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TPU3S014S6

Current limiting switch and D+/D-ESD protection for USB host ports

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Features

- Wide Supply Voltage Range: 2.9V to 5.5V
- Current-Limit and Short-Circuit Protections
- Typical Rdson 60mΩ (typ)
- Typical 2.1V under voltage lockout
- Output can be forced higher than input (Off-state)
- Hot Plug-In Application(Soft start)
- Low supply current 35uA at switch on state
- Reverse Current Flow Blocking (no body diode)
- RoHS and Halogen free compliance
- CB IEC60950-1 Certification
- TUV EN60950-1 Certification
- UL Approved-E353665
- ± 15kV contact discharge (IEC 61000-4-2)
- ± 20kV air gap discharge (IEC 61000-4-2)

Applications

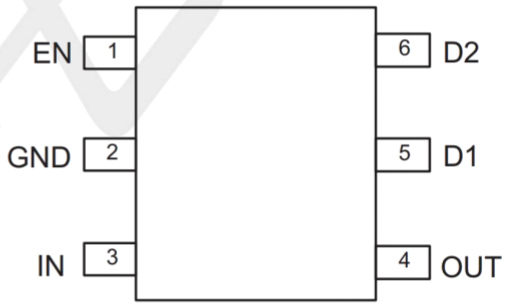
- USB Ports
- Notebook and Desktop Computers
- High-Side Power Protection Switchs
- Consumer Electronics
- Telecom Systems
- Digital TV
- USB Device Power Switch
- Motherboard USB Power Switch

General Description

This integrated device is equipped with a current limiting load switch and an electrostatic discharge (ESD) protection diode array based on a dual channel transient voltage suppressor (TVS), suitable for USB interfaces. The rated ESD impulse dissipation value of the TVS diode array is higher than the highest level specified in the IEC 61000-4-2 international standard.

Additional features include soft-start to limit the inrush current during plug-in, thermal shutdown to prevent catastrophic switch failure from high-current loads, under voltage lockout (UVLO) to ensure that the device remains off unless there is a valid input voltage present. The low quiescent current as 35uA makes this device ideal for portable battery operated equipment.

Pin Configurations (Top View)



SOT23-6

Pin Functions

Pin Number	Pin Name	Pin Function
1	EN	Enable Input, Chip Enable(Active High).
2	GND	Ground.
3	IN	Input voltage and power-switch drain; Connect a 0.1 μF or greater ceramic capacitor from IN to GND close to the IC.
4	VOUT	Power-switch output, connect to load.
5	D1	USB data+or USB data - electrostatic protection.
6	D2	USB data+or USB data - electrostatic protection.

Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

Characteristics	Symbol	Rating	Unit
Supply Input Voltage	V_{IN}	6.5	V
EN Input Voltages and VOUT Voltages		-0.3 to 6.5	V
FLAG Voltage		6.5	V
Package Power Dissipation	P_D	PD=(TJ-TA)/θJA	W
Operating Temperature Range		-40 to 85	°C
Junction Temperature	T_J	-40~125	°C
Storage Temperature Range	T_S	-65 to +150	°C
Thermal Resistance from Junction to ambient	θ_{JA}	218	°C/W
Thermal Resistance from Junction to case	θ_{JC}	130	°C/W

ESD Ratings

Characteristics			Rating	Unit
V(ESD) Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	All pins	±2000	V
	Charged device model (CDM), per JEDEC specification JESD22-C101(2)	All pins	±500	
	IEC 61000-4-2 Contact Discharge(3)	V_{OUT},Dx pins	±15000	
	IEC 61000-4-2 Air-Gap Discharge(3)	V_{OUT},Dx pins	±20000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±2000
V may actually have higher performance.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Pins listed as ±500 V
may actually have higher performance.
(3) VOUT was tested on a PCB with input and output bypassing capacitors of 0.1 μF and 120 μF, respectively

Electrical Characteristics

(V_{IN}=5V, C_{IN}=1uF, C_{OUT}=10uF per channel, T_A = 25°C, unless otherwise specified)

