Corvette®
Headphone Amplifier With Two 6922 (6H23P/6N1P) Tubes

Augustica®
Technologies

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DANGER

This amplifier kit has a high-voltage power supply, which provides high voltage and therefore may produce a lethal shock. Only persons who are competent at electronics assembly and understand the dangers of high voltages may attempt to assemble this kit! Safe assembly and operation of this kit is the users responsibility. The kit and this user manual are provided 'as is'. Augustica Technologies Inc. accepts no responsibility for any damage, injury or death as a result of assembling this kit or using the information herein. The assembled kit must be properly enclosed to prevent contact with high voltages and must be kept out of reach of children. Keep this kit away from water and other damp environs. As with any self-assembled electronics project improper assembly could cause damage to the kit, overloading of a circuit or an electrical fire. If you don't feel comfortable in assembling the kit or using the amplifier, please contact us to return it for a full refund.

Ideally, a variac should be used to slowly power up the power supply of the kit, as it is better to have a misoriented electrolytic capacitor or a mislocated resistor blow at low voltages, rather than at high voltages. Once the power supply is powered up, be cautious at all times. In fact, even when the power supply is disconnected or shut down, assume that capacitors of the power supply will have their high voltage charges retained and, therefore, still will be able to provide a lethal shock.

Wear safety eye goggles, which is not as bizarre as it may sound - a bursting power supply capacitor may spray hot caustic chemicals in your face. Make a habit of using only one hand, with the other hand behind your back, while attaching probes or handling high voltage gear, as a current flow across your chest can result in a lethal shock and death. In addition, wear rubber-soled shoes and work in dry environment. Remember, safety first, second, and last.

If you are not an experienced electrical practitioner, before attaching the transformer leads to the printed circuit board (PCB) of the amplifier, have someone who is well experienced in electronics review your work. Again, if you do not feel comfortable in assembling the kit or using the amplifier, please contact us to return it for a full refund.

INTRODUCTION

Tube circuit experts know that even power tubes that can deliver several hundred milliamperes of anode current can never drive a loudspeaker with an impedance of 8 Ω, since the internal impedance of a tube is several kiloohms. The two impedances are thus almost always matched using a transformer. In principle, there is no any objection to using this form of impedance matching, but every transformer tends to degrade the sound quality. Keeping this effect to a minimum requires very careful and complicated coil winding techniques, good-quality transformer iron and large core cross-sections. However, if the load impedance is not just a few ohms but instead several hundred ohms, as is the case with many types of headphones, and if in addition the required power level is not overly high, an amplifier with no output transformer - sometimes referred to as an 'output transformerless' (OTL) amplifier - can be a feasible option. In such a case, the load is driven directly by the tubes.

The headphone amplifier kit Corvette® allows building a headphone amplifier with outstanding sound. Corvette® omits the output transformer, avoids overall negative feedback and uses only high quality coupling capacitors, resistors and other components. The Electro Harmonix® 6922 tubes in left and right channels are closely matched, therefore, the amplifier guarantees a highly linear frequency characteristic and low crosstalk between the left and the right channels. The headphone amplifier Corvette® employs a cathode follower design suitable for use with a single or dual headphone, with each headphone element having impedance between 15 and 300 Ω for the total of 30 to 600 Ω.

AMPLIFIER - THEORY OF OPERATION

The circuit of the headphone amplifier Corvette® is shown in **Figure 1** (Corvette's schematic also appears on the website www.Augustica.com) uses the readily available Electro Harmonix® 6922 double triode to provide amplification. For the purposes of this discussion, we will be considering left channel of the amplifier. The right channel of the amplifier Corvette® is identical to the left channel. A preamplifier stage is necessary to generate signal amplitudes sufficient to drive a headphone. The first triode section with base pins 1, 2 and 3 is used for this purpose. The input signal arrives to the circuit board via a 100-kilo Ω logarithmic potentiometer R1 that serves as a volume control and is directly coupled to the preamplifier stage via capacitor C1. Resistor R2 provides the necessary negative grid bias. Resistor R5 determines the gain, while resistor R4 determines the maximum input voltage. The value of the resistor R5 is selected to assure that the quiescent anode current is situated in the most linear possible portion of the characteristic curve for 6922.

The inverted and amplified input signal on the anode of the first section of 6922 is coupled to the grid of the second section via capacitor C2. The cathode resistor of the second section is split into two resistors R7 and R8. The series resistance of R7 and R8

forms the load resistance, while the voltage division provided by the resistor pair allows the grid bias to be set to the proper level. The bias voltage is decoupled from the load and stabilized by resistor R9 and capacitor C3 before being applied to the grid of the second section of 6922. The anode current flowing through resistor R6 to the triode, which depends on the grid voltage and corresponding characteristic curve, generates a voltage across the combination of R7 and R8 that is exactly proportional to the current. This voltage is in turn fed to the headphone via coupling capacitor C5. Resistor R12 holds the output at ground potential for DC signals in order to avoid crackling noises when the headphone is plugged into stereo jack.

