



## 288 Monaural Amplifier



### Owner's Manual

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# WARNING



## Never power on the amplifier without connecting a proper load

Failure to do so will result in permanent damage to the output transformer and potentially other components in the output stage.

## This amplifier contains lethal voltages

High voltage can be stored in the power supply even if it is unplugged and not in use. Do not remove the back cover unless you are a qualified service technician. For service, contact Bandwidth Audio.

## High Vacuum Tube Temperatures

Vacuum tubes get extremely hot with bulb temperatures capable of reaching 200 degrees Celsius. Do not touch or attempt to remove the tubes while hot.

## Amplifier Bias

With the volume turned all the way down, the bias should be set between: **60 - 65mA**. This current can be read directly off of the 2 analog meters on the back of the amplifier after power on and warm up. **See Section 3.3 – Biasing.**

# 1.0 Amplifier Setup

## Pre-Operation Checklist

- Connect speakers to proper load impedance output.
- Insert tubes into proper sockets. **See Section 3.1 – Installing Tubes.**
- Connect Mains to 120V wall outlet. Ensure a proper outlet ground connection with a ground tester.
- Turn volume all the way down.
- After warming up, check power tube bias without attempting to input an audio signal. ***Ensure speaker load is connected before powering on!***  
**See Section 3.3 – Biasing.**

## 1.1 Amplifier Placement

For the best operation and longest life of components, the amplifier should be set up and used in a well-ventilated area with good air circulation. Do not use the amplifier in enclosed furniture as this may result in a fire.

Overheating can damage the amplifier and diminish tube life.

## 1.2 Setting The Load Impedance

***Never turn on your amplifier without speakers connected to the proper output load impedance.*** Operation of the amplifier without a speaker load or open circuited loudspeaker voice coil can permanently damage the output transformers as well as other major components.

To be safe, always ensure your speakers are connected before plugging amplifiers into an outlet. Likewise, always unplug the amplifier from the outlet before removing the speaker load.

This amplifier comes equipped with 4, 8, and 16-ohm output impedances for maximum flexibility. If you are unsure of your speaker's impedance, contact the manufacturer.

Connect speakers between 4, 8, or 16-ohm binding post on the back of the amplifier, based on nominal speaker impedance, and the Comm. Binding posts.

### **1.3 Powering ON & OFF**

The analog backlit VU meter on the front face of the amplifier illuminates when powered on.

Tube warm up time is typically 30 seconds. It will take at least this long for music to play from speakers. Best performance is achieved after the amplifier has been running for a period of time and up to a steady temperature, typically 30 minutes.

When powering off, music may still play for a few seconds. This is normal. While the tubes are hot, make sure not to move or knock into the amplifier since hot tubes are more susceptible to internal damage.

### **1.4 Input Setup**

This amplifier is designed to drive a speaker load to its full rated output power based on typical line level input signals via the RCA connector on the back.

Depending on the input source components, an additional preamp may be needed to achieve full output power.

**See Section 3.4 – Typical Specifications.**

## 2.0 Controls and Layout

### 2.1 Front Features



1. Volume

2. VU Meter 3. Power

#### 1. Volume

The volume knob controls the overall output of the amplifier by attenuating the input signal. Rather than a normal rotational potentiometer, a stepped attenuator is used. A stepped attenuator eliminates noise during rotation and also maintains volume balance between a pair of amplifiers driving separate speakers. Due to its construction, the volume knob will click into each slot, giving precise volume control.

## 2. VU Meter

The VU meter, or Volume Unit meter, gives the user an indication of the relative output power to the speakers. The backlight also indicates when the amplifier is on.

The VU meter is calibrated to indicate the amplifier's maximum clean RMS output power (rated at approximately 60 Watts of output power) when it is indicating +0dB.

Driving the output beyond this region will cause amplifier distortion. Although this is not harmful to the amp, there is a significant increase in the average output power as distortion increases. This can damage speakers rated close to the amplifier's maximum RMS output power.

## 3. Power Switch

The power switch is used to turn the amplifier on and off. **On** is in the up position, and **Off** is in the down position.

