The Trinity VRM
Kit Builder's Guide

For the sole personal use of Trinity Amps Customers.

Version 3.0

www.trinityamps.com

Version Control

Version	Date	Change
3.0	27Mar18	New issue based on previous versions for New PCB board & layout

VRM - Voltage Regulation Module

What is VRM?

VRM stands for Voltage Regulation Module. VRM is a method for controlling the power supply voltages within a tube (valve) amplifier. By controlling the voltage, you can control the amplifier's power output. VRM provides a continuously controllable voltage, and you can rotate a knob to get as much or as little power output as you like.

Before you start! There is no point installing VVR in an amplifier that has noise/hum/oscillation problems. It's important to fix those first so that you're starting with a known-good base to work from. So if you're building a Trinity Amps kit, finish it and complete all testing steps successfully. Then you're ready to add VRM.

This VRM kit is suitable for the following amplifiers: TC15, Tweed, 18 Watt and any other cathode biased amplifier less than 50 watts.

VRM modification - In its simplest form, the VRM circuit simply takes the power supply voltage from the amplifier's power transformer and rectifier and adds a control pot. You can rotate the pot to dial in as much or as little voltage as you want.

So, where an 18W amplifier might have a full B+ voltage of approximately 350V, you can dial it down to perhaps 250V, 180V, 115V or even lower . The attraction is that you get cranked amp tone at a lower room volume. For instance, dial the amplifier down from 350V to 115V and you have one-third of the original supply - approximately one-ninth of the amplifier's full power output. About 2W in our 18W example.

That's all that VRM on cathode-biased amps needs to do. In effect, you simply break the B+ path right after the standby switch, connect it to the VRM board and then connect the output of the VRM board (and a ground) to the rest of the amplifier circuit.

Ideally, the VRM would just do its job and have no ill effects. However, when the amp is fully voltage controlled by the VRM and the VRM control is turned down very low, a tiny DC offset voltage appears at a tube's grid. Where this grid is connected to a pot (e.g. guitar pot), the tiny DC voltage is altered at random by a dirty wiper. As you move the pot you create a tiny signal that's fed back to the same grid and appears as a low frequency rustle or scratch sound.

The sound is annoying and we don't want any DC voltage on our pickups either. The simplest solution is to use a capacitor to block the DC from getting to the pot. Typically we recommend a .1uF - .022uF value. This goes between the grids of the valve and the pot and we modify the grid topology as shown in several of the following layouts.
If **only** the Power and Phase Inverter is controlled by the VRM, this modification is not usually necessary.

The 1 meg resistor is the "grid load" resistor for the first tube stage of the amplifier. All tubes have to have a grid load resistance or they will not operate properly. With a DC blocking capacitor inserted in series with the input signal, there may be no direct grid resistance so it is better to move the 1M onto the tube grid directly.

Bill of Material (BOM)

VRM BOM ITEM	QTY	VRM BOM ITEM	QTY
SINGLE-GATE MOSFET N-CHAN 800V 7.8 AMP - IRFPE50	1	0.1uF or 0.047uF AXIAL CAPACITOR	2
6V 1W ZENER DIODE	1	4-40 x ½" MACHINE SCREW	1
1M-A POT WITH POWER SWITCH (1M-B POSSIBLE)	1	KNOB TO MATCH AMP OR BLACK CHICKEN HEAD	1
5R 2 WATT CARBON FILM RESISTOR	1	SIL-PAD /MICA INSULATOR	1
100K 1 WATT CARBON FILM RESISTOR	1	4-40 NUT	1
220K 1 WATT CARBON FILM RESISTOR	1	PRINTED CIRCUIT BORD	1