POWER SUPPLY -THEORY OF OPERATION

The power supply for the headphone amplifier Corvette® is shown in **Figure 1**. The power supply uses two transformers (not shown on the schematic). The first transformer is employed to provide high B-plus voltage applied to anodes of both sections of 6922 tubes and is connected to the terminal block K2. The second transformer is employed to provide low voltage applied to filaments of 6922 and is connected to the terminal block K3.

The high AC voltage produced by the first transformer is rectified by the rectifying bridge D1-D4 and then smoothened by capacitors C15, C16, C17, and C18. The capacitors connected in parallel with the diodes of the rectifying bridge D1-D4 suppress high-frequency noise generated by the diodes of the rectifying bridge. The high DC voltage then is applied to a MOSFET transistor that serves as a voltage regulator and AC filter. Resistors R24 and R25 are responsible for a 15 second delay during which the high B-plus DC voltage reaches its maximum level of 310 Volt. This delay is significantly increases longevity of the 6922 lifespan. Finally, additional smoothening of the high B-plus DC voltage is provided by capacitors C19 and C20. Red LED D7 serves not only as high B-plus DC voltage pilot light, but also, together with resistors R26 and R27, provides a minimum load and ensures that the high capacitance capacitors C16, C17, C18, and C20 are discharged once the power supply is switched off, even if no load is connected to the power supply.

The low AC voltage produced by the second (filament) transformer is rectified by the rectifying bridge D8–D11 and then smoothed by capacitors C25, C26, C27, and C28. The capacitors connected in parallel with the diodes of the rectifying bridge suppress high-frequency noise generated by the diodes of the rectifying bridge. High stability filament voltage of 6.3 Volt is produced in a simple manner using a low drop voltage regulator IC2 LD1084V. Green LED D10 serves not only as a pilot light, but also, together with resistor R30, provides a minimum load and ensures that the high capacitance capacitors C26, C27, C28, and C30 are discharged once the power supply is switched off, even if no load is connected to the power supply.

ASSEMBLY

Cleanliness is essential. Before soldering, be sure to clean both sides the PCB with 70% to 90% isopropyl alcohol. Do not use dull looking solder. Solder should shine. If it does not shine, first clean away the outer oxidation with some steel wool or a copper-scouring pad. If the resistor leads look in the least gray, clean away the oxidation with either steel wool or a wire sniper's sharp edges. Admittedly, with new resistors and a fresh PCB, such metal dulling is rare, but if the parts have sat in your closet for a year or two, then expect a good amount of oxidation to have developed.

Be consistent in orienting the resistors, capacitors and diodes. Keep nominal information on a resistor's or capacitor's body flowing from the left side to the right side as you face the resistor or the capacitor straight on. This will pay dividends later, if you need to locate and de-solder a resistor, a capacitor, or a diode placed in a wrong location. Because the board is double sided, with traces and pads on each side, it is easier to solder the resistors from their topside. As the PCB is overbuilt, it is difficult to remove an incorrectly placed part. Be sure to confirm all the electrolytic capacitor orientations, as a reversed polarized capacitor can easily vent (or even explode) when presented with high-voltage. Confirm trice, solder once.

Start with assembly of the high B-plus DC voltage bus of the power supply and first attach the MOSFET transistor IC1 to its heatsink. This transistor is extremely sensitive to electric static, therefore, you must use ESD safe soldering station and you also must ware an ESD bracelet. Once you attached the MOSFET transistor to its heatsink, you can insert heatsink leads and the MOSFET transistor leads into the PCB. Solder the leads of the MOSFET transistor to the PCB. At this point do not solder the heatsink's leads to the PCB - you will do it later.

Second, solder the rectifying bridge D1-D4 and capacitors C11, C12, C13, and C14. Pay attention to the polarity of the rectifying bridge D1-D4. Solder terminal block K2. Connect a transformer or variac to the terminal block K2 and slowly bring voltage to 220 Volt AC. Measure the high B-plus DC voltage produced by the rectifying bridge D1-D4. If you applied 220 Volt AC to the rectifying bridge, after rectification you should obtain about 320 Volt DC without any load.

Third, solder diodes D5 and D6 and then solder resistors R24 and R25 followed by capacitors C15, C16, C17, C18, C19 and C20. Now solder red LED D7 and resistors R26 and R27. Connect a transformer or variac to the terminal block K2 again and slowly bring voltage to 220 Volt AC. Measure the high B-plus DC voltage produced by the high voltage bus of the power supply as a whole. If you applied 220 Volt AC to the terminal block K2, the power supply should deliver about 320 Volt DC without any load. Measure AC component that is present in the DC voltage after it is regulated and filtered by the MOSFET transistor IC1. The AC component of the high B-plus DC voltage should fluctuate between 2 millivolts and 20 millivolts AC. If your measurements show

substantially higher values of the AC component present in the high B-plus DC voltage, your MOSFET transistor is probably burned out and it has to be replaced. Otherwise, the MOSFET transistor is regulating and filtering the high B-plus DC voltage properly and now you can solder to the PCB the heatsink on which the MOSFET transistor is situated.

