

Minotaur

Direct-Coupled Hybrid Vacuum Tube Amplifier

Quick-Start Guide and Owner's Manual



TAVISH DESIGN, LLC

Made in U.S.A.

TABLE OF CONTENTS

1. Quick Start	2
2. Safety Considerations	4
3. Description and Specifications	5
4. Operating Details	7
4.1. High-Bias Mode	7
4.2. Automatic Power Off	7
4.3. Ventilation and Cabinet Temperature	8
4.4. System Status Indication (Fault Modes)	9
4.5. Wireless Remote Control	9
4.6. Toroidal Transformer	10
4.7. Troubleshooting Grounding & Noise Issues	10
5. Maintenance and Vacuum Tube Replacement	11
6. Warranty and Service	13
7. Appendix A: Amplifier Block Diagram	14
8. Appendix B: Measured Distortion Performance	15
9. Copyright, Trademark, and Disclaimers	17

Please take time to read the Quick Start and Safety Considerations, and also Section 4.1, otherwise you'll never know about High-Bias Mode..... Thanks!

1 QUICK START

Thanks for buying the Minotaur! For safety, best results, and greatest enjoyment of your new amplifier, please take time to read these quick start instructions and the safety considerations in Section 2. You can skip sections 3-7 of the manual until you need them. Feel free to contact Tavish Design if you have any questions (info@tavishdesign.com).

1. **Place the amplifier in a location where it will receive adequate ventilation.** It dissipates about 70 - 160 watts with no input signal (about the same as a 20 or 35 watt-per-channel tube amp) and it is normal for it to get warm, especially on top, above the tubes. Place the amplifier on a firm surface so that the bottom ventilation slots will not be blocked, and also make sure the top & side vents are not blocked. Allow at least 4 inches of open space above the amp and 1-2 inches on each side for air circulation. We do not recommend stacking other equipment on top of the Minotaur. Do not place anything directly on top of the cabinet, especially not CDs nor LPs.

See Section 2 “Safety” for other installation considerations.

2. **Connect the antenna for the remote control.** The antenna is packed in the same bag as the remote control and threads onto a connector on the rear panel, near the power connector. If you place your Minotaur in an enclosed metal equipment rack, the antenna may have trouble receiving signals and the remote control range may be limited. See section 4.5 if you have this problem.
3. **Connect signal sources to the rear inputs.** The Minotaur accepts line-level analog signals, such as the output of an audio DAC or disk player. The standard version has 5 pairs of unbalanced (RCA) input connectors. The balanced version has 2 pairs of balanced (XLR) input connectors and 3 pairs of unbalanced (RCA) input connectors. The XLR inputs offer true balanced operation with more than 120 dB of common-mode rejection at 60 Hz. The Minotaur has high gain to accommodate a wide variety of signal sources.
4. **Connect your speakers.** Keep the speaker wires short and use the thickest gauge wire practical; the binding posts will accept up to 10 AWG wire (thicker wire has a lower AWG number). In most cases, the resistance of the speaker wire will set the damping factor of your system, rather than any characteristic of the amplifier itself. 14 gauge wire is a good compromise between low resistance and flexibility. Six feet of 14 gauge wire has about 40 milliohms of resistance and will degrade the system damping factor by a factor of 2.
5. **Connect the power cord to a 3-wire grounded outlet.** The Minotaur is designed to operate on a 120 V, 60 Hz line. It normally draws about 70 - 160 watts, but can draw as much as 600 watts at maximum output. For safety reasons, it must be connected to a 3-wire grounded outlet. Never defeat the safety ground on the amplifier!

6. **Turn the volume control to minimum (counter-clockwise), and turn on the POWER switch. The red “sleep” LED will glow. Wait at least 3 seconds and push the ON-OFF button. The amplifier begins a 60 second warm-up sequence.**

At any time after the ON-OFF button is pushed, the desired input 1-5 can be selected. The amplifier will remember your selection when turned off.

Depending on which portion of the AC power-line cycle the amp starts on, there may be a mechanical vibration as the large toroidal power transformer magnetizes. This is normal; it will subside by the end of the warmup period (see Section 4.6).

The ON-OFF switch will normally not glow, but if it does, see section 4.4.

The warmup sequence includes a 20 second fan test – after the test, the fan should not come on during normal operation (if it does, the amp probably has inadequate ventilation, see Section 4.3 and Section 4.1).

During turn-on, the amplifier can be placed in high-bias mode. See section 4.1 for details.

