GENERAL DESCRIPTION

The XR8113 is a high-efficiency monolithic synchronous step-down DC-DC converter with an input voltage range of 4.5V-18V. Constant On-Time (COT) mode architecture, capable of delivering up to 3A. Quiescent current of XR8113 is 400μA, and when it is turn off, shutdown current is 5uA.

DCM/CCM mode operation provides very low output ripple voltage for noise sensitive applications. Switching frequency is internally set at 600kHz, allowing the use of small surface mount inductors and capacitors. Low output voltages are easily supported with the 0.6V feedback reference voltage.

The XR8113 requires a minimal number of readily available, external components and is available in a small package.

FEATURES

- Wide 4.5V to 18V Operating Input Range
- 3A Continuous Output Current
- 600kHz Switching Frequency
- Short Protection with Hiccup-Mode
- Built-in overcurrent Limit
- Internal-fixed 0.8ms Soft-Start Time
- 94/63mΩ Low $R_{DS(ON)}$ internal MOSFETs
- Output Adjustable from 0.6V to 7V
- 98% Duty cycle Max
- Thermal Shutdown
- COT Mode for fast load Transient response
- SOT23-6 Package

APPLICATIONS

- Digital Set Top Boxes
- Flat Panel Television and Monitors
- Notebook computer
- Wireless and DSL Modems

TYPICAL APPLICATION CIRCUIT

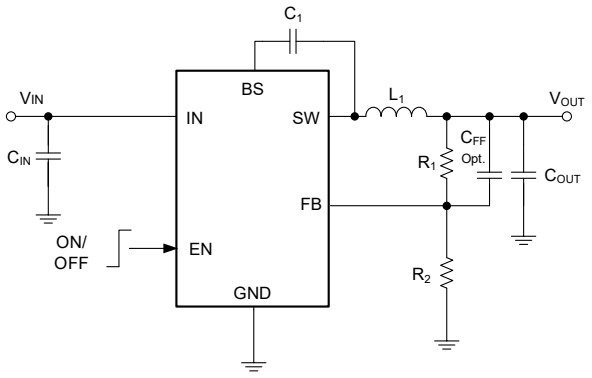
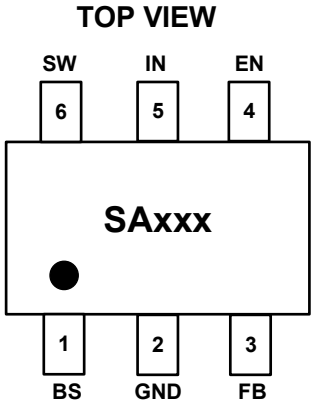


Figure 1. Basic Application Circuit

MARKING/PINOUT INFORMATION



XR8113 Top Marking
SA: Device Code
xxx: Date Code

Figure 2. Marking/Pinout Information

PIN DESCRIPTION

SOT23-6	Name	Function
1	BS	Bootstrap pin. A capacitor connected between SW and BS pin is required to form a floating supply across the high-side switch driver.
2	GND	Ground pin.
3	FB	Output Voltage feedback input pin. Connect FB to the center point of the external resistor divider.
4	EN	Enable pin. Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter micro-power shutdown mode.
5	IN	Power supply pin.
6	SW	Switching pin.

ORDER INFORMATION (1)

Part No.	Description	Temperature	Package	T/R Qty
XR8113	4.5-18V, 3A, 600kHz, VFB 0.6V, DCM	-40°C-125°C	SOT23-6	3000pcs

Item	Min	Max	Unit
IN voltage	-0.3	20	V
EN voltage	-0.3	20	V
SW voltage	-0.3	20	V
BS -SW voltage	-0.3	6	V
FB voltage	–0.3	6	V
Operating junction temperature, TJ	-40	125	°C
Storage temperature, Tstg	–65	150	°C
Lead Temperature (Soldering, 10sec.)		260	°C

Note (1): Exceeding these ratings may damage the device.

Note (2): The device is not guaranteed to function outside of its operating conditions.

