUT and IN. The maximum current in this mode is limited by the thermal performance of the device and at an ambient temperature of +25℃.

$$I_{MAX} = 1.17W/0.7V = 1.67A$$

This is purely a transitionary condition as once the voltage at IN exceeds the UVLO voltage of 2.4V (TYP) and the debounce time of 15ms has elapsed, the main power switch will turn fully on, significantly reducing the voltage drop from OUT to IN.

UVLO (Under-Voltage Lockout)
The device has a built-in under-voltage lockout (UVLO) circuit. When V_{IN} is rising, the output remains disconnected from the input until V_{IN} voltage is above 2.4V (TYP). This circuit has a 200mV hysteresis to provide noise immunity to transient conditions.

OVLO (Over-Voltage Lockout)
The SGM40659/60/61 adjustable version has a 1.213V (TYP) over-voltage trip threshold on the OVP pin. With a resistor-divider on OVLO pin from IN to GND, the over-voltage protection point of IN can be adjusted between 4V and 20V. Fixed OVP products are available with an internal resistor-divider providing 15.61V/6.80V/5.94V (SGM40659/60/61 TYP) OVLO threshold trip voltage. To activate the internal fixed OVP, the OVLO pin should be connected to GND.

Internal MOSFET Switch
The SGM40659/60/61 incorporate an internal MOSFET with a 27mΩ (TYP) R_{ON}. The MOSFET gate is driven by an integrated charge pump which generates the necessary voltage above IN.

Thermal Protection
The internal FET turns off when the junction temperature exceeds +150℃ (TYP). The device exits thermal shutdown after the junction temperature cools down by 60℃ (TYP).

APPLICATION INFORMATION

Input Capacitor

A 0.1µF or larger capacitor is typically recommended for C_{IN}. C_{IN} should be located close to the device IN pin. Ceramic capacitors are recommended for C_{IN}. Select capacitors with a voltage rating at least 5V higher than the maximum possible voltage during surge. 50V rated capacitors are ideal for most applications.

Output Capacitor

In order to ensure stability while the current limit is active, a small output capacitance of approximately 1µF is required at the output. The output capacitor has no specific capacitor ESR requirement. If desired, C_{OUT} may be increased to accommodate any load transient condition.

External OVLO Adjustment

If OVLO is connected to ground, the internal OVLO comparator uses the internally set OVLO value. The adjustable threshold uses a 1.213V (TYP) over-voltage trip threshold on the OVLO pin. With a resistor-divider on the OVLO pin from IN to GND, the over-voltage protection point of IN can be adjusted between 4V and 20V. Once the OVLO pin voltage exceeds the OVLO select voltage, V_{OVLO_SELECT} (0.27V TYP), the comparator reads the OVLO pin voltage (a fraction of IN) set by the external resistor-divider (R1, R2).

R1 = 1MΩ is a good starting value for minimum current consumption. Since V_{IN_OVLO}, V_{OVLO_TH}, and R1 are known, R2 can be calculated from the following formula:

$$V_{IN\_OVLO} = V_{OVLO\_TH} \times (1 + R1/R2) = 1.213V \times (1 + R1/R2)$$

This external resistor-divider is completely independent from the internal resistor-divider.

REVISION HISTORY

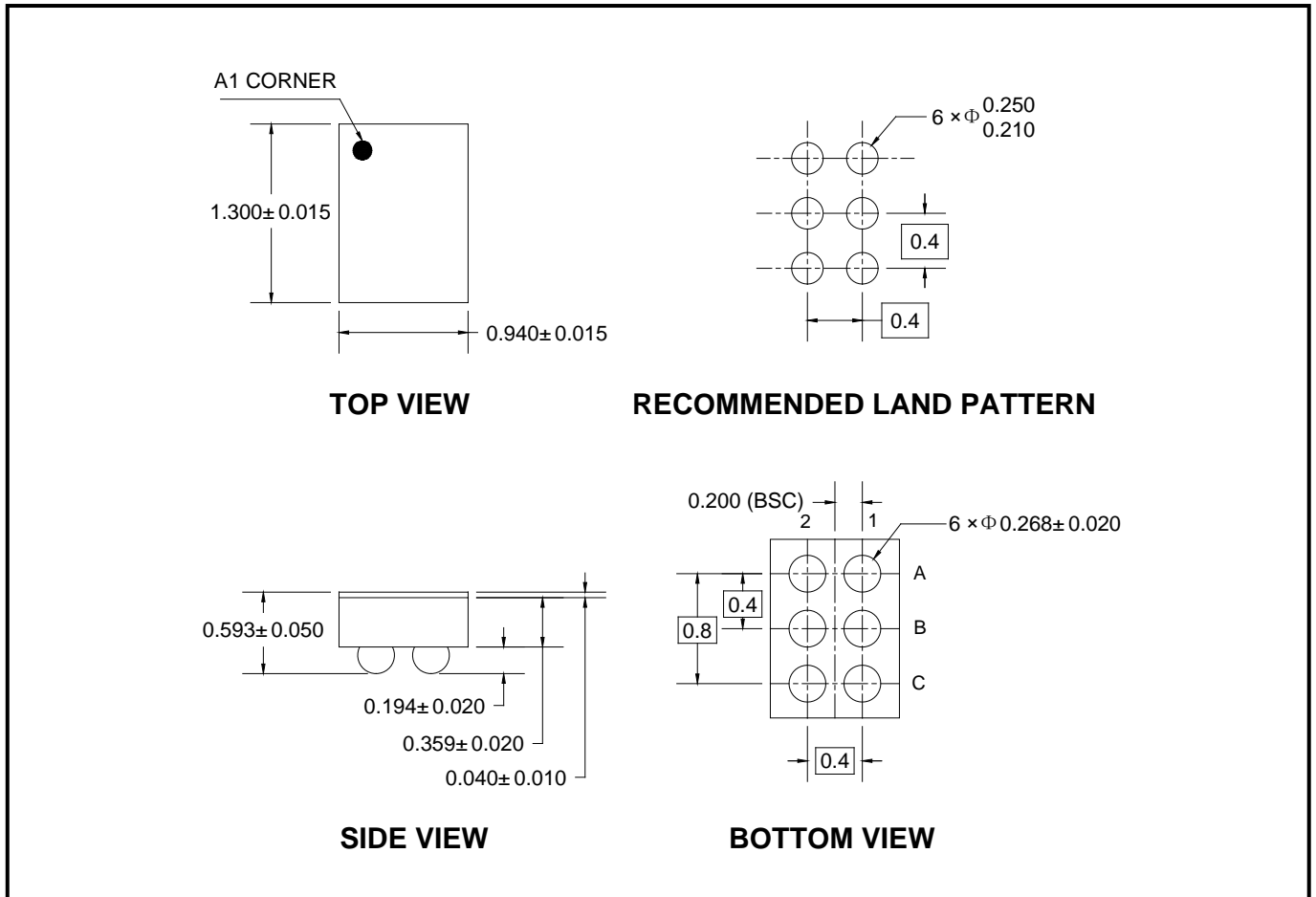NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (SEPTEMBER 2018) to REV.A

