SGM2536
5.5A, 24mΩ Electronic Fuse Supporting Bidirectional Current Conduction

GENERAL DESCRIPTION

The SGM2536 family is a compact electronic fuse (eFuse) with a full suite of protection functions. With precision current limit, the device can provide excellent accuracy and be well applied to many system protection applications. The output current limit threshold and the transient over-current blanking timer can be adjusted by the user. Due to the back-to-back FETs packaged inside the chip, the SGM2536 allows bidirectional current to flow through the channel when it is turned on, but prohibits bidirectional current flow when it is turned off, which is very suitable for USB OTG. The VOUT rise time can be programmed by setting an additional capacitor to the SS pin, which can minimize inrush current. Programmable over-voltage protection is used to turn off the device if the VIN raises over a threshold value and the downstream circuitry is not damaged by unintended power supply.

The SGM2536 is available in a Green TQFN-2×2-10L package.

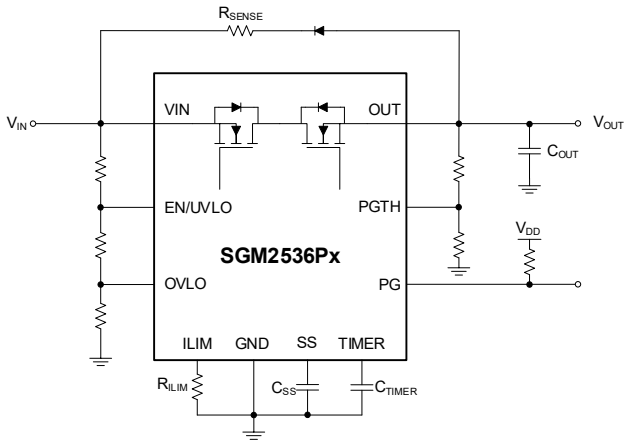
APPLICATIONS

Tablet PC
USB OTG
POS Device
Smartphone
Digital Camera
Wireless Charger

FEATURES

- **Input Voltage: 2.7V to 23V, Surge up to 28V**
- **Back-to-Back FETs Structure**
- **Low On-Resistance: 24mΩ (TYP)**
  - **On-State: Bidirectional Current Flow**
  - **Off-State: Reverse Current Blocking**
- **Programmable Output Ramp Time**
- **Programmable Current Limit: 0.5A to 6A (±10% Accuracy for I_{ILIM} > 1A)**
- **Full Set of Protections**
  - **Programmable Over-Voltage Lockout (OVLO)**
  - **Short-Circuit Protection on OUT Pin**
  - **Under-Voltage Lockout**
  - **Thermal Shutdown**
- **Indication Options**
  - **SGM2536Px: PG and PGTH**
  - **SGM2536Fx: SPGD and nFAULT**
- **Behavior after Fault**
  - **SGM2536xR: Auto-Retry**
  - **SGM2536xL: Latch-Off**

SIMPLIFIED SCHEMATIC

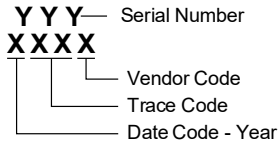


PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2536PR	TQFN-2×2-10L	-40℃ to +125℃	SGM2536PRXTSP10G/TR	0EB XXXX	Tape and Reel, 3000
SGM2536PL	TQFN-2×2-10L	-40℃ to +125℃	SGM2536PLXTSP10G/TR	0EC XXXX	Tape and Reel, 3000
SGM2536FR	TQFN-2×2-10L	-40℃ to +125℃	SGM2536FRXTSP10G/TR	0ED XXXX	Tape and Reel, 3000
SGM2536FL	TQFN-2×2-10L	-40℃ to +125℃	SGM2536FLXTSP10G/TR	043 XXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXX = Date Code, Trace Code and Vendor 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

