PR5 RIAA Vinyl Preamplifier - Technical Description

This RIAA vinyl preamplifier is designed to match the RedRoo SE5 power amplifier. It could be used with almost any stereo power amplifier that accepts a line-level input. An input selector switches between either two moving-magnet cartridge inputs, or a moving-magnet and a moving-coil cartridge when fitted with step-up Lundahl Transformers (at additional cost).

Contents

Build details are shown in the Construction Manual supplied with the kitset.

Difficulty Level (1-5)   3.5

Why Valves?

Despite the incredible technological development since the valve era, and the exceptional performance of modern solid-state devices, many musicians and audiophiles still prefer the sound of an old-fashioned clunky valve amplifier. How could valves possibly survive when they are clearly technically inferior? How could a state-of-the-art audio amplifier with impeccable specifications, vanishingly low distortion, and oodles more power, ever be considered inferior to something developed about a century ago?

Almost 40 years ago, (together with Ron Keeley, a noted Australian musician), I designed and described a 140 Watt DIY valve guitar amplifier in the Australian edition of Electronics Today International magazine (Eti) - a popular electronics magazine still published in some countries.

The words Ron and I penned on our Remington typewriters in 1980 are just as relevant today; "the valve vrs. transistor argument will probably never be settled conclusively. Despite all the obvious advantages of solid state musicians prefer valves because, they say, valve amps simply sound 'better', subjectively – like the preference some people have for an old Harley-Davidson or Triumph motorbike, rather than a modern high-revving performance machine. On the other hand there are definite technical reasons why a valve amp will sound 'different'.

3-500Z transmitting valves undergoing stress testing. If you ever see anodes this colour there is something very wrong! Photo: James Hawkins (Amateur Radio Callsign WA2WHV).

It's All About The Sound .....

"The reason most often advanced is that valves produce predominantly second harmonic distortion, whereas transistor amp distortion is mainly third harmonic. While this is true, it is not the whole truth; the distinctive sound of valves is caused by the synergy of many factors, and the spectral balance of the distortion factors is just one of them. Other important factors are the shape of the distortion-power curve, the fact that valve amps are transformer coupled to the load (which affects the overall response of the amp), the higher output impedance of valve amps (resulting in reduced damping of the loudspeaker and a more 'colourful' sound), and the higher 'dynamic output' of valve amps (the ability to deliver relatively constant power output to a varying load; i.e. a speaker). If all these factors could be built into a transistor amp, then possibly it would sound, subjectively, like a valve amp. Many have tried to do this – most have failed".

I do hope this little pre-amplifier brings you lots of satisfaction, both in its construction and its use. I also really do appreciate feedback on any issues you may have and any suggestions about how we can improve this project. Send us an email at www.redrookits.com.au   Have fun!

Phil Wait, RedRoo Kits, Sydney.

Safety Precautions - Read Me!

Valve amplifiers can be dangerous if they are physically damaged, misused, poorly located, or are being worked-on without taking appropriate safety precautions. Valve equipment contains hazardous voltages, (several hundred volts or more), and it can hold a high-voltage charge for a very long time even after the power is switched-off.

Valve circuitry can be very hazardous, even after the power is switched-off. Make sure the internal high voltage power supply is fully discharged before working on any part of the circuit.

- ***Only work on valve circuitry if you are experienced in working with high voltages.***
- ***Make sure somebody is with you, and have an emergency resuscitation chart on the wall of your work area.***
- ***Switch off the equipment at the power point and remove the power-plug.***
- ***Wait several minutes and then check the HV power supply with a DC voltmeter. Do not touch any part of the circuitry unless the DC voltmeter is reading less than 30V.***
- ***Even if the voltmeter reading indicates that the power supply is safe, never trust the meter alone - always double-check. Use a thick insulated wire (bared at the ends), or a screwdriver with a plastic handle, to short out the power supply to the chassis-ground.***
- ***If you need to take measurements or trace signals in valve circuitry while it is switched-on, always keep your free hand in your pocket. Never hold the chassis.***

Never work on hazardous voltage equipment if you are alone.