7. **About 60 seconds after the ON-OFF button is pushed, the yellow “warmup” LED will turn green (“ready”) and the output relay will close, indicating that the amplifier is ready to use.** Adjust the volume control after the green “ready” LED is glowing, since the Minotaur won’t pass any signal until then. The MUTE button is useful for temporarily muting the output without adjusting the volume control.
8. **The remote control may work a bit differently than you are used to: push and HOLD the desired button for a moment to change input source or volume.** The button only needs to be pushed for about 150 milliseconds, but if you push it too quickly, your selection may not be registered. The volume control moves slowly in response to the remote, to give you precise control.
9. **Push the ON-OFF button again to put the amplifier in “sleep” mode.** Sleep mode allows the amplifier to be turned on with the remote control. The amplifier draws <1 watt in sleep mode, but if you don’t like this, you can shut it off completely with the POWER switch. The amplifier will shut itself off after 30 minutes if it fails to detect any input signal at the selected input. To change this, see Section 4.2.

2 SAFETY

1. **This amplifier uses high voltages internally which could cause injury or death. Lethal voltages can remain in the electronics after the unit is unplugged. To avoid electric shock, do not remove the bottom cover** (it is secured in place with tamper-resistant screws). Refer servicing to Tavish Design, LLC. If the unit must be opened for servicing, unplug it and wait at least 30 minutes for internal capacitors to discharge. The bottom cover is secured with T15 Torx screws.
2. **Do not operate the amplifier without the top cover in place**, as the vacuum tubes and heatsink inside can get hot. Although high voltages are contained below the chassis, the control electronics are exposed to damage when the top cover is removed, and the control electronics present a low-voltage shock hazard.
3. **Do not allow liquids (such as from a spilled drink or flower vase) to run into the amplifier**, as this can damage the amplifier or create an electric shock hazard. Do not operate outdoors or in wet areas. Do not allow rain to enter the amplifier (by placing the unit next to an open window, for instance).
4. **A broken or improperly seated vacuum tube can cause electric shock.** Do not operate the amplifier if any vacuum tubes have broken glass shells. Align the tubes if any are leaning or not fully seated, prior to operating the amplifier. Vacuum tubes get hot, so allow them to cool before handling.
5. **To avoid electric shock, do not insert thin metal objects through the ventilation slots or allow children to do so.** A metal object inserted into the amplifier could possibly contact high voltages present internally. The top cover, the positioning of the ventilation slots, and internal baffles in the amplifier significantly reduce this hazard but cannot eliminate it completely. This hazard is similar to that of sticking a pin or thin screwdriver into an electrical outlet.
6. **Keep out of reach of children.** A high shelf or table is better than a low one, if children are present.
7. **The amplifier is designed to connect to a 3-wire grounded outlet. Never defeat the safety ground on the amplifier; doing so can create an electric shock hazard.** Please consult a qualified electrician if you are in doubt about the grounding of your electrical system.

3 DESCRIPTION AND SPECIFICATIONS

The Minotaur is an amplifier with a direct-coupled vacuum-tube signal path, direct-coupled to a transistor output stage. The design uses 7 vacuum tubes to handle the input, voltage gain, and driver stages of the amplifier. The high-bias class-AB (linear, non-switching) output stage uses the well-regarded MJL3281 and MJL1302 devices in a modified Sziklai configuration for outstanding linearity, and it operates in pure class-A up to either 1W or 5 W per channel (see Section 4.1). The vacuum tubes are powered from regulated high voltage and heater supplies to achieve minimum noise and operating drift. The Minotaur is configured as a stereo integrated amplifier; it features instrument-like construction with high-quality components and connectors throughout. For user convenience, it has a wireless remote control (no need to point, works anywhere in the house), using a classic ALPS “blue velvet” motorized potentiometer for volume control and OMRON low-signal relays for source selection.

The Minotaur takes advantage of both the linear, high-voltage-swing capability of vacuum tubes and the high-current-delivery capability of transistors, allowing the tubes and transistors to do what each does best. And, the Minotaur is direct-coupled from the input stage to the output, avoiding the use of coupling capacitors at high-signal levels, where they can cause slow recovery from overload transients.¹ The Minotaur is one of very few hybrids on the market to directly couple the tubes to the transistors.

In developing the Minotaur, particular attention was paid both to achieving very low distortion, and also to the character of whatever small distortion was produced; below clipping, the distortion spectrum is dominated by the single-ended 12BH7 vacuum tube driver stage and is predominantly second harmonic.

The system microcontroller monitors temperature, offset, and bias conditions, and alerts the user to the need for eventual tube replacement (see Sections 4.4 and 5.2). Output current limiting, output offset detection, and advanced safe-operating-area protection for the output transistors result in a highly reliable amplifier, without any of the maintenance issues sometimes associated with high power tube amps.

¹ A coupling capacitor is used at the amplifier input to prevent a DC offset from the signal source from being applied to the amplifier.