RECOMMENDED OPERATING CONDITIONS (1)

Item	Min	Max	Unit
Operating junction temperature (1)	–40	125	°C
Operating temperature range	-40	85	°C
Input voltage VIN	4.5	18	V
Output current	0	3.0	A

Item	Description	SOT23-6	Unit
RθJA	Junction-to-ambient thermal resistance	130	°C/W
RθJC(top)	Junction-to-case (top) thermal resistance	60	°C/W

Note (1): Measured by Hopesemi Demo HEM8113-N-01A，2Oz，75mmX75mm 2-layer Board.

Item	Description	VALUE	Unit
HBM	Human-body model, per ANSI/ESDA/JEDEC JS-001	±2000	V
CDM	Charged-device model, per ANSI/ESDA/JEDEC JS-002	±1000	V

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range		4.5		18	V
VIN Under-Voltage Lockout Rising Threshold			3.9		V
VIN Under-Voltage Lockout Hysteresis			400		mV
Quiescent current	V_{IN}=5.0V, No Switching, V_{FB}=0.65V		400		μA
Shutdown current	V_{EN} = 0V, V_{IN} = 12V		5		μA
Regulated Feedback Voltage	T_A=25°C	0.588	0.600	0.612	V
High-Side Switch On-Resistance			94		mΩ
Low-Side Switch On-Resistance			63		mΩ
High-Side Switch Leakage Current	V_{EN}=0V, V_{SW}=0V			1.0	μA
Low-Side Valley Current Limit			5.2		A
Oscillation Frequency			600		kHz
Maximum Duty Cycle			98		%
Minimum On-Time			70		ns
Soft Start Time	V_{OUT}:10%~90%		0.8		ms
Hiccup on Time			1.6		ms
Hiccup Time Before Restart			23		ms
EN Rising Threshold			1.1		V
EN Hysteresis			0.1		V
Thermal Shutdown Threshold			160		°C
Thermal Shutdown Hysteresis			20		°C

Note (1): Thermal shutdown specifications are guaranteed by correlation to the design and characteristics analysis.

