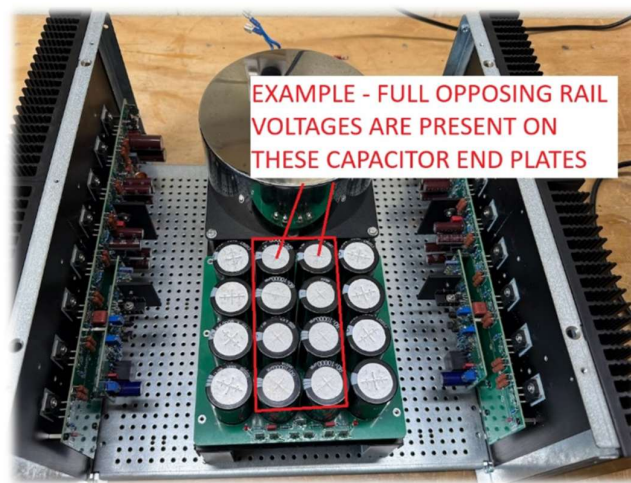


Foreword About Safety

Please ensure you are aware of and fully understand the following.

The Wolverine can operate with potentially dangerous high DC voltages up to 170VDC (-85V to +85V). These voltages can cause severe injury, permanent damage, or be fatal if mishandled. Care is taken in design so that these voltages are not located in finger proximity however there is always the possibility that two opposing sides of the amplifiers power supply somehow encounter a stray steel tool or hand. (Not Wolverine PCB related but with all Class AB amplifiers a common source of these two voltages being present is the uninsulated plates of the main filter capacitors in the case of a snap-in PCB see - below example PSU capacitor bank)

Mains voltages are even more dangerous due to their earth potential, even though this guide does not pertain directly to mains household voltages, it is likely that the builder will be performing some form of mains appliance wiring to run this amplifier. Therefore, it must be said that you must be familiar with and abide by your countries local wiring regulations. Remember that if someone is injured because of your work, you may be held liable for ensuing damages.



Your (and others) safety is top priority. Before continuing this build:

- Make absolutely sure you understand the risks involved in working with any household mains and power amplifier circuits.
- If you're not already experienced with safe handling of mains electricity and high-voltage DC, now is a good time to consult with a qualified electrician or technician who can familiarise you with the regulations and risks.
- Always disconnect the amplifier from the mains before removing any covers and test the power supply rails with an appropriately rated multimeter, before touching or modifying any internal wiring or components.
- Capacitors may store a **lethal charge** even after power is removed, yes this is applicable to both Linear power supplies and Switch Mode power supplies! Ensure they are fully discharged before proceeding. As above test the rails with a multimeter and use an appropriate capacitor discharge tool if your power supply does not have rail bleeding capacitors, or the connected amplifier does not drain the voltage through its internal bias circuitry (typically this will fail after a fault event so you must check the rails with a multimeter and not assume the amplifier has drained the capacitors.)
- Practice common safe working procedures for handling electrical appliances see here:
[Electrical Safety Requirements](http://www.sound-au.com/articles/mains-safety.htm) – www.sound-au.com/articles/mains-safety.htm
[Power Supply Wiring Guidelines](http://www.sound-au.com/psu-wiring.htm) – www.sound-au.com/psu-wiring.htm
- Do not attempt assembly, testing or fault finding when you are impaired, tired, distracted, or unsure about any step.
- Ensure that when testing, if you have long hair that it is tied back or up and if you have any pets, children or infirm persons, they are not near the amplifier when you have the lid off. Keep them isolated in other rooms and NEVER leave an amplifier unattended with covers off or in an incomplete state.

26. FAQ

26.1 Is Wolverine suitable for beginners?

Some experience in electronics and amplifier repair and building is required. Refer the safety foreword at the start of this guide.

If you have never worked with electronics or soldering irons, it is going to be too difficult as a first project, so it is not recommended. We recommend starting with a smaller amplifier project.

The Wolverine is an evolution of the “Honey Badger”, a simpler yet still very high-performance class AB amplifier available on diyaudio.com and the [diyaudio](http://diyaudio.com) store.

26.2 What are the minimum tools required to build Wolverine?

Minimum:

- Soldering iron
- Philips PH2 screwdriver
- Small 3.5mm flat head screwdriver
- Jewelers/very small flat head screwdriver to spin trimpots
- 2x 4 digit (000.0) Digital multimeters, 1x capable of AC and DC V & mV measurements, resistance, continuity (beep), diode and capacitor testing such as QM1321 or similar
- Precision Side cutters – TH1897 or similar
- Isopropyl Alcohol or circuit board cleaner
- ESD component Tweezers
- Toothbrush
- Cleaning cloth
- Solder sucker
- Dual rail benchtop power supply OR Variac OR Dim bulb tester

Recommended add:

- Soldering iron larger 40W+ for larger components
- Fine (Small components) and Chisel tips (Large components or thick traces) for your soldering iron.
- 2x more digital multimeters
- Component leg folding tool
- Solder Wick
- Long spacers to lift PCBs for component installation
- Brass wool solder tip cleaner
- 8- or 4-ohm dummy load
- Oscilloscope

26.3 How can I get the PCBs and the BOM?

The Wolverine amplifier PCBs are currently sold through group buys on the diyaudio.com forum. You can find the latest group buy thread, read the first post for all the information and then fill in an order form.

