Suitable for Type-C Interface, 30V OVP with NTC and Enable Function, 1.5A Two Lithium Battery Boost Charger

General Description

IU5096T is a boost charge management IC with 5V input and maximum 1.5A charging current, which supports the series application of two lithium batteries. IU5096T integrates power MOS and adopts asynchronous switch architecture, so that it requires only a few peripheral devices during application, which can effectively reduce the overall scheme size and BOM cost. The working frequency of the boost switch charging converter of IU5096T is 500KHz and the conversion efficiency is 90%.

IU5096T has four built-in loops to control the charging process, namely, constant current (CC) loop, constant voltage (CV) loop, chip temperature regulation loop, intelligently adjust the charging current, prevent the adapter output from being pulled down, and match the input adaptive loops of all adapters.

IU5096T integrates the 30V OVP function, and the input port can stably and reliably withstand the withstand voltage impact within 30V, and stop charging when the input exceeds 6V. It is very suitable for the application of type-C interface. At the same time, the output port of the chip bat has a withstand voltage of 30V, which greatly improves the reliability of the system.

Features

- USB 5V Input Asynchronous Switch Boost Charging
- Working Voltage 3.6 ~ 6V, Chip Withstand Voltage 30V, Internal Integrated High Voltage Transistor
- Maximum 1.5A Charging Current, External Resistance of Charging Current adjustable
- NTC Function, Reuse with Enabling Function
- Automatically Adjust Input Current to Match All Adapters
- Support LED Charging Status Indication
- 500KHz Switching Frequency
- Output Overvoltage / Short Circuit Protection
- Integrated 30V OVP Function
- IC Over Temperature Protection
- IC Temperature Adaptive Adjustment
- Good EMI Characteristics

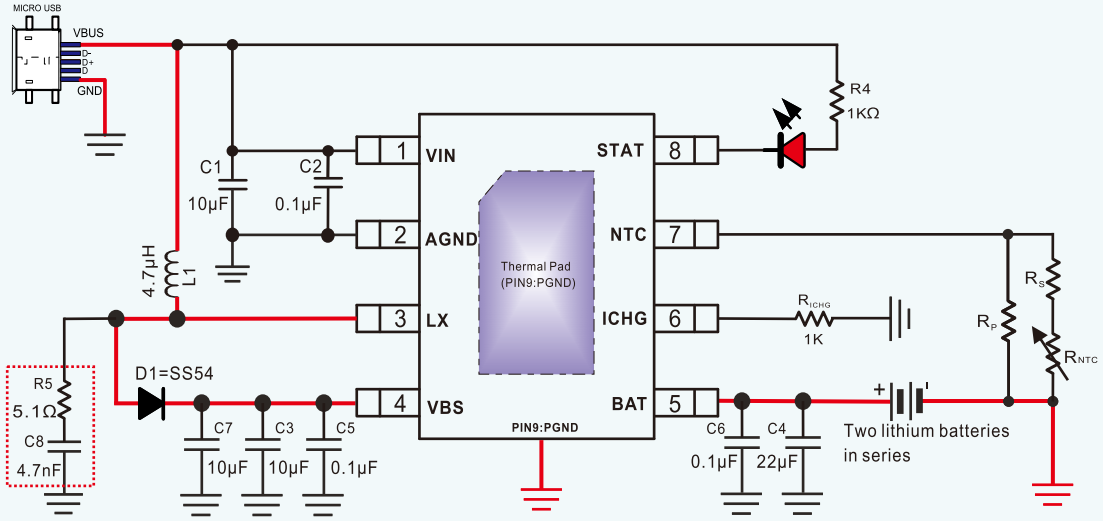
Applications

- Bluetooth Speakers
- E-Cigarette
- Handheld Transceiver
- POS Machine
- Lithium Battery Pack
- Toys