Fourth, assemble the low DC voltage (filament) bus of the power supply and start with attaching IC2 LD1084V low drop voltage regulator to its heatsink. Once you attached the LD1084V to its heatsink, you can insert heatsink leads and LD1084V leads into the PCB. Solder the regulator's IC2 leads to the PCB. At this point do not solder the heatsink's leads to the PCB - you will do it later.

Fifth, solder the rectifying bridge D8-D11 and capacitors C21, C22, C23, and C24. Pay attention to the polarity of the bridge D8-D11. Connect a transformer or variac to the terminal block K3 and slowly bring AC voltage to 8 Volt AC. Measure the DC voltage produced by the rectifying bridge D8-D11. If you applied 8 Volt AC to the rectifying bridge, you should obtain about 11 Volt DC after rectification.

Sixth, solder diodes D12 and D13 and then solder resistors R28 and R29 followed by capacitors C25, C26, C27, C28, C29 and C30. Now solder green LED D14 and resistor R30. Connect a transformer or variac to the terminal block K3 again and measure the DC voltage produced by the low voltage bus of the power supply as a whole. If you applied 8 Volt AC to the terminal block K3, the power supply should deliver about 11 Volt DC. Measure AC component that is present in the filament DC voltage after it is regulated and filtered by the IC2 LD1084V. The AC component of the filament DC voltage should be about 0.6 millivolts AC. If your measurements show substantially higher value of the AC component present in the DC voltage, your IC2 LD1084 is probably burned out and it has to be replaced. Otherwise, the LD1084V is regulating and filtering the filament DC voltage properly and now you can solder to the PCB the heatsink on which the LD1084V is situated.

Seventh, solder resistors, capacitors and tube socket of the left channel of the headphone amplifier Corvette®. Start with the tube socket, followed by the resistors and the capacitors. Finally, solder volume control potentiometer R1, headphone stereo jack, and terminal block K1.

Grounding of the volume control potentiometer is required as without it, the amplifier Corvette® may be subject to noise and/or interference. Cut out a wire having length of at least 15 centimeters. Strip out isolation from the wire. Wrap the wire around the threaded portion of the potentiometer's neck making two loops and after that twist together the two ends of the wire. Put on washer and nut included in the kit together with the potentiometer R1. Solder the wire to the ground pad on the bottom side of the PCB.

Eighth, solder resistors, capacitors and tube socket of the right channel of the headphone amplifier Corvette®. Start with the tube socket, followed by the resistors and the capacitors.

Before testing the headphone amplifier Corvette®, visually inspect the PCB for breaks in symmetry between the left and right channels.

TESTING

First, attach only the low voltage filament power supply's transformer windings to the terminal block K3, leaving the high voltage transformer leads unattached and electrical tape shrouded. Do not install 6922 tubes in their sockets.

Second, if you are using a variac, slowly bring up the low AC voltage, while looking for smoke or part discoloration or bulging.

Third, measure the filament voltage regulator's IC2 LD1084V output voltage without and with a load. If the filament voltage regulator LD1084V fails to regulate, try either lowering the DC filament voltage a tad, or increasing it a tad, for example try 10 Volt instead of 11Volt, as the 1 Volt difference might be enough to bring the regulator back into regulation. Power down the filament bus of the power supply by disconnecting low voltage filament transformer or variac.

Fourth, attach the high B-plus voltage transformer or variac windings to the terminal block K2 and slowly bring up the high AC voltage, while looking for smoke or part discoloration or bulging.

Fifth, measure the B-plus voltage provided by the MOSFET transistor IC1. If you applied 220 Volt AC to the terminal block K2, the power supply should deliver about 320 Volt DC without any load measured at the MOSFET transistor. If the headphone amplifier Corvette® is attached to the B-plus bus of the power supply, the power supply should deliver 270 - 280 Volt DC depending on resistance of the load.

Sixth, measure the voltage across ground and B-plus pads of the PCB. If the two channels differ by more than 10 VDC, try switching 6922 tubes from one channel to the other. If the imbalance does not follow the tubes, there is a problem, probably a misplaced part. Only after you are sure that both filament and B-plus power buses are working properly should you attach the amplifier Corvette® to a headphone.

LET US KNOW WHAT YOU THINK

If you would like to see some new audio PCB or kit or recommend a change to an existing product, drop us a line by e-mail on the website www.Augustica.com (begin the subject line with "Corvette" or the spam filters are sure to eat your message).