Specifications

Parameter	Specification
Rated Power Output	140 W per channel continuous, both channels driven into 8Ω
Power Output vs. Load Impedance	190 W per channel into 5Ω 220 W per channel into 4Ω 240 W per channel into 3Ω
Output Noise	<110 μV RMS C-weighted 30 Hz – 8 kHz >108 dB below rated power
Input Sensitivity and Gain	+0 dBu (0.78 V RMS) for full output, 32 dB gain
Total Harmonic Distortion	Typically <0.08% (predominantly 2 nd harmonic) at any frequency between 20 Hz and 20 kHz and any power level up to 120 W, 8Ω load. <1.0% at full rated power
Input Impedance	≥50 kΩ
Output Impedance (Damping Factor)	40 mΩ at 1 kHz (equivalent to a damping factor of 200)
Bandwidth	3 Hz – 150 kHz (-3 dB, ref. 1 W @ 1 kHz) unbalanced inputs 3 Hz – 80 kHz (-3dB, ref. 1W @ 1 kHz) balanced inputs
Size	17.2" wide, 17" deep, 6" high
Weight	34 lbs. (42 lbs. shipping weight)
Power Consumption (120 V, 60 Hz)	70 - 160 W typical, 600 W maximum, <1 W standby
Tube Complement	5751 (or 12AX7) x2, 12AT7 x4, 12BH7 x1
Output Transistors	MJL3281A x4, MJL1302A x4

Model and Serial

Post Burn-In Checkout

Offset Right	
Offset Left	
Power at Clipping (8Ω, 1kHz, 1% THD), Right	
Power at Clipping (8Ω, 1kHz, 1% THD), Left	
Total Harmonic Distortion (112.5 W [30 VRMS] into 8 Ω, 1kHz), Right	
Total Harmonic Distortion (112.5 W [30 VRMS] into 8 Ω, 1kHz), Left	
Date	

4 OPERATING DETAILS

4.1 HIGH-BIAS MODE

The high-bias class-AB output stage in the Minotaur can operate in two modes, “normal” and “high-bias”. By default, the amplifier operates in normal mode, operating in class-A up to about 1 W per channel into an 8- Ω load. In high-bias mode, the output stage quiescent current is increased so that it operates in class-A up to about 5 W per channel into an 8- Ω load.

The amplifier can be placed in high-bias mode during turn-on. Starting with the amplifier in “sleep” mode (red “sleep” LED on), push and hold the “5” switch while pressing the ON-OFF switch. Release both buttons after the amplifier turns on. An amber LED behind the vacuum tubes indicates that high-bias mode has been turned on. The high-bias mode is retained for subsequent operation after the amplifier is switched off; to return to normal mode, once again press and hold the “5” switch while turning the amplifier on with the ON-OFF switch.

The amplifier dissipates considerably more power in high-bias mode, and you should expect the external temperature of the cabinet to be noticeably warmer in this mode. It is even more essential that you provide good ventilation for the Minotaur when it is operated in high bias mode. You may notice the cooling fan come on if ambient temperatures are high or ventilation is suboptimal.

The bias point in normal mode has been selected carefully in both listening tests and measurements as a good compromise between performance and heat production; there is minimal improvement with increased bias, and most listeners do not notice any difference with high-bias mode. But depending on your listening environment, speaker efficiency, and program material, you may prefer high-bias mode for critical listening, reverting to normal mode for casual listening.

4.2 AUTOMATIC POWER OFF

The Minotaur monitors input signal level and is programmed to shut itself automatically after 30 minutes if it fails to detect a signal at the selected input (the volume control position does not affect this). This is done to save power and prolong tube life.

The automatic-power-off setting can be disabled during turn-on. With the amplifier in “sleep” mode (red “sleep” LED on), press and hold any of the source buttons except “5” (that is, MUTE or 1-4) while pressing the ON-OFF button (this key combination also works with the remote control). The red ON-OFF switch will flash twice slowly to indicate that automatic-power-off has been disabled. During each subsequent turn-on, the ON-OFF switch will flash to remind you that automatic-power-off has been disabled.

To turn it back on, press and hold any of the source buttons except “5” (that is, MUTE or 1-4) while pressing the ON-OFF button. The red ON-OFF switch will flash four times quickly to indicate that automatic-power-off has been enabled.

The automatic-power-off setting cannot be disabled in high-bias mode. If you disable it, the amplifier will place itself in normal bias mode.

The Minotaur should not be left running when not in use. Turning it off prolongs tube life and saves power. If the amplifier is used regularly, the vacuum tubes stabilize within minutes of turn-on.

4.3 VENTILATION AND CHASSIS TEMPERATURE

Some people are surprised that vacuum tubes generate heat. The Minotaur is designed to dissipate heat by having air flow in underneath the chassis and out through the top. If there is not enough air space above the amplifier (at least 4 inches), or if the top or bottom ventilation slots are blocked, or if the amplifier is placed in an enclosed space where little air can circulate, the amplifier will get quite warm and may overheat.

