

**UPDATE: 12/05/16**

The described Vintage Voltage Device has an issue you should know about:

Plugged into a wall socket, it will work exactly as expected, but it can get confused about a missing ground. It will still alarm, but the alarm will be "reversed polarity". If the ground is present, but the outlet has reversed polarity, the correct reversed polarity alarm will sound.

Long story short, with many wall outlets, in the absence of a ground, there can be enough neutral voltage and current to trick the device into thinking there is reversed polarity.

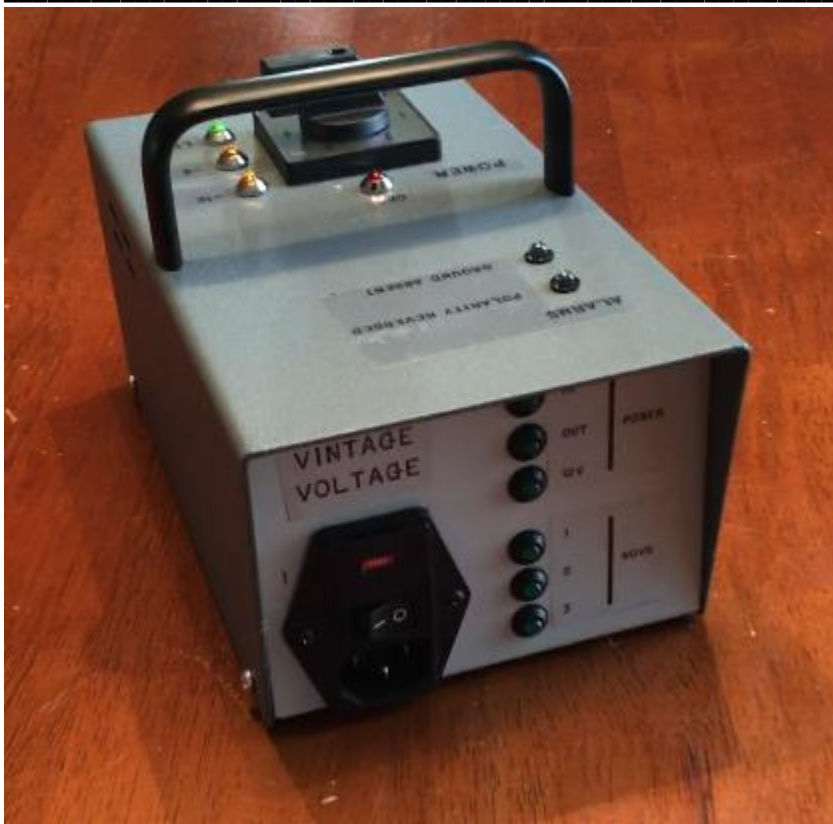
If an isolation transformer is used between the Device and the wall, both alarms should work as expected.

So... The device does deliver the desired selected voltage, but there is only one alarm, which tells you there is either reversed polarity or missing ground. Either way, you will know something is wrong and can work to correct it, or find another outlet or extension cord.

The fix is to either 1) use it as is, and realize that the alarm could mean *either* no ground or reversed polarity, or 2) incorporate an isolation transformer into the build. This would require a transformer rated at about 500 VA.

Best Regards,

Don



The Vintage Voltage Device allows the user to select the voltage for a vintage amplifier. Settings are:

1. 0 Volts (off)
2. -12 Volts (about 110 VAC)
3. -6 Volts (about 117 VAC)
4. Line Voltage ( 120 - 125 VAC )

The unit provides EMI filtering, spike protection, and fused input and output.

In addition, the Device will set an alarm if the ground is absent or if the polarity is reversed. The latter condition is exceedingly dangerous and all too common. Reversed polarity can cause electrical shock and in some cases has resulted in death.

I have built one unit and it works very well.

### **Missing Ground Connection Event:**

In this case, when a ground connection is missing from the wall, the voltage from the Device neutral wire to the *chassis ground* of the device can be 90 V or more (higher than the Line side of the device to the chassis ground, which is about 30 V). This is because the neutral is current-carrying for all the branch circuits downstream, all the way to the service entrance, where the neutral is connected to earth ground. The potential shows up in reference to the *chassis ground*, which in essence is floating with no reference to earth ground. Of course, the voltage between Line and Neutral measures as 125 VAC, or thereabouts.

In the fault condition of missing ground, the absence of a true earth ground, the relay in the device will energize when connected to neutral and ground (90V), as in the case of relay #2b - this causes the Reversed Polarity alarm.