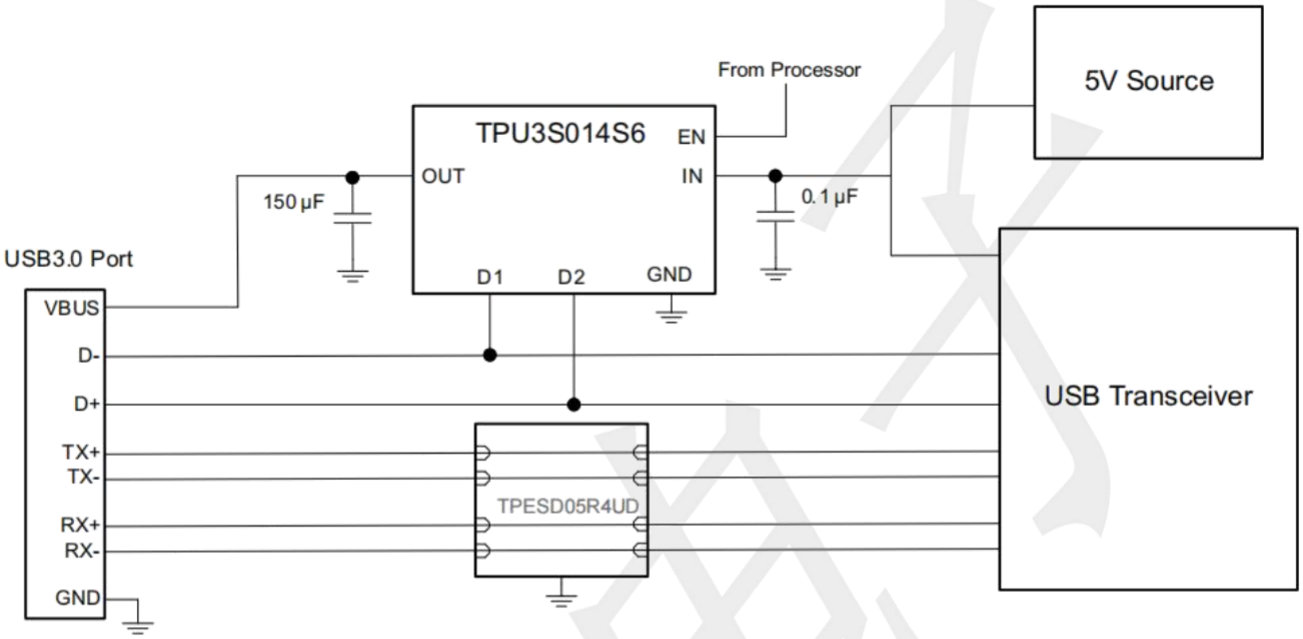
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}		2.9	--	5.5	V
Under Voltage Lockout	V_{UVLO}	V_{IN} Increase	1.7	2.1	2.4	V
Under Voltage Hysteresis		V_{IN} Decrease	--	100	--	mV
Input Leakage Current	I_{LEAK}	Disabled, OUT grounded		0.1	1	μA
Output Leakage Current		Disabled, R_{LOAD}=0Ω	--	0.5	1	μA
Reverse Leakage Current	I_{REV}	Disabled, V_{IN}= 0V, V_{OUT}= 5V, I_{REV} at V_{IN}	--	0.1	1	μA
Switch On Resistance	R_{DSON}	VIN=3.3V, I_{OUT}=0.5A	--	60	75	mΩ
		VIN=5.0V, I_{OUT}=0.5A	--	60	75	mΩ
Supply Current	IQ	Switch On, V_{OUT} = OPEN	--	35	55	μA
	I_{SHDN}	Switch Off, V_{OUT} = OPEN	--	0.1	1	μA
EN Threshold	V_{IL}	Low Voltage	--	--	0.7	V
	V_{IH}	High Voltage	1.3	--	--	V
EN Input Current	I_{SINK}	VEN From 0V to 5V	--	0.01	--	μA
Current Limit	I_{LIMIT}	V_{IN}= 5V, V_{OUT}= 4.5V,-40°C≤T_A≤85°C	2.2	3.0	3.8	A
Short Circuit Fold back Current Hysteresis	I_{SHORT}	V_{OUT}=0V,Measured prior to the thermal shutdown	--	1.2	--	A
Output Turn-on Rise Time	T_R	V_{IN}=3.3V-5.0V,C_L=1μF,R_{load}=3Ω, V_{OUT} Rise From 10% to 90%	--	1.6	--	ms
Output Turn-on Delay Time	$T_{D(ON)}$	C_L=1μF, R_{load}=10Ω,EN 10% V_{OUT} 10%	--	50	--	us
Output Turn-off Delay Time	$T_{D(OFF)}$	C_L=1μF, R_{load}=10Ω,EN 90% V_{OUT} 90%	--	10	--	us
Output Shutdown Discharge Resistance		Disabled	--	100	150	Ω
Thermal Shutdown Threshold	T_{SD}	Enabled	--	150	--	°C
Thermal Shutdown Hysteresis	T_{HYS}	V_{OUT} = 0V	--	20	--	°C
Reverse Working Voltage	VRWM	Input working voltage (D1, D2)	--	--	3.3	V
Breakdown Voltage	VBR	IT= 1mA(D1, D2)	6	--	--	V
Reverse Leakage Current	IR	VRWM=3.3V(D1, D2)	--	--	1	uA
Forward Voltage	VF	IF=5mA (D1, D2)	--	--	1	V
Junction Capacitance	CJ	VR = 0V, f = 1MHz,(D1 ,D2TO GND)	--	0.3	--	PF