BUILDING AND INSTALLING THE VRM

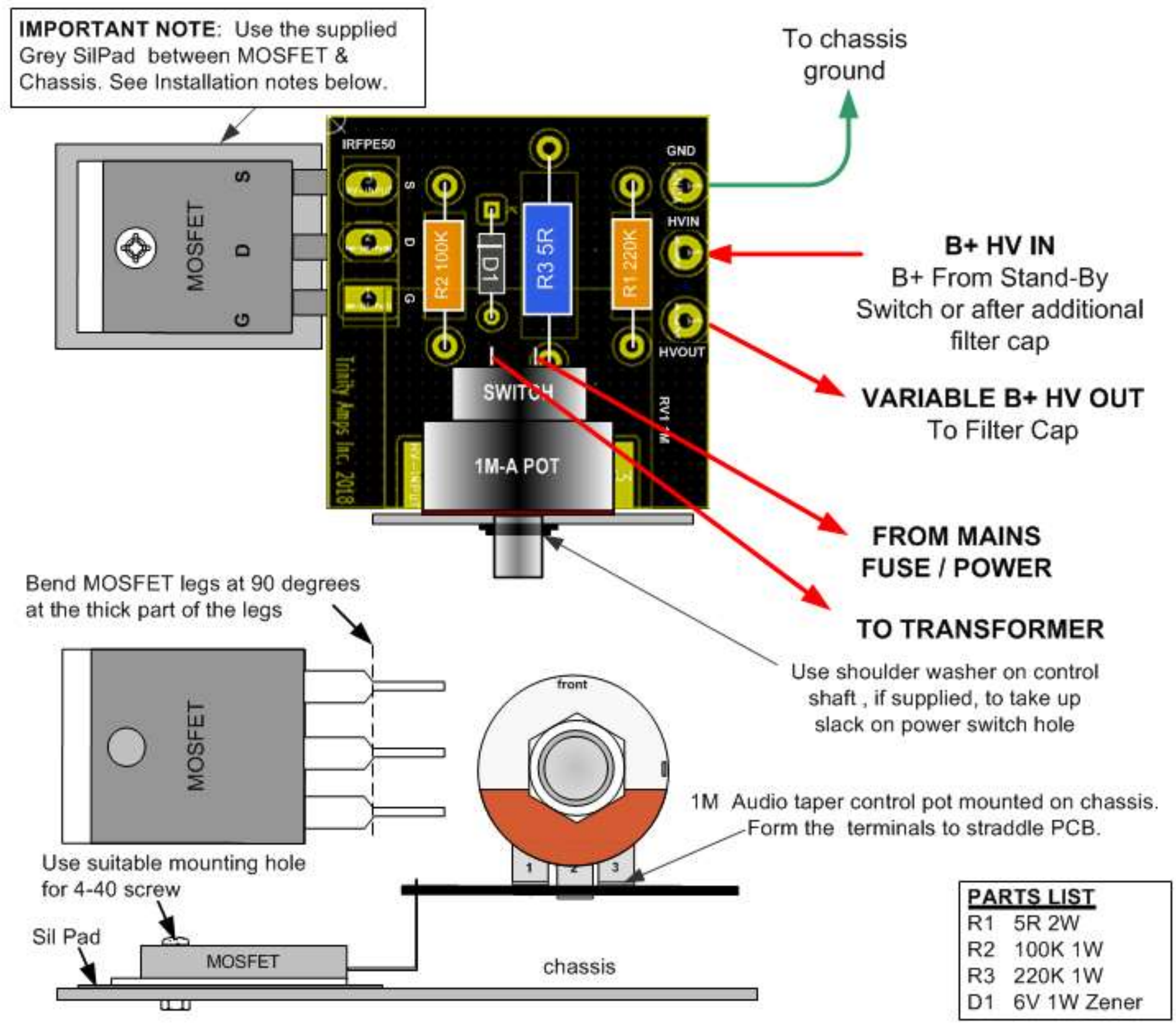
Handle MOSFET with care. The MOSFET is a static sensitive device. That means that static electricity that builds up in your body can destroy it. Always make sure you use normal static precautions when handling the MOSFET – touch a ground point before handling device.

1. Mount Resistors, Zener diode parts on PCB. Ensure the Zener diode is pointed in the correct direction. Make sure that the banded side of the diode is pointing towards the Gate (Gate is the terminal on left hand side of image below)
2. Carefully bend the 1M control pot legs to straddle PCB and align with the PCB pads.
   Use a needle-nose plier to flatten them against the PCB and when flat, solder all three in place.

   Optionally, you can also use short jumpers to connect the control pot or bend them underneath the PCB and solder to bottom side of board.

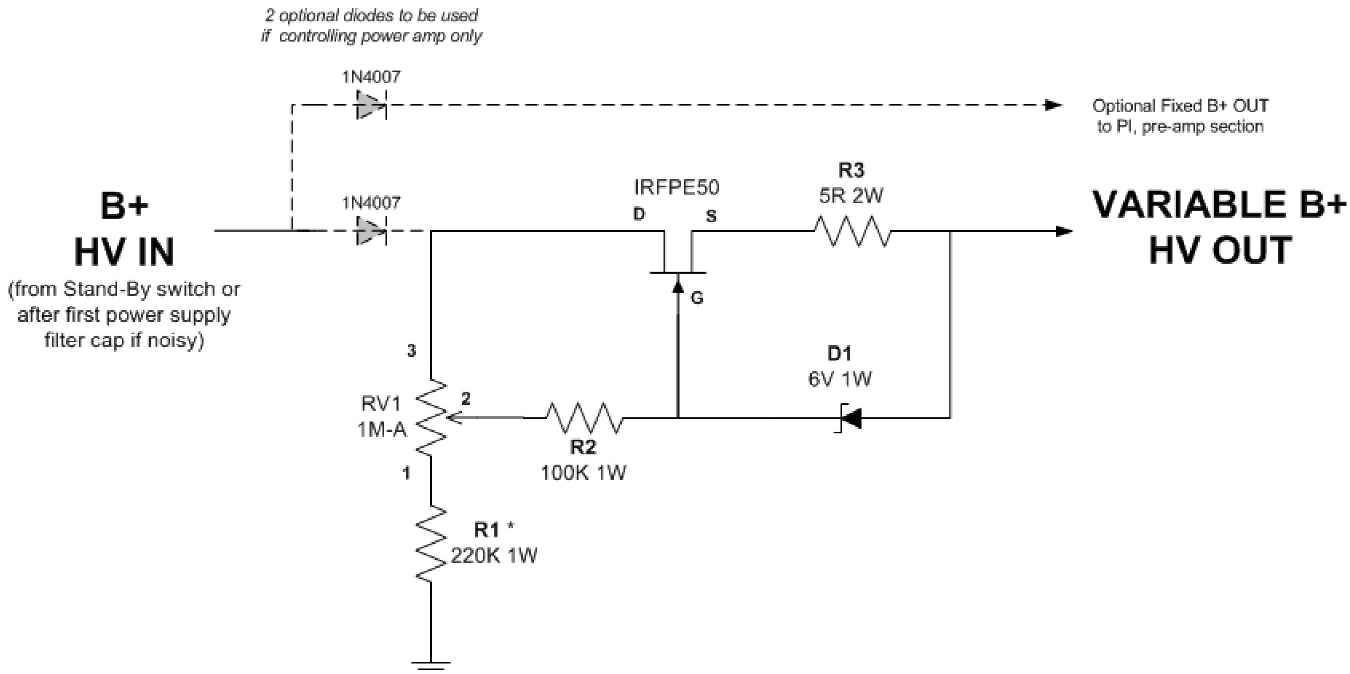
3. If you are mounting the MOSFET directly to the board, bend the MOSFET legs at 90 degrees at the thick part of the legs. Solder in place.
4. Locate a suitable mounting hole for the MOSFET. Some amp kits have a pre-drilled hole to mount the MOSFET remotely (Tweed). If necessary, drill and deburr a 1/8" hole to mount MOSFET to chassis.
5. **IMPORTANT**: Electrically Insulate the MOSFET from the Chassis.
   Install supplied Grey Sil-Pad insulator between MOSFET and Chassis.
   Note: If a Mica washer is used, apply some **non-conducting** heat sink compound on both sides of Mica Insulator and screw the MOSFET in place.
6. Mount VRM control but do not tighten.
7. Align MOSFET with pre-drilled hole and mount with 4-40 X ½" bolt/nut. Do not tighten.
8. When all holes and parts are aligned, tighten nuts and bolts.
9. Test to insure 100% insulation from MOSFET Gate, Drain and Source to chassis.
10. If using the switch feature, solder the two leads to be switched (e.g. replace the power switch) to the switch lugs on the back of the pot.
11. Modify the inputs to use DC blocking capacitors (0.1uF or .022uF) and move the 1M input jack resistors directly to the tube grid.

