# VC-03 IR Volume Control Kit

*DIYSoundLab.com*

DISCLAIMER:
PLEASE CAREFULLY READ THIS MANUAL BEFORE DOING ANYTHING WITH VC-03 UNIT!
WARNING!!! Dangerous high voltage is present on Power Supply module when plugged to AC outlet. Unsafe handling and manipulations of live unit may results in injury or death. Perform all operations with VC-03 unit at your own risk. This is an electronic kit item and not intended for use as finished product. It is intended for enclosed use as part of a project (inside a closed box) and by professional experienced technicians and engineers. We are not responsible for consequences of improper use or operation of VC-03 unit.
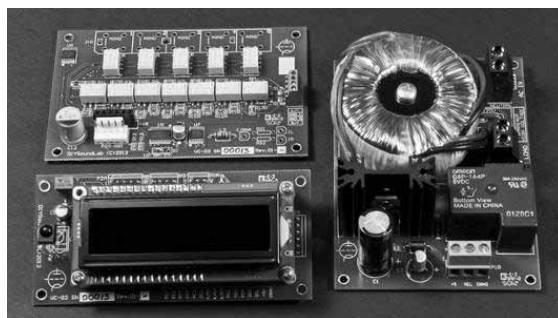
VC-03 consists of 3 main modules: Powers Supply, Control and Display Unit and Relay Modules.

There are two modifications of VC-03: Single End (SE) and Balanced. Balanced modification has two Relay Modules which are arranged in sandwich fashion. In that modification bottom Relay Module is dedicated to Right channel, and top module – to Left channel. Right and Left Relay Modules are slightly different to prevent possible ground loops during assembly and allow flexible kit implementation in different projects.
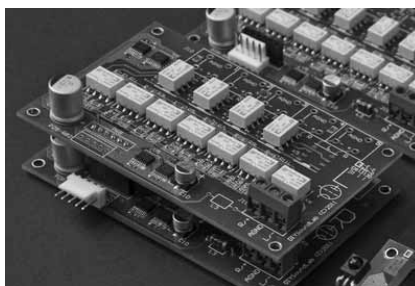

Balanced "sandwich" – VC-02 example

VC-03 Kit also includes:

- Top quality optical encoder assembly with 6 wire cable that normally mounts on front panel of enclosure (6 pins connector to Control and Display Unit). Please note, that encoder has a button, activated by pressing the shaft.

- Power cable (Power Supply to Control and Display Unit – 3 pins)

- Control Cable (Control and Display Unit to Relay Module /only to one relay module/ – 5 pins)

- Switch Cable (Control and Display Unit to power switch /not included/ and power LED indicator – 4 pins)

POWER SUPPLY module
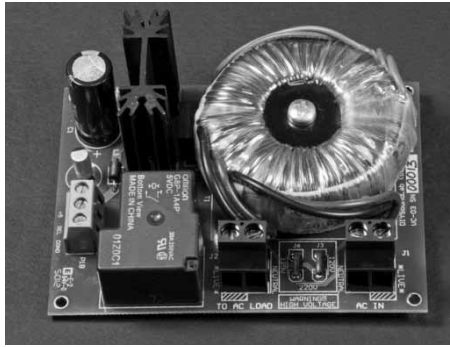
Power Supply has two main functions:

a) Supply power for VC-03 Control and Display Unit and Relay Module(s)

b) Switch On and Off 120V or 220V AC mains for the power supply of your project

Power Supply connects to main AC power source through terminal connector J1.

IMPORTANT! Always connect J1 and J2 terminals following the marking for live and ground wire. This is marked on PCB as *LIVE* and *NEUTRAL*. Power entry module with fuses is required. Power supply doesn't have own fuses. ALSO VC power supply will always be connected to AC power to supply 5V for CPU. For prolonged inactivity time it is suggested to use main power supply SWITCH for whole rig, like the one below:

Example of possible AC power entry module with fuses and switch (P/N 4304.6090)

J2 Terminal connector goes to the AC power entry point of your project (AC IN, power transformer). This is marked as "TO AC LOAD" on PCB. Maximum load is 30A 250VAC. At loads over 20A consider breaking little plastic pin in the corner of top surface of power relay to allow ventilation and prevent relay overheating. This will, however, expose relay contacts to moisture.

BEFORE CONNECTING power supply to AC, check or put in place jumper wires in voltage selector according to your country AC voltage in outlets. PCB marking shows required combinations of jumpers.

220-230VAC – one jumper: short J4 to J5

110-120VAC – two jumpers: short J3 to J5, J4 to J6.

Two jumpers for 120VAC, one jumper for 220VAC mains. 120VAC configuration shown on this picture. To the right from voltage selector: terminal block connector for AC mains input.

