6V Fixed Over Voltage and Over Current Protector with 38V Input Withstand Voltage

FEATURES

- Input Operation Voltage Range: 2.5V to 38V
- Low $R_{ds(on)}$: 150mΩ typical
- Internal Input OVP Threshold: 6.0V typical
- Internal Output Voltage Clamp Threshold: 5.7V typical
- OVP Response Time: 100ns typical
- Power on Delay Time: 18ms typical
- Internal OCP Threshold: 2.5A minimum
- Output Short Protection
- Output Auto Discharge Function
- Thermal Shutdown Protection
- TMI6401: SOT23-6 Package

GENERAL DESCRIPTION

The TMI6401 is an over voltage and over current protector. Input withstand voltage is up to 38V. It has 6.0V typical OVP threshold and 500ns fast OVP response time. The OCP threshold is 2.5A. The TMI6401 also include output short protection and thermal shutdown function protect the device against over current and high junction temperature.

TMI6401 is available in a space-saving SOT23-6 package.

APPLICATIONS

- Portable Media Devices
- Digital Cameras
- GPS and Navigation Equipment
- USB Port Input Protectors
- Storage and SSD Devices

TYPICAL APPILCATION

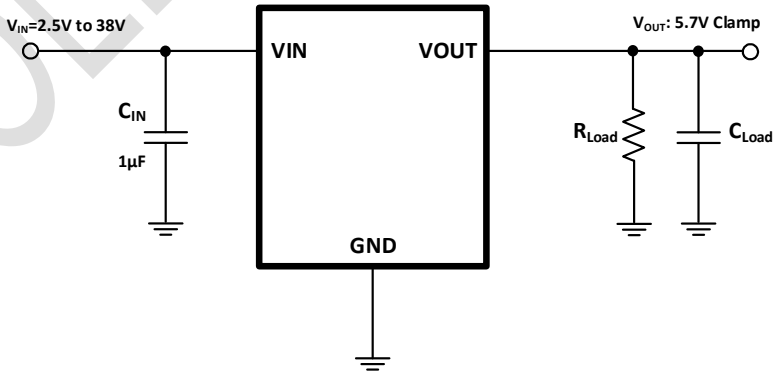
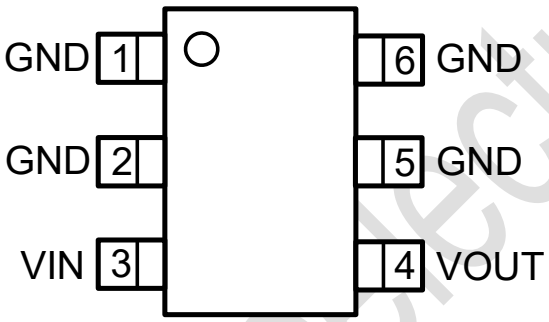


Figure 1. Typical Application Circuits

ABSOLUTE MAXIMUM RATINGS (Note 1)

Parameter	Min	Max	Unit
Input Supply Voltages	-0.3	40	V
VOUT Voltages	-0.3	10	V
Storage Temperature Range	-65	150	°C
Junction Temperature (Note 2)	-40	150	°C
Power Dissipation		1000	mW
Lead Temperature Soldering, 10sec		260	°C

PIN CONFIGURATION



SOT23-6 (Top View)

Top Mark: TODXXX (TOD: Device Code, XXX: Inside Code)

Part Number	Package	Top Mark	Quantity/Reel
TMI6401	SOT23-6	TODXXX	3000

TMI6401 devices are Pb-free and RoHS compliant.

PIN FUNCTIONS

Pin	Name	Function
1	GND	Ground pin.
2		
3	VIN	Power supply pin.
4	VOUT	Output pin.
5	GND	Ground pin.
6	GND	

ESD RATING

Items	Description	Value	Unit
V_{ESD_HBM}	Human Body Model for all pins	±2000	V
V_{ESD_CDM}	Charge Device Model for all pins	±1000	V

JEDEC specification JS-001

RECOMMENDED OPERATING CONDITIONS

Items	Description	Min	Max	Unit
Voltage Range	IN	2.5	38	V
T_J	Operating Junction Temperature Range	-40	125	°C
I_{OUT}	Output Current	0	2	A

THERMAL RESISITANCE (Note 3)

Items	Description	Value	Unit
θ_{JA}	Junction-to-ambient thermal resistance of SOT23-6	140	°C/W
θ_{JC}	Junction-to-case(top) thermal resistance of SOT23-6	42	°C/W