Trinity Amps recommends full amp power control. Some "gurus" suggest control of Power Amp/Phase Inverter only. Information for such control is provided for reference but it is not our preferred installation.



PARTS LIST	
R1	5R 2W
R2	100K 1W
R3	220K 1W
D1	6V 1W Zener

VRM BOARD LAYOUT



VRM SCHEMATIC

Note: Schematic shows Fixed PI/Pre-Amp options in dotted lines. Parts are not included for this configuration.

TROUBLESHOOTING and TESTING

Troubleshooting the VRM

These are some basic steps in troubleshooting the VRM...

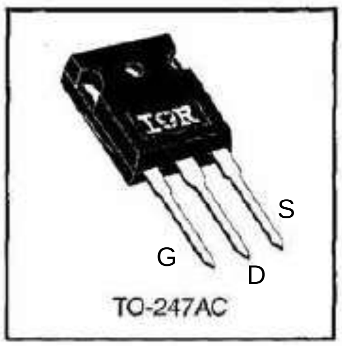
- If the VRM is doing nothing it's good to check the Zener diode out. Use a continuity tester and see if it conducts. If it does conduct it's bad.
- If the VRM won't pass voltage ON A TRAMP, check the 5W 100R resistor. You can measure it in the circuit to see if it reads correctly or it has opened up.
- Other than triple checking all your wiring, jumpers and component values then suspect the MOSFET.

Noise

If in your installation, you hear noise (hum, static, buzz) that wasn't present without the VRM, you can try adding an 8 to 16 uf 450V capacitor from the VRM board 'IN' terminal to the amps Power Ground.

Testing a MOSFET

This testing procedure is for use with a digital multimeter in the diode test-range with a minimum of 3.3 volt over d.u.t. (diode-under-test).



1. Connect the 'Source' of the MOSFET to the meter's negative (-) lead.
2. Hold the MOSFET by the case or the tab but don't touch the metal parts of the test probes with any of the other MOSFET terminals until needed.
3. First, touch the meter positive lead onto the MOSFET 'Gate'.
4. Now move the positive probe to the 'Drain'. You should get a 'low' reading. The MOSFET internal capacitance on the gate has now been charged up by the meter and the device is 'turned-on'.
5. With the meter positive still connected to the drain, touch a finger between source and gate (and drain if you like, it does not matter at this stage). The gate will be discharged through your finger and the meter reading should go high, indicating a non-conductive device.

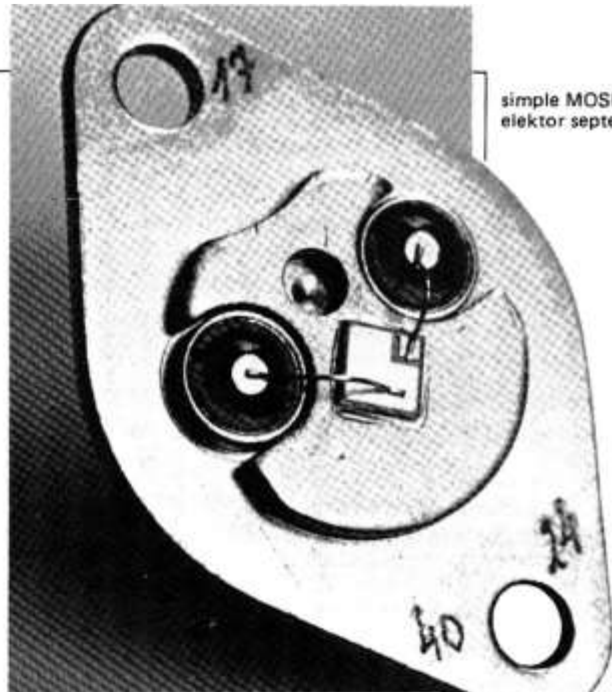
- This simple test is not 100% -- but is useful and usually adequate.
- When MOSFETS fail they often go short-circuit drain-to-gate. This can put the drain voltage back onto the gate where of course it feeds (via the gate resistors) into the drive circuitry, possibly blowing that section.

