

Universal Volume Control Application and Instructions

For DIY and assembled units

DIYHFS

8/13/2009

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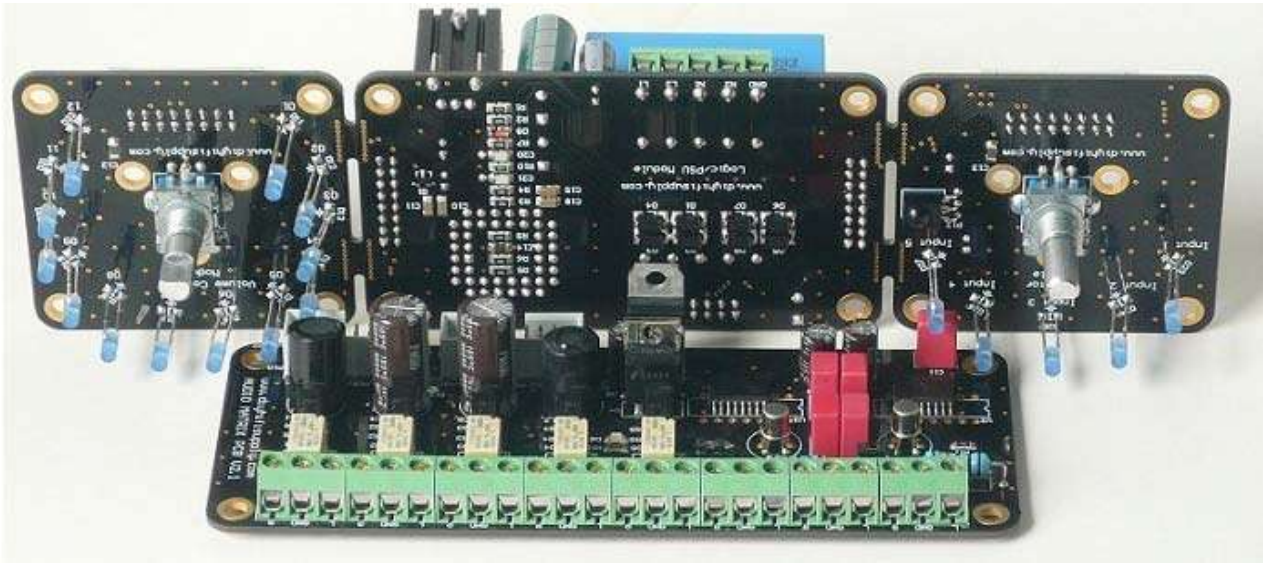
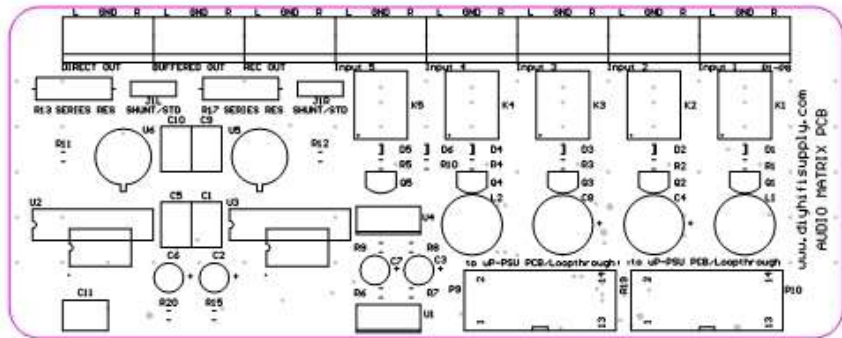
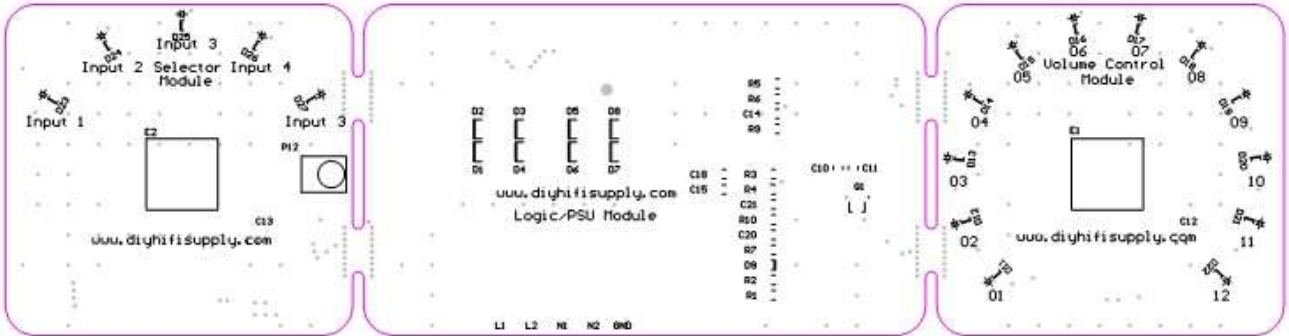
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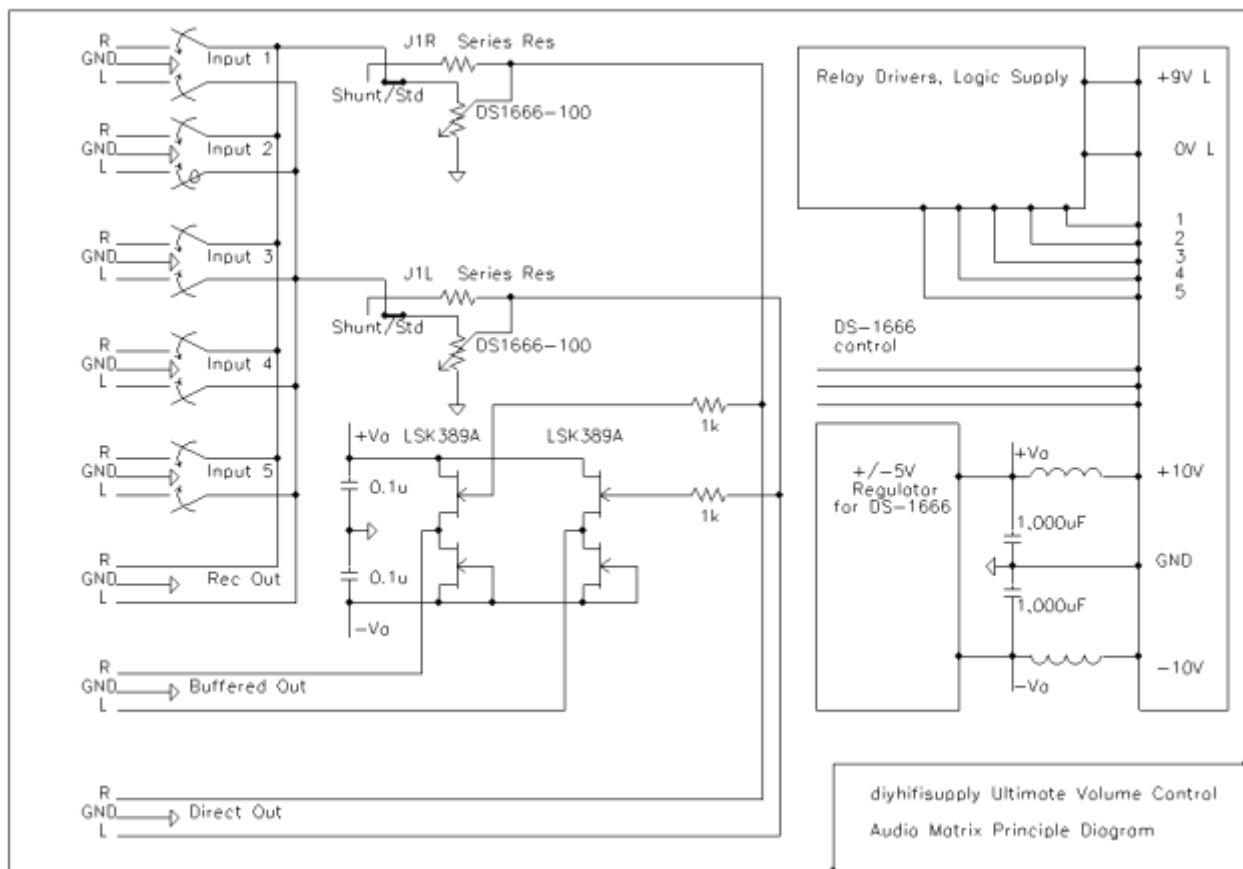
Introduction and Overview

