

## 3W Anti-Clip Class-D Audio Power Amplifier

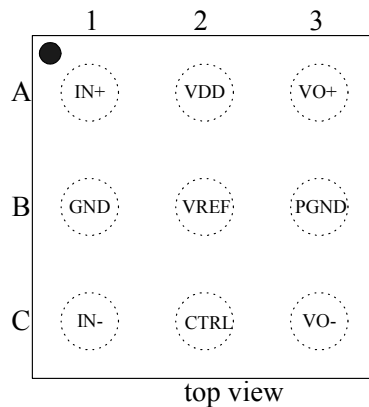
### Features

- Output Power
  - 3.0W ( $V_{DD}=5.0V$ ,  $R_L=4\Omega$ , THD+N=10%)
  - 1.8W ( $V_{DD}=5.0V$ ,  $R_L=8\Omega$ , THD+N=10%)
- Four mode can be selected with CTRL terminal: Anti-Clip 1, Anti-Clip 2, Anti-Clip off, Power-Down
- Low THD+N and Low Noise
- Low EMI
- Improved PSRR (-80dB) and Wide Supply Voltage (2.5 V to 5.0V) Eliminates Need for a Voltage Regulator
- Over-current and Thermal Protection function
- Pop noise reduction function
- Available in space-saving package: 9-Bump WLCSP

### Applications

- Mobile phone, PDA
- MP3/4, PMP, GPS
- Portable electronic devices

### Pin Diagrams



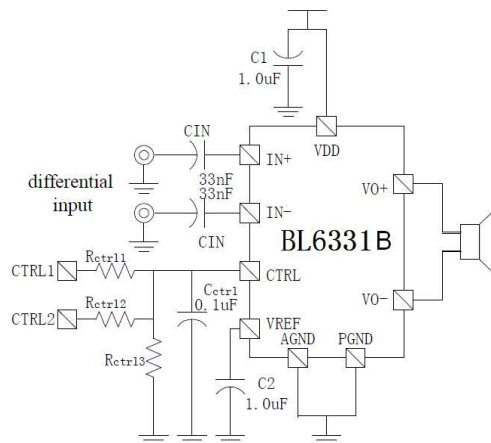
### General Description

BL6331B is a 3-W ( $V_{DD}=5.0V$ ,  $R_L=4\Omega$ ) high efficiency filter-free class-D audio power amplifier in a wafer chip scale package (WLCSP).

BL6331B has a "Professional Anti-Clip output control circuit" which reducing distortion of output signal due to either the over level input signal or power supply voltage down with battery.

Features like high efficiency, -80dB PSRR, over-current protection and thermal protection function make the BL6331B ideal for cellular handsets.

### Typical Application Circuit

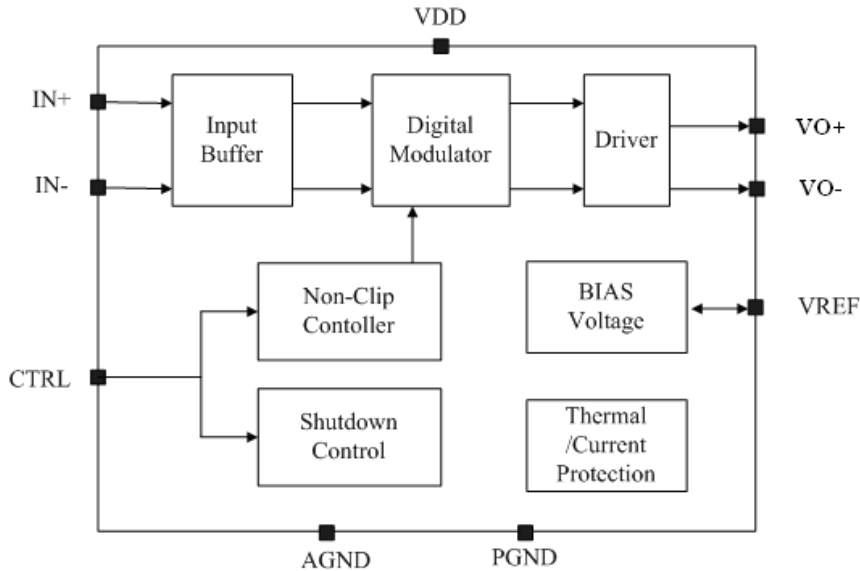


### Pin Description

PIN #	Name	Description
A1	IN+	Positive differential input
A2	VDD	Power Supply
A3	VO+	Positive BTL output
B1	AGND	Analog Ground
B2	VREF	Bypass capacitor connected
B3	PGND	Power Ground
C1	IN-	Negative differential input
C2	CTRL	Mode select
C3	VO-	Negative BTL output