ELECTRICAL CHARACTERISTICS

(V_{IN}=5V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		38	V
Input UVLO Threshold	V_{UVLO_R}	V_{IN} Rising		2.3		V
Input UVLO Hysteresis	V_{UVLO_H}			0.19		V
Input OVP Threshold	V_{OVP_R}	V_{IN} Rising	5.75	6.0	6.25	V
Input OVP Hysteresis	V_{OVP_H}			120		mV
Output Clamp Voltage	V_{O_CLAMP}	I_{OUT}=0A	5.55	5.7	5.85	V
Input OVP Response Time(Note 4)	t_{OVP}	V_{IN}>V_{OVP_R} to MOSFET turns off		100	200	ns
Operation Input Current	I_{IN_5V}	V_{IN}=5V, I_{OUT}=0A		80	120	μA
	I_{IN_38V}	V_{IN}=38V, I_{OUT}=0A		155		μA
Output Start Time	t_{START}	Time from V_{out} =0.5V to 4.5V		110		μs
Power on Delay Time	t_{ON_Delay}	Time from V_{IN}>V_{UVLO_R} to V_{OUT} start rising		18		ms
Switch On-Resistance	$R_{ds(on)}$	V_{IN}=5V, I_{OUT}=1A, T_A=25°C		150		mΩ
Over Current Limit	I_{OCP}		2.5	3		A
Over Current Protect Deglitch Time(Note 4)	t_{OCP}	Time from I_{OUT}>I_{OCP} to MOSFET turns off		35		ms
Over Current Recovery Time(Note 4)	t_{OCP_R}	Time from OCP to V_{OUT} start rising		1.2		s
Output Short Current Limit(Note 4)	I_{SC}	MOSFET is turning on		7		A
Output Short Protect Deglitch Time(Note 4)	t_{SC}	Time from I_{OUT}>I_{SC} to MOSFET turns off		1		μs
Output Auto Discharge Current	I_{O_DIS}	V_{IN}=7V, V_{OUT}=5V		3.8		mA
Thermal Shutdown Threshold (Note 4)	T_{OTP}			165		°C
Thermal Shutdown Hysteresis (Note 4)	T_{OTP_H}			30		°C

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + (P_D) \times \theta_{JA}$.

Note 3: Measured on JESD51-7, 2-layer PCB.

Note 4: Guaranteed by design.

FUNCTION DESCRIPTION

Input Under-Voltage-Lock-Out and Power On

The TMI6401 is an over voltage and over current protector with 38V withstand input voltage. The input voltage range is 2.5V to 38V. When VIN voltage is higher than under voltage lockout rising threshold V_{UVLO_R}, the device could be turned on and the output of the device start rising after typical 18ms delay time. The output start on time is about 110µs typically. When VIN voltage is lower than under voltage lockout rising threshold minus UVLO hysteresis, the device is turned off and internal timer is cleared.

Input Over Voltage Protection and Output Voltage Clamp

TMI6401 has input over voltage protection and output voltage clamp function to prevent output from high voltage damage. When input voltage of TMI6401 is higher than V_{UVLO_R}, the internal MOSFET is turned on and the output voltage is following input voltage. When output voltage is higher than 5.7V output voltage clamp threshold, output voltage is clamped to 5.7V. If input voltage keeps rising and higher than typical 6V input OVP threshold V_{OVP_R}, the inner MOSFET is turned off with fast response time. When input voltage is decreasing lower than input OVP threshold minus OVP hysteresis, the inner MOSFET is turned on and output voltage restart again after 18ms delay time.

Over Current Protection and Output Short Protection

The device has over current protection and output short protection function to protect over current condition or output short condition. When the current flowing through the device is larger than over current limitation I_{OCP} and the OCP duration time is larger than t_{OCP} 35ms typical, the MOSFET is turned off immediately. After typical 1.2s OCP recovery time, the MOSFET restart turning on automatically. if the over current is continuous, the MOSFET is turned off again.

The OCP deglitch time avoid the MOSFET is turned off unexpectedly in load current transient condition, however, it cannot turn off MOSFET during output short condition with large short current. TMI6401 adds the second output short protection to prevent short current. If the short current is larger than I_{SC} typical 7A, the MOSFET is turned off within 1µs to shut off short current. After short current protection, the MOSFET is turned on and output restart automatically after 18ms power on delay time.

