

ACA MinMax

Overview

In 2021, Nelson Pass created the [ACA Mini](#) as a follow up to the [original Amp Camp Amp](#). The ACA Mini is a Class A complementary, push-pull amplifier running on a single-ended (not bipolar) 24V DC power supply, rated for about 5 watts of power per channel. The output transistors use small “board level” heat sinks on the PCB to dissipate heat, and the complete amp was intended to be run “naked”, without any additional chassis. The stated goal was to “make a nice little class A amplifier that brings some interesting circuit design elements at a much lower cost, while still appealing to more sophisticated audiophiles.”

At Burning Amp 2023, [@PSz](#) asked [Nelson Brock](#) to adapt the ACA Mini into [the diyAudio Store's ACA chassis](#), to allow for higher power supply voltage and bias current. The ACA MinMax is the result of that collaboration.

Key Features and Specifications

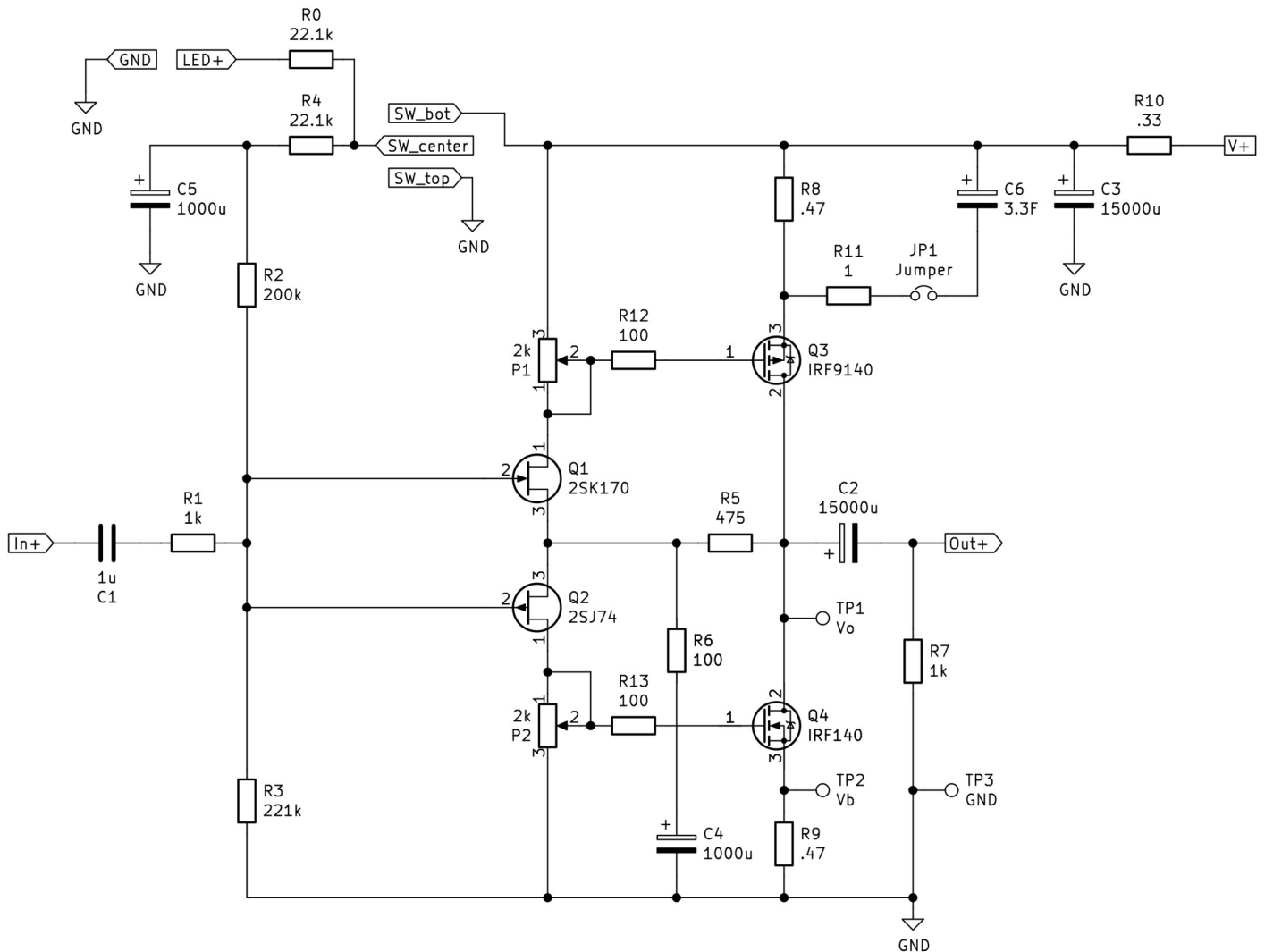
The ACA MinMax uses two “mirrored” PCBs, with each board providing a single channel of amplification. They are designed to mount in the ACA chassis available from the diyAudio Store (Store) or ModuShop. Because of the increased heatsink capability, the MinMax uses a 36V DC external power supply. The output power with 36V DC and the recommended 0.8A bias is estimated (not measured) to be around 10W/channel into 8 ohms. If the amplifier is configured as a parallel or balanced monoblock, then output power will roughly double, depending on speaker impedance. Additional features of the MinMax are:

- PCB holes and transistor locations match the Store chassis
- Right and left PCB layouts to keep wiring clean
- 35mm capacitor footprints for increased voltage rating (50V)
- Compatible with TO-220 or TO-247 output devices
- Optional gate resistors (R12, R13)
- Requires an **SPDT** front switch, (the original ACA uses **SPST**) which is used to enable or disable bias in the circuit
- XLR input for balanced mono (balanced source required)
- Rear switch can be used for parallel mono
- Markings on the ACA chassis’ back panel can be modified for the MinMax

Specifications

- Recommended 0.8 amp bias using a 36VDC power supply, other supply and bias options can be used (max 48V)
- Estimated power per channel: 10 watts @ 8 ohms. Double for monoblock operation
- Dimensions of each PCB: 60mm X 127mm

Schematic



One channel is shown

There are a few minor changes compared to the ACA Mini:

- Change output MOSFETs, Q3 and Q4, to IRFP9140 and IRFP140, respectively
- Reduce value of degeneration resistors, R8 and R9, from $0.75\ \Omega$ to $0.47\ \Omega$
- Add optional gate resistors, R12 and R13
- Increase voltage rating of C2, C3, C4, C5 from 25V to 50V
- Increase resistance of LED resistor, R0
- Each channel has its own LED

[Here is the recommended list of parts](#) (also called bill of materials or BOM)

Options

Output Transistors

The original ACA Mini specified TO-220 size output transistors. The MinMax kits come with IRFP140 and IRFP9140 transistors, which are in a larger TO-247 package. The primary benefit is lower junction temperature at higher bias due to better thermal transfer to the heatsinks. A wide variety of MOSFETs, including the original ACA Mini's IRF520 + IRF5920, will also work without issue as long as they make good thermal contact and are isolated from the heatsinks.

Gate stopper resistors R12, R13

These resistors are optional, and are only needed when the MOSFETs have high gate capacitance, which in theory could stress the JFETs if you run square waves through the amp, or in extreme cases cause ringing / oscillation. They are not necessary for any typical build of this design, but there is no real penalty for using them either. If you are of the "less is more" persuasion, leave them out. If you like the idea of a little extra JFET insurance, add them in. If you do not use these resistors, be sure to jumper the pads for each resistor with solder or a small length of wire.

2nd Harmonic Distortion Profile Adjustment

Like the ACA Mini, the MinMax includes an optional RC network (R11, C6) and a jumper (JP1) which, when connected, reduces the 2nd harmonic distortion at the output (see discussion in the original ACA Mini article). In short, jumper disconnected will have a "warmer" sound and jumper connected will be a "cleaner" sound. If you do not wish to have this adjustment available, then the resistor, capacitor and jumper can all be omitted.

Power Supply and Additional Filtering

The MinMax was designed with 36V DC operation in mind, and the kit in the Store will come with an external 36V, 5A switching power supply.