**Order Information**

Part Number	Package	Shipping
BL6331B	9-Bump WLCSP	3000 pcs / Tape & Reel

**Function Block Diagram**

**Absolute Maximum Ratings** (Over operating free-air temperature, unless otherwise noted)

$V_{DD}$	Supply voltage	-0.3V to 5.2V
$V_I$	Input voltage	-0.3V to $V_{DD}+0.3V$
$T_A$	Operation free-air temperate range	-40°C to 120°C
$T_J$	Operation free-air junction temperature	-40°C to 150°C
$T_{STG}$	Storage temperature range	-65°C to 150°C
$T_{SLD}$	Soldering temperature	300°C, 5sec

**Recommended Operating Conditions**

Symbol	Parameter	Conditions	MIN	TYP	MAX	UNIT
$V_{DD}$	Power Supply Voltage		2.5		5.0	V
$T_a$	Operating Ambient Temperature		-20		85	°C
$R_L$	Speaker Impedance		4			$\Omega$

**DC Characteristics** ( $V_{DD} = 2.5V$  to  $5V$ ,  $T_a = 25^\circ C$ , unless otherwise noted.)

Symbol	Parameter	Test Conditions	MIN	TYP	MAX	UNIT
$V_{UVLH}$	Power Supply Start-up threshold voltage			2.5		V
$V_{UVLL}$	Power Supply shut-down threshold voltage			1.8		V
$V_{MOD1}$	Anti-Clip1 mode setting threshold voltage		1.3		$V_{DD}$	V
$V_{MOD2}$	Anti-Clip2 mode setting threshold voltage		0.85		1.15	V
$V_{MOD3}$	Anti-Clip off mode setting threshold voltage		0.5		0.72	V
$V_{MOD4}$	Power-down mode setting threshold voltage		$V_{SS}$		0.14	V
$I_{DD}$	Consumption current	$V_{DD}=3.6V$ , no load, no signal input		5		mA
$I_{PD}$	Consumption current in power-down mode	$CTRL < 0.2V$			1	$\mu A$
$V_{REF}$	VREF voltage			$V_{DD}/2$		V

**AC Characteristics** ( $V_{DD} = 2.5V$  to  $5V$ ,  $T_a = 25^\circ C$ , unless otherwise noted.)

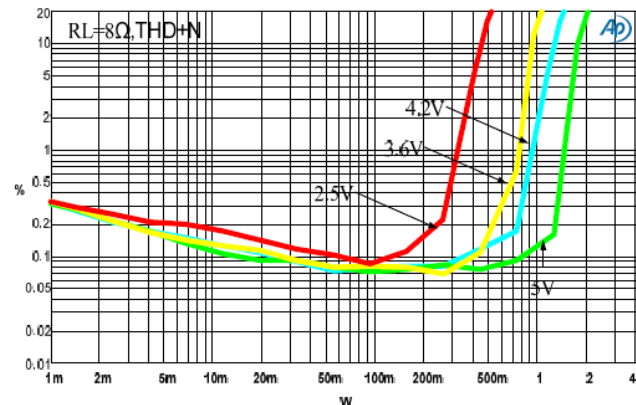
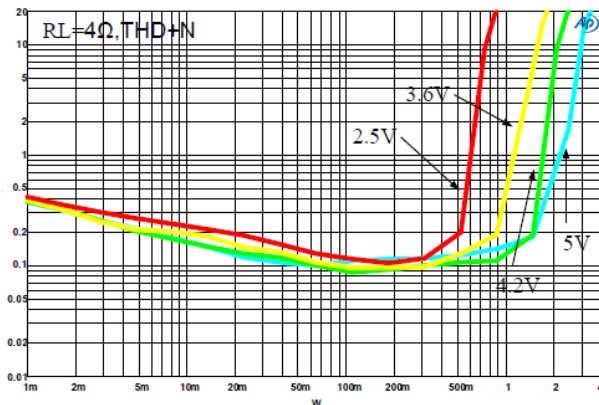
Symbol	Parameter	Test Conditions	MIN	TYP	MAX	UNIT
$t_{STUP}$	Start-up time	$V_{DD}=5V, V_r=1\mu F$		38		ms
$f_c$	Input cut-off frequency	$C_{IN}=33nF, A_v=17.5dB$		120		Hz
$t_{AT1}$	Attack time 1	$V_{DD}=5V, g=10dB$		45		ms
$T_{RL1}$	Release time 1	$V_{DD}=5V, g=10dB$		3.1		s
$t_{AT2}$	Attack time 2	$V_{DD}=5V, g=10dB$		10		ms
$T_{RL2}$	Release time 2	$V_{DD}=5V, g=10dB$		1.8		s
$t_{MOD}$	Each mode setting time(Except power down)		0.1			ms