Note

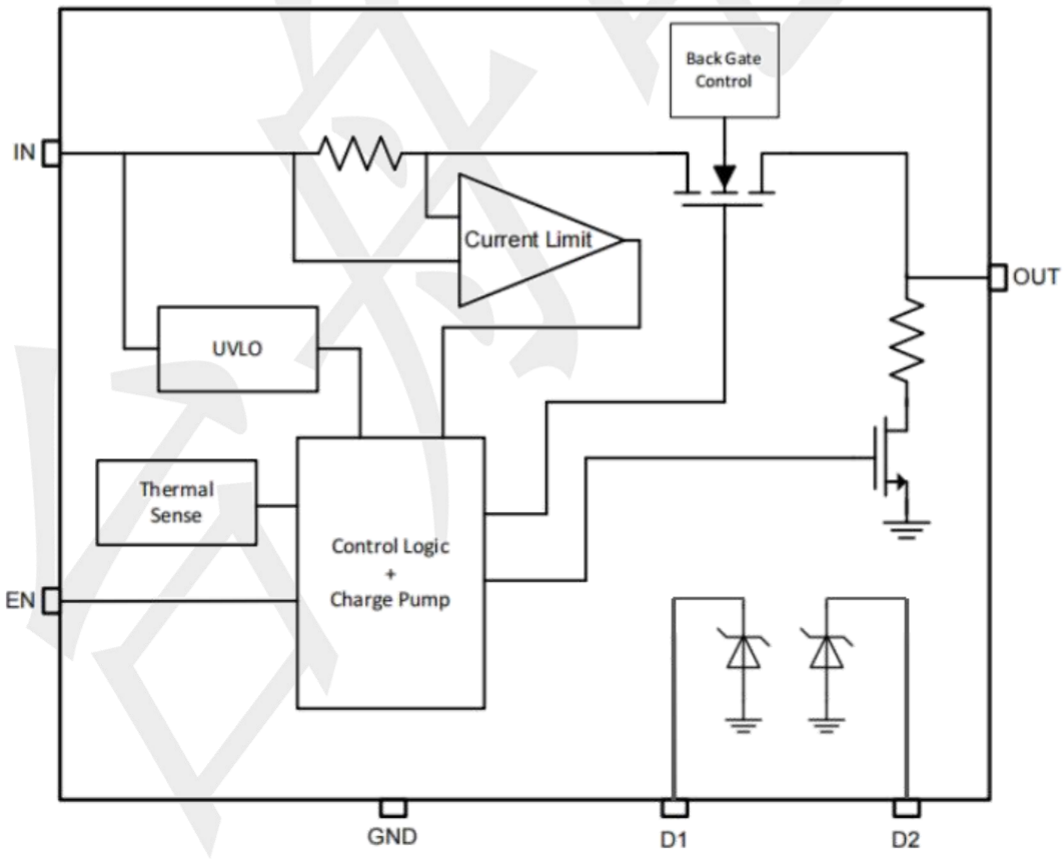
1: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

2: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization. The device is not guaranteed to function outside its operating conditions.