Package

- DFN2X2_8L

Typical Applications



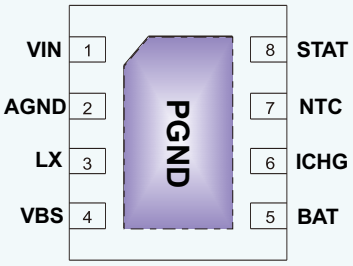
IU5096T Application Circuit

Note:

(1) L1 is a power inductor with a saturation current of 5A, and SS54 is a low-voltage drop Schottky diode.
(2) All chip capacitors need to be as close to the chip pin layout as possible.
(3) The pin 7 of the chip, namely the NTC pin, can be reused as an enable pin. When it is set to zero potential, chip charging is prohibited. When it is directly floating, the chip is enabled.
(4) In order to further improve the EMI characteristics, it is necessary to add a microwave absorbing network composed of R5 and C8.
(5) The setting value of constant current charging current must be greater than 500mA, that is, R_{ICHG} must be less than 2KΩ.
(6) When hot plug operation is required at the battery end, or inductive load such as motor is connected, it is suggested to add another capacitor of at least 100μF beside C4 to further improve reliability.
(7) The solid red line in the figure shows the path of high current flow.

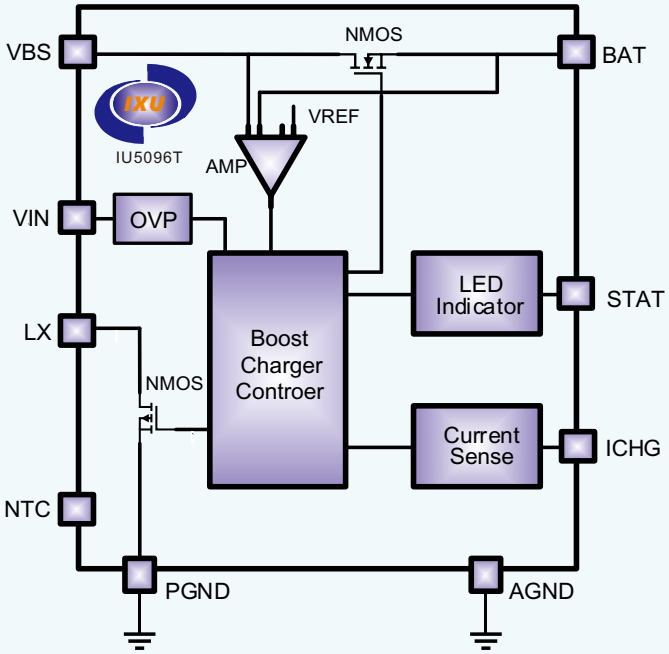
PIN Configuration and Functions

DFN 2X2_8L



IU5096T PIN	NAME	TYPE	DESCRIPTION
1	VIN	P	Analog power input pin.
2	AGND	-	Analog ground pin.
3	LX	I	Switch node pin, connect to external inductor.
4	VBS	P	Boost output pin.
5	BAT	P	Battery positive pin.
6	ICHG	O	Charge current program pin, pull down to AGND with a resistor can change the value of charging current.
7	NTC	I	Thermistor input pin, through the external thermistor to detect the battery temperature. And can be multiplexed as an enable port.
8	STAT	O	Charge status indication pin : output 0 level or high resistance state .
Thermal PAD	PGND	-	Power ground pin.