Input Voltage Range, V_{IN} ..... -0.3V to 28V
Output Voltage Range, V_{OUT}
-40℃ to +125℃.....-0.3V to MIN (28V, V_{IN} + 21V)
-10℃ to +125℃.....-0.3V to MIN (28V, V_{IN} + 22V)
Output Voltage Pulse (< 1μs), V_{OUT_PLS} .....> -0.8V
Voltage Range
$V_{EN/UVLO}$ ..... -0.3V to 6.5V
V_{OVLO} ..... -0.3V to 6.5V
V_{PG}, V_{PGTH} (SGM2536Px) ..... -0.3V to 6.5V
V_{SPGD}, V_{nFAULT} (SGM2536Fx)..... -0.3V to 6.5V
V_{SS} ..... Internally Limited
V_{ITIMER} ..... Internally Limited
V_{ILIM} ..... Internally Limited
Maximum Continuous Switch Current, I_{MAX}.....
..... Internally Limited
Junction Temperature.....+150℃
Storage Temperature Range .....-65℃ to +150℃
Lead Temperature (Soldering, 10s).....+260℃

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range, V_{IN} .....2.7V to 23V
Output Voltage Range, V_{OUT} ..... MIN (23V, V_{IN} + 20V)
Voltage Range
$V_{EN/UVLO}$ 5V (1)
V_{OVLO} .....0.5V to 1.5V
V_{SS} .....> V_{IN} + 5V
V_{PG}, V_{PGTH} (SGM2536Px) 5V
V_{SPGD}, V_{nFAULT} (SGM2536Fx) 5V
ITIMER Capacitor Voltage Rating, V_{ITIMER} .....> 4V
Resistance, R_{ILIM}..... 549Ω to 6650Ω
Maximum Continuous Switch Current, I_{MAX} 5.5A
Operating Junction Temperature..... -40℃ to +125℃

NOTE: 1. If the supply voltage is less than 5V, EN/UVLO pin can be pulled up to the VIN directly. If the supply voltage is larger than 5V, a 350kΩ (MIN) pull-up resistor is recommended for the EN/UVLO pin.

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

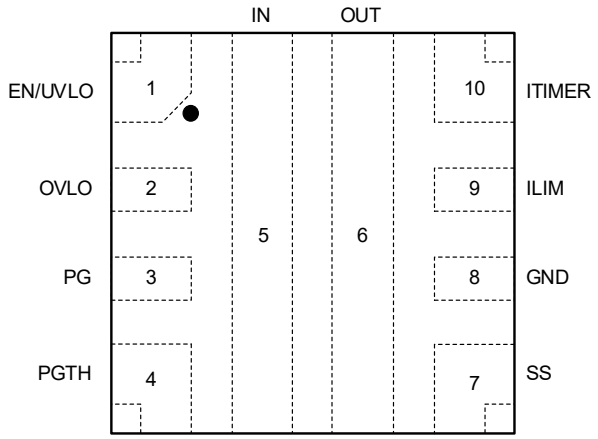
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

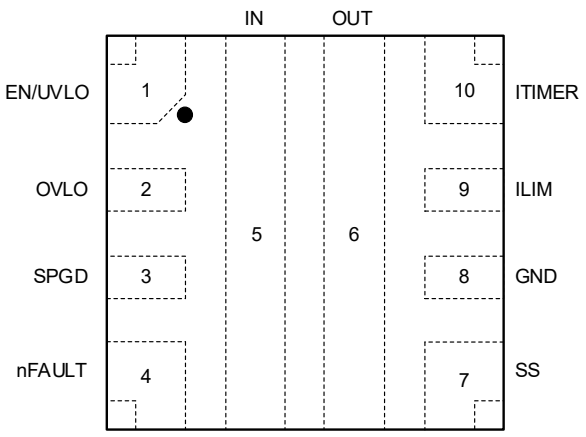
PIN CONFIGURATIONS

SGM2536Px (TOP VIEW)



TQFN-2×2-10L

SGM2536Fx (TOP VIEW)