Jumpers are for VC-03 power supply transformer only, so large wire diameter is not required.

After adjusting to desired length, connect provided power cable (3 wires, 3-pin connector) to **P1B** terminal connector on Power Supply. Please be careful to follow keying and connect wire properly using pin names as a guide. Power cable goes between **P1B** connector on Power Supply (terminal block type connector) to **P1A** on Control and Display Unit (Molex keyed style connector).
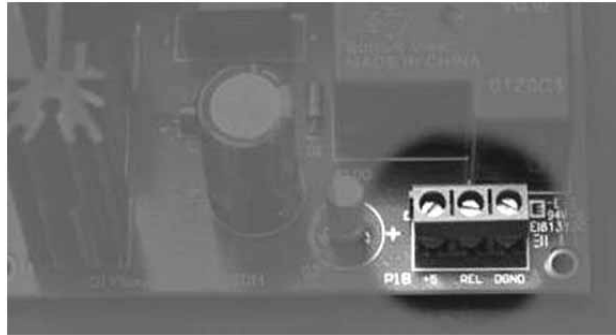
Power Supply P1B connector connects to P1A connector on Control and Display Unit with 3 wire cable. Pin names are marked on PCB to help you with correct connection (DGND, Relay control and +5)

Control and Display Unit

The heart of VC-03: houses microcontroller unit that controls all the functions of Volume Control. This module connects to Power Supply, Relay Module, optical Encoder, external power switch and optional Power LED indicator. All connectors on Control and Display Unit are keyed Molex headers with different pin count to prevent mistakes during connection.
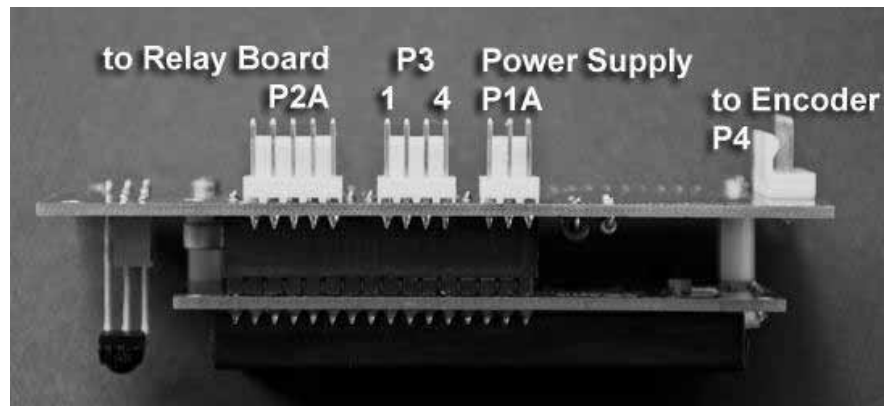
Top profile view of Control and Display Unit

Connect provided 4-wire cable (Switch cable) to **P3** connector.

- **Pins 1 and 2** connect to momentary power switch. **Only momentary switch have to be used** for power on/off function to work correctly. A momentary on-off switch only closes the circuit when the button is depressed (pushed).

Example of switch with ring LED indicator. Another option is a separate switch and LED indicator.

- **Pins 3 and 4** connect to power LED indicator. LED Cathode connects to pin 3, and anode - to pin 4. LED lights up when VC-03 is in "POWER ON" mode.
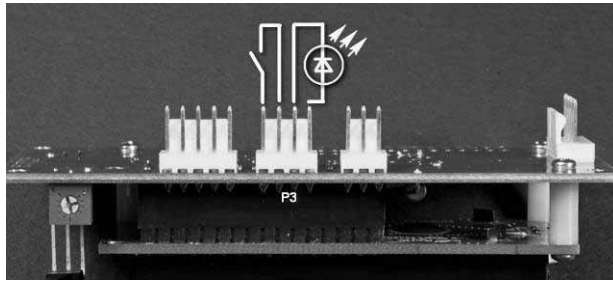
Connecting switch and LED to P3 connector on Control and Display Unit

Next, our attention moves to area of CPU board, outlined by rectangle on the picture below:

P9 Jumper changes appearance of you power LED indicator. Main Display of VC-03 dims after 6 seconds of inactivity (dim level adjustable from VC-03 setup menu). When P9 jumper is soldered for "DIM" position (middle and right pin), power LED will dim along with main LCD screen of VC-03. If you change jumper to short middle and left pins – power LED will not dim and will hold constant brightness, adjustable by R4 resistor on the PCB. R3 resistor adjusts contrast of LCD display.
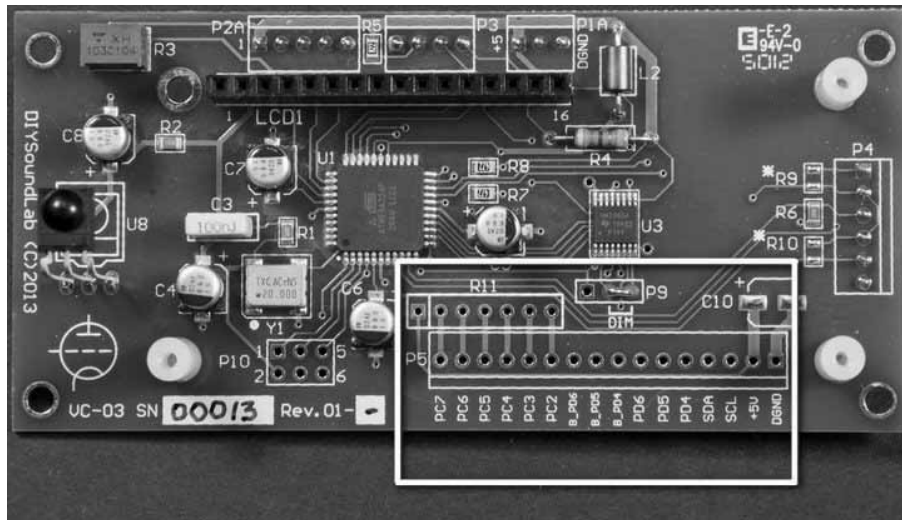
P5 connector location and pin names. LCD Display removed for better view.

P5 is an extension connector that provides extended functionality, with focus on custom build and firmware. However, 3 ports of P5 (PD4, PD5, PD6, B_PD4, B_PD5, B_PD6) work in base model to support you with additional functionality. PC2-PC7 ports require custom firmware. PC2 through PC7 have option of soldering pull-up resistors (R11) if required, with pin1 being common +5V.
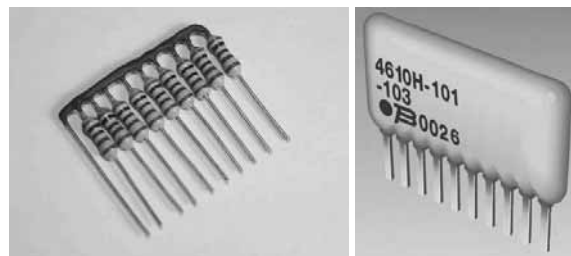
SIP pull-up resistors: DIY and thick film vertical package

I2C bus interface is available on P5 as well – SDA and SCL lines. I2C functionality requires custom firmware.

P5 connector pin description:

- PD4, PD5, PD6 – 3 ports with TTL level output, controlled from IR remote. High logical level means port is on, low logical level – port is off. ***Maximum current for each port is below 30mA***. Do not load ports with heavy load. Their purpose is to provide control voltage for further processing. In case you need high current ports, use buffered outputs (See next).

- B_PD4, B_PD5, B_PD6 – duplicates of PD4, PD5 and PD6 ports through powerful buffers. Active level is low. Inactive – high impedance. ***Maximum current when using VC-03 power supply – 300mA per port, but not to exceed 300mA total for all three ports. When using external supply for buffered port outputs, absolute maximum levels are 500mA at 30V for each port***.

    Ports, described above, are controlled from IR remote control (on and off). State of PD5 port is remembered in EEPROM of VC-03, so it is set to last state after power to module is restored. See more about PD5-6 ports under example schematic below.

How to use PD4, PD5 and PD6 ports?

For regular TTL level ports PD4, PD5 and PD6 usage is defined by customer schematic. Simple connection to any low consumption logic input will work with reference to the ground pin.

How to use B_PD4, B_PD5 and B_PD6 ports?

Below you will find example of using buffered ports, in this case B_PD6 to control relay. Picture shows usage of VC-03 to trigger the relay. 300mA maximum current rule applies here.
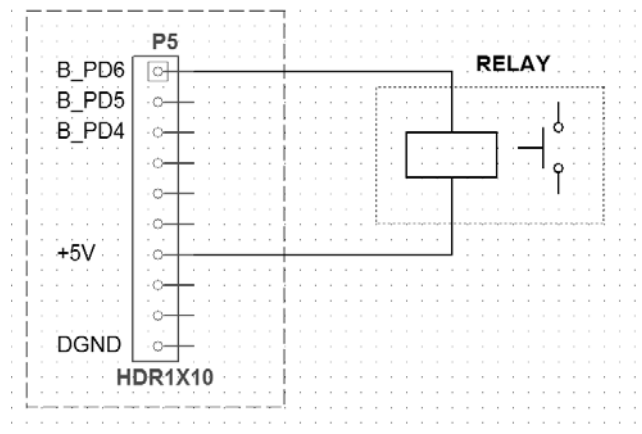
Connecting relay to buffered port B_PD6

Switching of PD5 and PD6 port is done through IR remote control. Buttons 7 and 8 on included generic IR remote control will switch port on and off. Action is displayed on LCD display in upper left corner and text of that action can be changed in VC-03 setup menu (it is called "D. Input", or digital input, because originally it was designed to switch digital inputs of a DAC).