APPLICATION CIRCUIT



Functional Block Diagram



APPLICATION INFORMATION

The is a single N-MOSFET high-side power switch with enable input, optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. The series are equipped with a charge pump circuitry to drive the internal N-MOSFET switch; The switch's low Rds(on),40mΩ meets USB voltage drop requirements .

Input and Output

VIN (Input) is the power source connection to the internal circuitry and the drain of the N-MOSFET. VOUT (Output) is the source of the N-MOSFET. In a typical application, current flows through the switch from VIN to VOUT toward the load. If VOUT is greater than VIN, current will flow from VOUT to VIN since the MOSFET is bidirectional when on. Unlike a normal MOSFET, there is no a parasitic body diode between drain and source of the MOSFET, the prevents reverse current flow if VOUT being externally forced to a higher voltage than VIN when the output .disabled (V_{EN} < 0.8V or $V_{\overline{EN}}$ > 2V).



Enable

The switch will be disabled when the EN pin is low . During this condition, the internal circuitry and MOSFET are all turned off and the supply current reduces to 0.1uA typically. Floating the EN may cause unpredictable operation. EN should not be allowed to be negative to GND. The
EN pin may be directly tied to VIN to keep the part on.

UVLO

Under-Voltage Lockout (UVLO) prevents the power MOSFET from turning on until the input voltage is up to approximately 2.1V. If the input voltage drops blow about 2.0V, UVLO turns off the power MOSFET switch . Under voltage protection is function when the part is enabled.

Soft Start for Hot Plug Application

In order to eliminate the upstream voltage droop caused by the large inrush current during the hot plug events, the soft start feature effectively isolates the power source from extremely large load capacitor, satisfying the USB voltage droop requirement.

Current Limiting and Short-Circuit Protection

The current limit circuitry prevents damage to the MOSFET switch and the hub downstream port but can deliver load current up to the current limit threshold of typically 2.5A through the switch of When a heavy load or short circuit is applied to an enabled switch, a large transient current may flow until the current limit circuitry responds. Once this current limit threshold is exceeded the device enters constant current mode until the thermal shutdown occurs or the fault is removed.

Input capacitor

A 1uF low ESR ceramic capacitor from VIN to GND, located at the device is strongly recommended to prevent the input voltage drooping during hot-plug events. However, higher capacitor values will further reduce the voltage droop at the input. Furthermore, without the bypass capacitor, an output short may cause sufficient ringing on the input (from source lead inductance) to destroy the internal control circuitry. The input transient must not exceed 6.5V of the absolute maximum supply voltage even for a short duration.