An isolation transformer will have a continuous ground connection from input to output unless it is an Isolated Ground transformer, which requires a separate earth ground local to the transformer. These are often used for medical equipment that is very sensitive to ground faults. An isolated ground transformer will not work for what we are trying to do. We want an isolation transformer with a continuous ground. There are also isolation transformers out there which are advertised as "isolated ground", where they just tie the transformer secondary neutral to ground; we don't want that one, either.

Due to the ferric isolation of the circuit, the neutral and line voltages will be essentially equal with respect to the device chassis ground. (you no longer "see" the effect of current-carrying neutral branch circuits on the neutral wire).

With an isolation transformer between the wall and the device, a missing ground will be detected and alarmed by the device. A reversed polarity condition will also be separately alarmed when it exists. When and if both conditions exist, both alarms will go off.

Bootleg grounds are a problem in older houses and venues before Electrical Code required a separate ground wire in all branch circuits. House flippers are notorious for wiring older homes with bootleg grounds to provide modern receptacles with grounds. The Device will not detect bootleg grounds, nor will most receptacle testers. There are testers which will detect bootleg grounds, but they are very expensive.

The Vintage Voltage Device was designed primarily as a means to reduce the modern wall voltage to be more appropriate for vintage amps, through use of a CT bucking transformer. The technology has been around for many years. The added value of this device is to alert the user in the event of a mis-wired power outlet, either the absence of ground or reversed polarity. Both of these conditions are very dangerous and life-threatening. The good news is that the device will alarm if *either* of those conditions exist - but if you want to separate the missing ground fault from the reversed polarity fault, you will need to add an isolation transformer with a continuous ground. You can buy an appropriately sized

isolation transformer with continuous ground for about \$75 if you look long enough.

I'm sorry for the confusion, but this is an experimental device, and as such I only recently uncovered this unexpected behavior, and immediately let people know so they could adjust their build accordingly.

The build is not inexpensive because it is built to code and with safety of paramount importance. It is possible to buy the 4-position switch for maybe \$20 from China, for instance, but it is not trustworthy. It is not UL listed, and I'm not even sure of its current ratings.

If all you want is a voltage-reducing device, then by all means just get a 6 or 12VAC transformer and build it into a box with an outlet. My idea was to help protect musicians from being exposed to potentially lethal electrical shock.

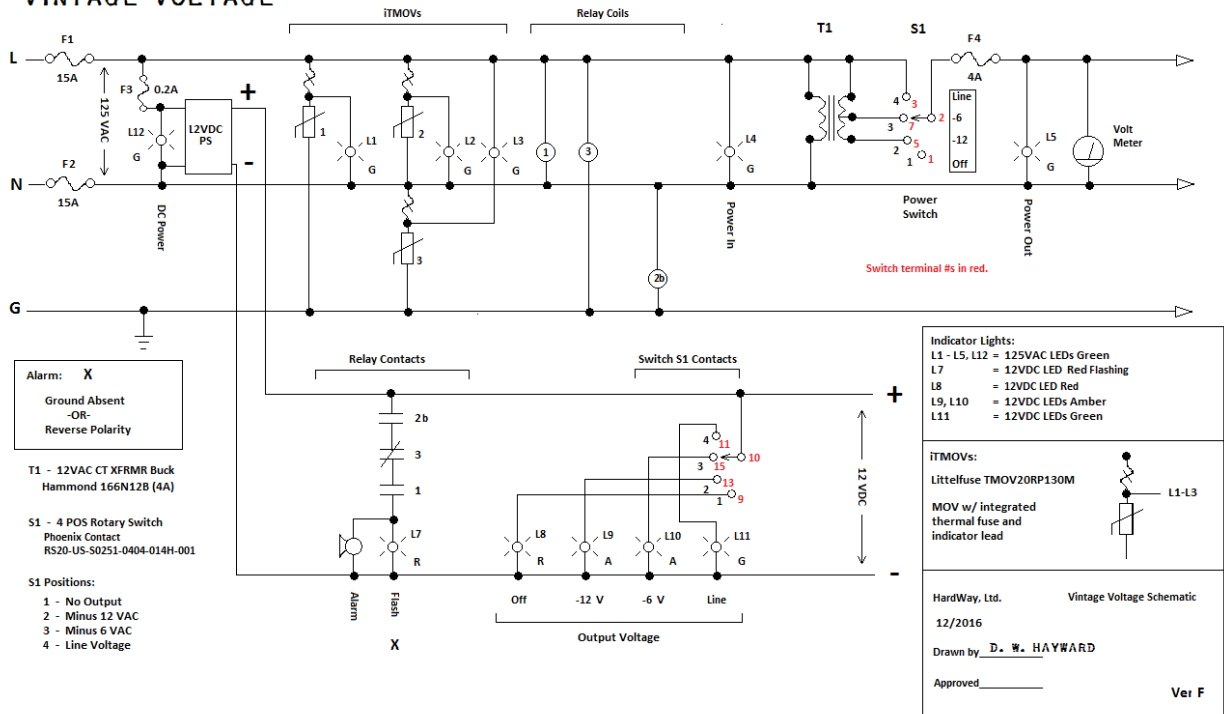
Of course you could (and should) carry a good quality outlet tester around with you and use it every time; this is a much less expensive alternative - but sometimes people forget to check an outlet, or forget the tester. If the tester is combined with a device you are going to always use with your amp, then you don't have that problem. Also, a tester used on a wall outlet won't find an extension cord with a cut-off ground pin unless you separately test the extension cord. The Vintage Voltage device will check every extension cord plugged into the power inlet.