Port PD6/B_PD6 is switched by button "9" – it is toggle style functionality with one button on/off.

Port PD4 is currently reserved for reset function and produces 0.8 sec pulse.

Functionality of each port can be changed upon request with custom firmware - additional charges apply.

Relay Module

Relay Module covers all audio functions: Input Selection and Volume Attenuation. It works as passive pre-amplifier – just add the box and audio connectors. Relay Module P2B connects to P2A connector of Control and Display Unit through 5-pin Control Cable (Round shielded cable).
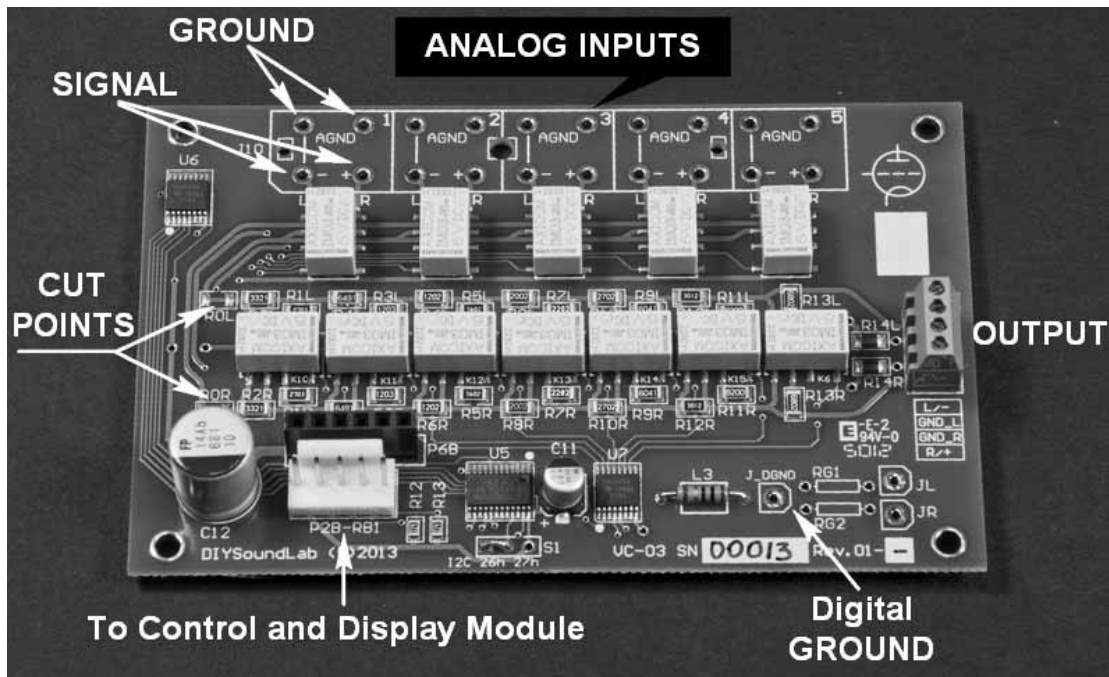
Relay Module – Stereo SE single board shown.
This single board also works as Right Channel Relay Module for Balanced (XLR) configuration.

Relay Module configuration determines SE Stereo or Balanced (XLR) version of VC-03 Volume Control. Single board, as presented on picture above, is used in SE Stereo version. In that version, output terminal connector J15 carries Right - R, Analog Ground for Right channel – GND_R, Analog Ground for LEFT channel – GND_L and Left channel - L signals. Input Connectors of J10 (1, 2, 3, 4 and 5) are fed with L and R signals according to silkscreen text. AGND holes closer to the edge of the board connect to Analog Ground from input RCA connectors. Optional RCA block connector for 4 inputs can be soldered into the Relay Module PCB board which will allow mounting to back panel of your equipment (appropriate pattern drilling is required):


Refer to page 8 for extended grounding information. ***Digital ground pin (J_DGND) must be connected to common ground point. Failure to connect digital ground will result in audible hum.***

For Balanced (XLR) version of VC-03, two Relay Module PCB Boards are supplied. They are marked with large letters R and L and connect sandwich-style through P6B connector. That means, each Relay Module board handles one channel of audio signal: R for right channel, L for left channel. Now follow silkscreen on-board marking for "+" and "-" differential signals for each channel. For balanced version Digital Ground (J_DGND) of ONLY ONE RELAY BOARD must be connected to common ground point. ***Multiple relay boards will have digital grounds connected internally. Connecting more than one relay board digital ground to common ground will create ground loop that will result in audible hum.***