FUNCTIONAL BLOCK DIAGRAM

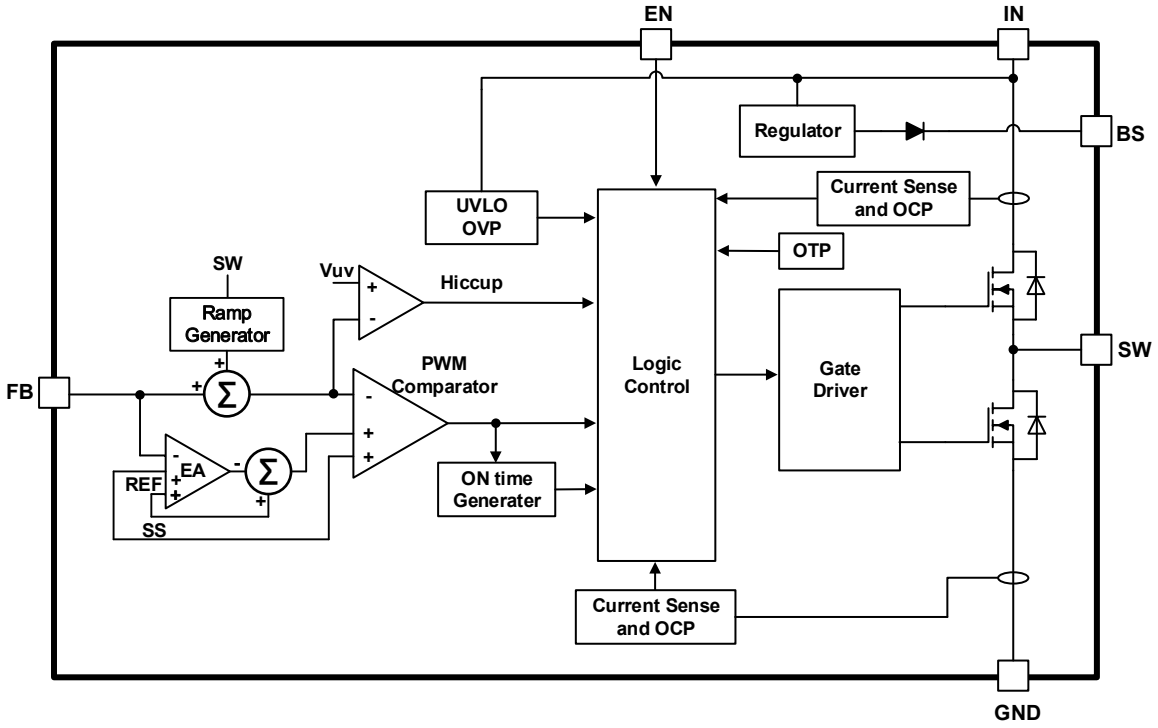


Figure 3. Block Diagram

FUNCTIONS DESCRIPTION

OVERVIEW

The XR8113 is a COT mode step down DC/DC converter that provides excellent transient response with no extra external compensation components. This device contains internal, low resistance, high voltage power MOSFETs, and operates at a 600kHz operating frequency to ensure a compact, high efficiency design with excellent performance.

STARTUP AND SHUTDOWN

If both VIN and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first, generating stable reference voltage and bias current, and then the internal regulator is enabled. The regulator provides stable supply for the remaining circuitries. Four events can shut down the chip: EN low, VIN_UV, VIN_OV and thermal shutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering. The comp voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdown command.

UNDER-VOLTAGE LOCKOUT (UVLO)

Under-voltage lockout (UVLO) protects the chip from operating at an insufficient supply voltage. UVLO protection monitors the internal regulator voltage. When the voltage is lower

than UVLO threshold voltage, the device is shut off. When the voltage is higher than UVLO threshold voltage, the device is enabled again.

THERMAL SHUTDOWN

The device features auto-recovery mode over temperature protection to guarantee IC safe operation when the internal power MOSFET regulator power loss is great. Once the power MOSFET thermal sensor detects that power MOSFET junction temperature exceeds 160°C, the device will be turned off. When the power MOSFET junction temperature cools down by approximately 20°C, the device will be recovered again.

INTERNAL SOFT-START

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.6V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than REF, REF regains control. The SS time is internally to 0.8ms (Typ.).

OVER-CURRENT-PROTECTION AND SHORT CIRCUITS PROTECTION

The XR8113 has a cycle-by-cycle over-current limiting control (OCL). The current-limit circuit employs a valley current-sensing algorithm. The part uses the RDS(ON) of the LS-FET as a current-sensing element. If the magnitude of the current-sense signal is above the current-limit threshold, PWM is not allowed to initiate a new cycle, even if FB is lower than REF.

Since the comparison is done during the LSFET on state, the OC trip level sets the valley level of the inductor current. The maximum load current at the over-current threshold (IOC) can be calculated using the following equation:

$$I_{OC} = I\_limit + \frac{\Delta I_{inductor}}{2}$$

The OCL itself limits the inductor current and does not latch off. In an over-current condition, the current to the load exceeds the current to the output capacitor, causing the output voltage to fall off. Eventually, the VFB drops below the under-voltage protection (UVP) threshold, XR8113 will enter hiccup protection.

ZERO-CROSSING DETECTION

The XR8113 device uses a zero-crossing (ZC) circuit to perform the zero-inductor current detection during skip-mode operation. The ZC threshold is set to a small positive value before the low-side MOSFET is turned off to compensate for delay in the ZC detection circuit, entering discontinuous conduction mode (DCM) operation.

APPLICATIONS INFORMATION

SETTING THE OUTPUT VOLTAGE

XR8113 requires an input capacitor, an output capacitor and an inductor. These components are critical to the performance of the device. XR8113 is internally compensated and does not require external components to achieve stable operation. The output voltage can be programmed by resistor divider.