BOM's are distributed digitally via dropbox links to purchasers of PCBs when a group buy has begun PCB manufacturing. The dropbox links contain more useful documentation and tools than just BOMs.

26.4 What are the differences between EF3-3, -4 & -5?

The difference is output power transistor pairs. An EF3-3 has six output power transistors, EF3-4 and EF3-5 have eight and ten respectively.

The EF3-3 board length is the shortest for 300mm deep chassis compatibility and the EF3-4 and -5 need 400mm deep chassis.

More output pairs give the ability to drive more difficult loads and run higher rail voltages, at the penalty of idle heat/power consumption and build expense.

All variants have the same exceptional distortion performance.

EF3-3 is suitable for most home environments and commercially available speakers.

26.5 What chassis / heatsink size should be used?

300mm deep chassis can only accommodate the EF3-3, for EF3-4 and EF3-5 you need a 400mm deep chassis.

50-60V rails use 3U minimum height heatsinks.

Higher than 60V rails use 4U minimum height heatsinks.

Higher than 70V rails use 5U minimum height heatsinks.

26.6 What power supply should I use?

Refer [section 2.1](#).

The conventional way to power a class AB amplifier is a Linear Power Supply. Bare minimum is 1x transformer with a center tapped secondary approx. 42-0-42VA, one full bridge rectifier and 2 18k uF+ bulk capacitors.

The simplest way is with an audio-designed dual rail SMPS that includes auxiliary 12V power output and a standby switch input. We do not recommend the use of "questionable quality" power supplies from AliExpress/Temu/Ebay.

26.7 What Rail Voltage should I use?

If you are unsure, ~54V DC if you have a 3U high chassis or ~63V DC for 4U or larger chassis is the best target for most users.

26.8 How much Capacitance for my Linear Power Supply?

40,000uF+ is good enough for most stereo builds up to 70V rails. (20,000uf per channel for dual mono)

26.9 What Drivers and Outputs to use?

If you are unsure, use Mouser active parts (at time of writing)

MJE15032 & MJE15033 for Drivers.

NJW0281G / NJW0302G (150W) Outputs for 60V or lower rail voltages.

NJW3281G / NJW1302G (200W) Outputs for 63V or higher rail voltages.

26.10 Do I need to match transistors?

Yes – and it can be achieved with your multimeter in diode mode. See [section 14.1](#) on how to do this.

Q1 and Q2 must be matched.

Q3 and Q4 must be matched.

Q5 and Q6 aren't as critical but are optional to match.

Pre-drivers do not need to be matched but must be complimentary.

Drivers do not need to be matched but must be complimentary.

Outputs do not need to be matched; however, they must be complimentary and it is recommended to buy these from a reputable source such as Mouser or DigiKey. This will ensure authentic parts, likely from the same batch, meaning very close in hFE and Vbe. Try and get the HFE of your NPN output transistor set as close as possible. Similarly, try and get the HFE of your PNP output transistor set as close as possible. You may like to purchase a few extra outputs transistors to help with this process.

26.11 What components are best to source higher quality?

Wolverine is ultra-high performance by design and the default BOM parts are chosen to uphold this standard. If you're inclined to spend a bit more on luxury parts, as listed in the BOM additional column, the best places to start are resistors in the negative feedback path:

- R0
- R21
- R1
- R2
- R31
- R32
- R9

Followed by emitter resistors, signal paths, then everywhere else.

26.12 What are the Trimpot parameters?

R11 – monitors current flow through the input LTP – with nothing connected to the input or speaker terminals connect to TP1 (DMM+) and TP2 (DMM-) and set for 5.5V DC. This represents a current flow of 5.5mA through the LTP. Best done with amplifier warm.

R25 – adjusts for DC offset – connect to speaker output positive (DMM+) and speaker ground (DMM-) with nothing connected to the input or speaker terminals and target for as close to 0.0mV DC as possible.

R109 – adjusts amplifier output stage bias – connect to TP101 (DMM+) and TP102 (DMM-) with nothing connected to the input or speaker terminals and target for 40-44mV. Monitor for 30 minutes allowing heatsinks to warm up to equilibrium. Final set with amplifier lid placed over top of test leads.

26.13 Do I need a Soft Start?

For linear power supplies – Yes.

For Audio grade SMPS – No.

For all Audio Amplifiers in general a startup muting circuit (typically integrated into the speaker protection) is used to avoid startup speaker thumps.