Bias Mode	Expected Temperature Rise Above Ambient With Adequate Ventilation	Expected Maximum External Cabinet Temperature, Assuming 80°F (27°C) Ambient
Normal	30 - 35°F (16 - 19°C)	115°F (46°C)
High	35 - 40°F (19 - 22°C)	120°F (49°C)

In high-bias mode, with adequate ventilation and an 80°F (27°C) ambient, the external cabinet may reach 120°F (49°C) above the tubes and heatsink. That is a very hot day in Phoenix, but not a contact hazard, nor even uncomfortable to touch. If you notice the amplifier becoming uncomfortably warm to touch (50°C or more), you should consider if the ventilation can be improved. If you use an equipment rack, be sure it provides for ventilation. If you want the amplifier to run cooler, run it in normal bias mode (see Section 4.1). And note (somewhat obviously) that if ambient temperatures are cooler, the amplifier will be correspondingly cooler.

If internal temperatures rise too much, the system microcontroller will first turn on a fan to cool the heatsink. Next, it will force the amplifier out of high-bias mode. Finally, the amplifier may shut down with a FAULT indication (see Section 4.4).

4.4 SYSTEM STATUS INDICATION (FAULT MODES)

The system has a number of status indicators and FAULT modes which are indicated with the red LED in the ON-OFF button. You will probably never need to know about these, but they are summarized here in case you do. Most problems can be resolved by restarting the amplifier with the ON-OFF button. If that doesn't work, try turning off the amplifier completely with the POWER switch, waiting until *10 seconds after the red "sleep" LED goes out*, then turning the POWER switch back on and restarting the amplifier with the ON-OFF button.

System Status LED (ON-OFF button)	Sleep LED	Condition
Off	On	The amplifier is in standby (or "SLEEP") mode. This is not a fault condition. Press the ON-OFF button to start the amplifier.
On	On	The amplifier has shut down due to a FAULT condition. This could be caused by overheating, an offset error, or a bias error. If the amplifier seems unusually warm, let it cool, then push the ON-OFF button to restart. See Section 4.3. An offset error or a bias error probably indicates the need for vacuum tube replacement, see Section 5.2.
Flashes twice slowly on turn-on	Off	Indicates that automatic-power-off mode has been disabled. See Section 4.2.
Flashes four times quickly on turn-on	Off	Indicates that automatic-power-off mode has just been enabled. See Section 4.2.
Flashes once every second for a minute.	Off (then On after SLEEP occurs)	In automatic-power-off mode, an indication that the amplifier is about to go to SLEEP because no input signal is detected. Apply a signal or press any source button (MUTE or 1-5) to keep the amplifier awake for another 30 minutes.
Flashes once every ten seconds while the amplifier is operating	Off	Indicates that the microcontroller has detected an output offset greater than approximately +/- 0.12V. This probably means that one of the 5751 vacuum tubes needs offset adjustment or replacement. The amplifier will continue to operate. If the output offset exceeds approximately +/- 0.5V, the amplifier shuts down due to a FAULT condition. See Section 5.2.

4.5 WIRELESS REMOTE CONTROL

The remote should work anywhere in the house, with no need to point it at the Minotaur. If it doesn't, make sure that the antenna (packed in the same bag as the remote control) has been threaded onto the antenna input on the rear of the amplifier. Also, be sure to press and hold the buttons on the remote control for at least 1/5th of a second. If you press the button too quickly, it may not register.

If the amplifier is placed in a metal equipment rack that blocks the radio signal from the remote control, the remote may have poor range or not work at all. In that case, an external antenna which can be placed outside the metal equipment rack is available from Tavish Design.

4.6 TOROIDAL TRANSFORMER CHARACTERISTICS

The Minotaur uses a large (500 volt-ampere) toroidal power transformer to allow for sustained power output into low impedance speakers. The transformer used in the Minotaur was selected (from among many tested) to provide very low mechanical (and electrical) noise during operation.

It is normal for the transformer to produce a sudden mechanical vibration on startup, as the core magnetizes. This may or may not happen, depending on which phase of the AC cycle it starts on. The vibration will subside by the end of the warmup sequence.

4.7 TROUBLESHOOTING GROUNDING AND NOISE (HUM) ISSUES

The Minotaur produces exceptionally low noise, and if hum can be heard from the speaker, there is probably ground-current-induced noise (sometimes called a “ground loop”). With the volume control turned down and the amplifier on MUTE, disconnect all other equipment from the inputs. With the Minotaur operating by itself, there should be no noise even with the volume control turned fully clockwise. With the volume control turned down and the amplifier on MUTE, try reconnecting equipment one piece at a time until you’ve found the source of the noise. As you add each piece of equipment, switch to that input and turn up the volume. Contact Tavish Design for further advice.