## 2.2 Back Features



- 4. Mains Input
- 5. Mains Fuse
- 6. Cathode Fuse
- 7. Bias Current Meters
- 8. Bias
- 9. Hum Balance
- 10. Speaker Outputs
- 11. Input

4. Mains Input      Socket to connect removable wall power cord to the amplifier. ***Use only the voltage indicated on the serial number tag below the mains input.***

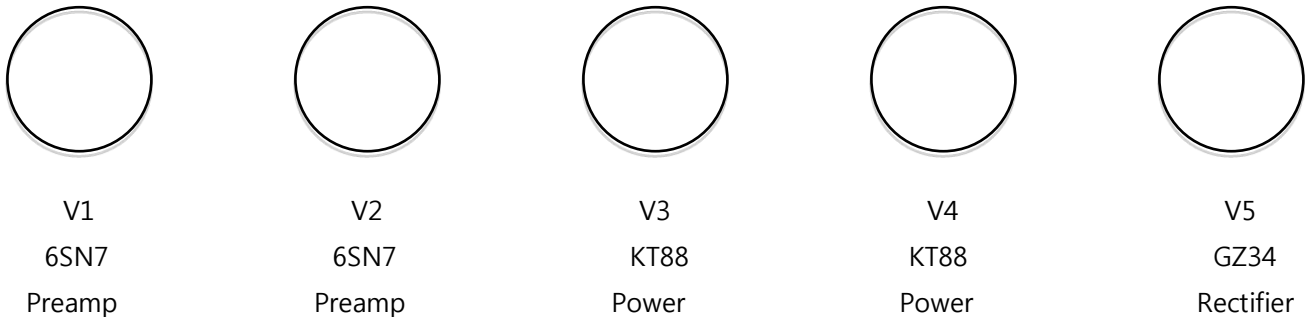
5. Mains Fuse      ***Use only 2.5 Amp Slow Blow Fuse.*** This fuse is in series with the mains current to protect the user and amplifier from various short circuit failures.

6. Cathode Fuse ***Use only ¼ Amp Slow Blow Fuse.*** This fuse is in series with V3 and V4 output tubes to protect the output transformers and other circuitry from a shorted or bad tube. If blown, check performance of the output tubes before replacing the fuse to prevent damage from a failed tube.
7. Bias Current Meters These measure the cathode current in milliamps of each power tube (V3 and V4, respectively). At idle, with no input signal, their value represents the power tube bias or idle current.
8. Bias Adjustment Screwdriver-adjustable potentiometer that is used to set the bias of the power tubes. ***See Section 3.3 – Biasing.***
9. Hum Balance Screwdriver-adjustable potentiometer that references the preamp tube filaments above voltage ground to lower the AC filament noise. This is usually set in the middle and requires no adjustment. However, if hum is discernable through the speakers, try rotating the potentiometer clockwise and counterclockwise from the center position to minimize it. If no change occurs, the hum is being picked up by another source.
10. Speaker Outputs Used for connecting the speaker load to the amplifier and makes sure that the selection matches the speaker's impedance to avoid damage to the amplifier. ***See Section 1.2 – Setting the Load Impedance.***
11. Input RCA line level input jack designed to accept audio signals from common audio components. ***See Section 1.4 – Input Setup.***



## 3.0 Technical Information

### 3.1 Installing Tubes



Position of vacuum tubes is as indicated in this top view with the front face of the amplifier toward the bottom of the page (V1-V5).

The tubes for positions V1 through V5 may be indicated on the boxes of the tubes that are shipped with the amplifier. These are selected for maximum performance, and their positions should be followed.

Tubes should always be installed and removed by handling the base of the tube, rather than the glass. Match the keyway in the tube socket with the key in the tube, and install with a slight and gentle circular rocking motion until the tube is fully seated against the socket. Follow the same procedure for removal.

### 3.2 Replacing Tubes

Vacuum tubes should be replaced when a lack of power becomes apparent. Dynamics and transients may seem lazy and less crisp in comparison to how they sounded when new. Under extreme cases, tubes may become noisy. A crackling or rustling sound from your speakers will indicate that an immediate tube change is necessary.