Functional Block Diagram



Absolute Maximum Ratings [1]

SYMBOL	PARAMETER	VALUE	UNIT
VMAX	VIN, BAT, LX, VBS, STAT	-0.3~30	V
	NTC, ICHG	-0.3~6	V
T_J	Junction operating temperature range	-40~150	℃
T_{STG}	Storage temperature range	-60~150	℃
T_{SDR}	Lead temperature (Soldering, 10 sec.)	260	℃

Recommended Operating Conditions

SYMBOL	PARAMETER	VALUE	UNIT
V_{IN}	Input voltage	3.6~6	V
T_J	Junction operating temperature range	-40~125	℃
T_A	Ambient temperature range	-40~85	℃

Thermal Information [2]

SYMBOL	PARAMETER	VALUE	UNIT
θ_{JA}	Package thermal resistance - chip to environment thermal resistance	80	℃/W

Ordering Information

Device	Package	Making	Reel Size	Tape Width	Quantity
IU5096T	DFN2X2_8L		7"	8mm	3000

ESD Range

HBM (Human Body Model) ---------- ±2kV

MM (Machine model) ---------- ±200V

1. The above parameters are only the limit values of device operation. It is not recommended that the working conditions of the device exceed the limit values. Otherwise, the reliability and life of the device will be affected, and even permanent damage will be caused.
2. Where the PCB board is placed in IU5096T, a heat dissipation design is needed. The heat sink at the bottom of IU5096T is connected with the heat sink area of PCB board.

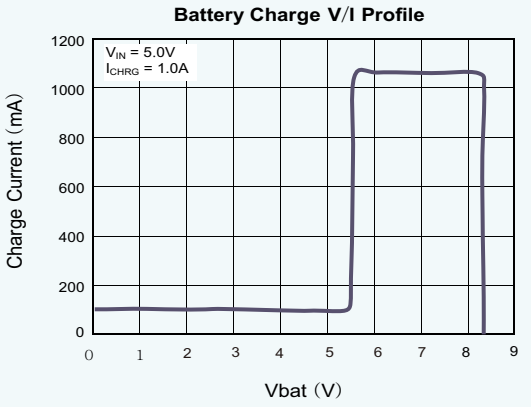
Electrical Characteristics (V_{IN}=5V , R_{ICHG}=1KΩ , L=4.7uH, unless otherwise specified)

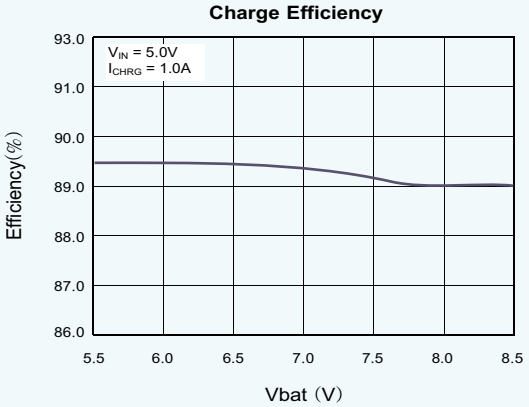
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Supply voltage		3.6		6	V
VIN_{OVP}	VIN over voltage protection	VIN rising		6		V
ΔVIN_{OVP}	VIN over voltage protection hysteresis			200		mV
I_Q	Input quiescent current			1		mA
I_{SD}	Input turned off current	V_{NTC}=0V		250		μA
I_{BAT}	Battery leakage current	Charging complete		16		μA
		V_{IN}=0V V_{BAT}=8.4V		7		
V_{CV}	Terminal battery voltage		8.34	8.42	8.50	V
ΔV_{RCH}	Recharge voltage			250		mV
V_{TRK}	TC charge mode battery voltage threshold	V_{BAT} rising		5.6		V
V_{SHORT}	Battery short threshold	V_{BAT} falling		2.2		V
V_{OVPB}	BAT over voltage threshold			9.2		V
F_{SW}	Switching frequency			500		KHz
V_{TRON}	Block Power MOS full on	V_{BAT}>V_{TRK} V_{TRON}= V_{BAT}-V_{IN}		150		mV
I_{CC}	CC charge mode current		0.5	1	1.5	A
I_{TC}	TC charge mode current	R_{ICHG}=1K, VIN=5V		70		mA
I_{BS}	Output short circuit charge mode current			70		mA
I_{TERM}	Terminate charge current			100		mA
A_I	CC charge mode current gain	A_I=I_{CC}/I_{ICHG}		1000		