5 MAINTENANCE AND VACUUM TUBE REPLACEMENT

5.1 MAINTENANCE

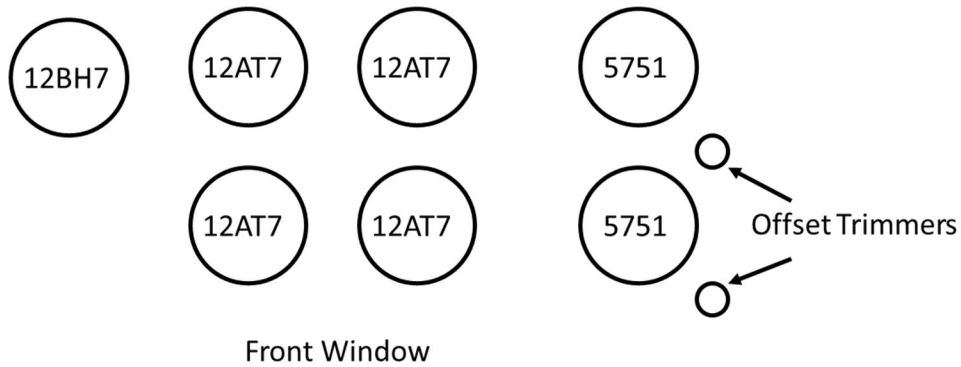
The only regular maintenance required is to keep the amplifier clean. If it is in a location where dust can settle on it, then dust will eventually accumulate inside the top cover due to the ventilation slots. To clean it, unplug the line cord and wait 30 minutes. Remove the top cover, which is held in place with 14 Philips-head machine screws (4 on each side, 6 on top). Wipe with a soft cloth or vacuum with a soft brush attachment. Isopropyl alcohol can be useful for cleaning the chassis, but do not wipe the tubes with it, as it can remove the markings. If you remove the vacuum tubes, be sure to replace them in the correct locations. In particular, the 5751 tubes must stay in their same front or rear location, or the offset trimmers will need to be readjusted (see Section 5.2). Be careful not to damage the control electronics during cleaning.

5.2 VACUUM TUBE REPLACEMENT

Although the lifetime of any particular tube is impossible to predict, vacuum tubes last much longer than most people think. Hopefully, it will be many years before you have to replace a tube in the Minotaur, as long as the amplifier is not left on continuously.

The system microcontroller monitors output offset voltage, which will probably be the first sign that a tube needs replacement. If the red LED in the ON-OFF button begins to flash every 10 seconds, it indicates that the output offset exceeds $\pm 0.12\text{V}$. That suggests one of the 5751 input tubes is drifting and needs replacement, although it may be possible to extend its service life with an offset adjustment. The other tubes (four 12AT7 and one 12BH7) are more likely to fail on startup, as indicated by the amplifier going into FAULT mode. Of course, FAULT mode may be caused by issues other than bad tubes; see Section 4.4.

Vacuum tube replacement is best done at Tavish Design, although an electronics technician experienced with high voltage equipment may be able to do it. Contact Tavish Design for further advice.



A broken or improperly seated vacuum tube can present an electrical shock hazard, which can result in serious injury or death! The following instructions in this section for tube replacement or substitution are for experienced electronics technicians only.

To replace a tube, unplug the line cord, disconnect all the inputs, disconnect the speakers, and wait 30 minutes. Remove the top cover, which is held in place with 14 Philips-head machine screws (4 on each side, 6 on top). To remove a tube, pull straight up while gently rocking very slightly from side-to-side. Never twist the tube! Replace tubes with the same type number. The 5751 is a low-noise, low-drift, lower-gain version of the 12AX7. If you cannot find a 5751, a 12AX7 may be used. JJ Electronics currently manufactures an excellent 5751.

If you are replacing one of the 5751 input tubes, you will have to perform an offset adjustment after replacement. Using the tool provided (or a potentiometer adjustment tool with an insulated handle – NOT a screwdriver with a conductive metal shaft), set the offset trimmer to the center of its adjustment range. Connect a voltmeter (set to the +/- 1V range or higher) to the output, turn on the amplifier, and wait for it to warm up. Adjust the offset trimmer until the voltmeter reads zero, then move to a more sensitive scale. You should be able to adjust the offset to +/- 0.02V or less, although it is normal for the offset to drift within a +/- 0.05V range. Allow the amplifier to operate for at least 30 minutes before making the final offset adjustment.

Tube Substitutions

Some experienced audiophiles like to experiment with different vacuum tubes to change the sound character of their equipment. Feel free, but be sure to replace tubes only with known-good tubes of the same type. Although unlikely, use of other tube types could possibly damage the amplifier and void the warranty. The only exceptions to the use of different tube types are the 12BH7, which can be replaced with a 5714 or a 12AU7, and the 5751, which can be replaced with a 12AX7. It is very unlikely that you will find a tube with less drift than the JJ 5751 supplied with the Minotaur (if you do, please let us know). New, old-stock (NOS) tubes tend to have higher noise and drift. The harmonic character of the amplifier is primarily determined by the 12BH7 driver tube. Note that if you replace one of the 5751 tubes, you will have to perform an offset adjustment (see above).

6 WARRANTY AND SERVICE

6.1 WARRANTY

With the exception of tubes, Tavish Design, LLC (hereinafter “Tavish Design”) warrants to the consumer this product to be free of defects in materials or workmanship for a period of six (6) years from the date of purchase (6 months on tubes). If you discover a defect, Tavish Design will (at its option) repair or replace the product at no cost to you (excluding return shipping and handling outside the 48 continental United States) provided that you send it prepaid to Tavish Design (see Section 6.2).