Valves run very hot and can cause a nasty burn. They can also ignite materials that come into contact with them such as a curtain flapping in the wind.

- ***Position valve equipment carefully so it is away from combustible materials.***
- ***Leave at least 200mm clearance on all sides and the top for adequate ventilation.***
- ***Do not locate valve equipment near curtains or any flammable material.***
- ***Never leave a valve amplifier switched on when unattended.***
- ***Keep out of reach of children***

Never leave valve equipment unattended. Always switch it off after use.

Overview

This design is for an RIAA phono preamplifier for driving the line-level input of a stereo power amplifier. It is designed to visually match the RedRoo SE5 stereo amplifier but can be used with any similar power amplifier. It will will rival RIAA pre-amplifiers many times the cost.

Valve technology is used exclusively in the audio signal path, with solid-state circuitry used where it makes good sense - in the high voltage power supply.

The preamplifier can be powered from any 12.0 - 13.2 Volt DC supply, however most constructors would use a commonly available 12 volt 5 amp in-line computer type power module.
An internal voltage-boost inverter module converts the nominal 12V DC input to the high voltage (280V) required by the valves.

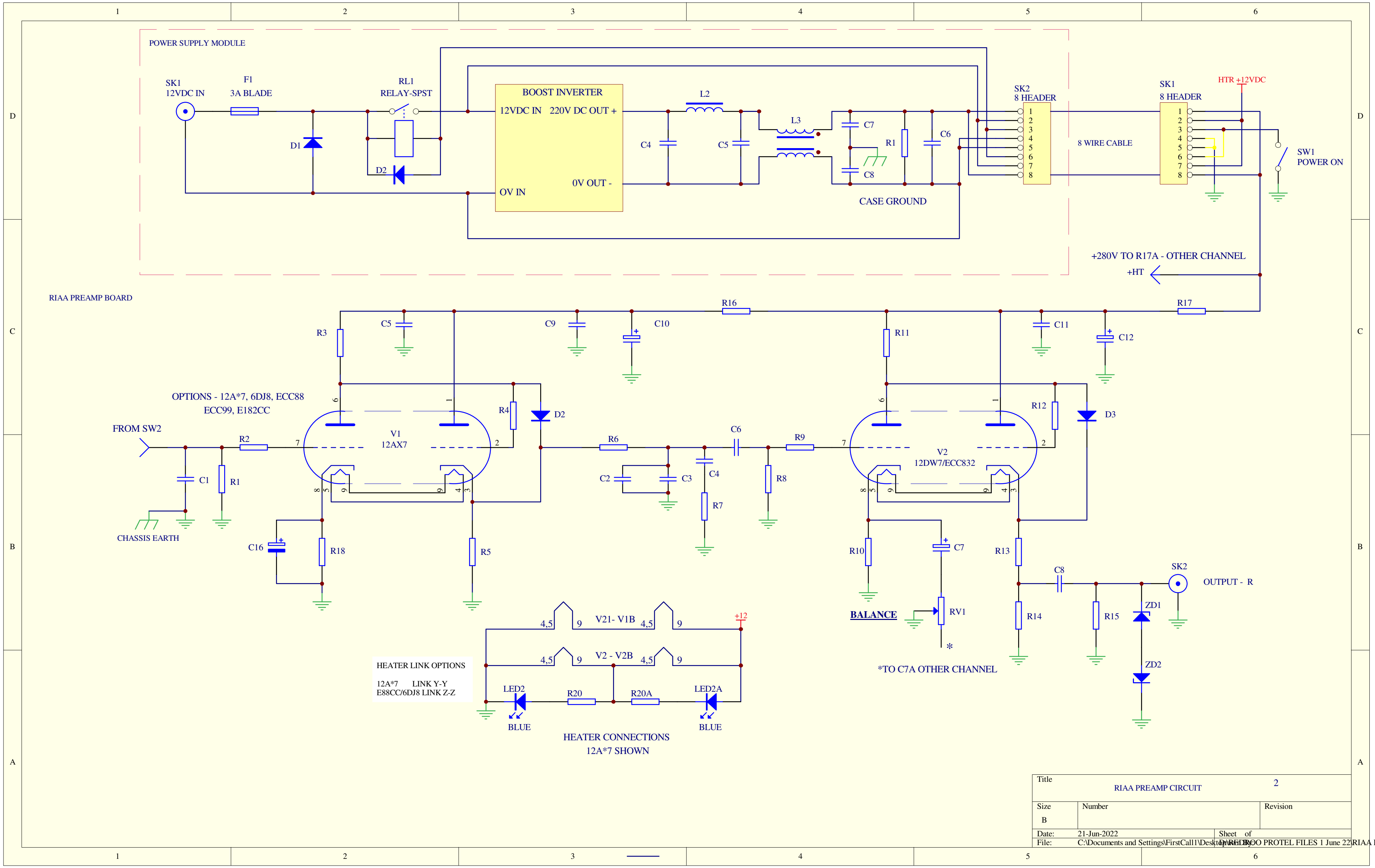
Using a boost-inverter power supply has several advantages over traditional mains-transformer based power supplies, including: much smaller and lighter and less expensive than transformer based circuitry; no power supply induced mains hum in the speaker output; 12V DC is available for the valve heaters; and most importantly, no need for DIYérs to work with mains-power wiring.