**Analog Characteristics**

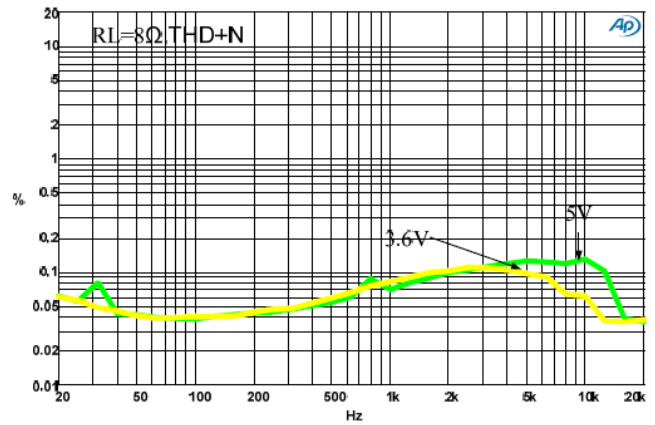
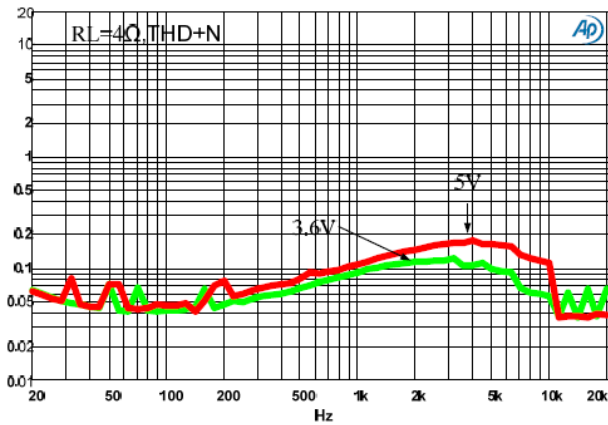
 ( $V_{DD} = 3.6V$ ,  $A_v=17.5dB$ ,  $T_a = 25^\circ C$ ,  $C_{IN}=100nF$ , Anti-Clip off, unless otherwise noted.)

Symbol	Parameter	Test Conditions	MIN	TYP	MAX	UNIT
$P_o$	Maximum output	$R_L=4\Omega, V_{DD}=5V$		3		W
		$R_L=8\Omega, V_{DD}=5V$		1.8		W
THD+N	Total Harmonic Distortion Rate	$R_L=4\Omega, P_o=0.65W, f=1KHz$		0.08		%
		$R_L=8\Omega, P_o=0.65W, f=1KHz$		0.06		%
N	Residual Noise	$A_v=17.5dB$ A-Weighted		60		$\mu V_{rms}$
SNR	Signal/Noise Ratio	$A_v=17.5dB$ A-Weighted		95		dB
PSRR	Power supply rejection ratio	217Hz		-80		dB
$\eta$	Maximum Efficiency	$R_L=8\Omega, P_o=0.6W$		85		%
		$R_L=8\Omega, P_o=0.1W$		80		%
$V_o$	Output offset voltage			$\pm 10$		mV
$f_{RES}$	Frequency characteristics	$C_{IN}=0.1\mu F, f=100Hz$ to $20KHz$	-3		1	dB
GV	Closed Loop Gain	$V_{DD}=5V$ Anti-Clip Off		17.5		dB