$$V_{OUT} = V_{FB} \times \frac{R1 + R2}{R2}$$

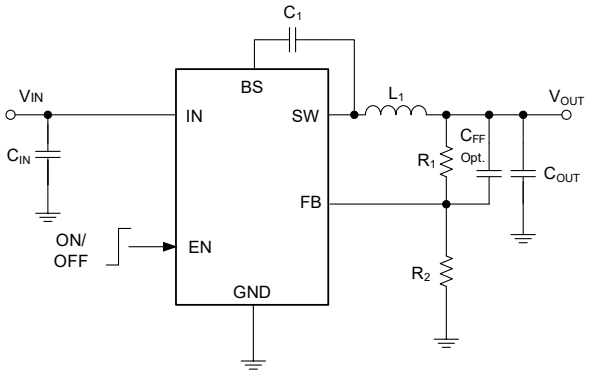


Figure 4. Typical Application

EXAMPLE OF COMPONENT SELECTION

VOUT(V)	R1(kΩ)	R2(kΩ)	L1(μH)	CIN(μF)	COUT(μF)	CFF (pF) Opt.
1.0	6.67	10	1.5	22	22	10-100
1.2	10.00	10	1.5	22	22	10-100
1.5	15.00	10	2.2	22	22	10-100
1.8	20.00	10	3.3	22	22	10-100
2.5	31.6	10	4.7	22	22	10-100
3.3	45.3	10	4.7	22	22	10-100
5.0	73.2	10	4.7	22	22	10-100

SELECTING THE INDUCTOR

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductor core does not saturate during any foreseeable operational situation. The inductor should be rated to handle the peak load current plus the ripple current: Care should be taken when reviewing the different saturation current ratings that are specified by different manufacturers. Saturation current ratings are typically specified at 25°C, so ratings at maximum ambient temperature of the application should be requested from the manufacturer.

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times F_{OSC}}$$

Where ΔIL is the inductor ripple current. Choose inductor ripple current to be approximately 30% of the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

SELECTING THE INPUT CAPACITOR

CIN The ripple current through input capacitor is calculated as:

$$I_{CIN\_RMS} = I_{OUT} \times \sqrt{D(1-D)}$$

To minimize the potential noise problem, a typical X5R or better grade ceramic capacitor should be placed as close as possible to the IN and GND pins. Care should be taken to minimize the loop area formed by CIN, and IN/GND pins.

SELECTING THE OUTPUT CAPACITOR

Special attention should be paid when selecting these components. The DC bias of these capacitors can result in a capacitance value that falls below the minimum value given in the recommended capacitor specifications table.

The output capacitor is selected to handle the output ripple noise requirements. Both steady state ripple and transient requirements must be taken into consideration when selecting this capacitor. For the best performance, it is recommended to use an X5R and more than 22μF or 10μF+10μF capacitance.

PCB LAYOUT GUIDELINES

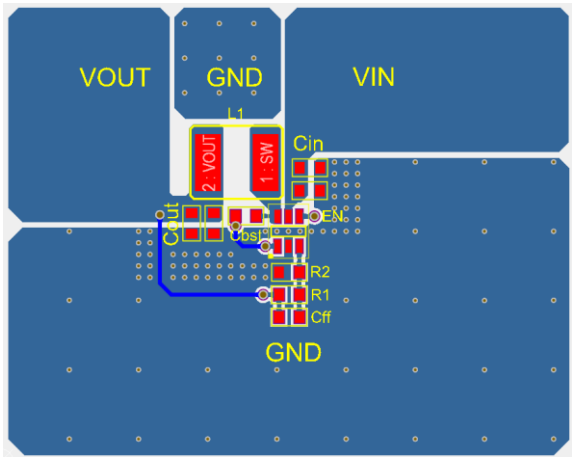


Figure 5. SOT23-6 Layout

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance. If change is necessary, please follow these guidelines:

1) Keep the path of switching current short and minimize the loop area formed by Input capacitor, IN pin and GND.