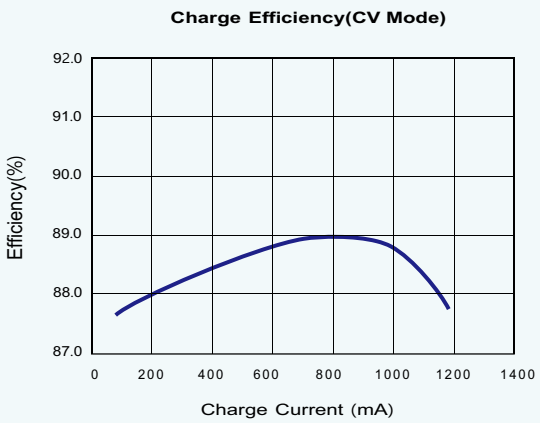
Electrical Characteristics (V_{IN}=5V , R_{ICHG}=1KΩ , L=4.7uH, unless otherwise specified)

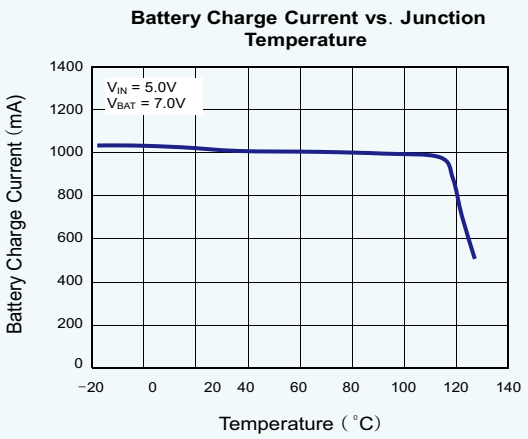
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{NTC}	NTC PIN output current		18	20	22	uA
V_{NTCL}	NTC low temp threshold	V_{NTC} rising		1.43		V
V_{NTCH}	NTC high temp threshold	V_{NTC} falling		0.38		V
T_{REG}	Chip thermal regulation threshold			120		℃
T_{SD}	Thermal shutdown temperature			150		℃
ΔT	Thermal shutdown temperature hysteresis			20		℃
TMR_{TC}	Trick charge time limit			9.5		Hour
$TMR_{CC/CV}$	CC/CV charge time limit			15.5		Hour

Typical Operating Characteristics (TA=25°C,unless otherwise noted)









IU5096T Application Points

1. Charge Process

IU5096T adopts complete CC/CV charging mode. When the battery voltage is less than 5.6V, the system charges the battery with trickle current. When the battery voltage is greater than 5.6V, the system enters the constant current charging mode. When the battery voltage approaches 8.4V, the system enters the constant voltage mode. When the system enters the constant voltage mode, if the charging current is less than the terminating charging current, the system will stop charging, indicating that the battery is fully charged. After that, if the battery voltage drops below the restart voltage, the system will restart to charge the battery. The charging current I_{CC} here refers to the current value flowing from the bat port to the positive electrode of the battery.

2. Protection Function

IU5096T has perfect battery charging protection function. When the chip has overvoltage at the input end, overvoltage and overtemperature at the output end, the boost charging function will be turned off immediately. When the battery voltage is lower than V_{SHORT}, the output short-circuit protection function is turned on, the main power tube is turned off first, and the Block tube will enter the linear mode and charge the battery with a small short-circuit mode charging current; When the battery voltage is higher than V_{SHORT}, the output short-circuit protection function is turned off.

3. Adaptive Input Current Limit Function

IU5096T is equipped with a special loop, which can automatically adjust the charging current to protect the input DC power into the overdrive state. Because the large charging current will lead to the drop of input power supply voltage. With the decrease of the power supply voltage, the input of the internal adaptive loop operational amplifier also drops. When the internal reference value is reduced, the built-in adaptive loop will automatically adjust the duty cycle of the system, so as to reduce the charging current, thus reducing the driving pressure of the input power supply, so that the output voltage is fixed at 4.2V.

