Moving-Magnet Phono Preamplifier (Issue 1) User Manual

ValveWizard, 2020

The ValveWizard Moving-Magnet Phono Preamplifier PCB is a versatile platform for building a professional quality, stereo phono stage. Many different circuit combinations are possible, with either split or all-in-one RIAA equalisation.

Features:

- Classic three-valve architecture –lots of tube options;
- Passive RIAA equalisation –split or all-in-one;
- DC-coupled output cathode follower buffer for driving long cables;
- Grid-cathode arc protection –no HT standby required;
- Very low noise LED biased input stage (could be replaced with ordinary cathode resistor bias);
- Balance trim (can be omitted);
- Low-impedance output with overvoltage protection;
- Series or parallel heaters;
- Multiple resistor/capacitor sites and solder pads to allow different device combinations and packages;
- PCB holes can be used for LED uplighting;
- Compact form factor;

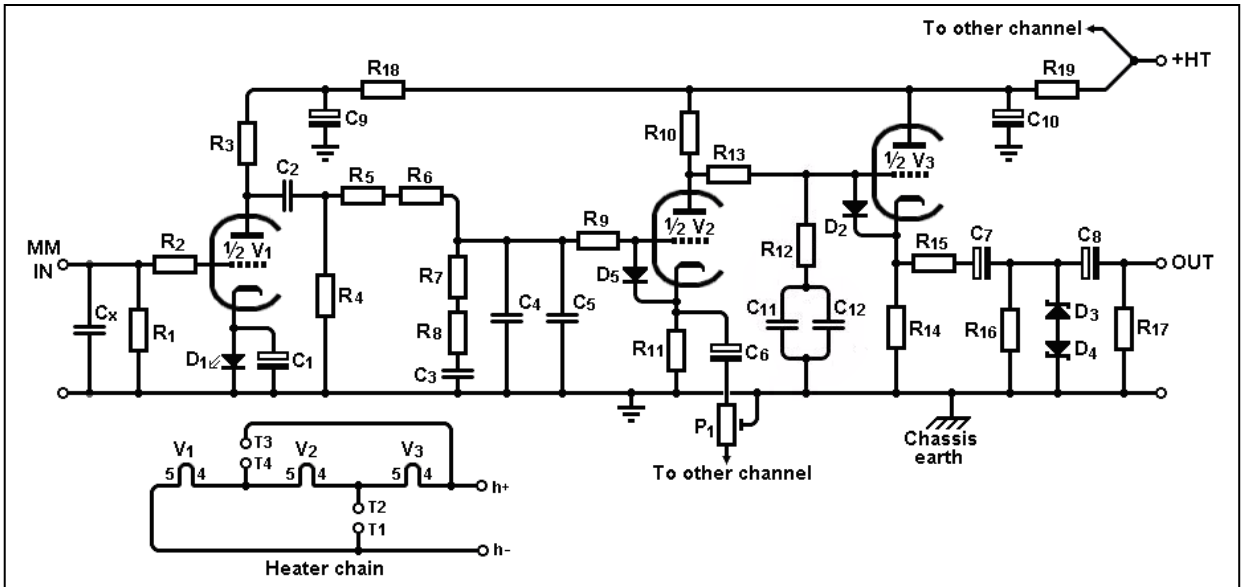


Fig. 1: Schematic showing left channel. Components in the right channel begin with '2', e.g. R18 → R218

Power Supply Requirements:

The two stereo channels each use a pair of cascaded RC power supply smoothing filters to eliminate ripple and to decouple the various stages. The PCB requires an external power supply to provide a single shared HT (B+). The HT voltage must be less than $350V_{dc}$ owing to creepage distance. An HT between 250V and 300V is recommended. When using the component flow chart the phono webpage, the total HT current consumption will typically be 20 to 30mA.

An external heater supply is also required. The total heater current must be less than 1.2A owing to track thickness. A regulated DC heater supply is recommended for minimum noise. It is also recommended that you elevate the heater supply by about one fifth of the HT voltage, to reduce stress on the cathode follower's heater insulation.

Valve Choice:

Check the flow chart for some common valve choices. Valves that are not appropriate for certain positions have been crossed out. However, you also need to consider the heaters. The PCB allows the heaters to be connected all in series, or all in parallel, as shown in fig. 2. Some combinations of valves are therefore not possible.