The diyhifisupply® Ultimate Volume Control (UVC) has been designed to offer a State of the Art volume control and input switching selection. It is intended to be applied to integrated amplifiers and preamplifiers, to be used with any compatible following active stage.

The Ultimate Volume Control is built around the Dallas Semiconductor DS-1666 digitally controlled analogue potentiometer (DCAP), as used in all current Audio Research Preamplifiers.

Unlike other common volume control chips the DS-1666 DCAP does not contain a build in op-amp, nor does it require them to be applied externally. In essence it is just a 128 Step Attenuator on a chip, using a resistor ladder and FET Switches instead of a resistor ladder and mechanical switches.

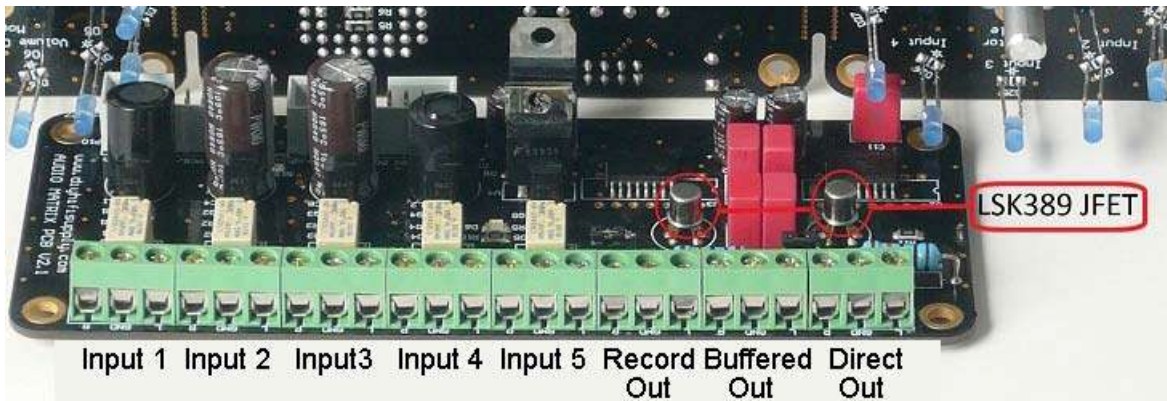
Additionally an option is provided on-board to add a pair of direct coupled, zero negative feedback J-FET buffers, thus making the UVC into a fully self contained buffered passive preamplifier.



The Ultimate Volume Control (UVC) is made up of two circuit boards, one circuit board, the Audio Matrix, handles all audio functionality, the second circuit board, the Control Matrix handles all logic functions and contains the power supply.

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The Audio Matrix PCB



Each Audio Matrix PCB has five 2-Channel line level inputs selected via high grade hermetically sealed gold over silver contact relays, and five two channel attenuators using the DS-1666 DCAP and optionally a 2 Channel J- Fet Buffer (2pcs LSK389A available separately). It also contains the local power supply with LC filtering for the buffer and further regulation for the DS-1666 DCAP.

Where more than two channels are required, multiple Audio Matrix modules can be used to give the number of channels required. For example two Audio Matrix Modules are needed for a balanced preamplifier, 3 Audio Matrix Modules offer 6 single ended channels for 5.1 channel surround sound systems.

The DS-1666 DCAP can be used in standard mode or shunt mode for sound quality that is improved or adjusted to personal taste.

When using shunt mode there is always only one resistor in series with the signal. This resistor on the UVC is a standard 1W Metal Film type but may be replaced by Tantalum Resistors, Vishay Bulk Foil or Allen Bradley carbon composition types or any others to suit personal taste.

In addition using values other than the 100KOhm series resistor fitted as standard allows the volume control range to be adjusted to best match a given system. Larger values than 100KOhm increase the attenuation when the volume control is set to maximum, giving more control at lower levels.

For example, when using the UVC with an amplifier that produces full power at 100mV input (ie many vintage valve amplifiers) a CD source would always require at least 26dB attenuation.

In this case adding a 820KOhm resistor into each of the signal lines from the CD Input will produce around 20dB attenuation with the volume control fully open, thus matching amplifier sensitivity correctly to the source and allowing the available 52dB attenuation range to be used optimally.

Shunt-mode resistor: written on the PCB "series res" and is next to "shunt/std" Jumper.

To calculate resistor value for any given attenuation: Where

Rs	-	Series Resistor	(KOhm)
Rmax	-	DS1666 maximum resistance	(KOhm)
Rmin	-	DS1666 minimum resistance	(KOhm)
Att	-	Attenuation	(dB)

For the DS1666-100 the maximum resistance is nominally 100KOhm and the minimum resistance (before mute) is nominally 243Ohm or 0.243KOhm.

AttMin	=	$20 * \text{LOG} ((Rs + Rmax) / Rmax)$
AttMax	=	$20 * \text{LOG} ((Rs + Rmin) / Rmin)$

Example: the supplied 100K series resistor the maximum attenuation is 52dB and the minimum attenuation is 6dB as follows:

AttMin100K	=	$20 * \text{LOG} ((100 + 100) / 100) = 20 * \text{Log}(2) = 6\text{dB}$
AttMax100K	=	$20 * \text{LOG} ((100 + 0.243) / 0.243) = 20 * \text{Log}(428.4) = 52\text{dB}$

Attenuation for any other resistances derives using the same method.

If the load impedance is not infinite (e.g. UTS at 12dB gain ~ 250K) this must be taken into account and calculated as being in parallel with the DS1666 Resistance

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The Control Matrix PCB

The matrix is supplied as one whole PCB for ease of use, but can be broken up into three separate PCB's for increased flexibility in mounting it.



For ease of application all connections on the Ultimate Volume Control are provided as solder less screw terminals for all audio connections and IDC Cables (included) for all logic and power supply connections. All configurations are handled by gold-plated jumpers, so no soldering is required on the actual Control Matrix.

For those desiring soldered connections instead we recommend to simply solder the wires to the solder pads below the PCB. It is also possible to unsolder the screw terminals and solder the wires in the holes thus available.

Equally, for those wishing a soldered configuration instead of jumpers, simple solder bridges can be soldered across the jumper pins below the PCB, or the jumpers can be removed completely and a wire bridge inserted.