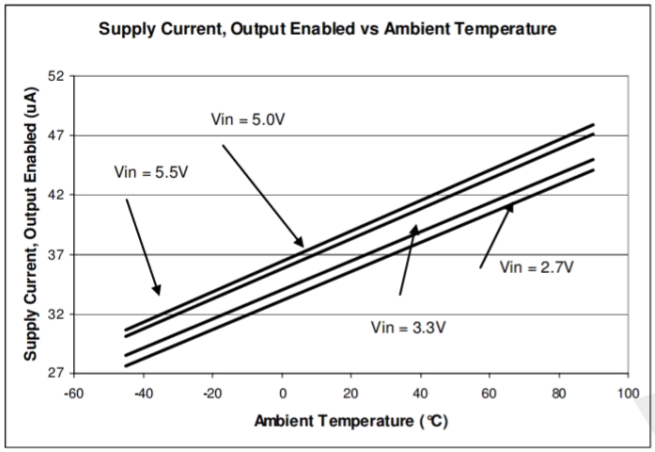
Output capacitor

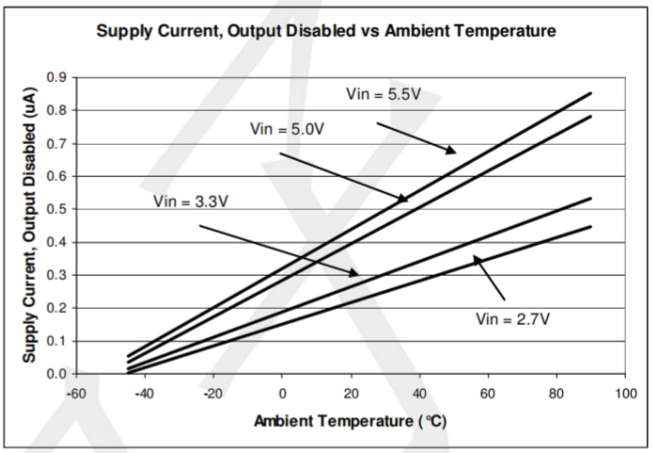
A low ESR 150uF aluminum electrolytic or tantalum between VOUT and GND is strongly recommended to meet the 330mV maximum droop requirement in the hub VBUS (Per USB 2.0, output ports must have a minimum 120uF of low ESR bulk capacitor per hub). Standard bypass methods should be used to minimize inductance and resistance between the bypass capacitor and the downstream connector to reduce EMI and decouple voltage droop caused when downstream cables are hot insertion transients. Ferrite beads in series with VBUS, the ground line and the 0.1uF bypass capacitors at the power connector pins are recommended for EMI and ESD protection. The bypass capacitor itself should have a low dissipation factor to allow decoupling at higher frequencies.

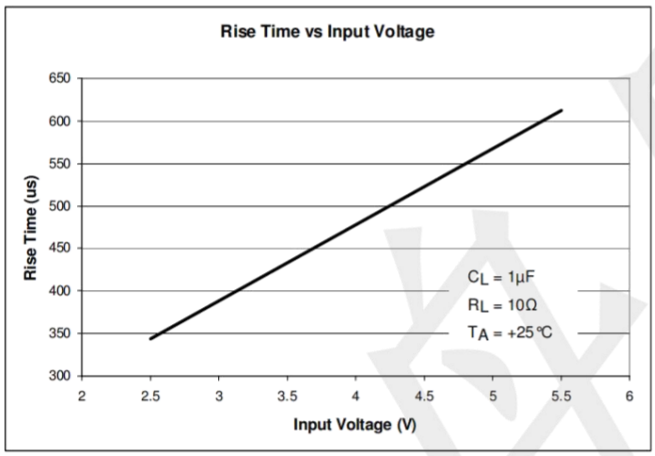
PCB Layout Guide

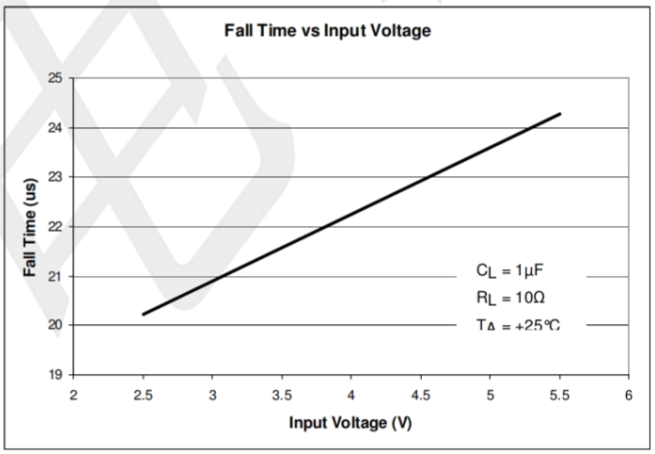
For best performance of the , the following guidelines must be strictly followed:
1. Input and output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
2. The GND should be connected to a strong ground plane for heat sink.
3. Keep the main current traces as possible as short and wide.