In application with large output capacitor, inrush current is produced during MOSFET powers on. The over current protection of TMI6401 limits capacitance on output side during the power on process. The recommended maximum output capacitance is 100µF to avoid OCP during start up with 5V input application.

Thermal Shutdown Protection

The device also has thermal shutdown function. It can protect the device against thermal damage due to high junction temperature. When the device junction temperature is higher than thermal shutdown threshold, the MOSFET is turned off immediately, and when junction temperature drops thermal shutdown hysteresis value, the MOSFET turns on again.

Output Discharge Function

The device has output discharge function with about 3.8mA discharge current from output to GND when MOSFET is turned off after input over voltage protection, over current protection, output short protection and thermal shutdown protection.

FUNCTIONAL BLOCK DIAGRAM

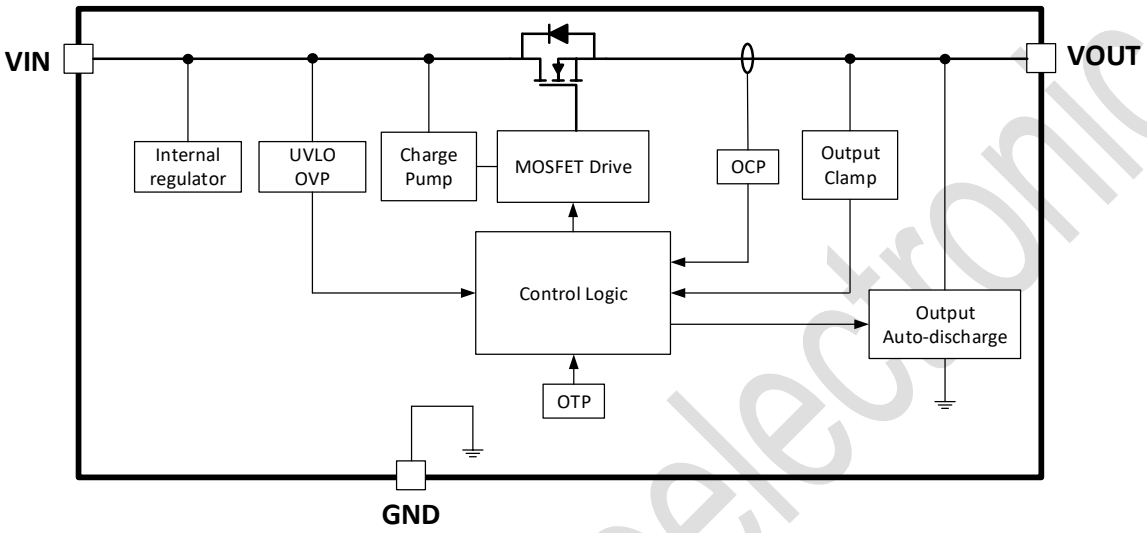
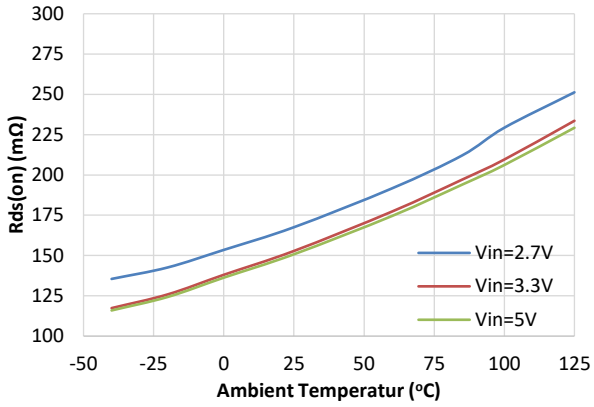