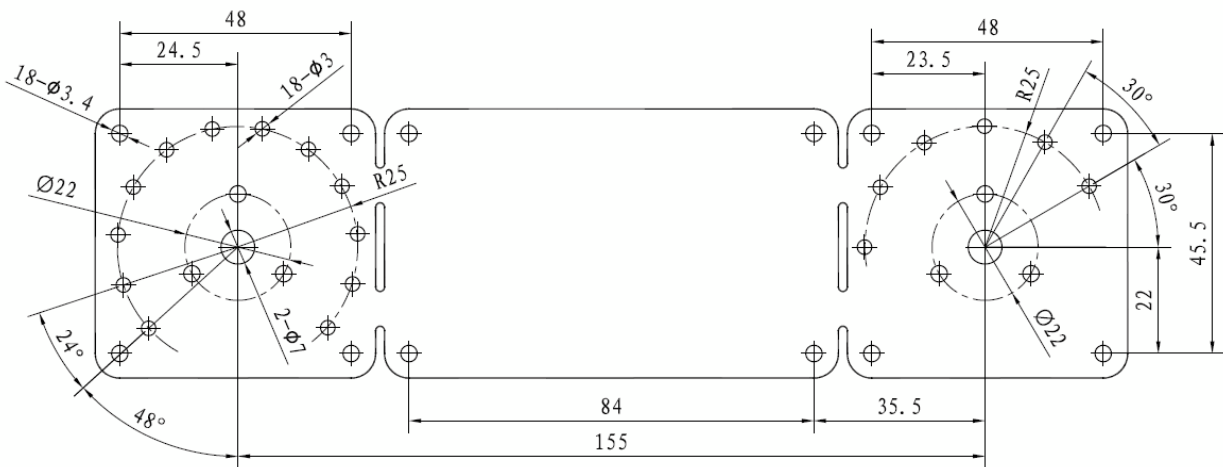
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1 Mounting & connecting the Control Matrix

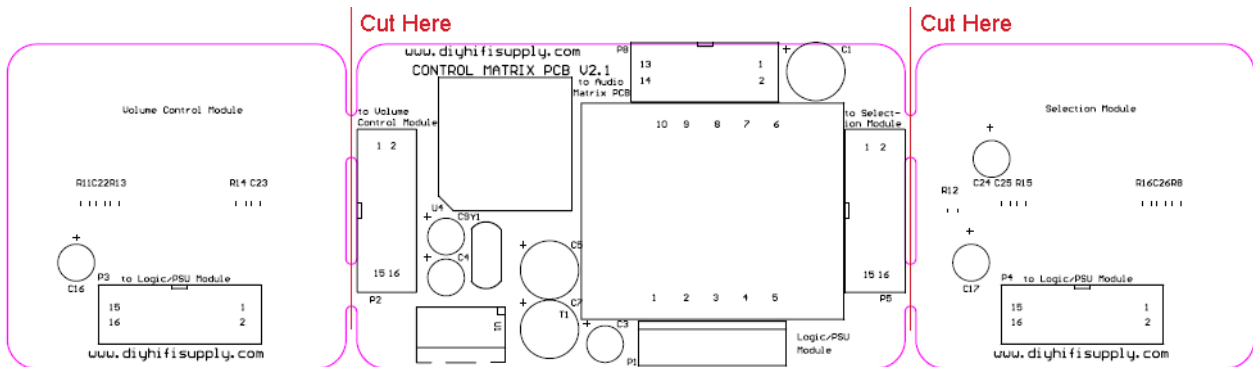
1.1 Mounting the Control Matrix

If using a pre-machined front panel, simply mount the Control Matrix PCB using the supplied hardware. It is not necessary to fit the ribbon cables between Logic/PSU Module and the Volume Control and Selector Module if the pcb is used as a single module (ie not broken in 3 parts)

If fitting to your own front panel or into existing equipment use the supplied drill guide to drill the necessary holes. Several fixing options exist, including for the use of standoffs; use what is most appropriate for the actual application.



If it is necessary to detach the Volume Control and Selector modules, use a sharp hobby knife and cut cleanly along the lines indicated (they are also printed on the PCB) several times. This will cut the connecting PCB traces cleanly.

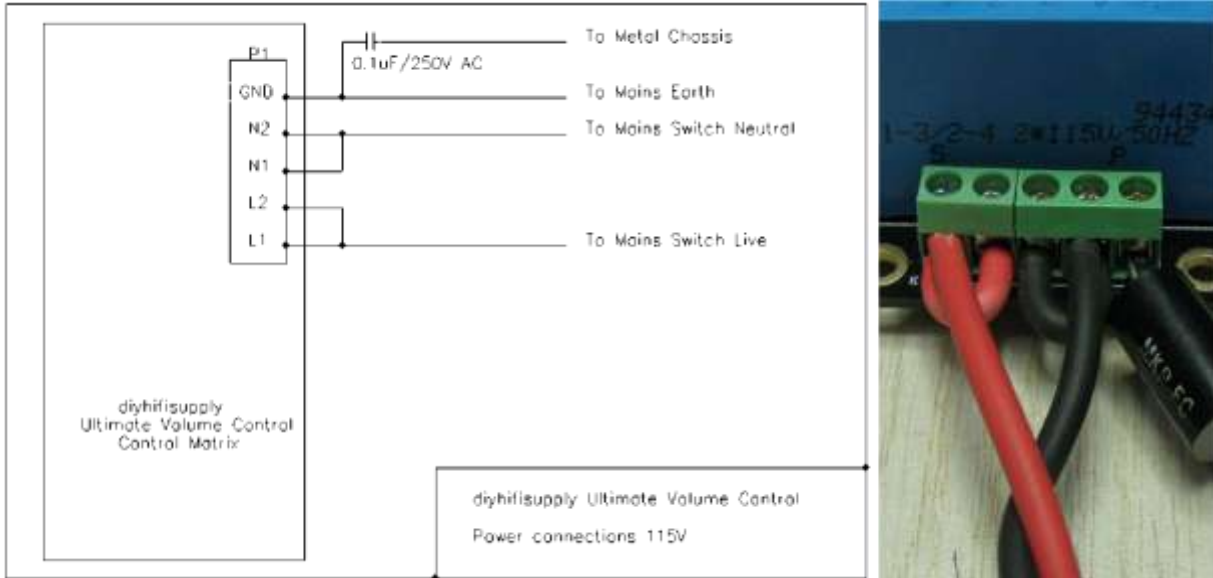


Following this the Volume Control and Selector modules can be broken off quite easily.

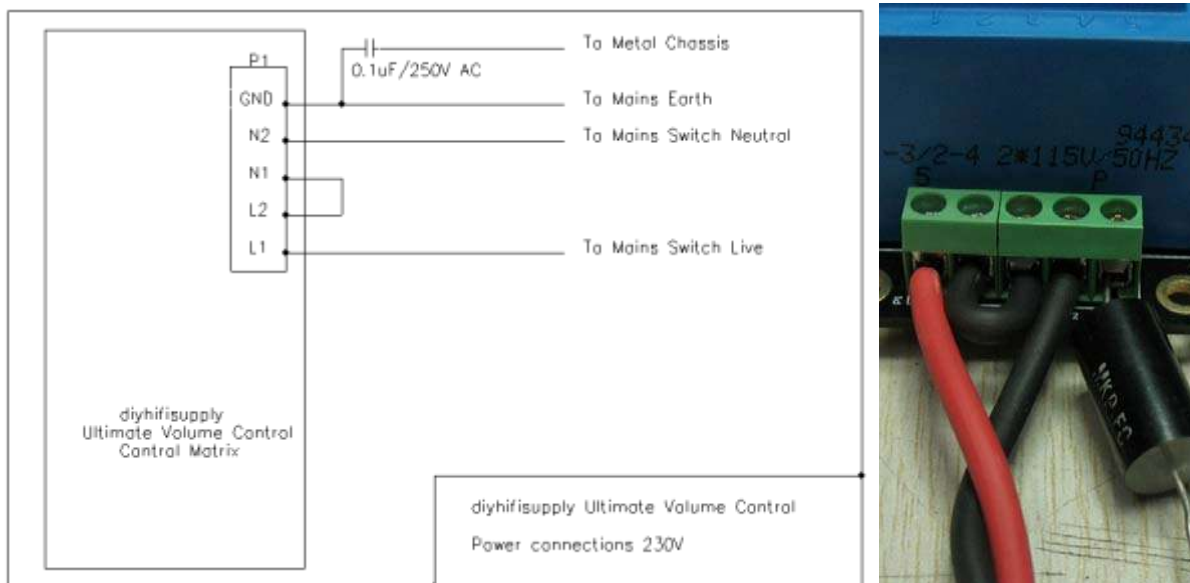
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1.2 – Power Supply Wiring

If your local power supply is in the range of 100V to 120V AC wire up the mains connections as shown below.