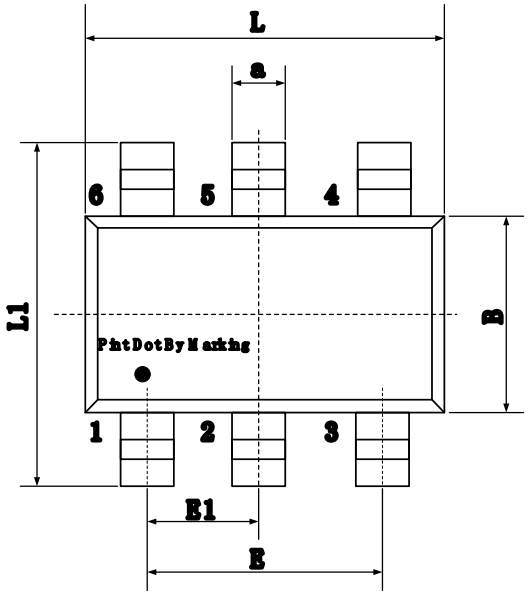
2) Bypass ceramic capacitors are suggested to be put close to the IN Pin.

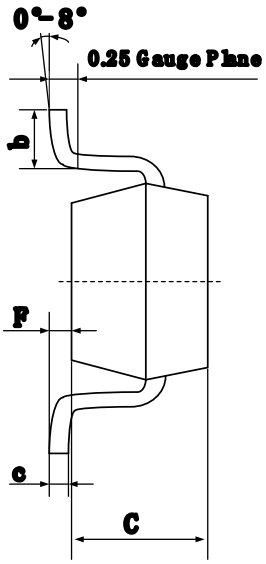
3) Ensure all feedback connections are short and direct. Place the feedback resistors as close to the chip as possible.

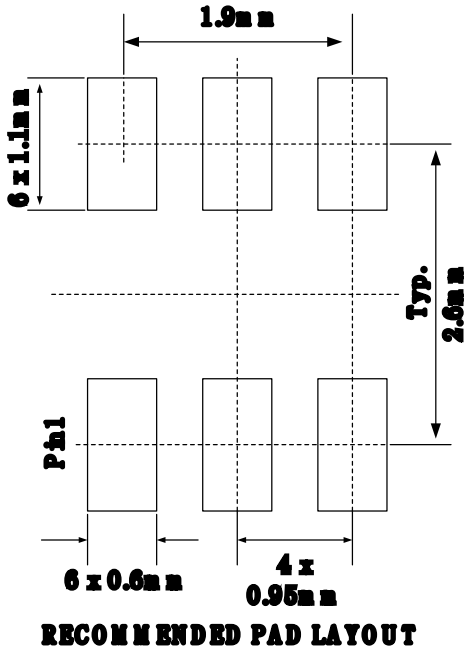
4) Keep BS and SW away from sensitive analog areas such as FB.

5) Connect IN, SW, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.

PACKAGE DESCRIPTION







Unit: mm

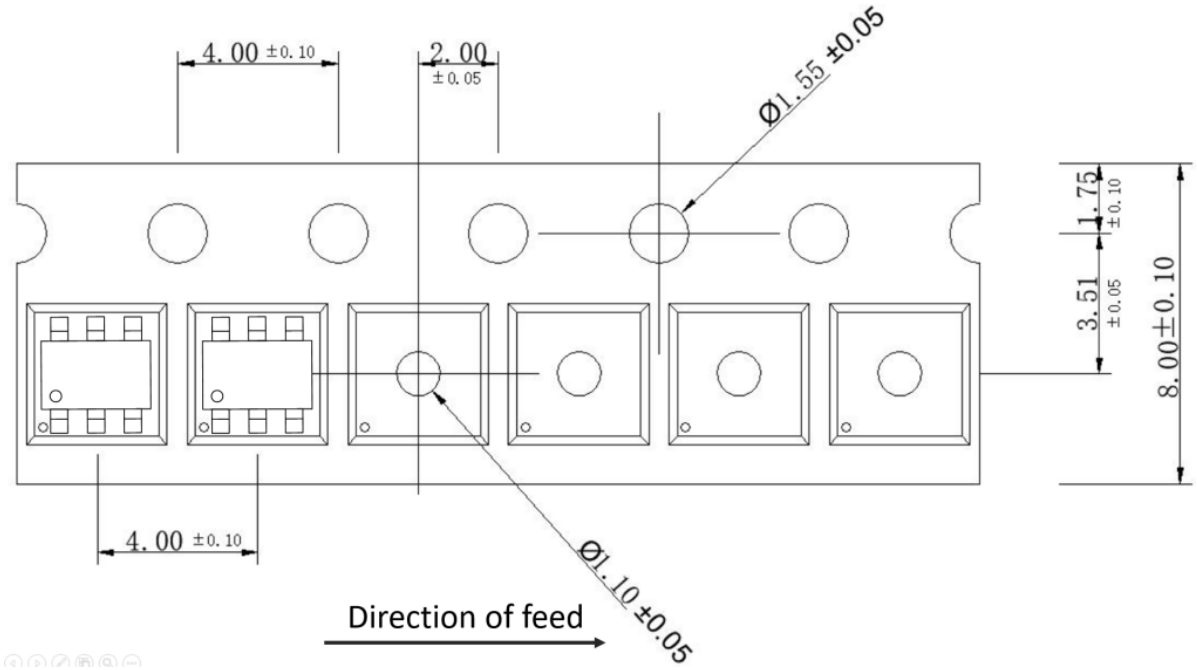
Symbol	Dimensions Millimeters	
	Min	Max
L	2.82	3.02
B	1.50	1.70
C	1.00	1.20
L1	2.60	3.00
E	1.80	2.00
E1	0.85	1.05
a	0.35	0.50
c	0.10	0.20
b	0.35	0.55
F	0	0.15