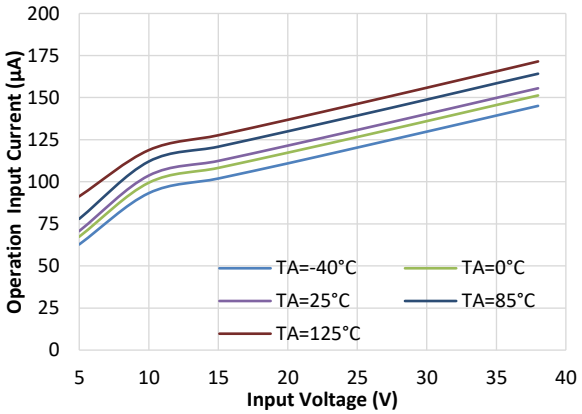
Figure 2. TMI6401 Block Diagram

TYPICAL PERFORMANCE CHARACTERISTICS

$R_{DS(ON)}$ vs. Temperature

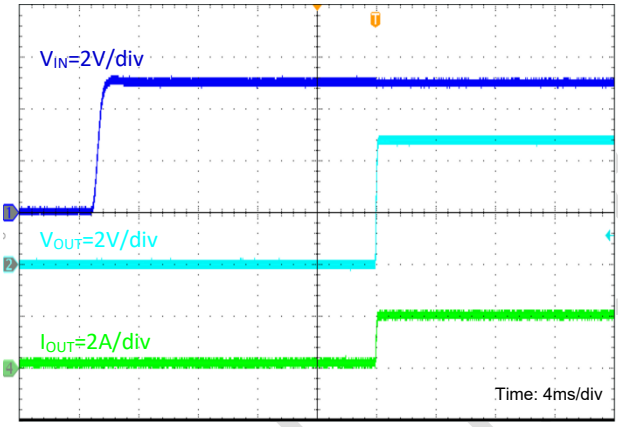


Operation Current vs. Input Voltage



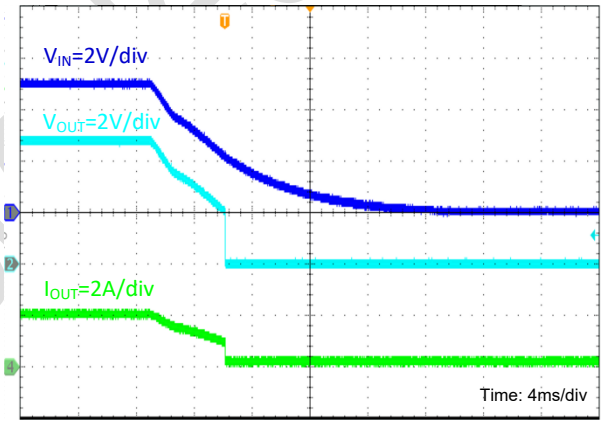
Power On

V_{IN} =5V, R_{Load}=2.5Ω



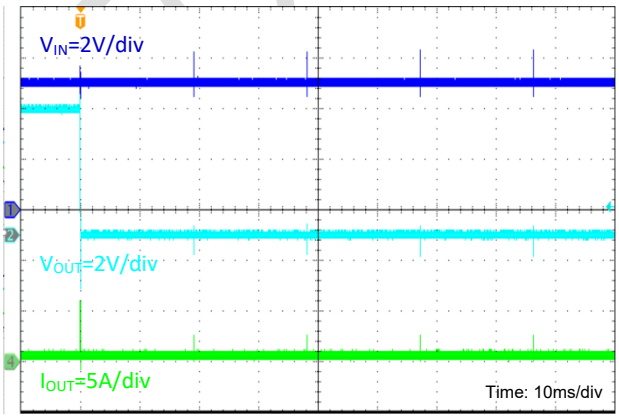
Power Off

V_{IN} =5V, R_{Load}=2.5Ω



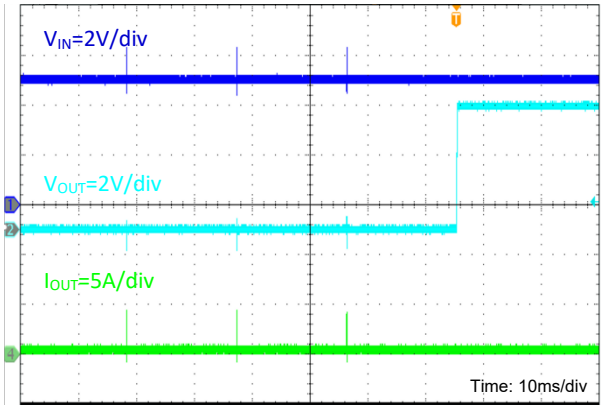
Output Short

V_{IN} =5V, Output Short to GND



Output Short Recover

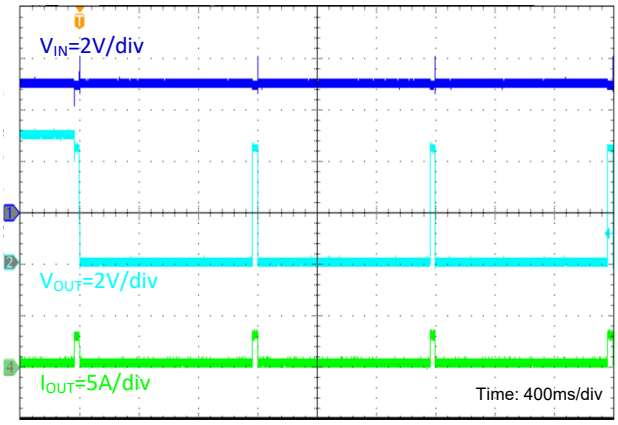