If your local power supply is in the range of 220V to 240V AC wire up the mains connections as shown below.



In order to ensure electrical safety please make sure that the PCB is mounted at least 6 mm Distance between its solder side (lower surface) and nearest metal chassis part (e.g. the front panel).

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1.3 – Connecting the Ribbon Cables

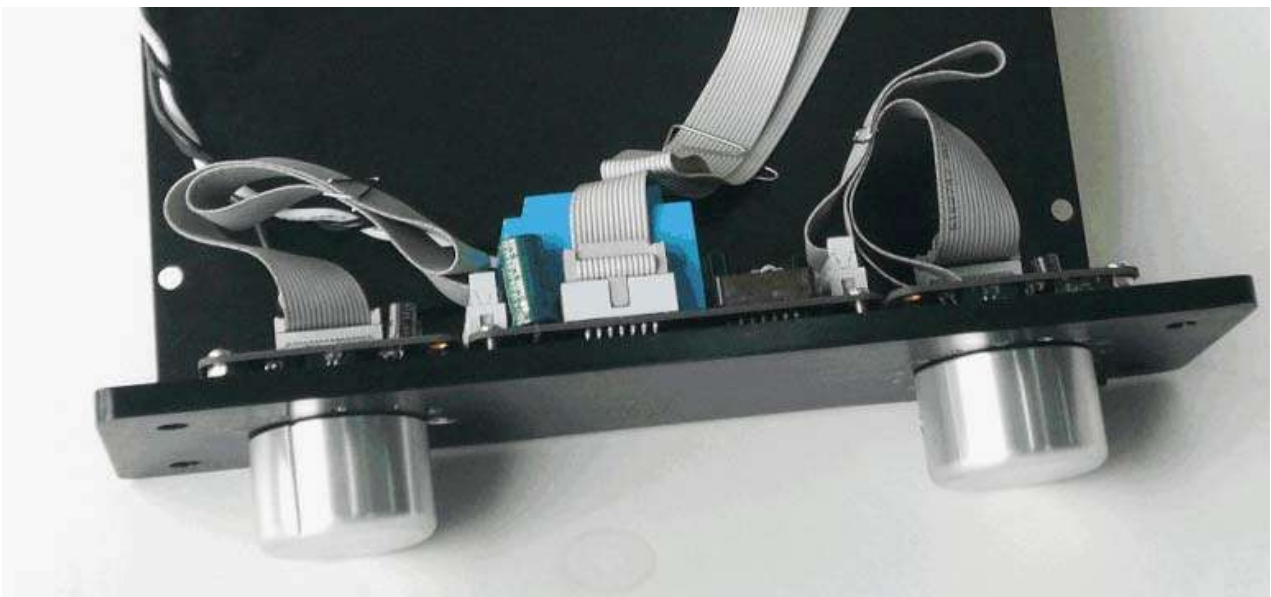
The Control Matrix PCB is fitted with five connectors for IDC type ribbon cables.

Four of these connectors are of the 16-Pin type. They are used to connect the Volume Control and Selector modules to the Logic/PSU module if they have been detached from each other.

If the whole Control Matrix has been retained as a single block it is not necessary to connect these cables.

Make sure you connect the correct module to the correct socket (the sockets on the Logic/PSU Module are labeled, as are the Volume Control and Selector modules).

Shown below is the Control Matrix with all cables connected correctly. Note: the two outside cables are not needed if the volume and selector modules have NOT been detached



The fifth connector is a 14-Pin type and connects the Logic/PSU Module to the Audio Matrix. This cable carries the analog and digital power supplies and the control signals for the input selection and the DS-1666 analog potentiometers. The logic lines are only active when the volume or input is changed and normally there should be no need for any additional shielding or other special routing precautions.

If using multiple Audio Matrix PCB's the cable from the Control Matrix connects to one of the two connectors on the Audio Matrix, the second board is connected using a short IDC jumper cable to the first one and so on.

The power Supply on the Audio Matrix can supply up to three Audio Matrix PCB's with the J-Fet buffer circuits fitted or six Audio Matrix PCB's without J-Fet Buffers.

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2 Audio Matrix Input connections

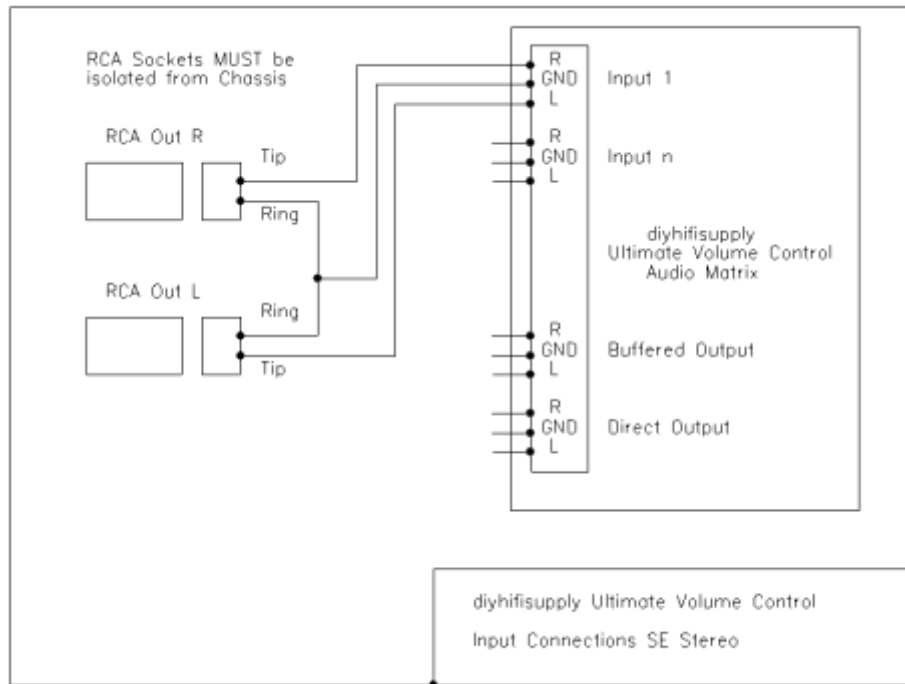
Simply connect the Inputs using suitable wire or cable (shielded cable is recommended) from your input connectors to the UVC Module.

Connections are labeled on the PCB.

Make sure the sockets used do not allow electrical contact between RCA Socket ground and the chassis. Connect each RCA input pairs ground connection to the middle connection of a given input connector. Connect the signal wires (L/R) to the respective connections of the input connector.