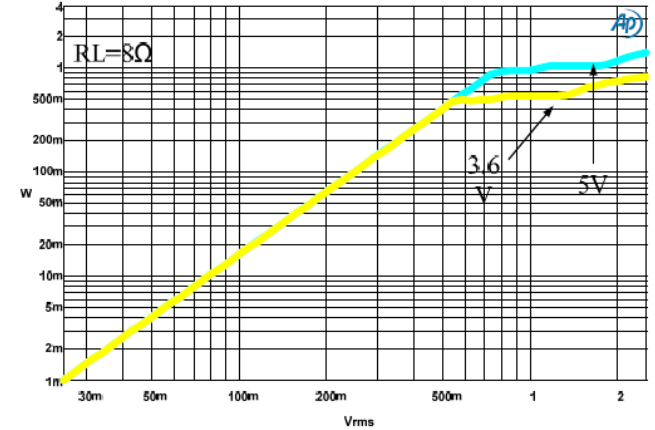
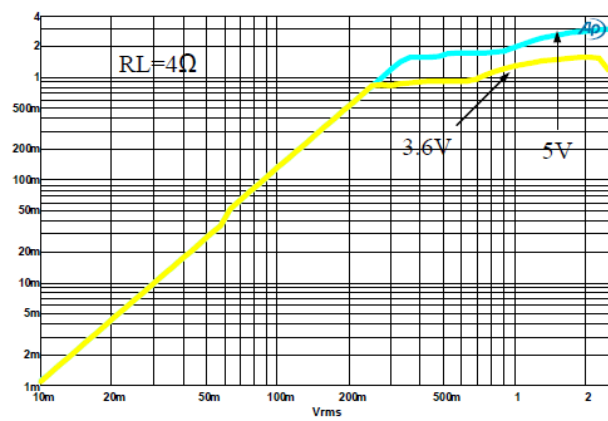
**Typical Operating Characteristics**

 (Gain=17.5dB,  $T_a=25^\circ C$ , Anti-Clip off,  $C_{IN}=100nF$ , unless otherwise specified)


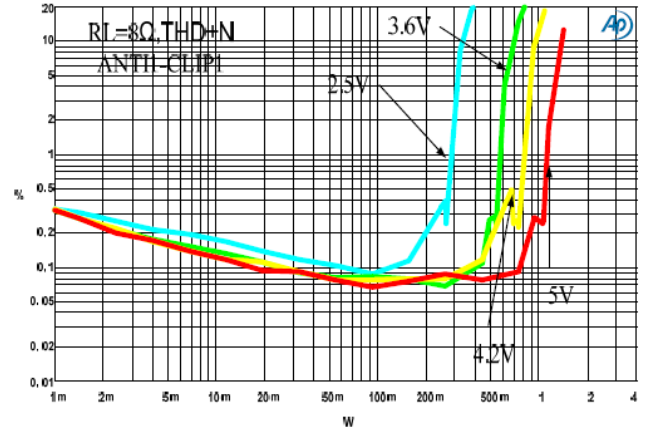
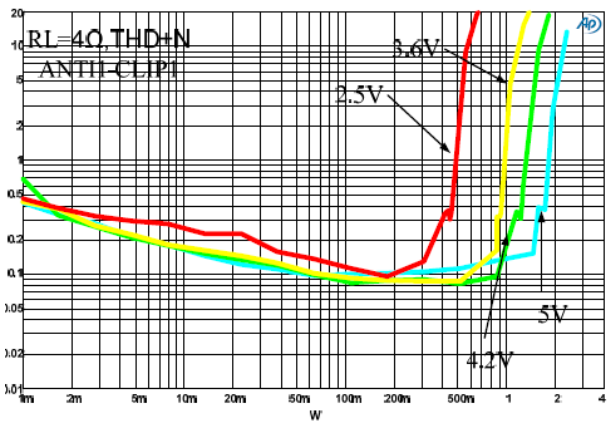
OUTPUT VS THD+N



Frequency VS THD+N



INPUT VS OUTPUT (Anti-Clip1 mode)



OUTPUT VS THD+N (Anti-Clip1 mode)

## Application Information

### Anti-Clip Control Function

This is the function to control the output in order to obtain a maximum output level without distortion when an excess input which causes clipping at the differential signal output is applied. That is, with the Anti-Clip function, BL6331B lowers the Gain of the amplifier to an appropriate value so as not to cause the clipping at the differential signal output. And, BL6331B follows also to the clip of the output wave form due to the decrease in the power-supply voltage. The Attack time and the release time of Anti-Clip control are fixation two levels, and selects with the CTRL terminal. The Attack time is a time interval until from gain falls to target attenuation gain -3dB with a big signal input enough. And the Release time is a time from target attenuation gain to not working of Anti-Clip.