V_{IN} =5V, Output Short Released



TYPICAL PERFORMANCE CHARACTERISTICS

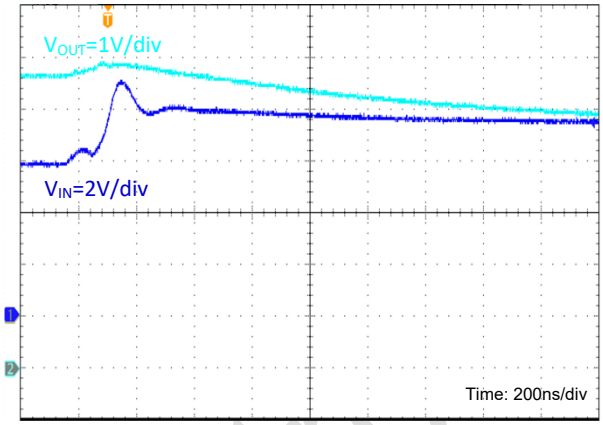
Over Current Protection

V_{IN} =5V, No load to R_{Load}=1.5Ω



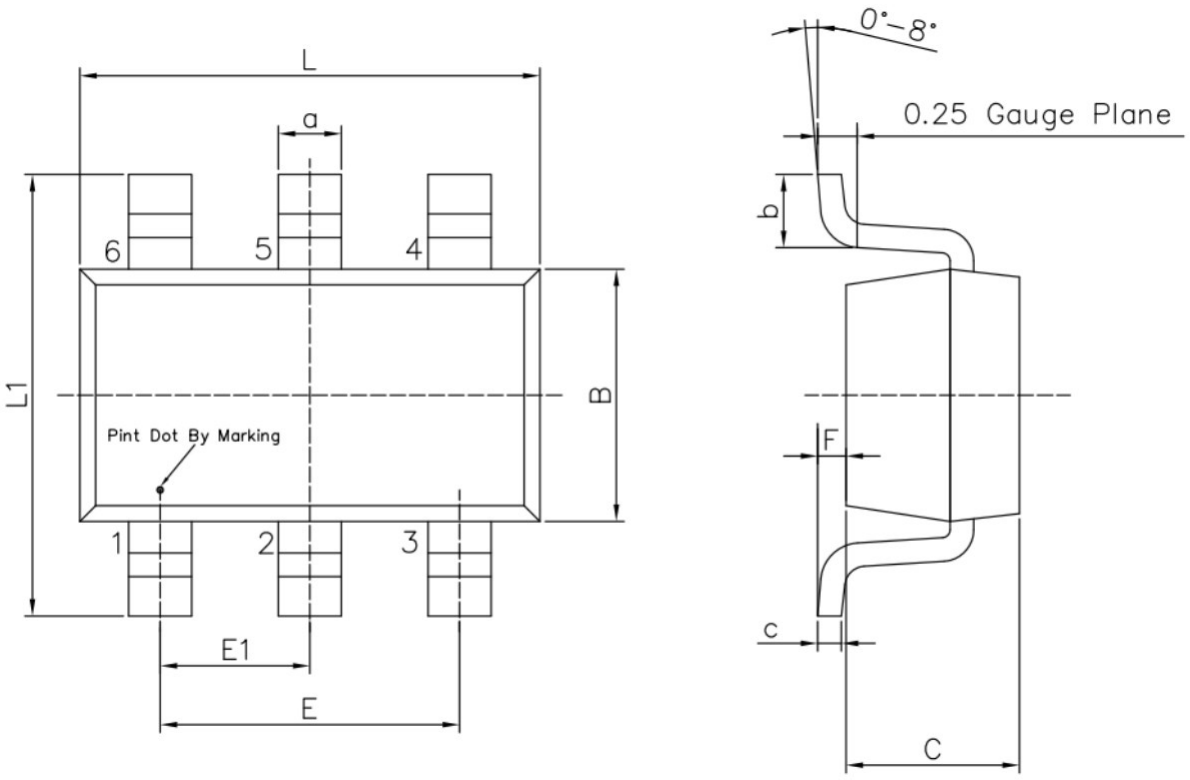
Input OVP Response

V_{IN} transient from 5.9V to 6.8V, No load



PACKAGE INFORMATION

SOT23-6



Unit: mm

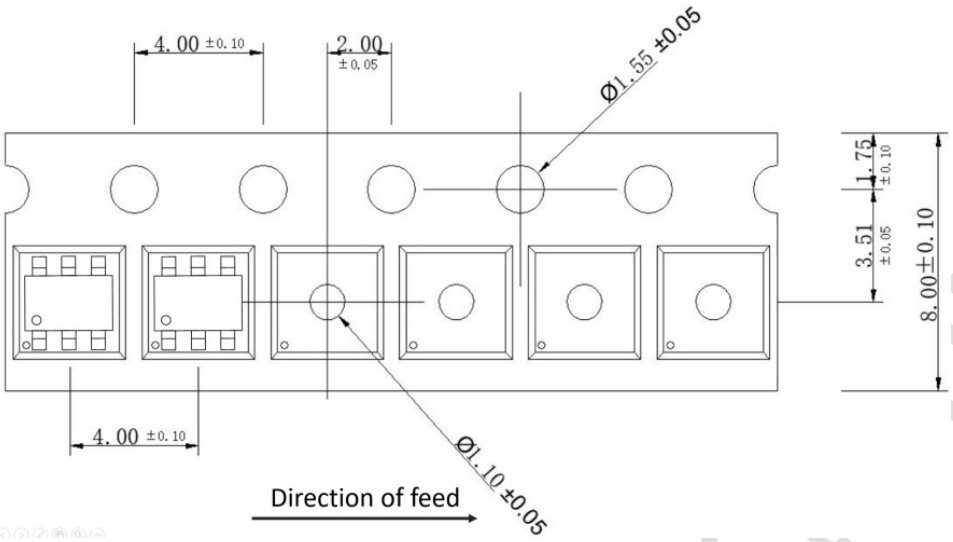
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

Note:

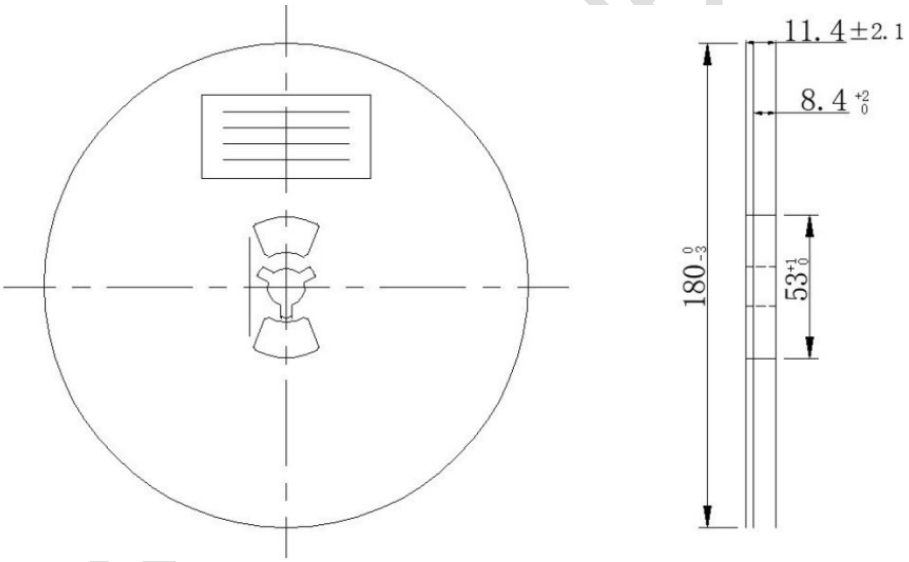
1) All dimensions are in millimeters.
2) Package length does not include mold flash, protrusion or gate burr.
3) Package width does not include inter lead flash or protrusion.
4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
5) Pin 1 is lower left pin when reading top mark from left to right.

TAPE AND REEL INFORMATION

TAPE DIMENSIONS: SOT23-6



REEL DIMENSIONS: SOT23-6



Note:

1) All Dimensions are in Millimeter
2) Quantity of Units per Reel is 3000
3) MSL level is level 3.

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