TQFN-2×2-10L

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	EN/UVLO	Analog Input	Enable and Under-Voltage Lockout Input. Asserting EN/ULOV pin high enables the device. As a UVLO pin, the UVLO threshold is programmed by an external resistor divider. This pin cannot be left floating.
2	OVLO	Analog Input	Over-Voltage Lockout Pin. The over-voltage lockout threshold is programmed by the resistor divider from the power supply to the OVLO terminal to GND. The device is enabled when this pin is tied to low level. This pin cannot be left floating.
3	PG	Digital Output	Power Good Indication (SGM2536Px). This is an open-drain pin, when the internal channels of the chip are all turned on and the PGTH signal value is higher than the set value, the pin is set to high level.
	SPGD		Supply Good Indication (SGM2536Fx). This is an open-drain pin, when the input voltage is within the valid range and the surge has finished, this pin goes high.
4	PGTH	Analog Input	Power Good Threshold (SGM2536Px).
	nFAULT	Digital Output	Fault Event Indicator (SGM2536Fx). This pin is an open-drain output, and when a fault occurs, it will be low.
5	IN	Power	Input Supply Voltage.
6	OUT	Power	Output of the Device.
7	SS	Analog Output	Soft-Start Pin. The capacitor between SS and GND pins will set the slew rate according to the application requirements. When this pin is left floating, the device will start up at the fastest rate.
8	GND	Ground	GND.
9	ILIM	Analog Output	Programming Current Limit Pin. A resistor between this pin and GND sets the overload and short-circuit current limit levels. Do not float this pin.
10	ITIMER	Analog Output	Place a capacitor between this pin and GND can set the over-current blanking time, at this stage, the output current value can temporarily exceed the internally set current limit value (but not exceed the fast-trip threshold). After this time, the device will take action if it is still in over-current state. Leaving this pin open will provide the fastest response to an over-current event.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 12V, $V_{EN/UVLO}$ = 2V, R_{ILIM} = 549Ω, V_{OVLO} = 0V, OUT, SS, ITIMER, PGTH/nFAULT, PG/SPGD pins are open, typical values are at T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Supply (IN)						
Under-Voltage Protection Threshold	V_{UVP_R}	Rising		2.53		V
	V_{UVP_F}	Falling		2.30		
Supply Quiescent Current	I_{Q_ON}			128		μA
Supply Disabled State Current	I_{Q_OFF}	$V_{SD\_F} < V_{EN/UVLO} < V_{EN/UVLO\_F}$		45		μA
Supply Shutdown Current	I_{SD}	$V_{EN/UVLO} < V_{SD\_F}$		1.6		μA
On-Resistance (IN - OUT)						
On-Resistance	R_{ON}	V_{IN} = 12V, I_{OUT} = 3A, T_J = +25℃		24		mΩ
		2.7V ≤ V_{IN} ≤ 23V, I_{OUT} = 3A, -40℃ ≤ T_J ≤ +125℃		24		
Enable/Under-Voltage Lockout (EN/UVLO)						
EN/UVLO Threshold	$V_{EN/UVLO\_R}$	Rising Threshold		1.2		V
	$V_{EN/UVLO\_F}$	Falling Threshold		1.09		
EN/UVLO Falling Threshold for Lowest Shutdown Current	V_{SD_F}			0.7		V
EN/UVLO Leakage Current	I_{ENLKG}			0		μA
Over-Voltage Lockout (OVLO)						
OVLO Rising Threshold	V_{OVLO_R}			1.2		V
OVLO Falling Threshold	V_{OVLO_F}			1.09		V
OVLO Pin Leakage Current	I_{OVLKG}	0.5V < V_{OVLO} < 1.5V		0		μA
Over-Current Protection (OUT)						
Over-Current Threshold	I_{ILIM}	R_{ILIM} = 6.65kΩ		0.52		A
		R_{ILIM} = 3.32kΩ		1.01		
		R_{ILIM} = 1.65kΩ		2.02		
		R_{ILIM} = 750Ω		4.34		
		R_{ILIM} = 549Ω		5.92		
Circuit Breaker Threshold	I_{nFAULT}	ILIM pin open		0.12		A
		ILIM pin shorted to GND		1.07		
Scalable Fast-Trip Threshold	I_{SCGain}	ISC: ILIM Ratio		200		%
V_{OUT} Threshold to Exit Current Limit Foldback	V_{FB}			1.9		V
Over-Current Fault Timer (ITIMER)						
ITIMER Internal Pull-Up Voltage	V_{INT}			2.59		V
ITIMER Internal Pull-Up Resistance	R_{ITIMER}			18		kΩ
ITIMER Internal Discharge Current	I_{ITIMER}	I_{OUT} > I_{ILIM}		1.9		μA
ITIMER Discharge Differential Voltage Threshold	ΔV_{ITIMER}			1.45		V
Output Load Current Monitor (ILIM)						
Analog Load Current Monitor Gain (I_{MON}: I_{OUT})	G_{IMON}	I_{OUT} = 0.5A to 1A, I_{OUT} < I_{ILIM}		178		μA/A
		I_{OUT} = 1A to 5.5A, I_{OUT} < I_{ILIM}		183		μA/A