Up to five inputs can be accommodated.

For single input applications this input can be connected to REC OUT (ie tape out) connector, bypassing the input switching.



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3 Audio Matrix Output connections

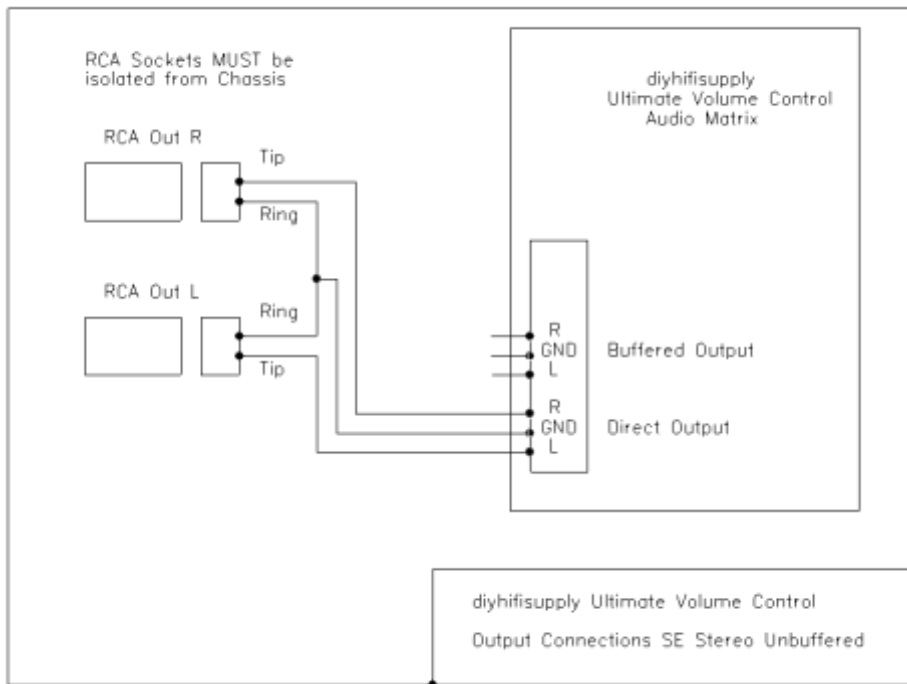
3.11 – Connecting the Direct Output to RCA Output Connectors

The direct output can be connected to an RCA output.

Simply connect the outputs using suitable shielded cable from the UVC Module to the RCA output connectors. Connectors are labelled on the PCB.

Make sure the sockets used do not allow electrical contact between RCA Socket ground and the chassis. Connect the RCA output pairs ground connection to the middle connection of a given output connector. Connect the Signal wires (L/R) to the respective connections of the output connector.

However note should be taken of the high output Impedance (up to 50KOhm in shunt mode and 25KOhm in standard mode) of this output. This may result in hum when using poorly shielded cables and high frequency roll-off when long cables are employed.

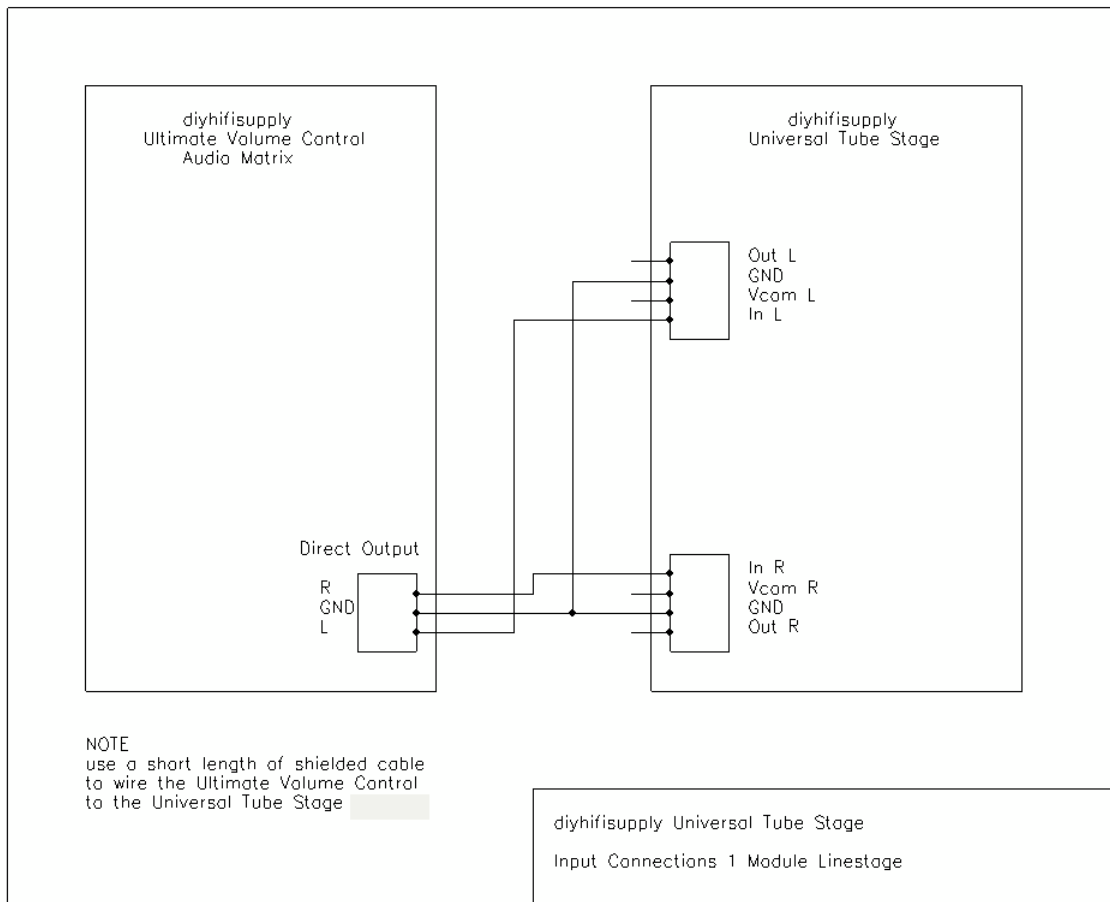


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3.12 – Connecting the Direct Output to an active Linestage

It is preferable to use the direct output to drive a buffer stage or line stage placed in the same chassis as the UVC. Such a circuit may be realised using the Universal Tube Stage (UTS) Module or indeed any other tube or solid state line stage.

Connect the ground (GND) connection to the line stage to the ground connection of the UVC and then connect the left & right signal lines as required.

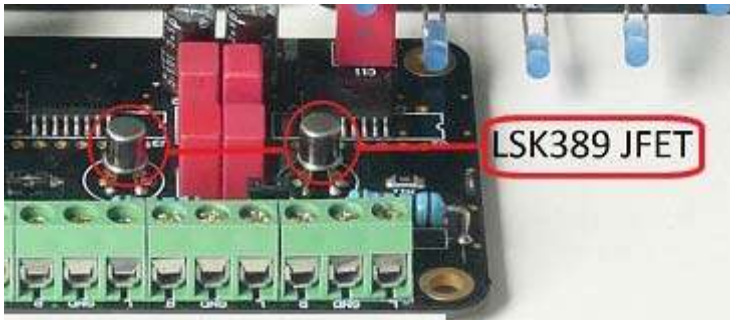


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3.2 – Connecting the Buffered Output

The Buffered output is (optionally) fitted with a minimalist zero feedback J-Fet Buffer of conventional design. This is based around the military grade, metal encased LSK389A monolithic dual J-Fet. Using this expensive but exceptional part combined with the split rail power supply allows to dispense with any input and output coupling capacitors, such as found necessary in some other recent buffered passive preamplifier designs.