The MinMax can be powered at the original 24V, or as high as 48V, if that suits your goals for the build. In any case, the bias should be adjusted to keep the heatsinks below 60°C. The dissipated power is roughly equal to the PSU voltage times bias current, so more voltage will mean proportionally lower bias for a given heatsink.

When using a linear power supply, you must check to ensure that its unloaded (open circuit) voltage will never exceed the voltage rating of the capacitors (50V caps in the kit). The on/off switch of this amplifier reduces the bias to zero, but does not disconnect the supply from the filter capacitors.

If you are using a switching power supply, then you may consider using a SMPS DC filter in your MinMax like the [P089ZB filter](#) sold in the Store. Another alternative is the [AmyAlice filter](#), which uses surface mount devices (SMD) and is not sold in the Store (you need to have your own PCBs fabricated from Gerber files available on the AmyAlice thread. Both the P089ZB and AmyAlice filters were designed by [Mark Johnson](#). You will have to devise your own mounting solution within the ACA chassis.

Construction notes

A step by step build guide is in the works and will be linked here in a future revision. The usual advice of verifying that you have all the parts needed before starting, stuffing the boards with components from smallest to largest, and checking the value of each part with a multimeter as you go, all apply here. The chassis wiring is expected to be the most difficult part of the build.

The kit provides TO-247 output transistors with alumina ceramic thermal pads and thermal grease. The grease packet provided, spread equally between both sides of all four thermal pads is the correct quantity to use. It might seem like too little, but the purpose of the compound is to fill in the very tiny irregularities between the heat sink, pad, and transistor case. A thick coating actually *reduces* thermal transfer. High quality silicone pads, for example Keratherm Red, match the performance of the alumina + grease and are a convenient no grease option, though they are relatively expensive. Lower quality silicone pads are not recommended for this power level.

If you are using output transistors with TO-220 cases, keep in mind that the screw needs to be isolated from the tab, so use a stepped isolation washer, or a nylon screw.

Adjustment

Set-up and adjustment should follow the procedure in the original ACA Mini article or build guide, but with the following changes using a 36VDC power supply:

Before first power up, be sure to turn trimmer potentiometers P1 and P2 so that they measure zero ohms between all three pads. This should mean fully counterclockwise, but there is a large variety in trim pot design, so the best way to avoid errors is by measuring and adjusting them just after soldering.

Output voltage balance: the voltage between Test Point 1 (labeled “Vo” on the PCB) and ground TP3 (labeled “GND”) should be between 17.2 and 17.8 volts.

Bias: For the recommended 0.8 amp bias, the voltage between TP2 (labeled “Vb”) and ground should be 0.38 volts if you are using the 0.47 ohm degeneration resistors (R8, R9). For those who wish to experiment with other biases or resistors, Ohm’s law is used to calculate the bias, current equals voltage divided by resistance.

$$I = \frac{V}{R} \qquad 0.8 \text{ Amps} = \frac{0.38 \text{ Volts}}{0.47 \text{ Ohms}}$$

Ultimately it is up to each builder to select an appropriate bias current for their build that takes into consideration the local climate, airflow around the heatsinks, and personal tolerance for hot metal objects in the home.

Best practice is to not exceed 60°C (140°F) external temperature. You should be able to place a hand on the heatsinks for several seconds without pain. The MinMax does not have temperature compensation and bias can increase as temperature increases. It is a good idea to periodically check the bias current and readjust as needed, especially when the weather is warm.

Rear Panel Mods

The ModuShop / diyAudio ACA chassis allows us to easily configure this amplifier as balanced or parallel mono. The ACA has a third option, bridged mono, that the MinMax does not support. The ACA 1.8 is an inverting amplifier which allows for a cool hack that connects the inverted output of one channel back to the input of the other channel. The MinMax (and Mini) are non-inverting, and cannot do the same. We are reusing the ACA chassis, so the markings on the rear panel need to be modified to show the appropriate connections and configurations for this build. A graphic showing how to modify the rear panel is in the appendices of this document.

Stereo Operation

Wiring the MinMax for stereo operation is straightforward. Put the rear switch in the up position and make connections as you would any other amplifier.

Monoblock Operation

The MinMax can be configured for either balanced, or parallel monoblock operation. This combines the two amplifier channels into a single, more powerful channel.