ELECTRICAL CHARACTERISTICS (continued)

(V_{IN} = 12V, $V_{EN/UVLO}$ = 2V, R_{ILIM} = 549Ω, V_{OVLO} = 0V, OUT, SS, ITIMER, PGTH/nFAULT, PG/SPGD pins are open, typical values are at T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power Good (PG) Indication: SGM2536Px or Supply Good (SPGD) Indication: SGM2536Fx						
PG/SPGD Voltage while De-Asserted	V_{PGD}	V_{IN} < V_{UVP_F}, V_{EN} < V_{SD_F}, weak pull-up (I_{PG} = 26μA)		0.51		V
		V_{IN} < V_{UVP_F}, V_{EN} < V_{SD_F}, strong pull-up (I_{PG} = 242μA)		0.64		
		V_{IN} > V_{UVP_R}, I_{PG} = 10mA		0.16		
PG/SPGD Leakage Current, PG/SPGD Asserted	I_{PGLKG}			0		μA
Fault (nFAULT) Indication: SGM2536Fx						
nFAULT Leakage Current	$I_{nFAULTLKG}$			0		μA
nFAULT Pull-Down Resistance	R_{nFAULT}			13.5		Ω
Over-Temperature Protection (OTP)						
Thermal Shutdown Temperature	T_{SD}	Rising Threshold		153		℃
SS						
SS Pin Charging Current	I_{SS}			2		μA

TIMING REQUIREMENTS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Over-Voltage Lockout Response Time	t_{OVLO}	V_{OVLO} > V_{OV_R} to V_{OUT}↓		2.5		μs
Current Limit Response Time	t_{LIM}	I_{ILIM} = 2A, I_{OUT} > 1.2 × I_{ILIM} and I_{ITIMER} expired to I_{OUT} settling to I_{ILIM}		250		μs
Scalable Fast-Trip Response Time	t_{SC}	I_{OUT} > 3 × I_{ILIM} to I_{OUT}↓		500		ns

SWITCHING CHARACTERISTICS

(R_L = 100Ω, C_{OUT} = 1μF, typical values are at T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	V_{IN}	C_{SS} = Open	C_{SS} = 1800pF	C_{SS} = 3300pF	UNITS
Output Rising Slew Rate	SR_{ON}	V_{IN} = 2.7V	6.62	0.87	0.44	V/ms
		V_{IN} = 12V	18.90	0.89	0.48	
		V_{IN} = 23V	33.58	0.92	0.46	
Turn-On Time	t_{ON}	V_{IN} = 2.7V	0.61	3.67	7.21	ms
		V_{IN} = 12V	0.84	13.2	24.8	
		V_{IN} = 23V	0.9	23.9	47.1	
Turn-On Delay	t_{D_ON}	V_{IN} = 2.7V	0.28	1.18	2.31	ms
		V_{IN} = 12V	0.34	2.4	4.5	
		V_{IN} = 23V	0.35	3.7	7.6	
Rise Time	t_R	V_{IN} = 2.7V	0.33	2.48	4.9	ms
		V_{IN} = 12V	0.51	10.82	20.2	
		V_{IN} = 23V	0.55	20.1	39.6	
Turn-Off Delay	t_{D_OFF}	V_{IN} = 2.7V	6.8	6.8	6.8	μs
		V_{IN} = 12V	5.5	5.5	5.5	
		V_{IN} = 23V	4.6	4.6	4.6	