This buffer is to provides an output that is compatible with driving long cables and offering a low output impedance well into the radio frequency range. This buffer turns the UVC into a stand alone buffered passive preamplifier.



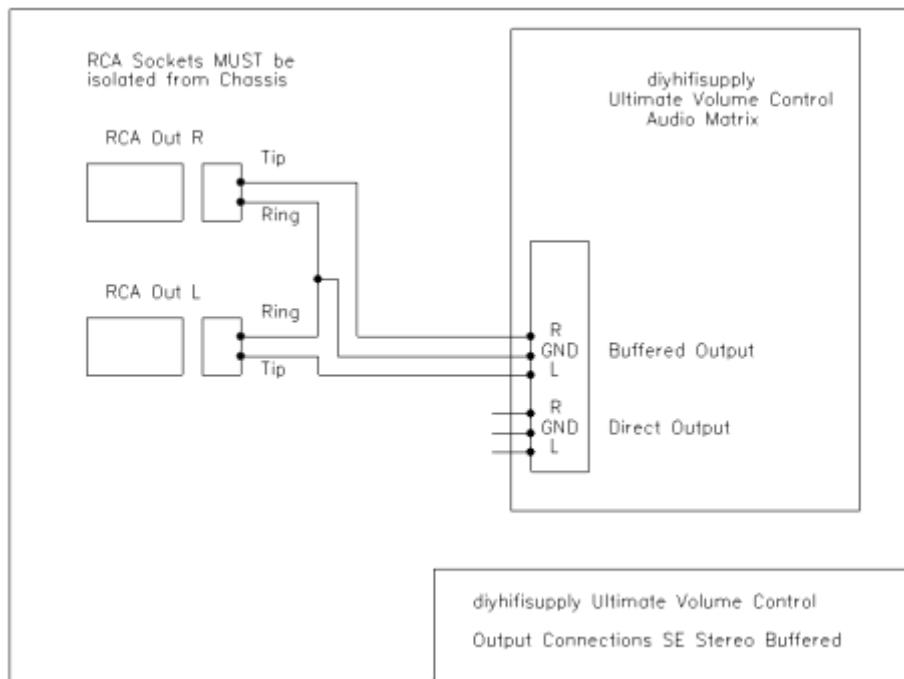
When using this output it is necessary to fit the optional LSK389A Transistors as shown to the left.

Following this simply connect the Outputs using suitable cable or wire (shielding is optional but recommended) from the UVC Module to your output connectors. Connectors are labeled on the PCB.

Make sure the sockets used do not allow electrical contact between RCA Socket

ground the Chassis.

Connect each RCA output pairs ground connection to the middle connection of the buffered output connector. Connect the Signal wires (L/R) to the respective connections of the output connector.



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4 Using Universal Remote Controls to operate the Ultimate Volume

Control

The UVC can be remote controlled from any remote control that implements the RC-5 remote control protocol (see Appendix 1) and supports audio components (Amplifier/Preamplifier).



Examples of relatively inexpensive remote controls that are known to work are the Altronics stock number A1009 "Universal 6 in 1 Remote Control"

<http://www.altronics.com.au/index.asp?area=item&id=A1009>

and the Altronics stock number A0977 "6 In 1 Jumbo Pre-programmed Remote Control".

<http://www.altronics.com.au/index.asp?area=item&id=A0977>



Similar or identical remote controls are available from a range of electronic retailers. Many also offer considerably more sophisticated universal remote control solutions (Logitech, Sunwave etc.) at higher cost which tend to all allow the programming for the use with the UVC.

There are also many universal remote that it intend to only control TV/DVD/VCD/VCRs, but no audio equipment. This type of remote control will not work with the VC. Please make sure the remote control supports audio amplifier devices before purchase as indicated by programmability for audio devices such as 'tuner' 'preamplifier' 'amplifier' etc.

Most universal remote controls work by entering a three or four digit "brand code". This code is in no way standardised, but specific to the individual remote.

It is usually printed in small print on a page included with the remote, listing brand codes and equipment. An example of such an instruction/code page is found here:

<http://www.altronics.com.au/download/Instructions/Other/A0977.pdf>

Note that these codes ONLY apply to the Altronics A0977 "6 In 1 Jumbo Pre-programmed Remote Control" and not to any others.

Select a brand code for an audio amplifier, receiver or audio preamplifier by Marantz, Philips or Rotel. This should produce a working control. Often several codes are listed and it may be necessary to try several ones and possibly several brands.

A Brand Code for an audio device must be used, in other words, a brand code for Philips amplifier will work, but a brand code for Philips TV will not.

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Appendix 1

The RC-5 Remote Control Protocol

The DIYHFS's UVC uses industrial standard Philips RC-5 code

The RC-5 protocol was developed by Philips in the late 1980s as a semi-proprietary consumer IR (infrared) remote control communication protocol for consumer electronics. However, it was also adopted by most European manufacturers, as well as many US manufacturers of specialty audio and video equipment. The advantage of the RC-5 protocol is that (when properly followed) any CD handset (for example) may be used to control any brand of CD player using the RC-5 protocol. #

The RC5 code is made up of 2 parts:

- (1) Device Address (to identify the correct device; e.g. TV, VCR, Pre-amp etc.)
- (2) Command (e.g. Volume +)

The UVC's software is set to respond to RC-5 IR Commands as follows:

Device (Address)

- ¾ Pre-amp01 (0x10)
- ¾ Pre-amp-02 (0x13)
- ¾ Tuner (0x11)

Note: any one of the above device will work.

Commands (address):

- ¾ Volume + (0x10)
- ¾ Volume – (0x11)
- ¾ Channel + (0x20)
- ¾ Channel – (0x21)

www.en.wikipedia.org/wiki/RC-5

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Appendix 2

Features, Technical Data and Application Examples

Features:

- 127 step volume control from -52dB to 0dB attenuation with 12 LED level indicators
- 5 Inputs with LED indicators
- Remote control via universal remote control (RC5 code)
- Options for shunt operation (-52dB to -6dB)
- 5 way Silver alloy relay input switching
- LED's driven on/off, not "multiplexed" to remove digital noise
- Audio PCB includes option for fitting two LSK389A forming a direct coupled zero feedback J-Fet buffer to make a stand alone buffered passive preamplifier
- Control PCB delivered as one PCB but allows "break-off" of the rotary encoder & LED parts connection via supplied 20-Pin IDC cables
- A single Control PCB can control up to 3 Audio PCB's (6 channels single ended or 3 channels balanced)
- Control PCB connects to Audio PCB via 20-Pin IDC cables (supplied)
- Power Supply using schottky diodes and low noise regulators
- Mains transformer with 115/230V Primary capable of supporting 3 Audio PCB's with buffer
- Gold plated, 70 micron Copper PCB's
- Includes drill template (PDF for printing on paper) for drilling front panels for LED's, encoders and fittings

Specifications:

Passive operation standard mode

- Maximum input/output level: 3.5v rms
- Input impedance: Fixed 100kOhm
- Adjustment range: -52dB to 0dB in 127 steps
- Output impedance: < 25kOhm

Passive operation 100k shunt mode (option)

- Maximum output level: 3.5V RMS (note, input level is not limited in shunt mode)
- Input impedance: > 100kOhm
- Adjustment range: -52dB to -6dB in 127 steps
- Output impedance: < 50kOhm