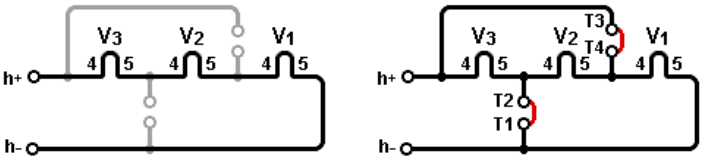


Fig. 2: The heaters are connected in series as standard. To connect the heaters in parallel fit jumper links between the labelled PCB pads as shown.

For example, the 6N1P requires 600mA heater current, so its heater cannot be placed in series with a 12AU7 which requires 150mA. Similarly, the 12AU7 requires 12.6V heater voltage, so its heater

cannot be connected in parallel with an ECC88 which requires 6.3V.* Additionally, the heater current must be less than 1.2A, so you cannot connect three 6N1P heaters in parallel since this would add up to 1.8A. You could, however, connect them in series (600mA).

Pin 9:

When using 9AJ-based valves such as the ECC88 / 6DJ8 or 6N1P, pin-9 is connected to an internal shield. You should therefore connect each pin-9 to ground with a wire jumper, using the pads labelled '9' on the PCB. When using 9A-based valves like the ECC83 / 12AX7, pin-9 is connected internally to the heater, so you should leave these pads unconnected.

Cartridge Loading:

Capacitor C_x can be used for additional cartridge loading. This is not normally needed since there is already enough capacitance provided by the input valve and audio cable, but it may be worth experimenting. R_1 provides the cartridge load resistance which is normally 47kΩ, but check your cartridge manufacturer's recommendation.

Grounding:

Use insulated phono sockets for the audio inputs and outputs. Connect them to the PCB with twisted pair or screened cable. You may also wish to add ferrite beads over the audio input wires to help block RF interference. Add a mounting stud or screw to the chassis near the input sockets –this is for earthing your turntable.

One of the PCB mounting holes is electrically connected to circuit ground, so this will automatically connect circuit ground to chassis if you use metal standoff. No other circuit connections to chassis should be made, including within the power supply!

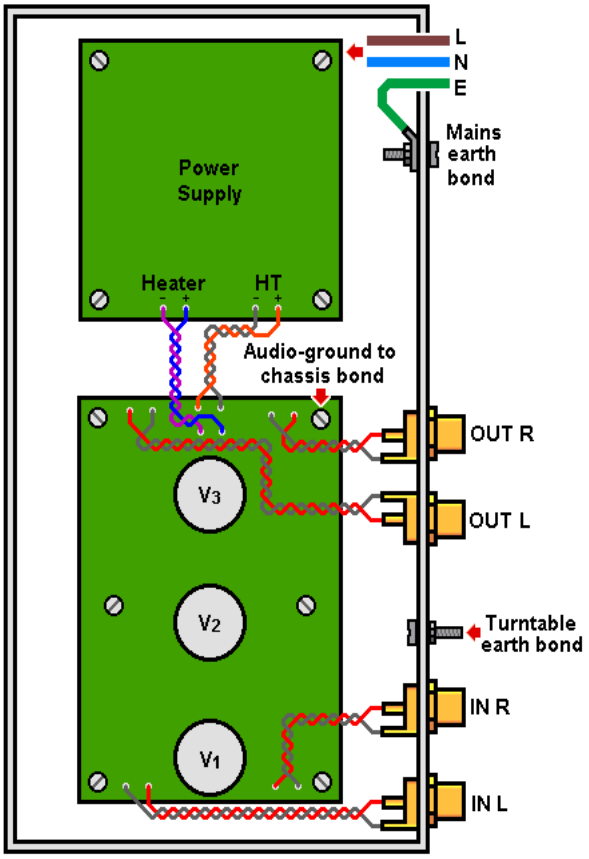
The chassis should be connected to mains earth (house ground) where mains power comes in –see fig. 3.

General Construction:

You can enclose the whole phono stage inside the chassis, or have the valves poking out the top like missiles leaving a silo. Use the PCB as a template –poke a pen through the mounting holes to mark your drill points (do this before populating the PCB!).