A miniture input selector toggel-switch on the front panel allows switching between two moving-magnet inputs, or a moving magnet and a moving coil input when Lundahl moving-coil step-up Transformers are fitted, (option at additional cost).

All electronic components are mounted on an extra thick (2mm) high quality printed circuit board with extra with thick copper tracks, (2oz copper - twice as thick as usual). The heavy duty PC board provides high mechanical rigidity, durability, and improved heat transfer.

All components have been carefully selected for superior performance, long-term stability, and ease of DIY construction. The attractive chassis is constructed from precision cut, bent, and powder coated steel, with detatchable printed fiberglass front and rear panels. Chassis components and spare parts are avaliable from www.redrookits.com

RedRoo kits acknowledges www.tubecad.com for the basic design of the CCDA based preamplifier.


POWER SUPPLY MODULE
SK1
12VDC IN
F1
3A BLADE
RL1
RELAY-SPST
D1
D2
BOOST INVERTER
12VDC IN
220V DC OUT +
OV IN
0V OUT -
L2
L3
C4
C5
C7
C8
R1
C6
CASE GROUND
SK2
8 HEADER
8 WIRE CABLE
SK1
8 HEADER
HTR +12VDC
SW1
POWER ON
+280V TO R17A - OTHER CHANNEL
+HT
RIAA PREAMP BOARD
R16
R17
R3
C5
C9
C10
R11
C11
C12
OPTIONS - 12A*7, 6DJ8, ECC88
ECC99, E182CC
FROM SW2
R2
R1
C1
CHASSIS EARTH
V1
12AX7
R4
D2
R6
C6
R9
C2
C3
C4
R7
R8
V2
12DW7/ECC832
R12
D3
C16
R18
R5
R10
C7
R13
C8
SK2
OUTPUT - R
BALANCE
RV1
R14
R15
ZD1
ZD2
*TO C7A OTHER CHANNEL
V21- V1B
V2 - V2B
4,5
9
+12
HEATER LINK OPTIONS
12A*7 LINK Y-Y
E88CC/6DJ8 LINK Z-Z
LED2
R20
R20A
LED2A
BLUE
HEATER CONNECTIONS
12A*7 SHOWN
Title
RIAA PREAMP CIRCUIT
2
Size
B
Number
Revision
Date: 21-Jun-2022
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File: C:\Documents and Settings\FirstCall1\Desktop\RED ROO PROTEL FILES 1 June 22\RIAA PreAmp 8JUN22