Proof of purchase in the form of a dated bill of sale which indicates that the product is within the warranty period may be required to obtain warranty service, if the date of sale is not in our records.

This warranty does not cover cosmetic damage or any damage that results from product misuse, product abuse, installation error, connection to an incorrect voltage supply, accident, improper maintenance, alterations, modifications not authorized in writing by Tavish Design, lightning, power surges, or acts of God. Use of parts not obtained from Tavish Design may void this warranty.

This warranty is limited to the replacement or repair of this product and not to damage to equipment of other manufacturers. Any applicable implied warranties, including warranty of merchantability, are limited in duration to a period of the express warranty as provided herein beginning with the original date of purchase and no warranties, whether express or implied shall apply to the product thereafter. Under no circumstances shall Tavish Design be liable for any loss, direct, indirect, incidental, special, or consequential damage arising out of or in connection with the use of this product.

This warranty does not cover the cost of parts and labor which would be otherwise provided without charge under this warranty, obtained from any source other than Tavish Design.

This warranty applies only to the consumer use of this product. The product is not warranted for use in public address, sound reinforcement, in any trade or business, or in an industrial or commercial application.

The warranty applies only to the original owner and is not transferrable.

This warranty is only valid in the United States of America.

6.2 SERVICE

Please contact Tavish Design for service (in or out of warranty) if you believe your amplifier needs repair. Most technical issues can be resolved by email or phone. If your unit does require repair, we'll issue a return merchandise authorization (RMA) number, along with packing and shipping instructions and a street address for delivery.