Testing Zeners / Diodes

- If you just want to know if a Zener Diode has opened up or shorted out, then test it as described below as for standard diodes. Remove one end of the diode from the circuit to do the test.

- To test a silicon diode all you need is an ohm-meter. If you are using an analog meter, set it to one of the lower ohm scales, say 0-2K, and measure the resistance of the diode both ways.
- If you get zero both ways, the diode is shorted. If you get infinity both ways, the diode is open. If you get opposite readings, then the diode is good.

- If you are using a digital multi-meter (DMM), then there should be a special setting on the Ohms range for testing diodes. Often the setting is marked with a diode symbol.
- Measure the diode resistance both ways. One way the meter should indicate an open circuit, the other way should get a reading (around 600 maybe). That indicates the diode is good.
- Again, If you get zero both ways, the diode is shorted. If you get infinity both ways, the diode is open. If you get opposite readings, then the diode is good.



All home constructors are constantly looking for simple ways of checking whether electronic components they have in stock are fit for use. This is particularly so in the case of the more expensive transistors, such as the power metal-oxide field-effect transistors, or simply power MOSFETS, as used, for example, in the Crescendo amplifier featured in our December 1982 issue. Although the complete electrical testing of such devices requires complicated, expensive test gear, it is perfectly feasible to check them with a multimeter.
The tests described refer to n-channel devices; by reversing the test leads indicated in the text, p-channel types can also be checked.

Gate to source

With the multimeter set to highest resistance range (x 10MΩ or x 100 MΩ) check that the resistance between gate and source is infinite. Reverse the test leads and check again.

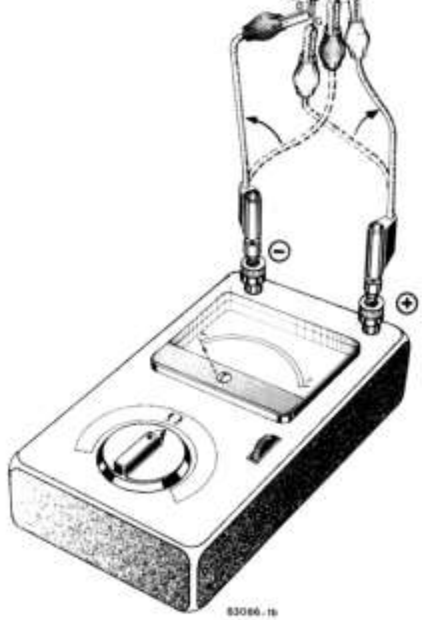
simple MOSFET check

Drain to source (see figure 1)

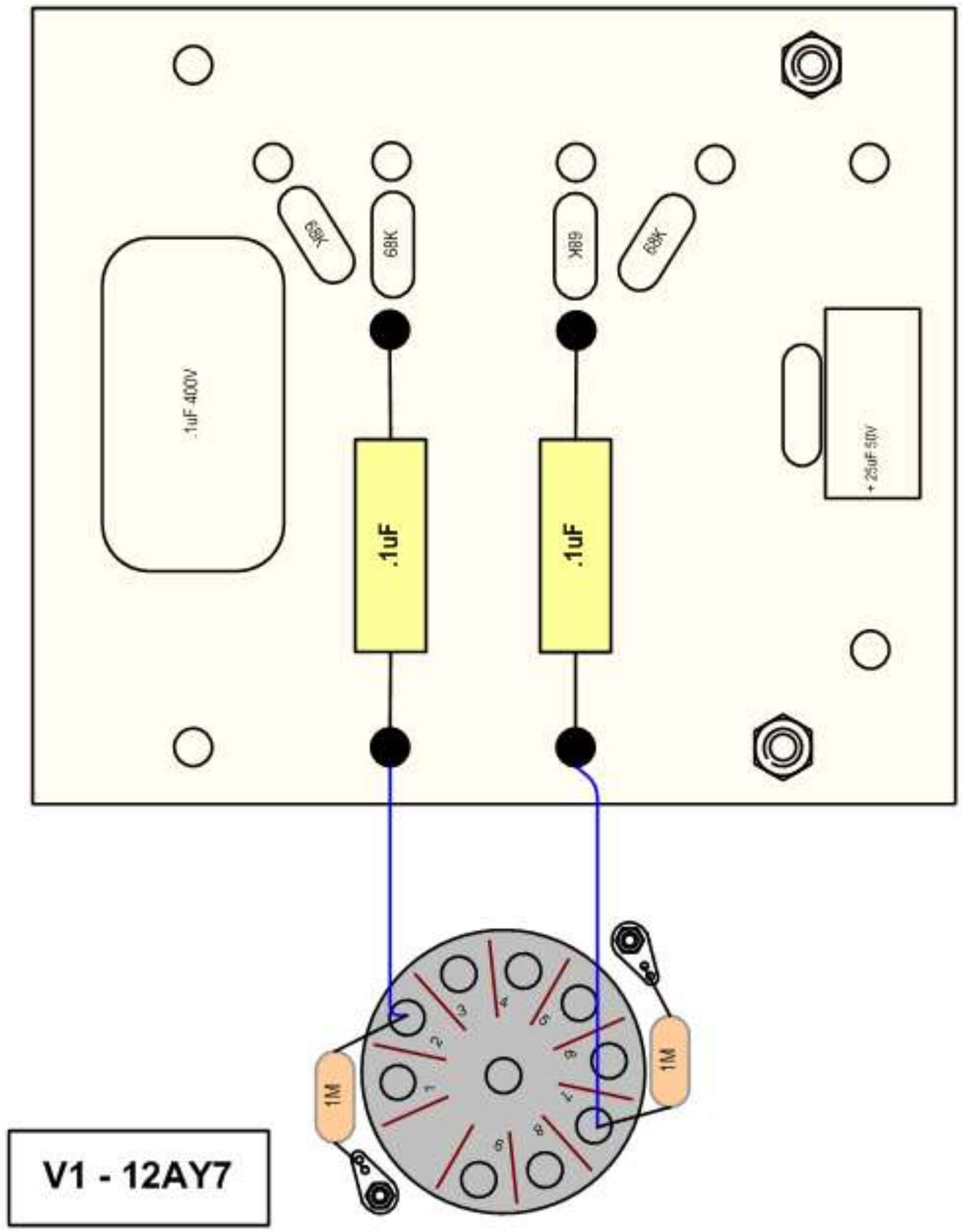
- Set the multimeter to the lowest resistance range.
- Connect the (red) lead from the + terminal to the source, and the (black) lead from the – terminal to the gate. The gate is now forward biased.
- Move the black lead from the gate and connect it to the drain. The multimeter should now indicate zero ohms (see figure 1a)
- Connect the (black) lead from the – terminal to the source and the (red) one from the + terminal to the gate. The gate is now reverse biased.
- Connect the – lead to the drain and the positive one to the source (see figure 1b). The meter should not deflect because of the equivalent diode between drain and source. If now the + lead is connected to the drain and the negative one to the source, the meter should deflect.
- If the above checks are satisfactory, the device is perfectly fit for use. As many months of experience with, for instance, the 2SK135 and 2SJ50 MOSFETs has shown that these devices are very reliable, a negative result of the above checks is very unlikely.