I think the best solution is for manufacturers to build fault detectors into their amps. This would not be expensive to incorporate into the power section of an amp, particularly with the advantages of mass production and computerization.

I grew up when amps were designed with "2-prong" plugs and turning the plug around 180 degrees in the socket was the best way to reduce hum. You just inserted the plug into wall in the way that gave the least hum. You were essentially reversing the polarity of the circuit deliberately. Getting shocked was an almost daily occurrence with equipment (like the PA and the guitar amp) was plugged into two different outlets. As you may know, musicians have died from being shocked by this condition.

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# VINTAGE VOLTAGE



VINTAGE VOLTAGE

PARTS LIST

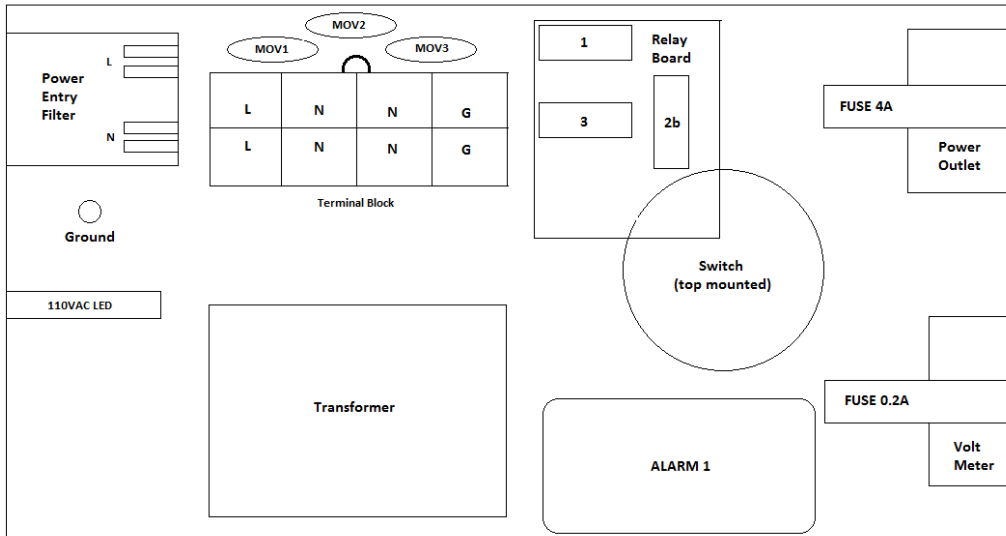
- (1) T1 - 12VAC CT XFMRM Buck  
Hammond 166N12B (4A)  
Mouser #546-166N12B
- (1) S1 - 4 POS Rotary Switch  
Phoenix Contact (Mouser)  
R520-US-S0251-0404-014H-001
- (3) ITMOVs:  
Littelfuse TMOV20RP130M
- (6) LED 110VAC Grn panel indicators  
Mouser #642-Q8P1BXXG110E
- (1) Mean Well 12VDC power Supply  
LED Supply #LPV-20-12
- (1) Power entry filter  
Digi-Key 8-6609940-7-ND
- (2) Mouser #: 576-03453LF1H  
Mfr. #: 03453LF1H  
Desc.: Fuse Holder Shock Safe 3AG High Profile
- (3) Miniature 110 VAC relay, 1PDT Phoenix Contact  
Digi-Key #REL-MR-120AC/21HC AU
- (1) Enclosures, Boxes, & Cases Ventilated  
8.63x4.75x3.5" Steel  
Mouser #546-513-0900
- (1) 108db Mini Siren Piezo Warble Alarm 12VDC  
e-Bay maziz3
- OR-
- (1) 95DB Alarm DC 3-24V 12V  
e-Bay newlauch
- (1) Single sided PCB Perf Boards 5 x 7 cm  
e-Bay smilingdogsystems
- (1) Green
- (2) Amber
- (1) Red
- 8mm 12v LED Metal Indicator Light FILN  
e-Bay boeschbuilt
- (1) 4 Position 600V 25A Barrier Dual Row Terminal Block  
e-Bay angela5532015
- (1) Hubbell 5284 Panel Mount Single Receptacle Brown  
125VAC 15A  
e-Bay derrammstein
- (1) PRE WIRED LED 12 VOLT FLASHING RED 12V DC  
e-Bay 1michiganger
- (1) Modutek 0-150 Volt Panel Meters  
e-Bay avitarunlimited
- (25') 14 AWG stranded MTW wire Black, Red, White  
-various-
- (25') 20 AWG stranded MTW wire Black, Red, White  
-various-
- (25') 24 AWG stranded wire red, white, black, yellow, green  
-various-
- (1) Handle, black, #1427C2BK  
Arrow.com