Attack time and Release time

Anti-Clip mode	Attack time	Release time
1(Recommendation)	45ms	3.1s
2	10ms	1.8s

### Over-current Protection function

This is the function to establish the over-current protection mode when detecting a short circuit between BL6331B differential output terminal and VSS, VDD, or another differential output. In the over current protection mode, the differential output terminal becomes a high impedance state. Once the short is removed, the device will be reactivated..

### Thermal Protection function

Thermal protection on the BL6331B prevents damage to the device when the internal die temperature exceeds 150 °C. There is a  $\pm 20^{\circ}\text{C}$  tolerance on this trip point from device to device. Once the die temperature exceeds the thermal set point, the outputs are disabled. This is not a latched fault. The thermal fault is cleared once the temperature of the die is reduced by  $20^{\circ}\text{C}$ . The device begins normal operation at this point with no external system intervention.

### Under Voltage Lock-out (UVLO)

The BL6331B incorporates circuitry designed to detect low supply voltage. When the supply voltage drops to 1.8V or below, the BL6331B outputs are disabled, and the device comes out of this state and starts to normal function when  $V_{DD} \geq 2.5\text{V}$ .

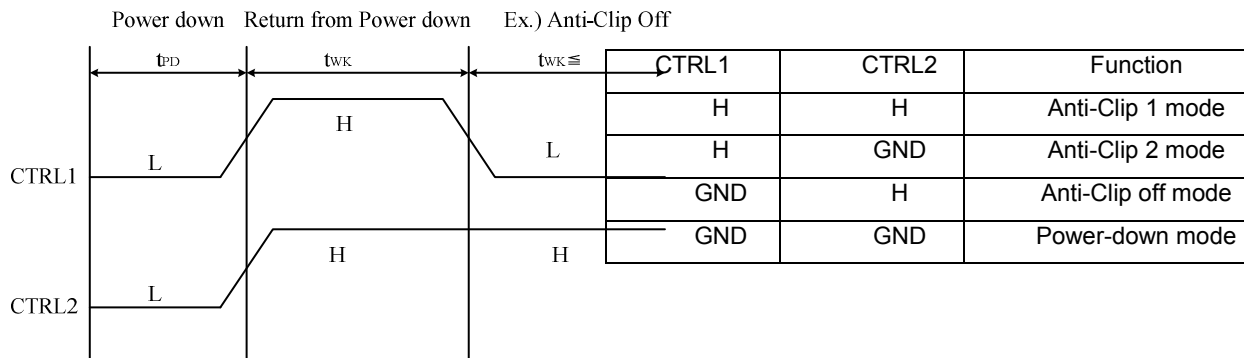
### VREF terminal output

The voltage of  $V_{DD}/2$  is output from the VREF terminal. Capacitor (1uF) is connected between the VREF terminal and GND for stabilization.

### Power down and Initialization function

When CTRL terminal is connected to the GND potential, the IC goes to the power-down mode. In the mode, all the circuit functions stop and its current consumption becomes the lowest.

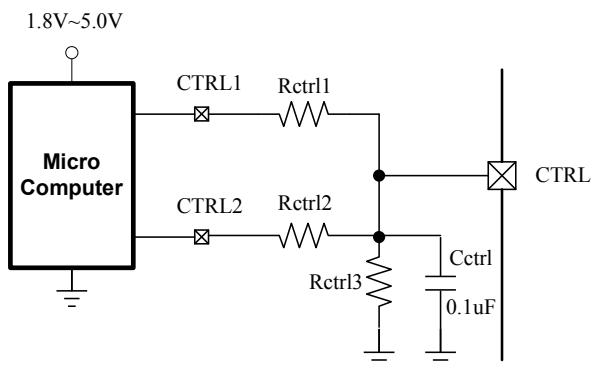
when CTRL terminal is set to H level, the power-down mode is canceled and the IC starts up after startup time ( $t_{\text{STUP}}$ ). In order to return from the power-down mode a desired mode needs to be set after setting both CTRL1 and CTRL2 to H level during  $t_{\text{WK}}$ . In addition, at startup, cancel the power-down mode after supply voltages has been sufficiently stabilized.