1a

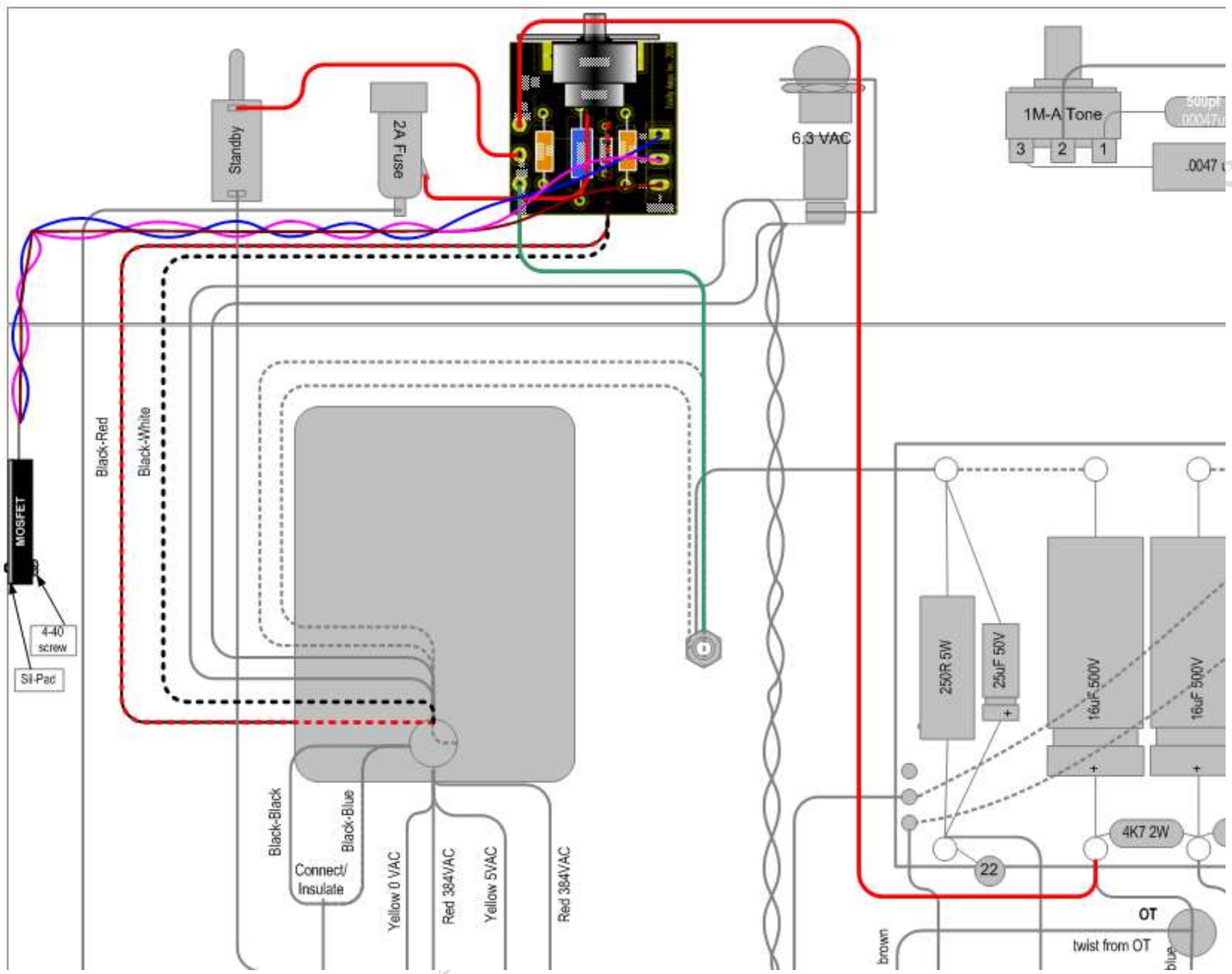
b



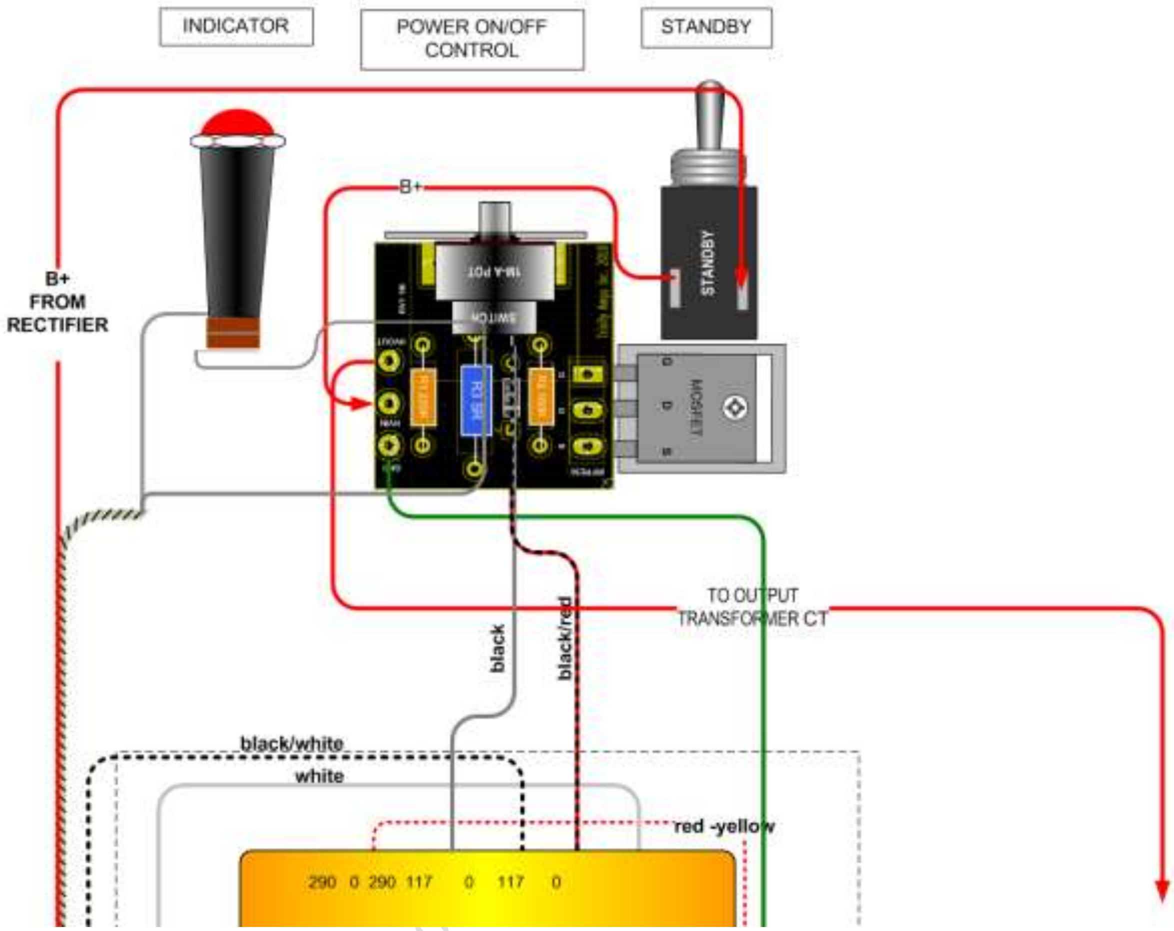
TWEED INSTALLATION (FULL AMP POWER CONTROL)