Balanced operation requires a balanced signal into the XLR connector and the rear switch in the up position (same as stereo). The speaker positive is connected to the output A positive (red) terminal and speaker negative is connected to the output B positive (red) terminal.

Parallel operation takes a single ended signal into either RCA input with the rear switch in the down position, which connects the two inputs together. The A and B outputs need to be connected in parallel by adding a wire externally between both positive (red) terminals. The negative (black) terminals are already internally connected. The speaker now gets connected to either set of terminals as you would expect, red to red, black to black.

Links

[Nelson Pass' original ACA Mini Article \(PDF\)](#)

[Recommended Parts List \(BOM\)](#)

ACA MinMax Build Guide

[ACA MinMax thread on diyAudio.com](#)

[ACA Mini thread on diyAudio.com](#)

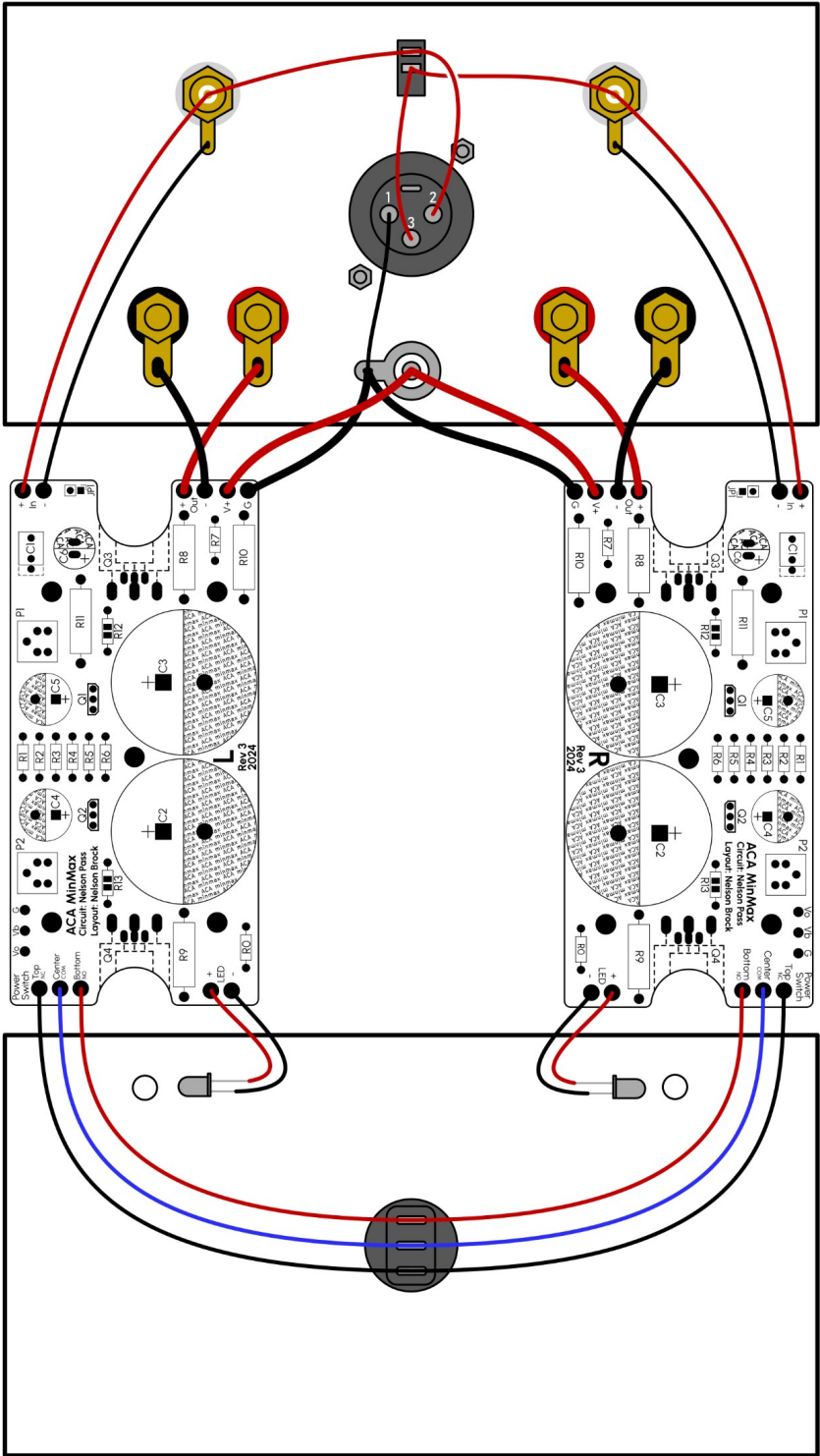
ACA MinMax kit at diyAudio Store

Appendices

Chassis Wiring Diagram

Rear Panel Modifications

ACA MinMax Wiring
For diyAudio Store ACA chassis

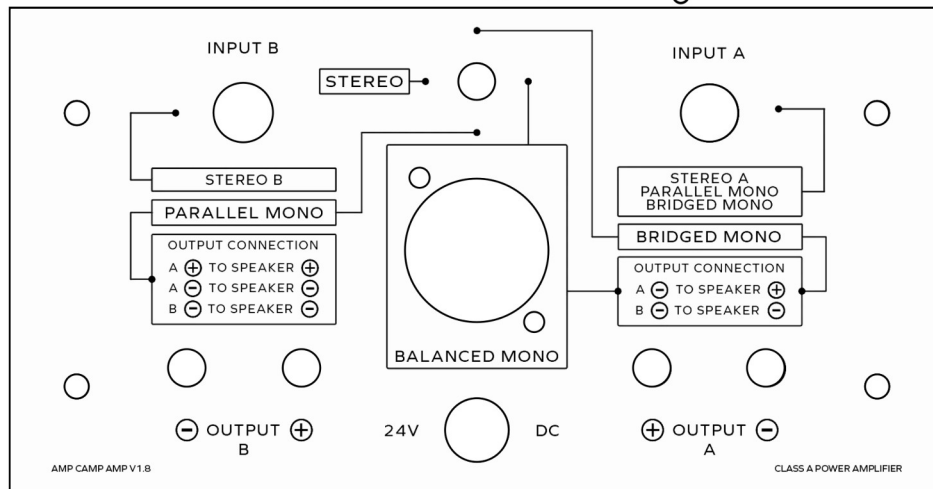


Colors modified for print
Revised 2024/05/07

ACA MinMax Rear Panel Mods

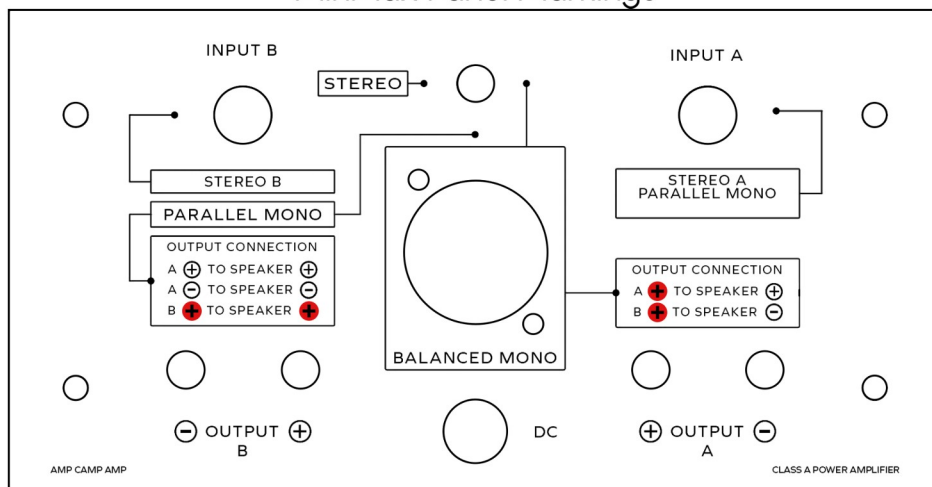
For diyAudio Store ACA chassis

Standard ACA Panel Markings



Use permanant marker to black out the bridged mono markings and use stickers to change output connection polarity as shown below

MinMax Panel Markings



Mark voltage as appropriate for your build

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Revised 2024/04/25