4. Chip Temperature Adaptive Adjustment Function

IU5096T has a built-in temperature control loop. When the chip is in the constant current charging process, if the temperature rises to 120℃, the temperature control loop will start to work. The charging current will gradually decrease, and the chip temperature will drop. Finally, the chip temperature will stabilize at the set value, thus playing the role of protecting the chip.

5. LED Indicator

- The charging process is always on, and it will be extinguished when fully charged.
- In case of input over voltage, battery over voltage, abnormal battery temperature detected by NTC port, battery short circuit, charging time timeout, chip over temperature, flicker at the frequency of 1.6Hz.

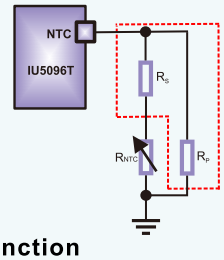
6. NTC Resistance Setting

IU5096T supports NTC protection function when the battery is charging, through NTC pin check the temperature of the battery, and its specific application is shown in the figure below. When the detection temperature exceeds the set window value, the system will stop charging.

The operation mode of this function is to output a constant 20A current from NTC pin, and the external resistance on NTC is connected to GND. The temperature range of the battery is determined by the voltage drop generated by the current on the resistance. The internal low temperature judgment point is 1.43V, and the high temperature judgment point is 0.38V.

As shown in the figure, the resistance network composed of R_P and R_S can be designed with appropriate NTC resistance.

If the NTC function is not required, the pin needs to float directly.

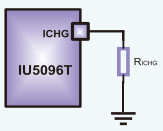


7. Enable Function

The NTC pin can be reused as a chip enable pin. When the NTC pin voltage is connected to the zero level (the maximum is not more than 0.2V), the chip charging is prohibited, and the STAT pin outputs the high resistance state at the same time.

8. ICHG Resistor R_{ICHG}

The value of the ICHG terminal resistance reflects the size of the charging current. According to different applications, the size of the charging current can be easily determined by adjusting the value of the ICHG terminal resistance R_{ICHG} (R_{ICHG} must be less than 2KΩ). The specific circuit is shown in the following figure:



The relationship between I_{CC}, R_{ICHG} in CC charging mode is determined by the following equation:

$$I_{CC} = \frac{1*1000}{R_{ICHG}}$$

9. Selection of Inductance

The following factors shall be considered when selecting inductive type:

•Determine the ripple current of the inductance.

Generally, the recommended ripple current of inductance is 40% of the average current of inductance, and its calculation formula is as follows:

$$L = (\frac{V_{IN}}{V_{OUT}})^2 * \frac{V_{OUT}-V_{IN}}{I_{CC}*F_{SW}*40\%}$$

F_{sw} is the switching frequency, and the charging current set by I_{cc} is quite adaptable to different ripple amplitudes, so even if the value of the final inductance deviates slightly from the calculated value, it will not affect the overall performance of the system.

•The saturation current of the selected inductor must be greater than the peak current of the inductor when the system is working in the full load range.

$$I_{SAT.MIN} > \frac{V_{OUT}}{V_{IN}} * I_{CC} + (\frac{V_{IN}}{V_{OUT}})^2 * \frac{V_{OUT}-V_{IN}}{2*F_{SW}*L}$$

•The DCR and core loss of the inductor must be as low as possible to obtain better system efficiency.

•We recommend the use of CD54 power inductor with a inductance of 4.7μH and a saturation current of 5A.

IU5096T PCB NOTE

The PCB shown in the figure is only for reference and does not mean that the customer must completely follow the figure below to layout and route their own products. Please make layout and wiring according to the actual components and product requirements, but there are general principles:

•The power wiring shall be as wide as possible, and IU5096T shall be supplied with power from the power wiring alone.