Tavish Design, LLC

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Amawalk, New York 10501

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914-262-6988

7 APPENDIX A: BLOCK DIAGRAM

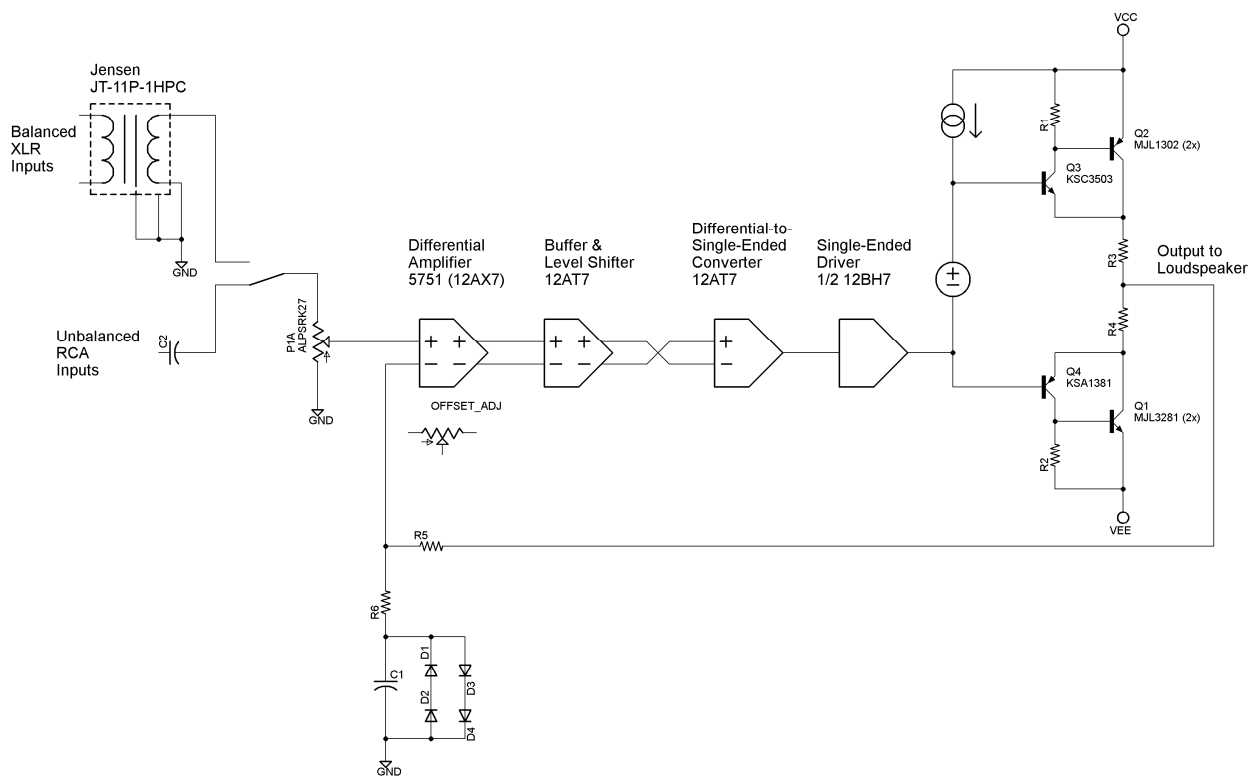


Fig. 7.1: Amplifier (Simplified) Block Diagram

8 APPENDIX B: TYPICAL MEASURED DISTORTION PERFORMANCE

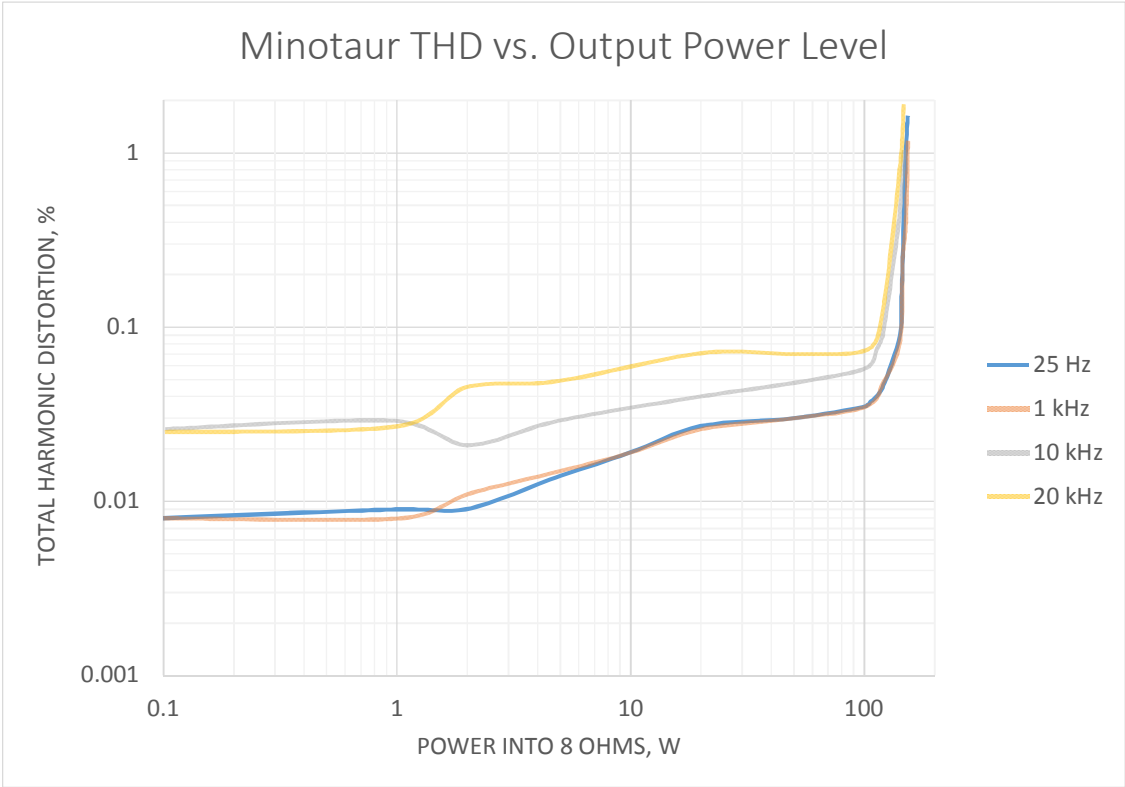


Fig. 8.1: Typical measured Total Harmonic Distortion (THD) in percent, versus power output into an 8Ω load, at four different frequencies (25 Hz, 1 kHz, 10 kHz, and 20 kHz). Data taken with a Picoscope 4262.