**VC-03 can support more than two relay boards for multi-channel systems**.

It is possible to mix SE Stereo and Balanced (XLR) inputs on Balanced VC-03 version. For example, input 1 and 2 are Balanced and inputs 3 and 4 SE Stereo. In that case put jumper wires between "-" and "AGND" holes **ON EACH** RELAY MODULE for SE STEREO INPUTS according to the following drawing:
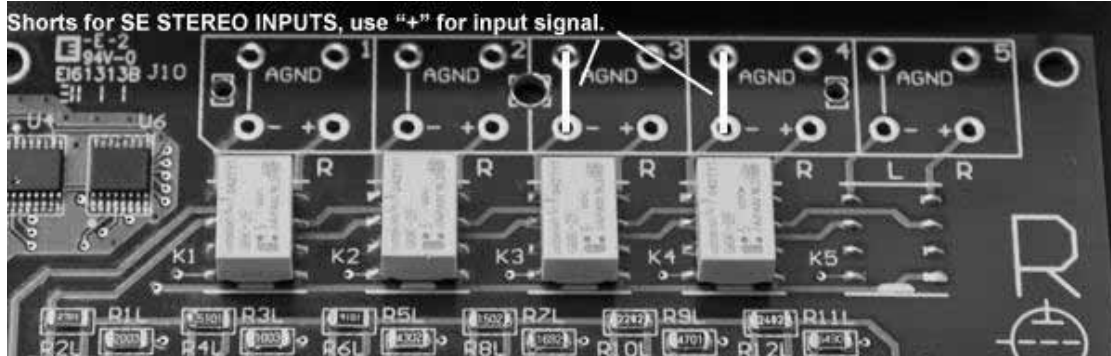
Mixed Balanced (XLR) and SE Stereo inputs – SE Inputs 3 and 4 must be shorted between "-" and "AGND" on BOTH RELAY MODULE BOARDS.

Few notes about "CUT POINTS" highlighted on earlier picture – placeholders for optional resistors R0L and R0R. There are two possible uses to this option.

To enable those options, cut/remove copper traces between R0L and R0R resistors' SMD pads:
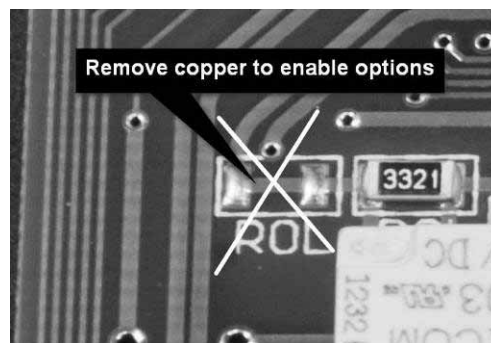
Option 1: solder resistors to increase input impedance of VC-03 ladder or add initial attenuation to particular channel or both channels. Value of resistors varies between 1kOhm and 32kOhm, depending on impedance differences or needed attenuation. 1kOhm value will create approximately 1dB attenuation.

Option 2: After copper is cut, use resistor SMD pads as signal points ***to insert amplification/buffer stage between input selector and volume ladder***.

Relay Module Ground Routing and Hum/Noise reduction. Ground Loops.

In this section we will examine different audio ground routing scenarios and ways to avoid hum and noise. There will be few examples which don't cover all possible ways to route ground and are for reference only. VC-03 was designed to have separate ground for each channel on relay board. Each relay board has two channels to be used as Left and Right for SE (stereo) option, or as "+" and "-" channels for Balanced (XLR) option, in which case one relay board works for one channel.

In previous section we covered Digital Ground connection. In case of multiple relay boards, Digital ground of only ONE PCB board connects to common ground point.

SE (stereo) option. That option includes one relay board with 2 channels – Left and Right, and two ground traces – one for each channel.