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VINTAGE VOLTAGE

LAYOUT

NOT TO SCALE

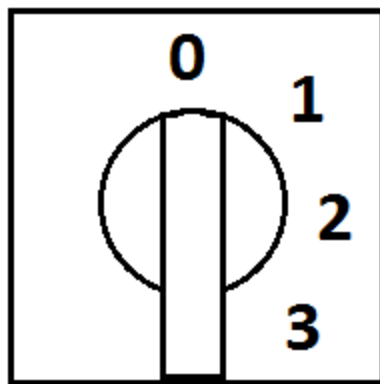


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## ALARMS

- POLARITY REVERSED
- GROUND ABSENT

## POWER



- OFF
- LINE 125 VAC
- 117 VAC
- 110 VAC

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**These notes are not instructions. It is assumed that the user is qualified and well-versed in electrical assembly, soldering, reading of electrical schematics, and the Electrical Code and safety. HardWay, Ltd. takes no responsibility for improper use, and, as this is an experimental device, makes no warranty for the components, the device, its use, or application whatsoever.**

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Power input filter module uses 15A fuse on both L & N legs  
Solder relay pins to perf board as in layout array  
The relay board is installed with the relays down, pin connections up  
Solder 110VAC relay coils using 24 AWG twisted pair wire  
110VAC LED indicator lamps us 24 AWG twisted pair  
Use 20 AWG wire from 12 VDC + power to switch term #10  
Use 24 AWG from 12 VDC LEDs to switch terminals  
Solder red 24 AWG to wire Rung "X" relay contacts

Use min 14 AWG wire for power Line, Neutral, and Ground connections  
The ITMOV short leg is the indicator, it connects to the thermal fuse  
Do not test the device on a variac - it will give misleading results

The following items are critical design components:  
Switched, DPDT, 2 Fused, Shielded Input filter module  
Transformer T1  
Switch S1  
110 VAC miniature relays  
ITMOVs  
Hubbel 15A receptacle

Other items are less critical and can be substituted with similar specs

The ground can be established to the chassis with a bolt or welded stud  
Connect a jumper between the two neutral terminals of the terminal block

Almost all components, including critical components can be ordered from:  
Mouser.com  
Digi-Key.com

LEDs, wire, alarms, enclosure feet, and etc. readily available on e-Bay

The Vintage Voltage schematic shows the fuses F1 and F2. These are internal to the power input filter module, which is not shown on the schematic.

Read the data sheet that accompanies the 4-position switch -  
There are two decks, one for the power connections to the line and the transformer, and one deck for switching 12 VDC to the indicator LEDs.  
The switch terminal numbers are in RED on the schematic, but there is also a diagram in the switch data sheet.

You can use female 22-16 AWG tab connectors (red) to connect the 110 VAC LEDs. Use spade connectors (blue or yellow) to connect to the terminal block - some of these connectors will join 6-8 24 AWG wire ends.

Silkscreen label templates are included, but these can also be used to make clear adhesive labels. Sizing and formatting will be required.

The specified enclosure is just large enough for the components to fit. Some forethought and skill will be required to make connections and arrange the components so that the enclosure lid can be removed and the device serviced if necessary.

Pay particular attention to the mounting of the switch so that it does not interfere with internal components.

Do not connect the 12 VDC power supply negative to chassis ground.