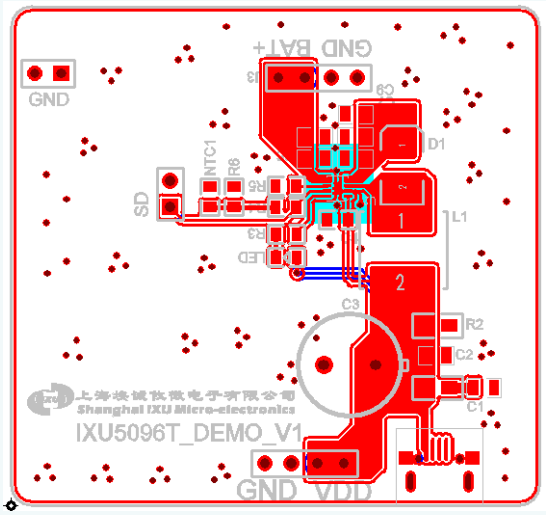
•The ground wire shall be routed on the same layer to avoid through-hole jumper and be short and thick.

•LX wiring shall be as short as possible to reduce EMI.

•Inductance and Schottky shall be directly short and thick connected to avoid via jumper.

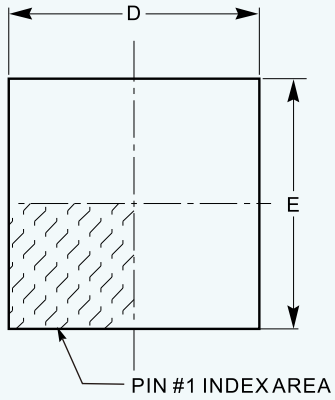
•The capacitor at the power end should be placed as close to the chip as possible.

•The bottom heat sink of the chip is a power ground and should be connected to a large piece of ground. The bottom heat sink must be reliably welded to the ground.

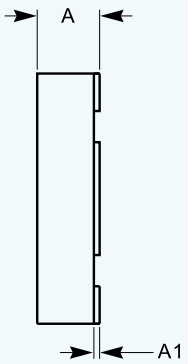


Package Information

IU5096T PACKAGE OUTLINE DIMENSIONS (units:mm)

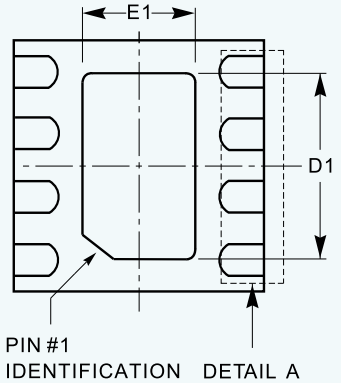


TOP VIEW

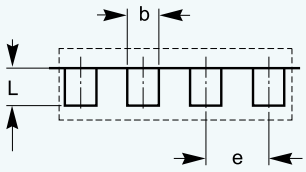


SIDE VIEW

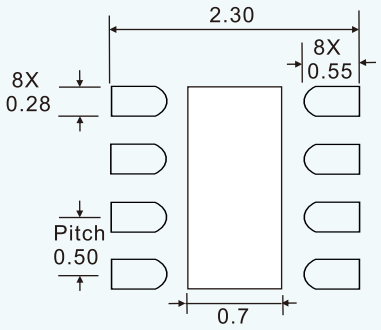
SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
b	0.18	0.25	0.30
D		2.00BSC	
D1	1.10	1.20	1.30
E		2.00BSC	
E1	0.50	0.60	0.70
e		0.50 BSC	
L	0.30	0.35	0.40