If input RCA connectors are used, every effort has to be made to isolate RCA connectors from chassis. Analog/Audio ground connects to chassis in one point and one point only.
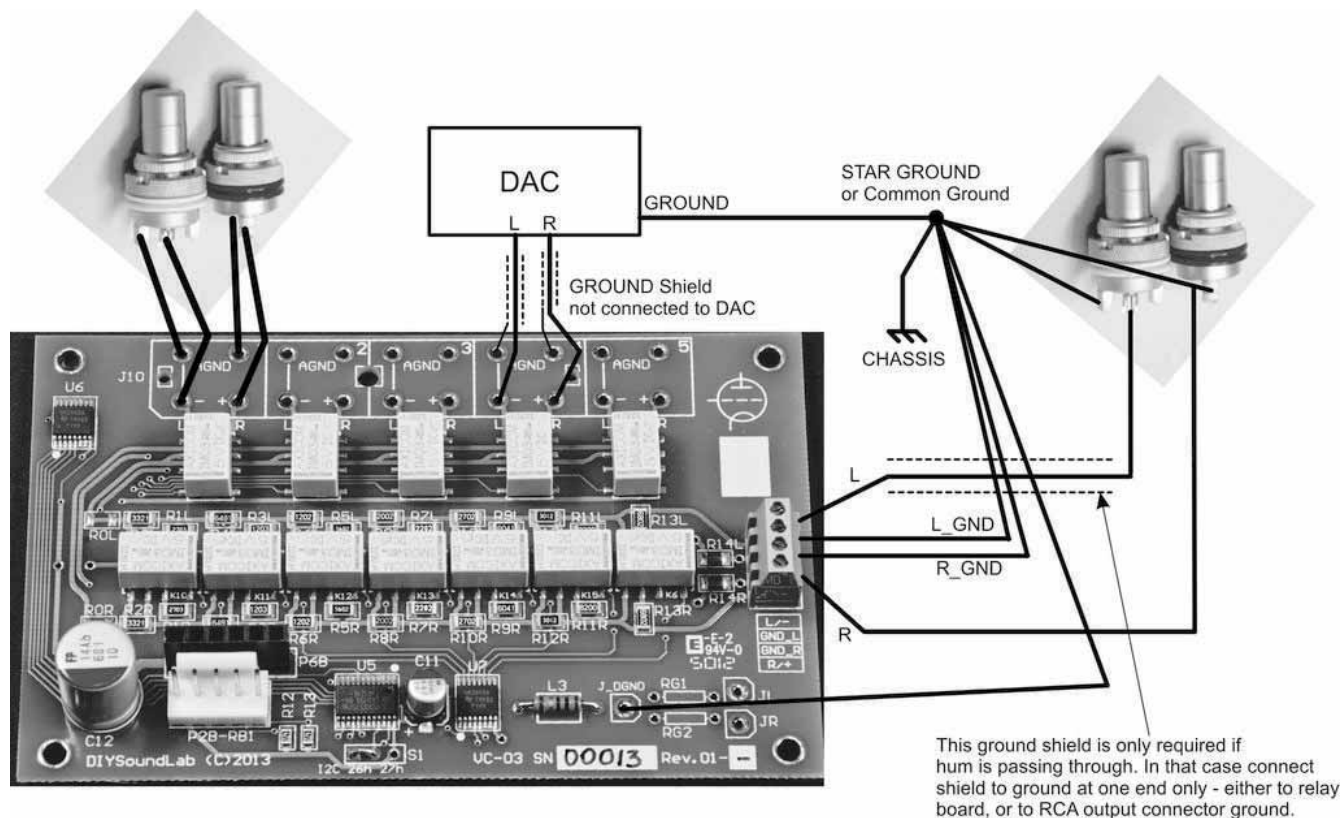

In this drawing two possible audio sources are covered: RCA input connectors and other source, like DAC (Inputs 1 and 4 of J10 were chosen for illustration only). With proper design, shielding of wires going to and from VC-03 relay board (except RCA connectors) might not be required. Also, consider placing star/common ground point close to VC-03 relay board output connector. This will help to reduce ground potential differences along ground wires. Star/common ground point should be connected to chassis by wire, **never** create Star/common ground directly on chassis!

Another possible solution for output RCA connectors: disconnect RCA connectors from star ground point and use shielded cable from VC-03 to RCA with shield connected to output terminal connector of VC-03 at one end, and to RCA ground at other. Some experimentation is required to come up with most quiet design. Try to change volume from mute to 0dB to check if no hum is present in whole range of volume levels. Do not apply input signal during that test to avoid damaging equipment and ears.

Instead of shielded cable between Input RCA connectors and VC-03 relay board, good results were achieved when simple twisted pair wires were used. In that case one wire is signal, and other is ground.