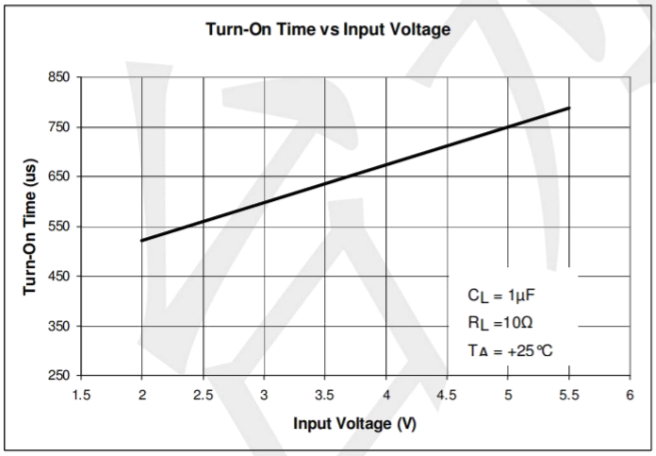
Typical Operating Characteristics

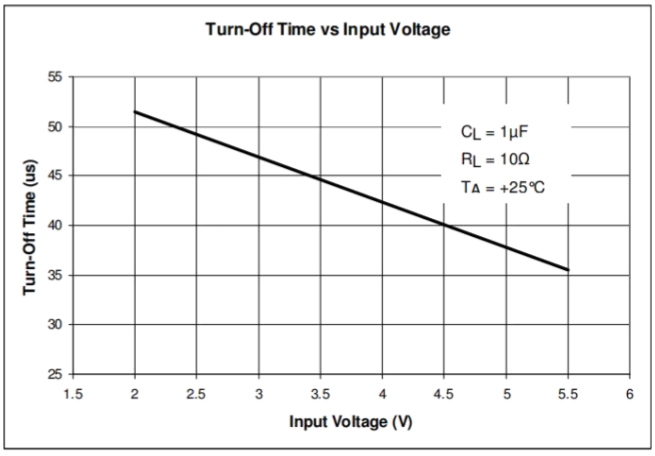






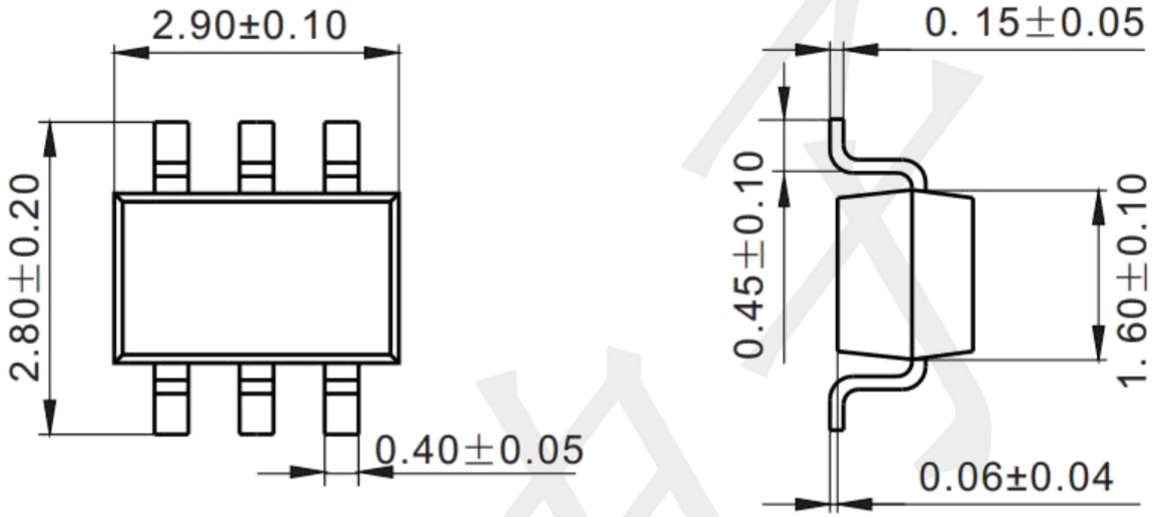


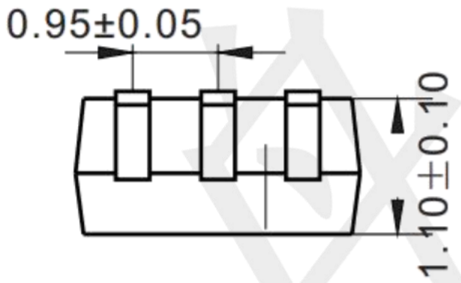




Package information (Unit: mm)

SOT23-6





Mounting Pad Layout (unit: mm)