BOTTOM VIEW

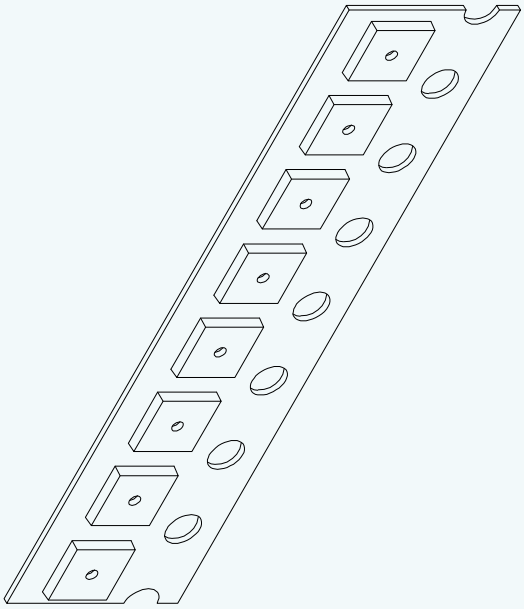


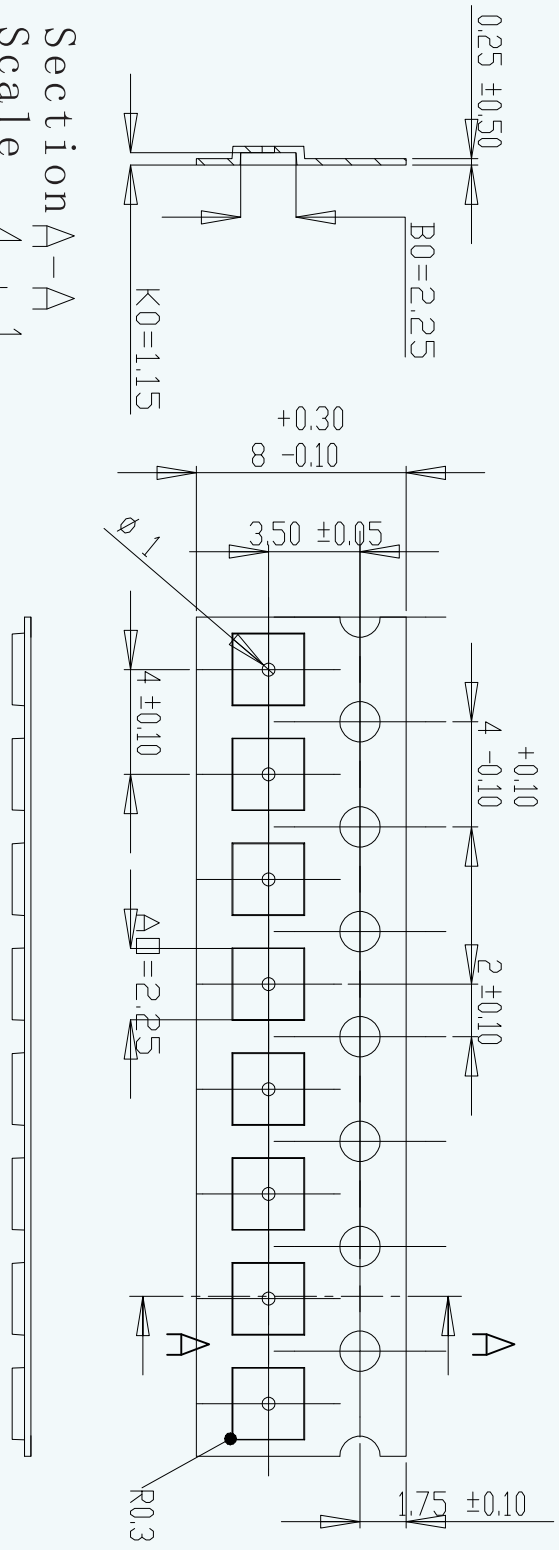
DETAIL A



UNIT:mm

TAPE AND REEL INFORMATION





Section A-A
Scale 4 : 1

1:Measured from centreline of sprocket hole to centrelline of pocket
2:Cumulative tolerance of 10 sprocket holes is ± 0.2
3:Measured from centreline of sprocket hole to centreline of pocket
4:other material available