Figure 6. SOT23-6 Package Description

NOTE:

1. CONTROL DIMENSION ARE IN MILLIMETERS.
2. PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3. PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.10 MILLIMETERS MAX.
5. DRAWING CONFORMS TO JEDEC MS-012, VARIATION BA.
6. DRAWING IS NOT TO SCALE.

TAPE AND REEL INFORMATION



REEL DIMENSIONS

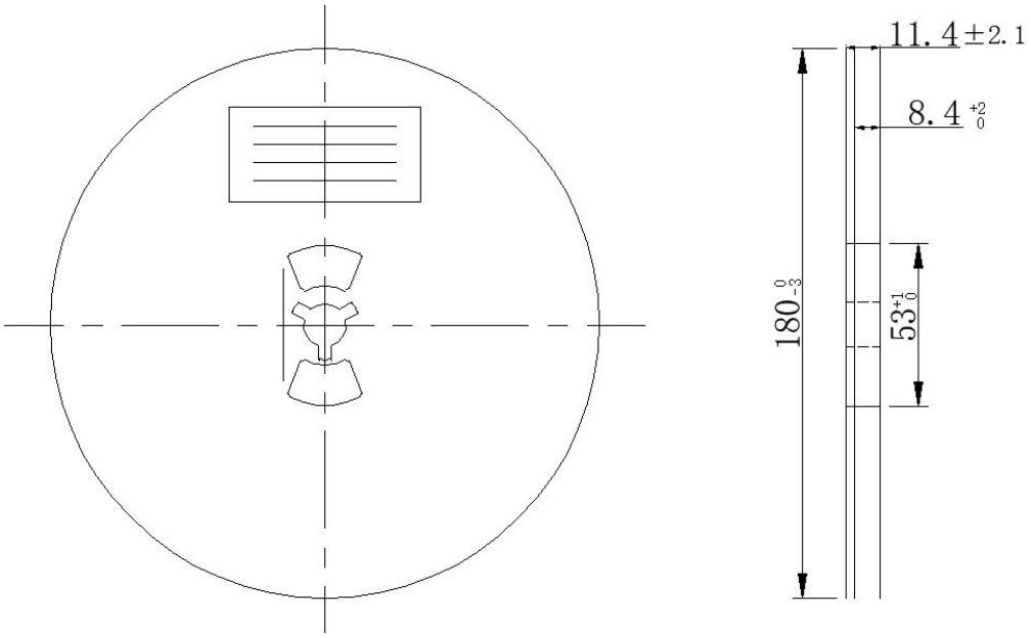


Figure 7. SOT23-6 Tape and Reel Information

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. QUANTITY OF UNITS PER REEL IS 3000.
3. MSL LEVEL IS LEVEL 3.