In the entire normal voltage range, the output voltage rise rate is set by the internal circuit and remains unchanged to ensure that the load state does not affect the start-up sequence. Adding capacitance between the SS pin and GND can change the OUT rising slope. Increasing capacitor C_{SS} will reduce the rate of rise (SR) of the output voltage. For a detailed description, please refer to the relevant sections on inrush current suppression (SS) and slew rate. However, the time that V_{OUT} falls when the device is turned off is determined by the RC time constants of the load resistor (R_L) and load capacitor (C_{OUT}). The control of the switch only affects the power-on sequence when the chip is turned on.

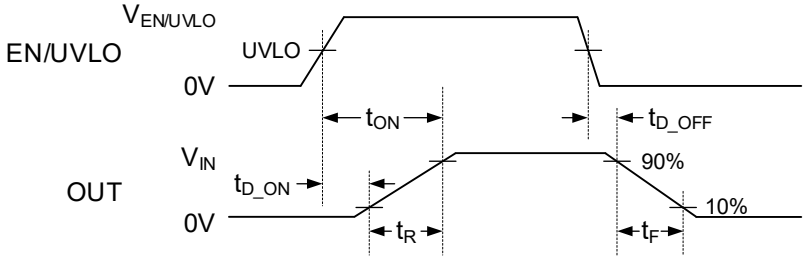
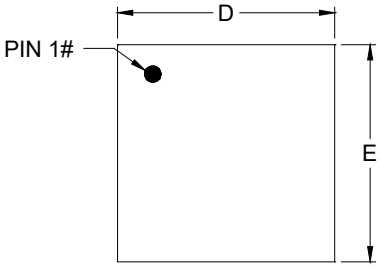