**We recommend the following tube replacement schedule:**

- Under normal bias conditions, power tubes typically last 2 years depending on hours of use and average listening volume. Speakers demanding maximum power may push the tube lifespan to less than 2 years. With very efficient speakers, which require little power for acceptable listening levels, tubes can last much longer than 2 years.
- Preamp tubes will last longer than power tubes, assuming no premature failures. We recommend changing preamp tubes every other time the power tubes are changed unless the utmost performance is demanded or they have gone bad.
- The tube rectifiers only need to be replaced when they fail. There is no need for regular change unless reliability is a concern or the amplifier has seen a lot of vibration from transportation. Moving the amps when they are on or hot can damage the rectifier and other tubes.

**Always re-bias your amplifier after changing the power tubes!**

***The bias of the amplifier should be checked immediately after replacing the KT88 Power tubes V3 and V4.***

A matched pair of KT88 output tubes should be used for V3 and V4 positions. This ensures a balanced output and low distortion. Matching output tubes between separate amplifier channels is not critical, but recommended.

Preamp tube V2 contains two sections in a single glass envelope. These sections should be tightly matched for balance drive to the output tubes.

All tubes from Bandwidth Audio are matched in this fashion.

### 3.3 Biasing

Your amplifier has been biased from the factory. However, the bias setting should be checked on first startup and periodically thereafter to maintain performance and longevity of the power tubes.

**Note:** preamp tubes are automatically biased. No adjustment is needed

#### A. Checking the Bias:

To check the bias, power the amp on and let it warm up for at least 10 minutes. The bias reading for the power tubes can be made off of the two analog ammeters located on the back face of the amplifier.

#### **Bias Set Point: 60 to 65mA**

With the volume turned all the way down, the bias should be set between 60 - 65mA.

To adjust, use the screwdriver-adjustment potentiometer labeled "**Bias**" on the back of the amplifier. This range is based on sound preference as well as desired output tube life. The lower the bias, the longer the tube life with the expense of higher distortion.

When using a matched pair of KT88 tubes, **each meter should read +/- 7mA or less for best performance.** A well-matched quad of tubes will measure much better than this.

If the bias variation between meters exceeds +/- 7mA, try switching the position of the V3 and V4 power tubes. If the current variation follows the position of the power tubes, then the tubes have become unmatched. If the tubes are new and the meters read significantly differently as described, then the set is not correctly matched.

## B. Bias Drift:

Under normal operation, the bias current may slowly increase or decrease as the tube characteristics change. This is normal, and it is encouraged to bring the idle back to the target point whenever it is noticed to be off.

## C. Operating with Incorrect Bias:

Running the amplifier with a bias setting far below 60mA will cause no damage to your amplifier. In fact, the power tubes can last longer. However, distortion will rise steeply – causing significant distortion figures, less power, and bad sound.

Running the amplifier with a bias setting over 53mA will decrease the life of the power tubes. A bias of well over 65mA will cause “red plating,” or glowing of the internal metal plate structure of the tube due to excessive heat. This can be so excessive that the glass envelope of the tube melts! If red plating occurs, turn off the amplifier immediately and let it cool completely. Then turn it back on and quickly re-bias if the ammeters overshoot the 65mA bias target.

## 3.4 Typical Specifications

### Maximum Output Power

60 Watts RMS

### THD+N @ at 60-Watts 1KHz

1%

### Full Power Bandwidth (60-Watts)

<20Hz – 35KHz at -0.5dB

### THD+N at 1-Watt 1KHz

<0.035%

### 1-Watt Bandwidth

<13Hz – 50KHz at -0.5dB

### Input Voltage for Rated Output

1.7V RMS

### SNR 1-Watt into 8ohms (600-ohms source impedance, volume set to maximum)

-93dB A-Weighted

### SNR 60-Watts into 8ohms (600-ohms source impedance, volume set to maximum)

-110dB A-Weighted

### Gain

22dB

### Negative Feedback (Closed Loop Only)

15dB

### Input impedance

250K ohms

**Speaker Taps**

4, 8, & 16 ohms

**Power Tubes**

2x KT88

**Preamp Tubes**

2x 6SN7

**Rectifier Tube**

GZ34

**Power Consumption**

150 Watts

**Dimensions**

20" x 13" x 9.5"

Actual performance will vary depending on vacuum tube quality.

## 4.0 Notes:

Date: _____	Bias Current:	V3 _____	V4 _____
Date: _____	Bias Current:	V3 _____	V4 _____
Date: _____	Bias Current:	V3 _____	V4 _____
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Date: _____	Bias Current:	V3 _____	V4 _____

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