**CTRL terminal function**

By connection external resistors (Rctrl1, Rctrl2, and Rctrl3: Accuracy of 1%) to CTRL terminal, and impression setting threshold voltage of each mode to CTRL terminal, the followings can be set: Anti-Clip1, Anti-Clip2, Anti-Clip OFF, and power-down mode. When turning on the supply voltage or cancelling the power-down mode, control the CTRL terminal according to the procedure for cancelling power-down.

Connect the terminal to the ground through a capacitor Cctrl (a ceramic capacitor of 0.1μF or more)



“H” level indicates a microcomputer’s I/O port H level output voltage that is input to CTRL1 and CTRL2 terminals and GND indicates GND of the microcomputer.

GND level of the microcomputer must be the same as that of BL6331B.

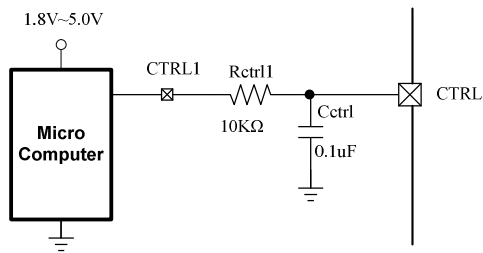
The control of CTRL terminal is based on I/O port H level output voltage of microcomputer that is connected.

Set resistance constants according the I/O port H level output voltage of each microcomputer as shown below.

I/O port H level output voltage of Microcomputer	1.8V	2.6V	3.0V	3.3V	5.0V
Rctrl1	27KΩ	33KΩ	33KΩ	33KΩ	56KΩ
Rctrl2	43KΩ	51KΩ	51KΩ	51KΩ	82KΩ
Rctrl3	82KΩ	27KΩ	22KΩ	18KΩ	15KΩ

Functions of CTRL pin are designed with their control by two control pins (CTRL1 and CTRL2)

Only a Switching control between Anti-Clip1 mode and Power-down is available when a single control terminal used. A setting voltage should be set according to VMOD1 and VMOD4, and use a RC filter with time constant of 1msec or more in order to eliminate noise at transmission side such as Micon etc. (Example. Rctrl1=10KΩ and Cctrl=0.1μF).



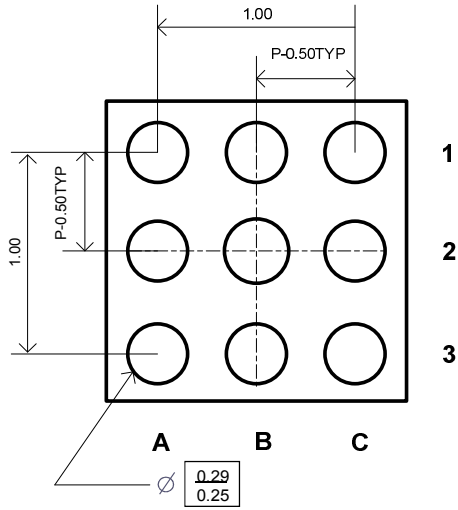
CTRL1	Function
H	Anti-Clip 1 mode
GND	Power-down mode

### POP and Click Circuitry

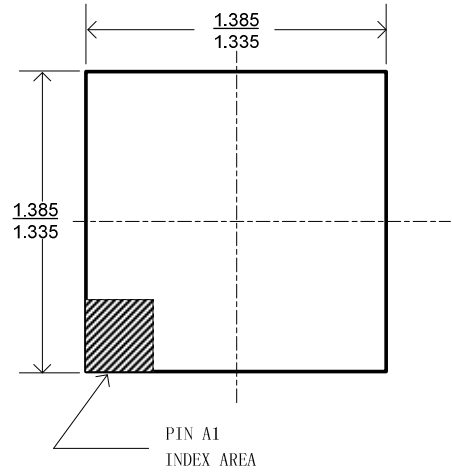
The BL6331B contains circuitry to minimize click and pops. For the best power-off pop performance, the amplifier should be set in shutdown mode prior to removing the power supply voltage.

**Package Information**

Unit: Millimeter



Top View



Top View