Passive operation all modes

- -3dB Bandwidth: 100kHz (with no capacitive load)
- THD + N: < 0.0001%
- Noise: > -120dB (re. 2V)

Audio module with LSK389 buffers fitted

- -3dB Bandwidth: 100kHz (with capacitive loads up to 1nF)
- THD + N: < 0.004% (2V RMS 10K load)
- Noise: > -120dB (re. 2V)
- Output impedance: < 50 Ohm

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Application Examples:

1. 2-channel buffered passive Linestage of highest quality with remote

- 1 X Control Module
- 1 X Audio Module
- 2 X LSK389

2. Upgrade any 2-channel preamplifier or integrated amplifier with remote control

- 1 X Control Module
- 1 X Audio Module

3. 2-channel tube preamplifier of highest quality with remote

- 1 X Control Module
- 1 X Audio Module
- 1 X Universal Tube Stage (UTS) Module

4. 2-channel balanced tube preamplifier of highest quality with remote

- 1 X Control Module
- 2 X Audio Module
- 2 X UTS Module

5. 5.1-channel tube preamplifier of highest quality with remote

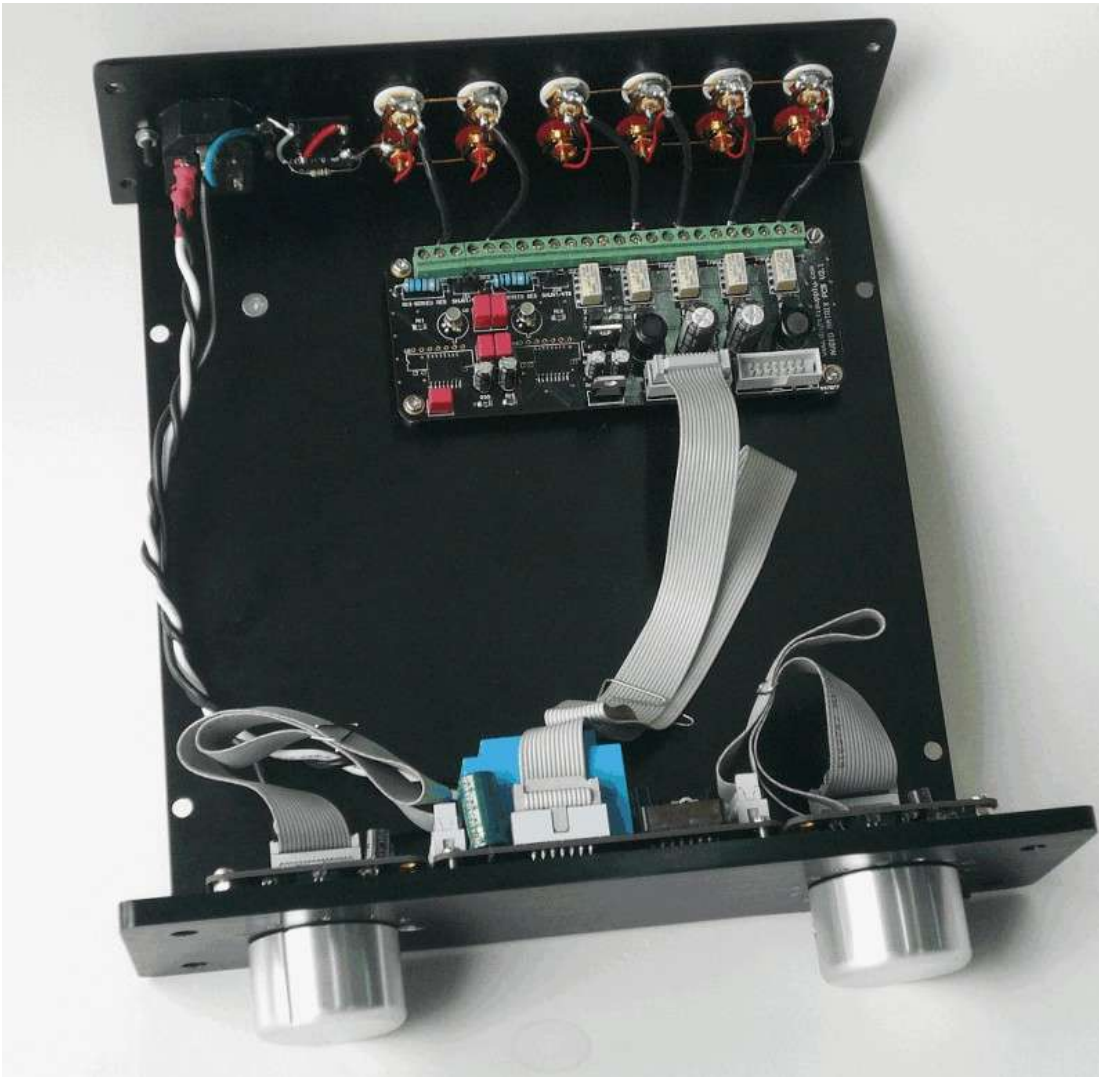
- 1 X Control Module
- 3 X Audio Module
- 3 X UTS Module

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Appendix 3

The UVC based 2 Channel buffered passive Linestage

The picture below illustrates the complete installation of all components of the UVC system in a compact chassis, thus creating a complete passive buffered preamplifier with remote control (requires optional universal remote control).



This project is in many ways comparable to “Aunt Corey’s Homemade Buffered Passive Preamplifier” originally published by Corey Greenberg in the November 1991 Issue of Stereophile (<http://www.stereophile.com/solidpreamps/54/>) updated for the 21st century.

Instead of the long discontinued BUF-03 Buffer IC the UVC’s own buffer uses a very simple, but very high performance J-Fet circuit derived from tube circuitry designed for direct coupling and shown among others by Erno Borbely in Issue 06 1999 of Audio Electronics (Page 18, Fig 15c).