How it Works

Please refer to the circuit diagram. The preamplifier contains four-stages per channel with a passive RIAA equalisation network between each tube. Tubes are used exclusively in the audio path and solid state technology is used in the power supply module. Each channel uses two DC coupled constant current draw amplifiers (CCDA) separated by the passive RIAA equalisation network. The cathode follower stage (V1b) ensures a low impedance drive to the RIAA equalisation network, and the second cathode follower (V2b) provides a low impedance output for driving signal cables and the input impedance of a power amplifier. A balance control gives about +/- 5dB of gain adjustment between the two channels.

Input Switching: The input source is selected between two pairs of RCA inputs on the rear panel. One set of RCA inputs can be connected to a moving-magnet phono cartridge. A second set of RCA inputs can either provide a second moving-magnet phono input, or if two optional Lundahl moving-coil step-up Transformers are fitted, a moving-coil input.

Switching between inputs is done by RL1, a gold-contact telecommunications relay. This simplifies the input selection and allows an attractive miniature toggle-switch to be used on the front panel rather than a large hand-wired rotary switch with a bundle of shielded cable terminations.

The Input Stage: The phono signal is DC coupled to the grid of V1a. V1 is configured as a constant current draw amplifier (CCDA) consisting of two cascaded DC-coupled triodes. The first triode is configured as a common-cathode amplifier with an amplification factor (gain) of about 70, and the second triode is a cathode-follower providing no gain but a low output impedance to drive the passive RIAA network.

The main benefits of the CCDA are low output impedance and a constant DC current drain from the power supply. When the input signal at the grid of the first triode goes positive and its conduction increases, its anode voltage will fall. As a result, the voltage on the grid of the DC coupled second triode will fall inline with the anode of the first triode, and its conduction will decrease. Its anode voltage will rise. If both triodes are set-up to have the same anode currents in the zero-signal state, they act as a see-saw; as the anode current through the first triode rises the anode current through the second triode falls. The total current supplied to both triode stages is therefor constant throughout an entire input signal cycle. Diode D3 prevents exceeding the maximum cathode to heater voltage on the second triode during the warm-up period after switch-on, when the valve is not fully conducting. A 12AX7/ECC83 is used for V1 for its high gain.

Passive RIAA Stage: The passive RIAA network (R6-R8, C2-C4, C6) modifies the frequency response of the preamplifier, so it is exactly the inverse of the frequency response of the recording process. If the RIAA network in a preamplifier is accurate, and doesnt deviate from the RIAA specified frequency response mask, the preamplifier will accurately reproduce the original recorded music.

The Output Stage: The passive RIAA stage introduces about 20dB of loss at 1kHz, so it needs to be followed by another amplifier. V2a is a second CCDA amplifier, again providing gain of about 70. The output stage (V2b) is another cathode follower which provides a low impedance to drive the signal cables and the input of a power amplifier.

The ECC832 is a combination tube: the input section is half a 12AX7 and the output section is half a 12AU7. This tube has the advantage of providing very high gain in V2a and good driving power in V2b. A 12AX7 could also be used in all but the most demanding applications. Zener diodes ZD1 and ZD2 limit the output pulse voltage at turn-on, caused by the capacitive coupling effects of C8 and R15. Without these zeners a high voltage pulse on turn-on could damage the unput of an unprotected solid state amplifier.

Readers of the excellent Tube Cad Journal (www.tubecad.com) will recognise the basic CCDA circuitry.

The Power Supply: Power supplies in valve amplifies are large, heavy, and very expensive compared to modern solid-state amplifiers. Because mains pow-
er transformers operate at very low mains frequencies (50Hz or 60Hz depending on country) they have high inductance windings (lots of turns), and large heavy cores in order to avoid magnetic core saturation. Toroidal transformers (those with a closed-loop steel or ferromagnetic core in the shape of a doughnut) offer a significant improvement, but they are still comparatively large and are even more expensive.