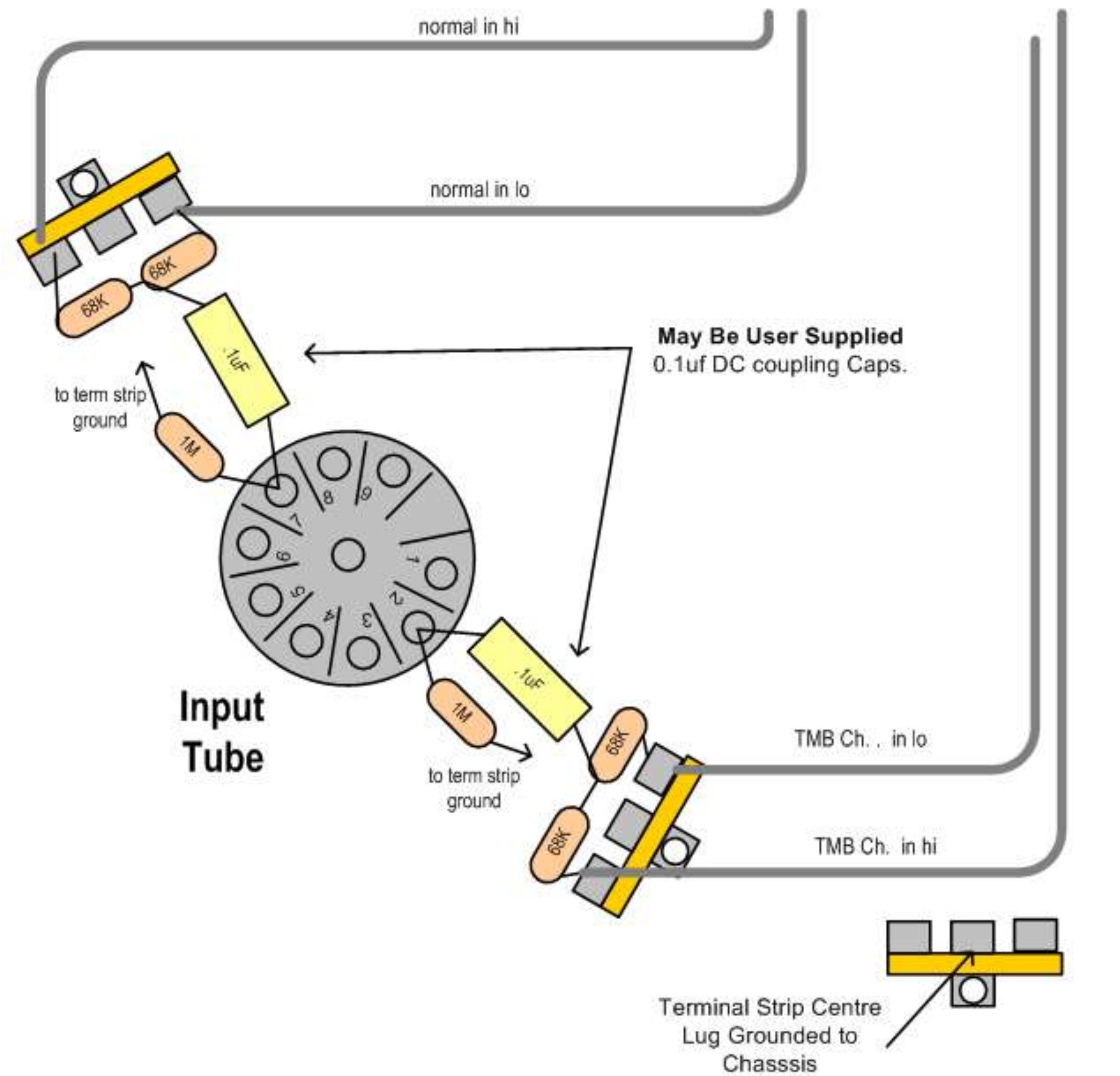
TWEED INSTALLATION (FULL AMP POWER CONTROL)



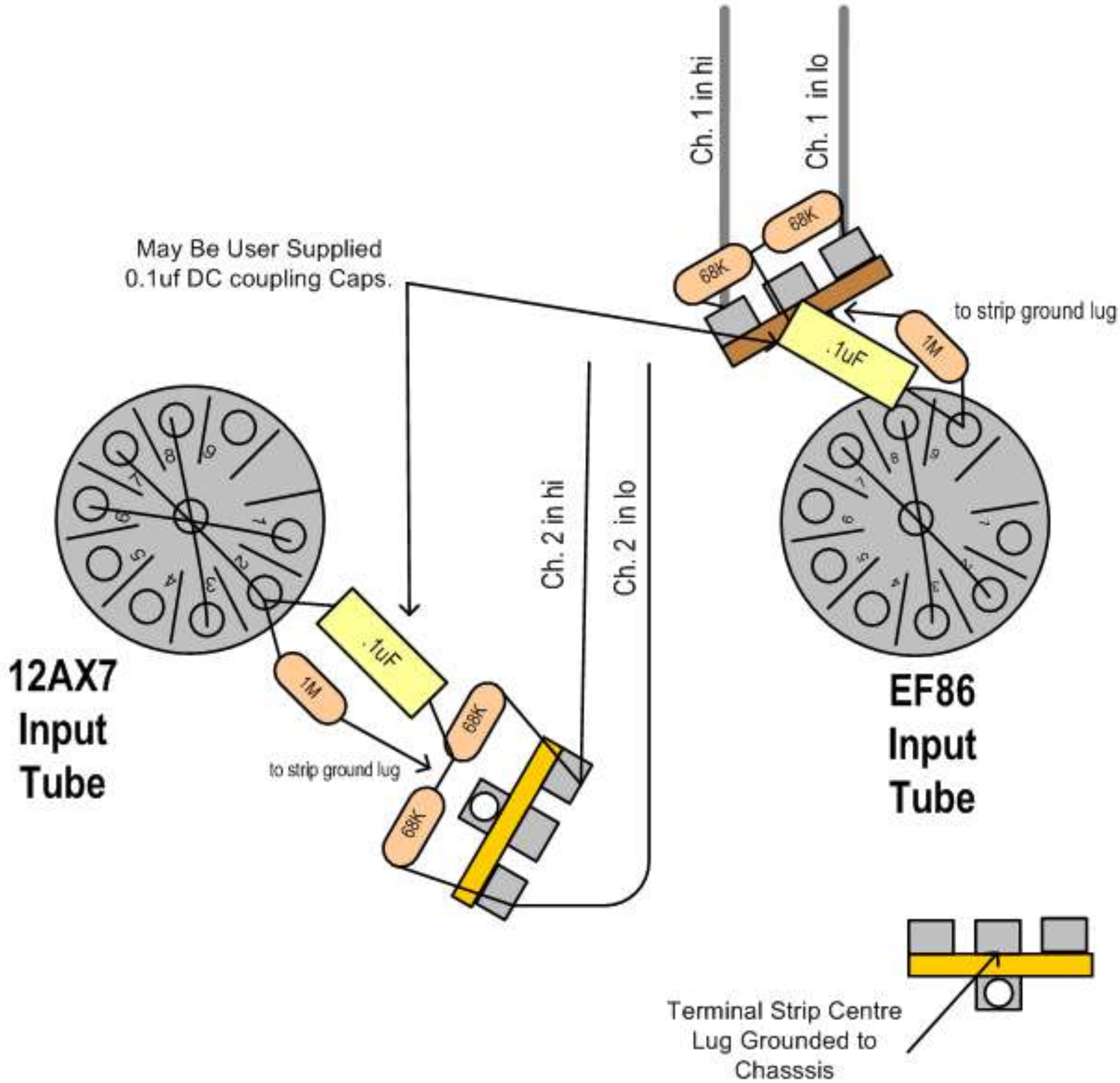
18 WATT AND TC15 INSTALLATION (FULL AMP POWER CONTROL)