Appendix 4

The UVC/UTS based 2 Channel active Linestage

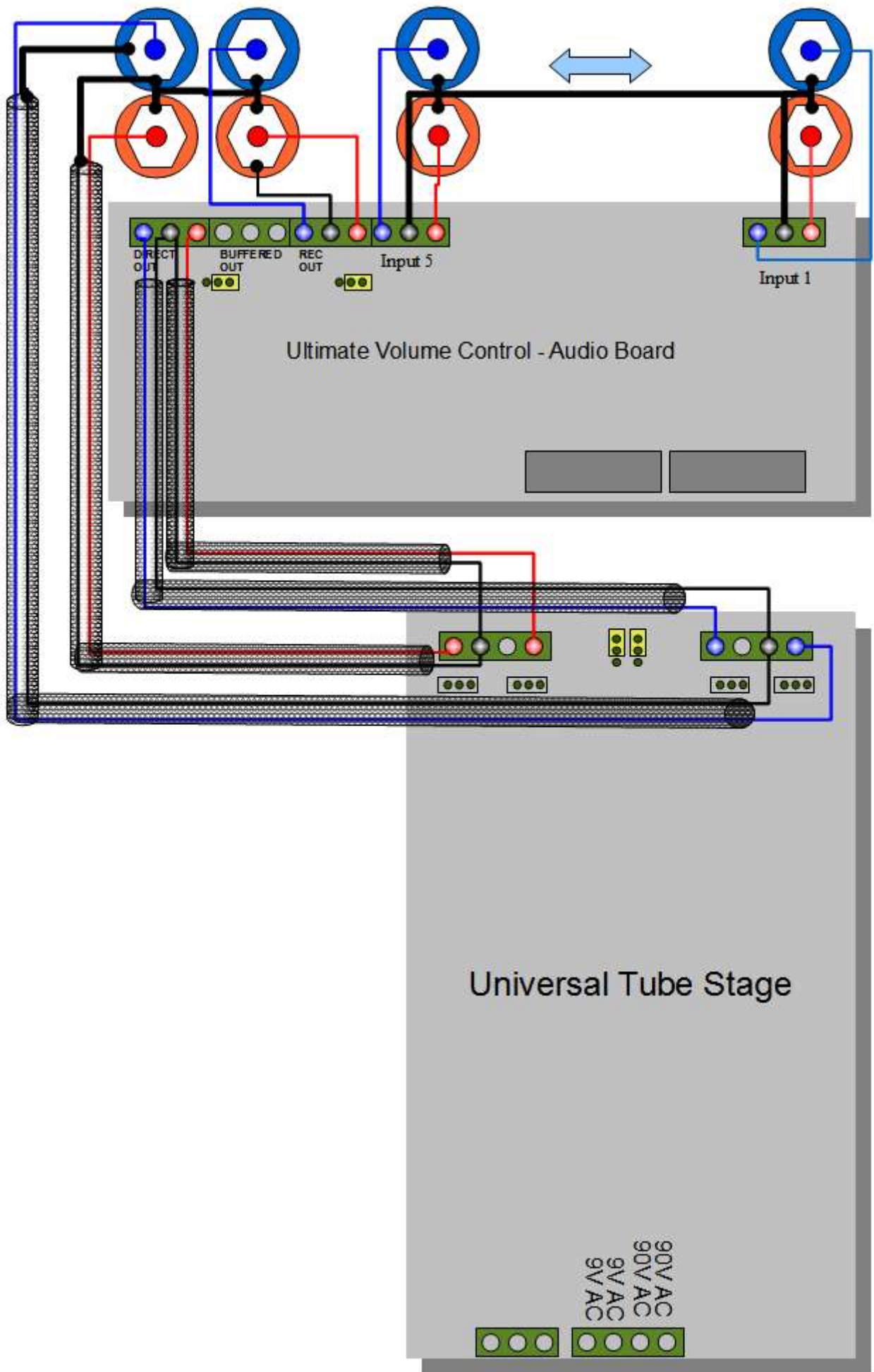
The chassis has 3 boards. For reference they are 1. Audio board closest to RCA jacks, 2. Control matrix board on the front panel and 3. UTS (universal Tube Stage) in the middle.

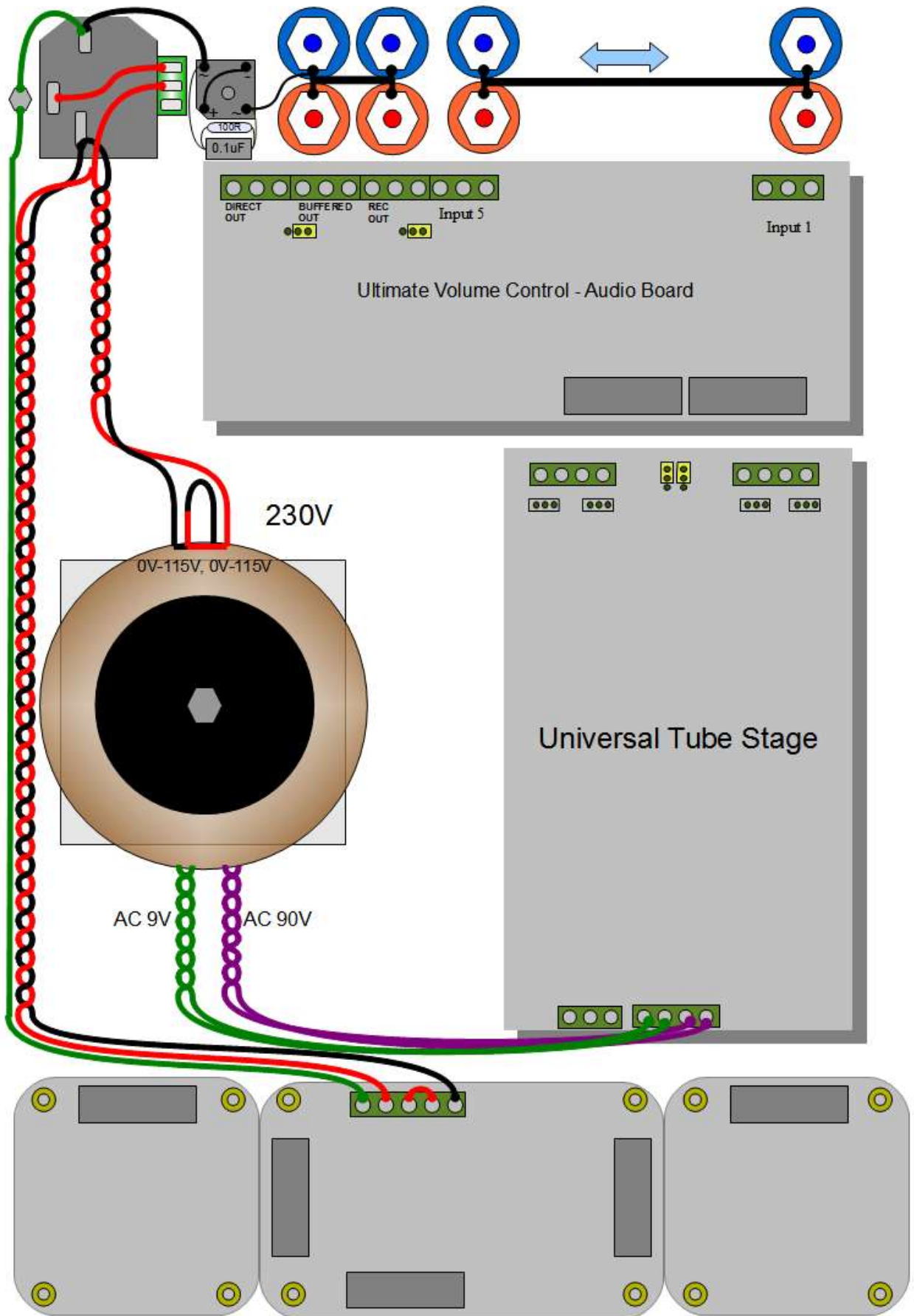
Notes:

1. Audio Board J1L and J1R changes settings between standard and shunt volume control. If used in shut position, the R13 and R17 resistors will have an effect on sound quality. Suggest to use the best available as discussed on page 3
2. Gain on the UTS is selectable and best set to match desired overall system gain. Shunt mode operation will consume some gain so that the user may want to select UTS gain to a higher level (ie 12db instead of 6db gain). It will depend on sensitivity of speakers and amplifier. Output impedance will remain extremely low in each setting.
3. JFET output is not needed when the UTS is used.
4. The volume control knob is attached to an Alps encoder. It is normal for the encoder shaft to have some axial slack
5. Knobs need to be installed by the customer. 2mm hex key to fit the grub screw.
6. Connect AC power to the blue power transformer mounted on the Control Matrix as shown on page 6
7. Connect the AC power to the torroid transformer and to the UTS pcb as shown on pages 20 and 21

The picture below illustrates the complete installation of all components of the UVC system in a compact chassis with Universal Tube Stage, thus creating a complete ultra low output impedance active preamplifier with remote control (requires optional universal remote control).







Optional Side Plate Mounting of power Switch