Use the flow chart on the phono webpage to find component values to suit some popular valves. Depending on your choices, some components will not be required and have been crossed out. Valve choices that are not suitable have also been crossed out. The chart also provides the estimated Miller capacitance at the input, the gain of each valve stage, and the final output impedance of the preamp. Multiply all three gain figures and divide by ten to get the overall gain at 1kHz.

* Actually you *can* if both V_2 and V_3 are 9A-based and are configured for 6.3V operation, which is possible using some longer jumper wires, but I leave this to experienced practitioners to figure out.



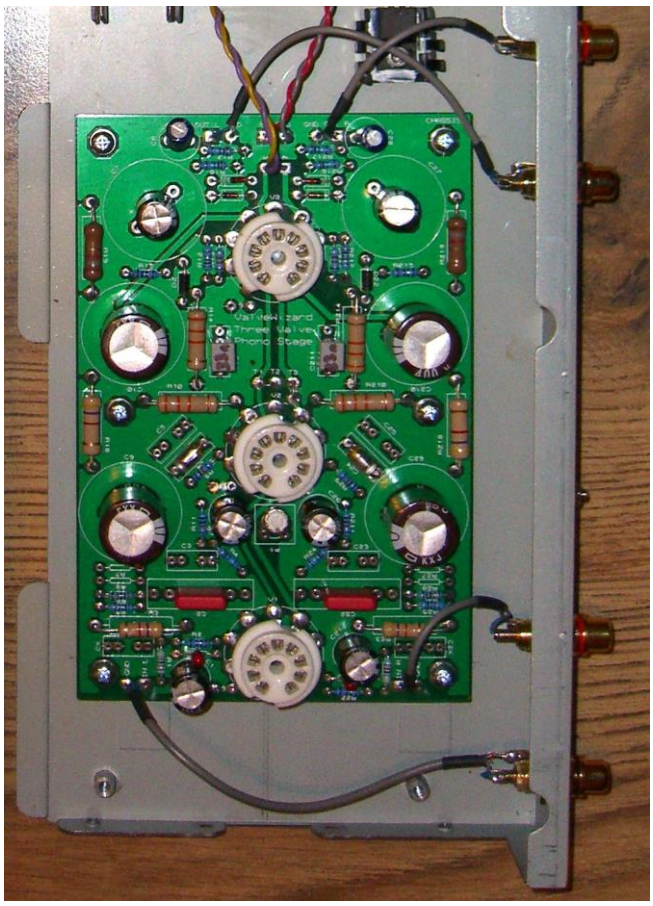


Fig. 3: Simple wiring example.

Clean both sides of the PCB with isopropyl alcohol to remove any grease. Populate the smallest components first, e.g. diodes, followed by small resistors and capacitors. It is recommended that you space the power resistors off the board by about 5mm to allow better air cooling.

Best soldering practice is to tack-solder the component in place first so it does not fall out, then snip off the excess leads. Then re-solder the joints properly. This ensures the cut ends will be fully coated in solder. Failure to do this will leave exposed copper that will oxidise over time.

Testing:

Visually inspect the populated PCB. Check for symmetry between the two halves. Especially check the diodes and electrolytic capacitors' polarities (if the '+' symbol is obscured you can check it against fig. 4).

Attach the heater supply first. If you have a Variac you can use it to bring up the voltage slowly. Measure the heater voltage across the 'H+' and 'H-' solder pads, and check that the valves are glowing normally (a darkened room may help).

When you are satisfied that the heaters are operating normally, turn the heater supply off and attach the HT supply. Switch on the HT (use a Variac if you have one) and carefully measure the voltage across the 'HT' and 'GND' solder pads. The voltage may be higher than normal since the

heaters are not operating. Check the voltage on each side of R18 and R19 and compare with the voltages on each side of R218 and R219 –they should match.

When you are satisfied that there are no problems, switch on the heater supply. The bias LEDs D1/D21 should slowly begin to glow. Check the voltages across R18/R19/R218/R219 again –they should have fallen to a lower level. A mismatch of a few volts is to be expected, since the valves are not perfectly matched.