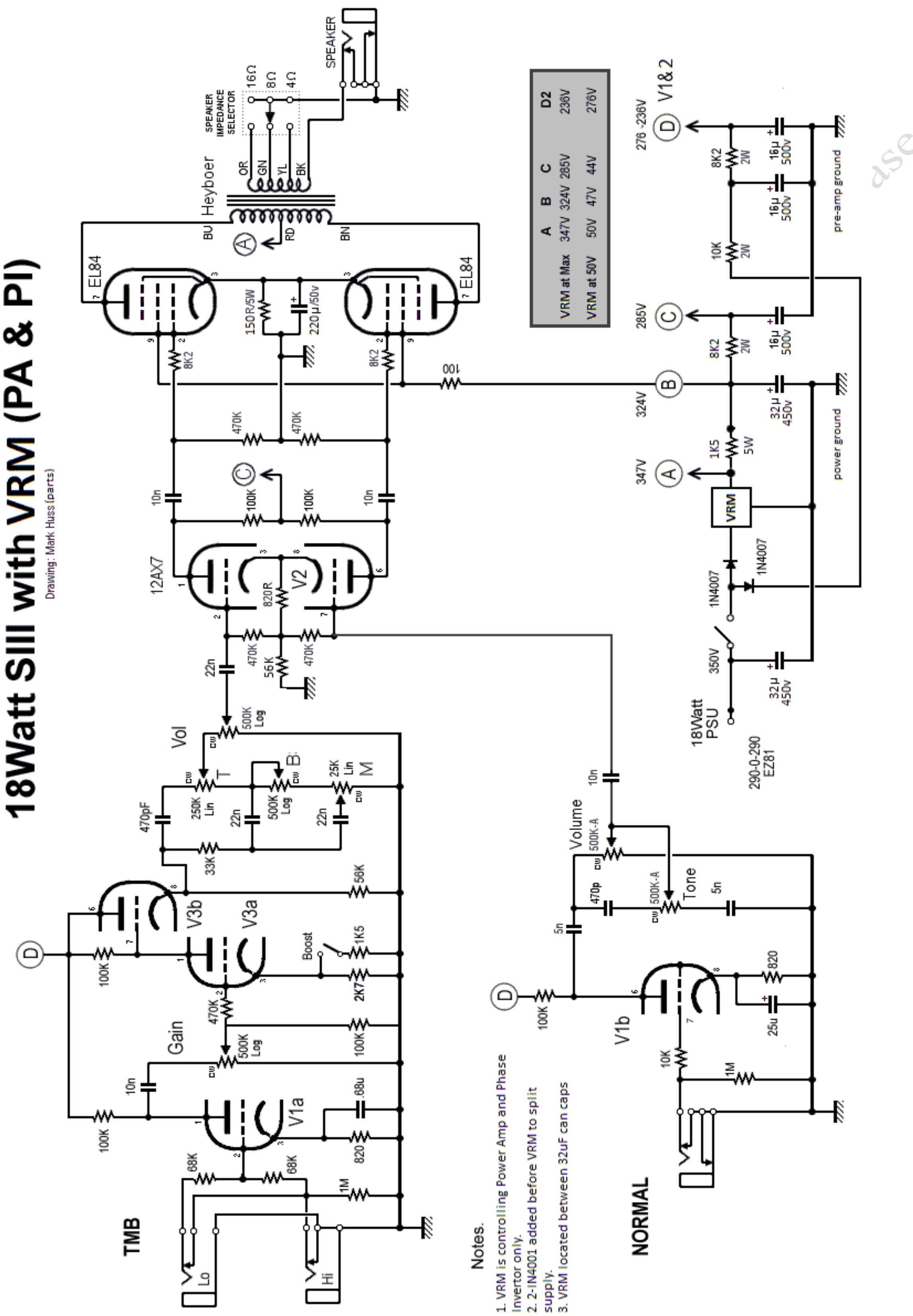


18 WATT INSTALLATION (FULL AMP POWER CONTROL)



TC15 INSTALLATION (FULL AMP POWER CONTROL)




18Watt SIII with VRM (PA & PI)
Drawing: Mark Huss (parts)
VRM at Max 347V 324V 285V 236V
VRM at 50V 50V 47V 44V 276V
A B C D2
Heyboer
SPEAKER IMPEDANCE SELECTOR
16Ω 8Ω 4Ω
SPEAKER
EL84
12AX7
V2
V1&2
276 -236V
285V
324V
347V
350V
18Watt PSU
290-0-290
EZ81
VRM
1N4007
pre-amp ground
power ground
Vol
Gain
Boost
Volume
Tone
V1a
V3a
V3b
V1b
TMB
NORMAL
Lo
Hi
Notes.
1. VRM is controlling Power Amp and Phase Invertor only.
2. 2-IN4001 added before VRM to split supply.
3. VRM located between 32uF can caps