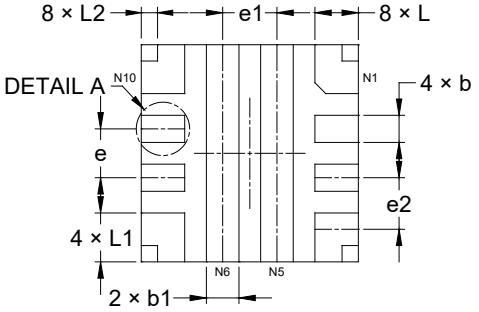
Figure 1. SGM2536 Switching Times

PACKAGE OUTLINE DIMENSIONS

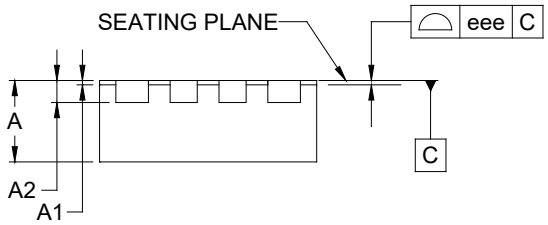
TQFN-2×2-10L



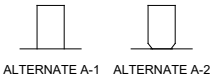
TOP VIEW



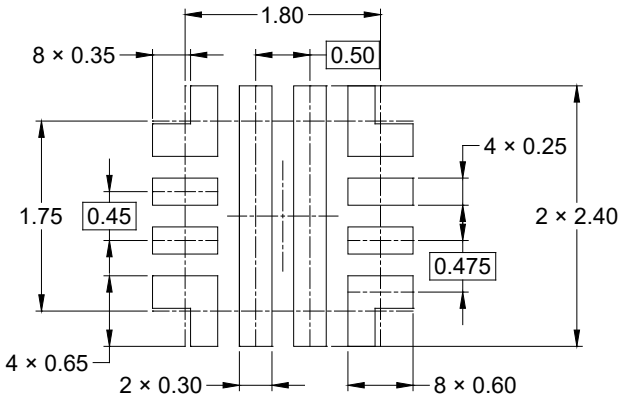
BOTTOM VIEW



SIDE VIEW



DETAIL A
ALTERNATE TERMINAL CONSTRUCTION



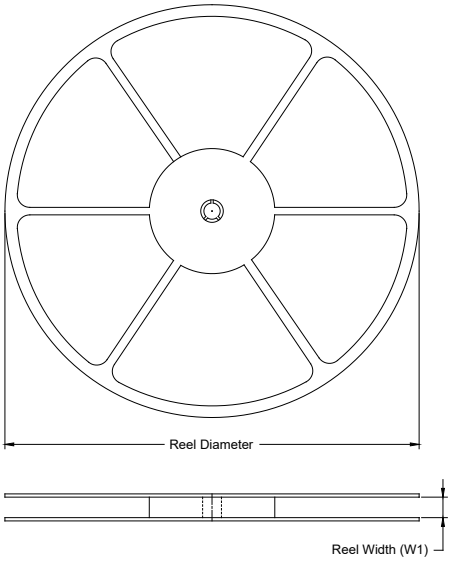
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.200	-	0.300
b1	0.250	-	0.350
D	1.900	-	2.100
E	1.900	-	2.100
e	0.450 BSC		
e1	0.500 BSC		
e2	0.475 BSC		
L	0.300	-	0.500
L1	0.350	-	0.550
L2	0.150 REF		
eee	0.080		

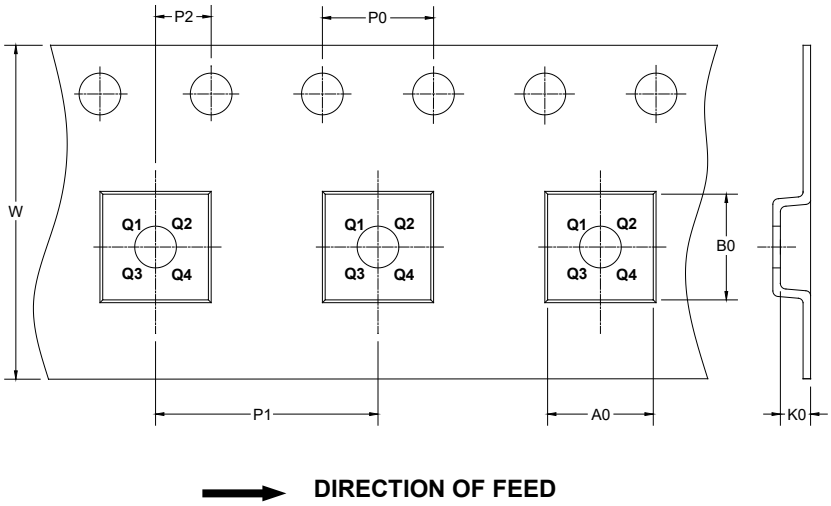
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

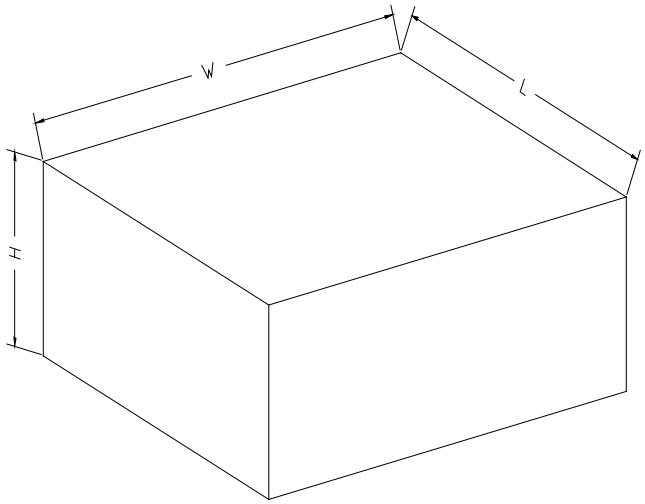
NOTE: The picture is only for reference. Please make the object as the standard.

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
TQFN-2×2-10L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q2

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