Balanced (XLR) version. Input XLR connectors and DAC examples are used.
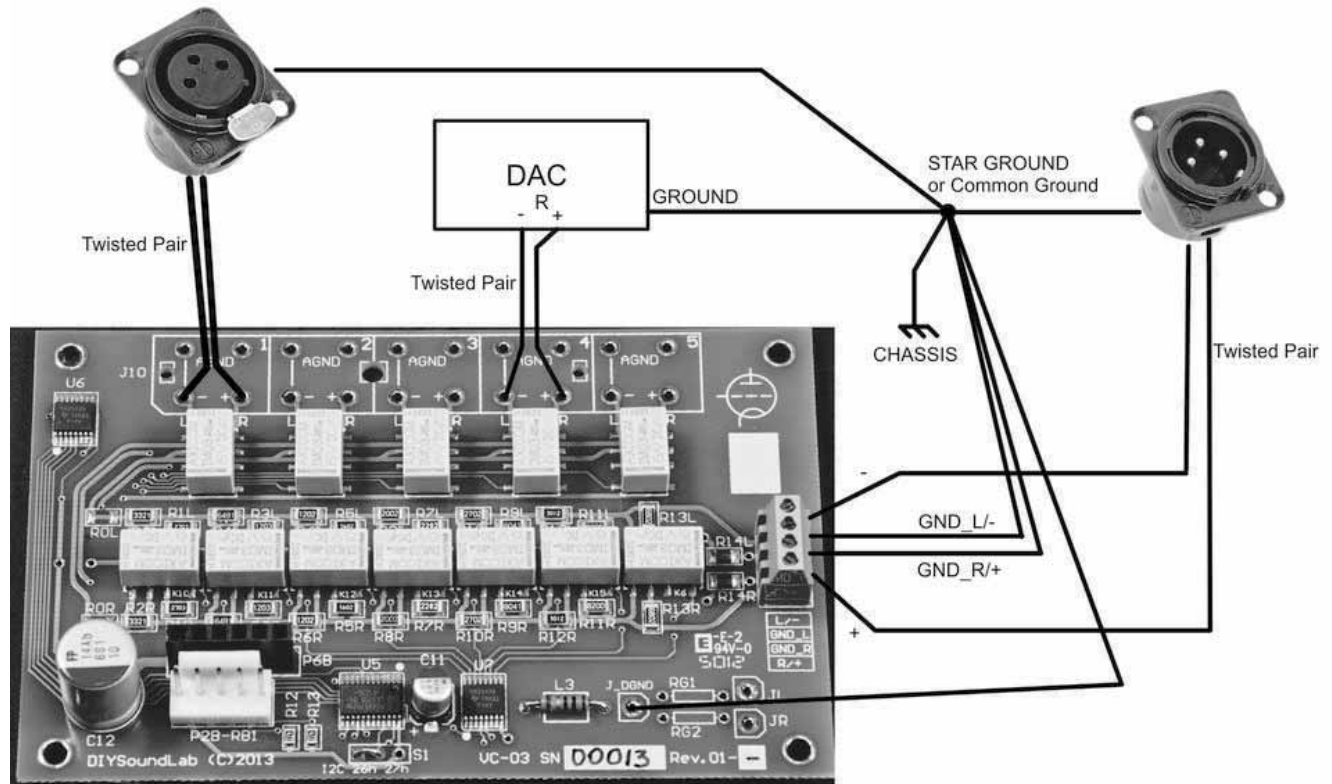
This is one of many possible configurations. Testing over the whole range of volume levels is also required. *J_DGND (Digital Ground) is connected to common ground only from one VC-03 relay board.*

Main idea in proper ground routing is to avoid ground loops. A ground loop usually refers to a current, almost always unwanted, in a conductor connecting two points that are supposed to be at the same potential, like ground, but are actually at different potentials. Ground loops created by improperly designed or improperly installed equipment are a major cause of noise and interference in audio and video systems. Ground loop is also created when two points of ground are connected through more than one path/wire. In this case loop antenna is created, that picks up noise (usually 50-60Hz and harmonic products) and passes it into the signal path. Please refer to following link for more information about ground loops:

http://www.jensen-transformers.com/an/generic%20seminar.pdf

Control and Setup

ENCODER FUNCTIONS:

Note: Encoder button press has to last for at least 1 sec – this was programmed to prevent accidental press during volume regulation.

INPUT SELECT

1. Press button for 1 sec - input select menu will be displayed.

Input Select
12345 DAC

2. Rotate encoder to select desired input (underscored) and press button again (>=1 sec.) to confirm selection and return to main screen.

Source DAC
■■.................. -51dB

SETUP MENU

1. Press and hold encoder button for >=6 sec. Volume controller will switch into setup menu. Rotate encoder to go through setup menu options. Setup menu starts with Volume Step.

   a) *Volume Step* – setup how many full encoder rotations is required for complete 63Db volume change. Press button again (short press) – number will start blinking. Rotate to select desired step and press button to confirm. Slowly rotate encoder clockwise to next step, or until "Exit Setup" is shown then press button to exit setup menu.