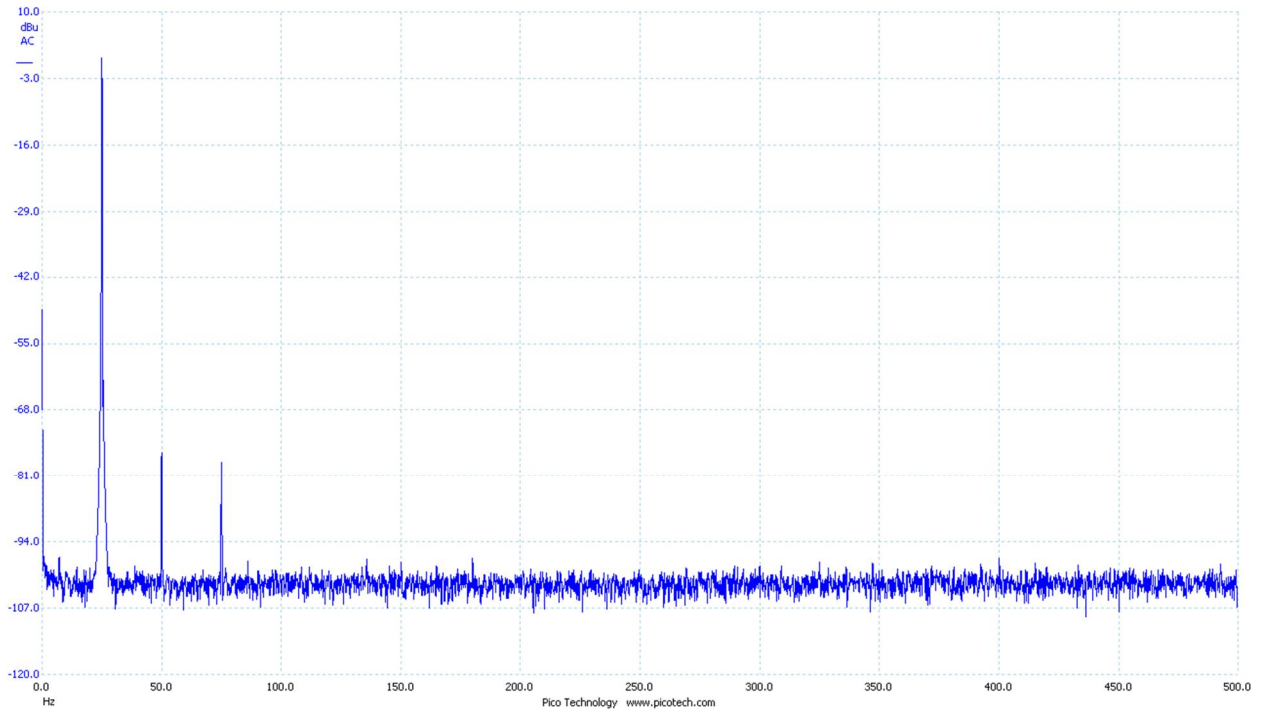


Fig. 8.2: Distortion spectrum for a 25 Hz input frequency, 10 W into an 8Ω load. The THD is approximately 0.02%.

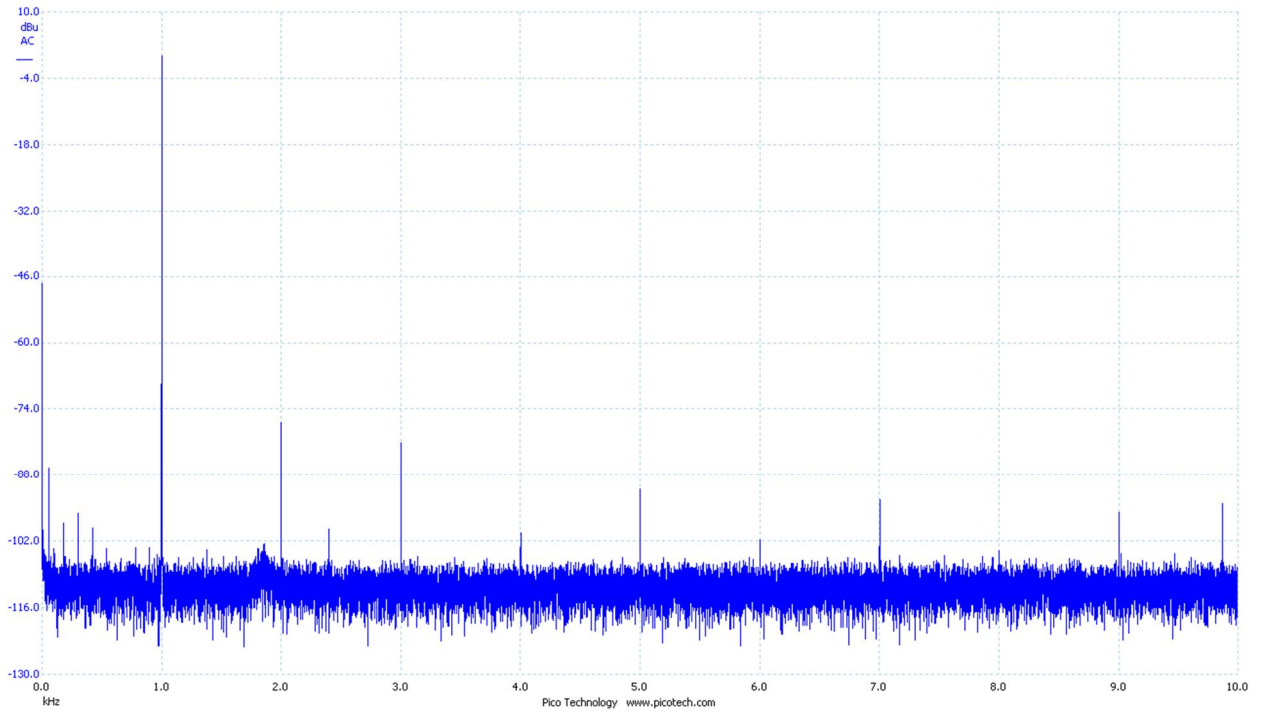


Fig. 8.3: Distortion spectrum for a 1 kHz input frequency, 10 W into an 8Ω load. The THD is approximately 0.02%.

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