If you have a signal generator and audio millivoltmeter / oscilloscope you can now use them to measure the gain and adjust the balance pot. You may need to build an attenuator to bring the audio level from your signal generator down to down to about $5mV_{rms}$ to avoid overloading the input.

.

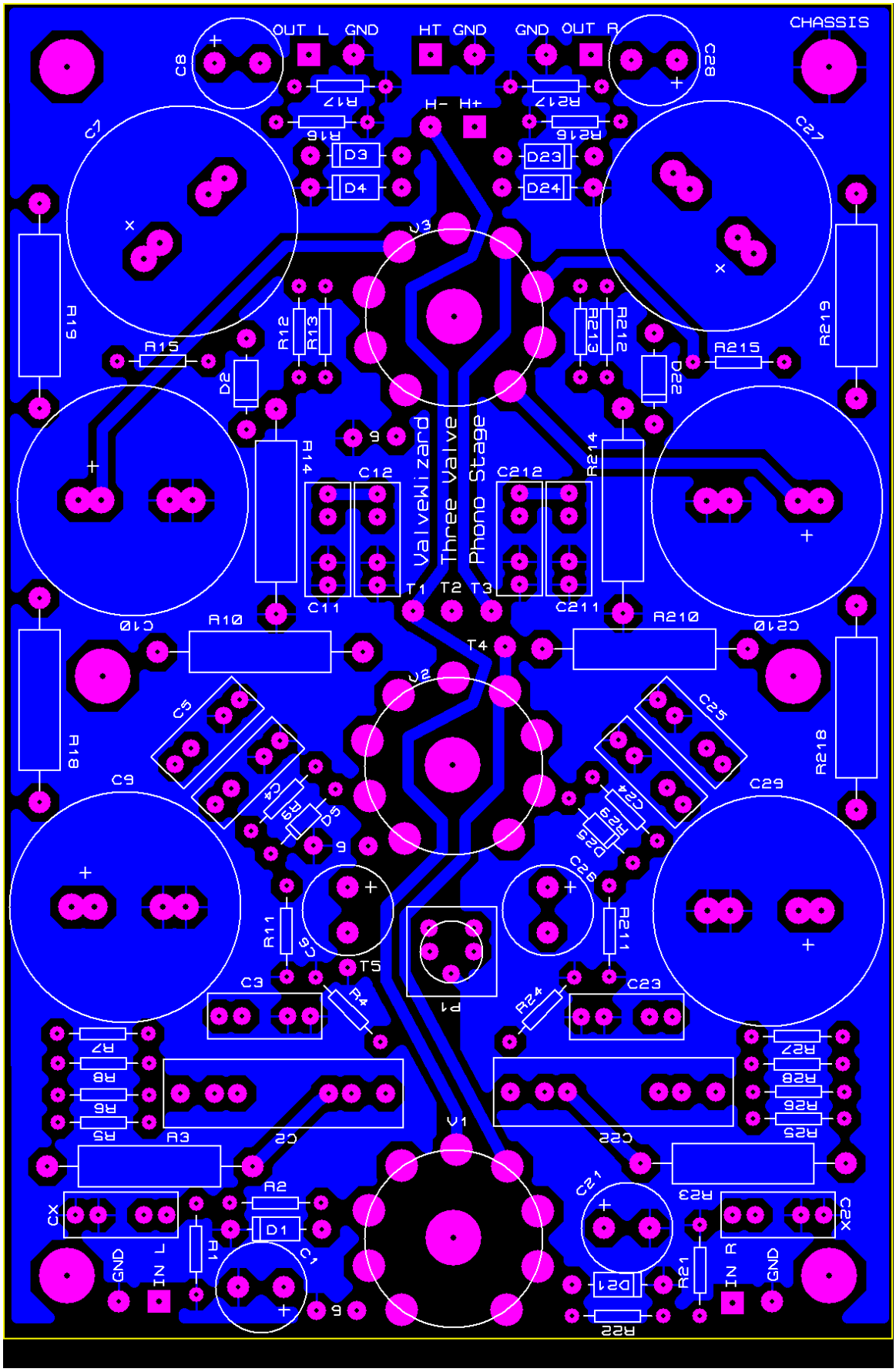


Fig. 4: Top copper and silkscreen. The PCB measures 10 x 15cm.