The output of a full-wave rectifier is 100Hz or 120Hz pulsating DC. Turning this into smooth DC suitable for an audio amplifier requires a multi-stage low-pass filter consisting of large value filter capacitors, and often one or two large and expensive iron cored inductors (chokes). Additionally, the stray pulsating low frequency electromagnetic field emanating from such large transformers and chokes is often difficult to contain and can easily interfere with sensitive circuitry.

The power supply in this valve amplifier is different and, we believe, a highly worthwhile concession to the 21st century. This amplifier requires 12V DC at approx. 2 Amps, and the 12V DC is up-converted to about 280V DC using a small and efficient voltage-boost inverter module.

Due to the small input signals from a phono cartridge, it was thought prudent to place the inverter in its own shielded enclosure, and also include both a differential-mode filter (C4, C5, L2) and a common-mode filter (L3, C7, C8).

There are significant advantages to this approach:

1. The inverter converts 12V DC from a commonly available in-line or bench power supply to a high frequency AC waveform, which is then transformed up to the high voltage using a very small, lightweight, and inexpensive ferrite-cored transformer. (This is possible because of the high switching frequency, about 37kHz).

2. As the switching frequency is well above the human hearing range, there is no audible power supply noise (hum) in the loudspeakers.

3. The filter components following the rectifier in the inverter (C4-C8, L2, L3) are small and inexpensive. (Again due to the high switching frequency).

4. The inverter is supplied as a pre-assembled module. The resulting preamplifier is smaller and lighter. (The 150 Watt inverter used is loafing along).

5. And, possibly most important of all - there is no need to work on mains power wiring. The external 12V DC power supply is commonly available in most countries and, if purchased locally, should carry all the necessary regulatory approvals and the correct power plug for the country of purchase.

There are some excellent resources for those who wish to learn more about valve audio technology. For those starting out www.valvewizard.co.uk is excellent, or for those up for a challenge John Broskie's TubeCad Journal at www.tubecad.com is our favourite. Morgan Jones' Valve Amplifiers, Third Edition ISBN: 978-0-7506-5694-8 is required reading.

Specifications

The following measurements are of the prototype. All measurements taken with and HP8903B Audio Analyser and reverse RIAA equalisation network

Circuit Configuration:
Input stage - Twin-triode CCDA configuration using 12AX7. Alternative input valves include: 6DJ8/E88CC/and all 12A*7 series with minor component changes. PC Board links can convert heater connections for 6 volt heater valves such as 6DJ8/E88CC.
Output stage - Twin-triode CCDA configuration using 12AX7. Alternative input valves include: 6DJ8/E88CC/and all 12A*7 series with minor component changes.
DC heaters - Heaters connected in series to 12V DC input.

Signal Inputs:
Two-position toggle switch selects between two sets of RCA phono inputs. One input can be configured for a moving-coil phono cartridge by inserting optional Lundahl LL9226 step-up transformers (etra cost).

Circuit Gain (moving-magnet): 49dB

Balance control range: +5dB -0- +5dB

RIAA Accuracy: +/- 0.5dB 20Hz - 18kHz (Simulated)
(Actual measurement is limited by the accuracy of inverse RIAA network used for testing. Measured within +/- 1.5dB)

Distortion: 0.3% @ 1V rms output @ 1kHz

Hum and Noise: -55dB wrt 1Vrms output unweighted 20Hz - 30kHz
(Be careful comparing this figure to 'weighted' measurements which will appear much better but are largely meaningless).

Channel Separation: 53dB

DC Input: **12 V @ 1 Amps 12 W**
(Input voltage range 12.0 -13.2 VDC. Polarity protected by reverse diode and a 3A internal fuse. Input connector is normal 5.5 x 2.1mm concentric - centre +)

Dimentions and Weight: 154mm x 240mm
(inc. balance knob)

Specifications are typical specifications and may change without notice.