Changed from product preview to production data..All

PACKAGE OUTLINE DIMENSIONS

WLCSP-1.30×0.94-6B

A1 CORNER

1.300± 0.015

0.940± 0.015

TOP VIEW

6 ×Φ 0.250 / 0.210

0.4

0.4

RECOMMENDED LAND PATTERN

0.593± 0.050

0.194± 0.020

0.359± 0.020

0.040± 0.010

SIDE VIEW

0.200 (BSC)

2   1

6 ×Φ 0.268± 0.020

0.4

0.8

A

B

C

0.4

BOTTOM VIEW

NOTE: All linear dimensions are in millimeters.

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TAPE AND REEL INFORMATION

REEL DIMENSIONS
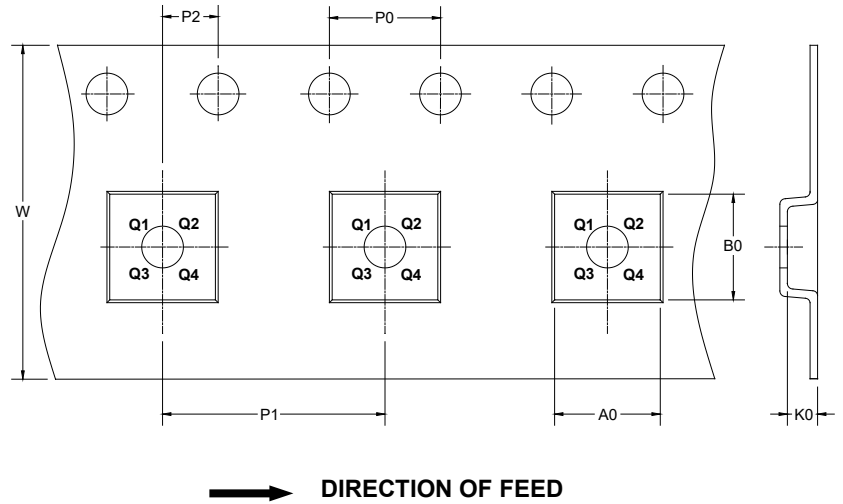
Reel Diameter

Reel Width (W1)

TAPE DIMENSIONS

| Q1 | Q2 |
| Q3 | Q4 |

DIRECTION OF FEED

NOTE: The picture is only for reference. Please make the object as the standard.
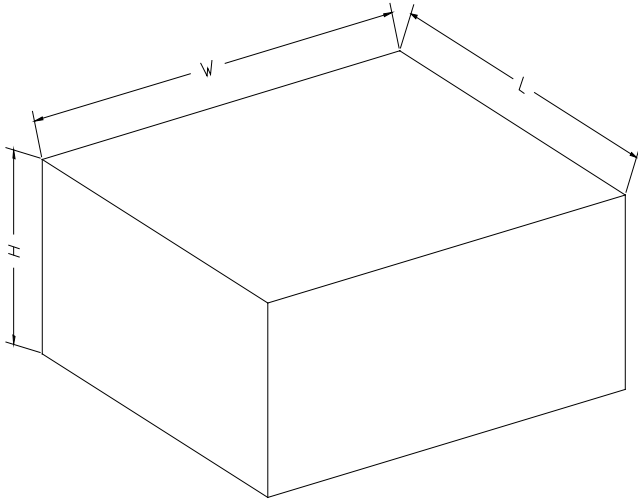
KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
WLCSP-1.30×0.94-6B	7″	9.0	1.07	1.52	0.72	4.0	4.0	2.0	8.0	Q1

DD0001

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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

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