26.14 Does Wolverine have speaker protection built in?

No. It must be added by the builder with a third-party board. Also offered with the group buy.

26.15 Is Speaker Protection mandatory?

Objectively speaking for the amplifier to function – No.

We recommend using speaker protection.

This applies to all audio amplifiers.

26.16 Can I use this part I have, instead of this part in the BOM?

Generally, no. If you have resistors that match in value and power rating, they should be fine to substitute for BOM parts. The BOM also advises some parts that can be exchanged with similar equivalents. If you are unsure, consult with the build team on the forum.

27. Troubleshooting FAQ

27.1 Hum/noise, what could be the cause?

The most common cause of hum with Wolverine or class AB amplifiers is having power supplies or lines too close to the input stage/board. Consider trying to keep your transformer and rectifiers, or SMPS at the opposite end (generally the front) of the chassis to the IPS boards (which would be at the rear, closest to the line level inputs).

Ground loops should be mitigated by the correct use of ground lift as [section 2.1.3](#).

Ground loops can be caused by partnering appliances – remove any upstream devices from the Wolverine, and short the inputs with an old cheap RCA cable - cut and join the shield to the core. This will rule out the other appliances or the Wolverine.

Any other speaker hum is likely due to poor wiring arrangements inside your chassis. Refer to “How to wire an Audio Amplifier” document by hifisonix – provided in the Wolverine dropbox link.

Mechanical chassis hum is either from most commonly; low quality transformers, second; very bad/high mains and third; in some cases, a DC filter on the mains can fix a growly transformer core. Some builders have had success with resin “potting” lower quality transformers to “contain” the noise.

27.2 Wolverine is getting too hot, what should I check?

Check bias is set correctly – R109 – [section 20](#), point L

Confirm your rail voltages are not drifting high, due to high mains voltages.

Confirm your heatsinks are not airflow obstructed and are sized accordingly – [section 26.5](#)

Consider the ambient temperature and the environment the amplifier is being used in. Did you perhaps bias it in winter on an open bench with good airflow, but now it's summer and you have the amplifier confined in a cabinet? [Section 21](#), point G.

27.3 No sound output?

Confirm there is no fault with the amplifier by testing DC offset at the speaker outputs – [Section 26.12](#) – note this fault will also damage a speaker.

Confirm your speaker protection has not activated from a DC fault (usually class AB amplifiers this is by a blown power output transistor from poor heatsink contact or overloading for long periods).

Confirm your power supply has not failed by checking rail voltages.

Confirm the rail fuses have not blown.

Confirm your source for output by using another amplifier with your source or another source into the Wolverine.

Check your cabling, including any line level cabling or soldered cable joints.

Before moving back to bench and/or isolated testing refer [Section 24](#) and [Section 23](#)

28. Wolverine Specifications

Class	AB
Rated Output (Power Supply Dependent)	240W + 240W (8Ω) Rail Voltage 71Vdc 430W + 430W (4Ω) Rail Voltage 71Vdc 200W + 200W (8Ω) Rail Voltage 64Vdc 360W + 360W (4Ω) Rail Voltage 64Vdc 160W + 160W (8Ω) Rail Voltage 57Vdc 280W + 280W (4Ω) Rail Voltage 57Vdc 120W + 120W (8Ω) Rail Voltage 50Vdc 210W + 210W (4Ω) Rail Voltage 50Vdc
Input Impedance	Unbalanced 10KΩ or 22KΩ
Input Sensitivity	1.8V/ 10KΩ/ 200W (8Ω) 1.7V/ 22KΩ/ 200W (8Ω)
Gain	24.0dB @10 KΩ 24.5dB @22KΩ
Frequency Response	20Hz to 20kHz (+0, -0.1dB) 5Hz to 180kHz (+0.1, -3.0dB)
Total Harmonic Distortion	0.0000053% (-145.5dB) @1kHz/ 80W/ 8Ω 0.000065% (-123.7dB) @20kHz/ 80W/ 8Ω
IMD	0.0001096% (-119.2dB) [f1 = 19Khz and f2 = 20Khz] 0.0001122% (-119.0dB) [f1 = 1Khz and f2 = 5.5Khz] 0.0002818% (-111.0dB) [f1 = 250hz and f2 = 8Khz] 0.0002818% (-111.0dB) [f1 = 60hz and f2 = 7Khz]
S/N Ratio (IHF-A)	118dB
Quiescent Noise (Input shorted A weighted)	15uV (19uV unweighted)
Slew Rate	76V/μs
Pairs No. Output Devices (Per Channel)	3, 4 or 5
Damping Factor	110 @ 20Hz (4 pair output devices)

IMD figures show V3.9 versions, however V5.0 meets or exceeds all previous versions. Specifications will be updated in later build guide revisions, and the build team reserves the right to correct or update these specifications at any time. These specifications are obtained in controlled environments, and similar performance is not guaranteed outside of these environments and without precision measurement equipment.