   VC-03 Setup Menu
   Volume Step 3
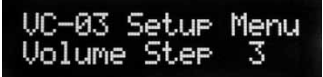
   b) *Inputs Used* - or Number of Inputs: Select how many inputs Volume Control will switch between. Press button again (short press) – number will start blinking. Rotate to select desired number of inputs and press button to confirm. If only one input is chosen, input select menu will be disabled. Slowly rotate encoder clockwise to next step, or until "Exit Setup" is shown then press button to exit setup menu:

   VC-03 Setup Menu
   Inputs Used 5

   c) *LCD B.Light* - LCD backlight illumination in idle mode (dimmed). Press button again (short press) – number will start blinking and display will dim according to that number value. Rotate to select desired dim backlight and press button to confirm. Slowly rotate encoder clockwise to next step, or until "Exit Setup" is shown then press button to exit setup menu:

   VC-03 Setup Menu
   LCD B.Light 80

d) *IR Learning* - IR remote commands setup. Different commands in VC-03 may be programmed to come from different remote models/brands. IR remote program recognizes NEC, SONY, RC5 and RC6 protocols.

```
VC-03 Setup Menu
IR Learning
```

Press button again (short press) to switch into IR setup submenu:

```
Press POWER
```

Active command will be blinking. Rotation of encoder will switch IR command for programming in a loop. When IR remote control button is pressed – code read from IR remote will display on the screen:

```
Press POWER
NEC  6f9c03f
```

Press encoder button to write code into MPU ROM. Repeat procedure for each button: Power, Volume UP, Volume Down, Mute, Input1, Input2, Input3, Input4, Input5, Next Input (INPUT+), Previous Input (INPUT-), PD4 RST, Digital Input 1, Digital Input 2, Dig3 PD6, "TO EXIT".

Please note that if input names are assigned to Input1, Input2, Input3, Input4, Input5, Digital Input and Digital Input 2 – those names will be displayed instead.

Exit IR setup by pressing button when "TO EXIT" at the end of the loop is displayed. Slowly rotate encoder clockwise to next step, or until "Exit Setup" is shown then press button to exit setup menu.

WARNING!!! It is strongly suggested to remember IR codes for all commands prompted on the screen, even if some of them will not be used, or less than 5 inputs is used. This will prevent possible memory corruption for complex IR codes.

e) *Name Inputs* menu: Each input can remain unnamed (Input1, Input2, Input3, Input4, Input5) or can have specific name assigned. Example: DAC, CD etc.

```
VC-03 Setup Menu
Name Inputs
```

Press encoder button to enter input naming mode:

```
INPUT 1 NAME
[DAC      ]
```

When desired input is displayed, press button again to enter edit mode. Symbol to be changed will be underscored. To edit symbol, press button again – symbol will blink. Rotate encoder to choose desired symbol and press button to confirm selection. Rotate encoder to move to next symbol and repeat procedure if required. After last symbol is reached, cursor will move to the "right arrow" symbol in lower right corner of display. Press encoder button to exit edit mode. Rotate encoder to move to the next input or to "EXIT". Press button to repeat input naming or exit:

```
INPUT   NAME
     EXIT
```

f) *Name D.INP* – Name digital inputs or functions assigned to PD5 port.

```
VC-03 Setup Menu
Name D.INP.
```

Procedure is similar to Name Inputs. There are two inputs (or two functions) to name:

```
D.INPUT 1 NAME          D.INPUT 2 NAME
   [SPDIF ]                [AES/EBU]
```

As it was said earlier, functionality of PD5 port was originally assigned to switching a relay which in return switches digital inputs of a DAC. Please refer to earlier chapter about extension connector P5 to learn more about port PD5 usage.

After D.INPUT names are assigned, EXIT option will appear. Press button to exit to setup menu:

```
D.INPUT   NAME
   ╪ EXIT
```

Slowly rotate encoder clockwise to next step, or until "Exit Setup" is shown then press button to exit setup menu.

g) *Display Dig* – turn on or off display of PD5 port function on main display:

```
VC-03 Setup Menu
Display Dig   No
```

Press encoder button – Yes or No option will start blinking. Rotate encoder to choose desired option and press button to confirm selection. When "Yes" is selected – option will constantly be displayed in upper left corner of LCD screen. If "No" is selected – during switching, function will appear on screen for few seconds and then disappear.

Slowly rotate encoder clockwise to next step, or until "Exit Setup" is shown then press button to exit setup menu.

h) *LOGO Change* – in this submenu text, displayed when VC-03 turns on, can be changed. This can be changed to company name, equipment model or anything else. Procedure is similar to "Name Input".

```
VC-03 Setup Menu
LOGO Change
```

After completing Logo change, slowly rotate encoder clockwise to last step: "Exit Setup" is shown. Press button to exit setup menu:

```
VC-03 Setup Menu
  EXIT SETUP
```

For any questions or support requests please contact: tarasiv@diysoundlab.com (Taras)