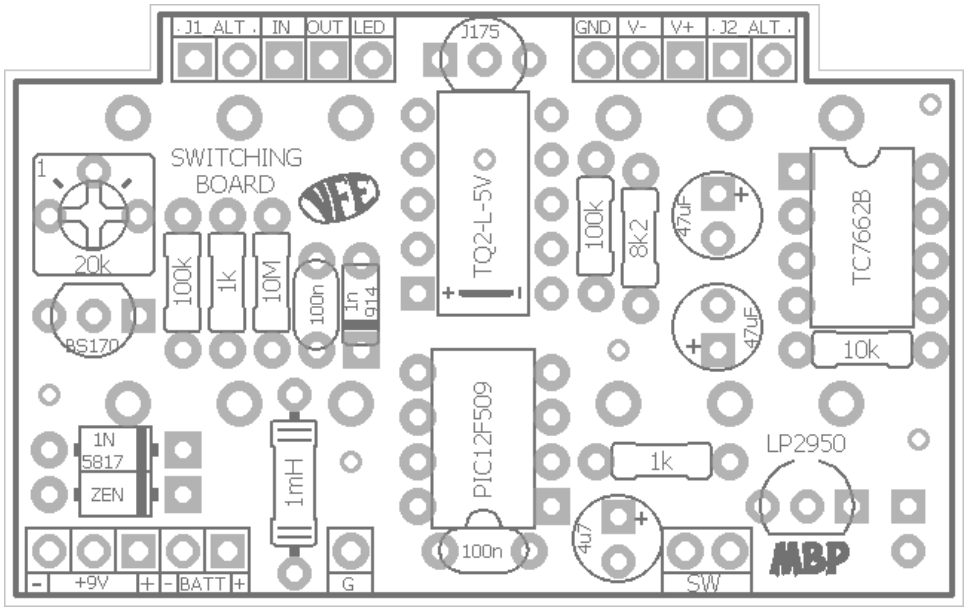
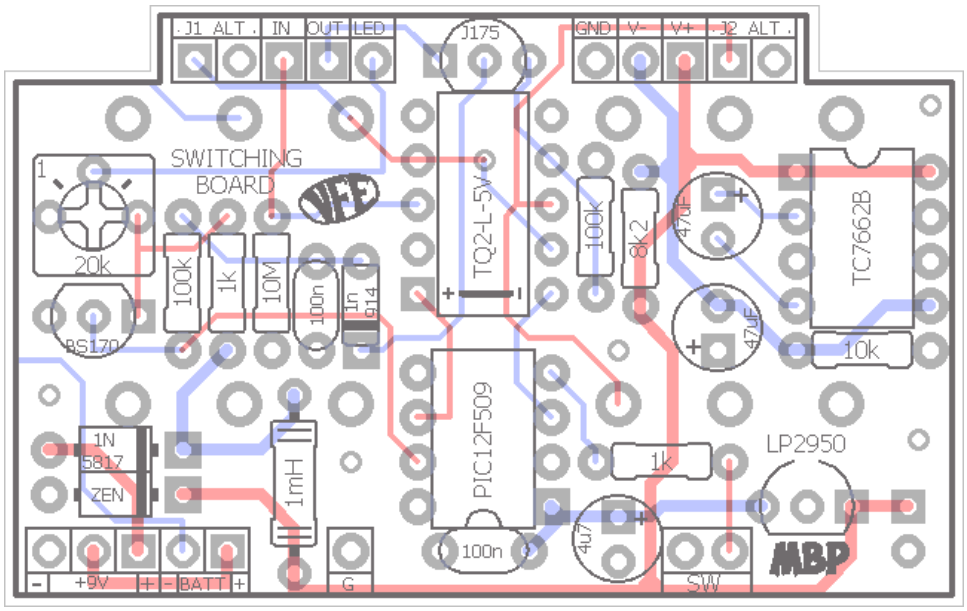
VFE SWITCHING BOARD V.2

2.15” W x 1.33” H





REMINDER: PETER RUTTER / VFE DOES NOT PROVIDE SUPPORT FOR THESE PROJECTS. PLEASE DO NOT CONTACT HIM FOR QUESTIONS OR TECHNICAL SUPPORT. VISIT THE VFE SECTION OF THE MADBEANPEDALS FORUM FOR QUESTIONS AND ANSWERS!

New for 2017 – v2 changes

There are a number of changes to the v.2 switching board. These changes were made to conform to my personal preferences with effects building and what I perceive most DIY will appreciate. My only intention is to make the process of building the VFE projects slightly easier and to require less workarounds for different styles of building.

- 1/4W resistors instead of 1/8W.
- Elimination of “sleeve make” style jack and necessary workarounds when using other types of jacks.
- Eliminated the PCB mounted DC Jack.
- Inclusion of the option to use no PCB mounted hardware.
- Slight change in power decoupling with the micro-controller (low profile 4u7 electrolytic and 100n MLCC).
- PCB mounted jacks (optional) were moved slightly inward for easier mounting in the 1590B enclosure.
- Larger pads for easy soldering.
- Nearly the exact same size as the previous switching board.

By in large, there are no circuit changes except for the power decoupling on the micro-controller. And, this was only done to serve my personal preference (yeah, completely selfish).

The Basics

The **VFE Switching Board and micro-controller** are included with all the VFE projects available from madbeanpedals. This switching scheme employs “soft bypass”, meaning a momentary non-latching SPST foot-switch is used in place of the ubiquitous 3PDT. This offers some advantages:

- SPST momentary switches and relays generally have much lower failure rate than the 3PDT.
- It’s easier to actuate than a latching bypass.
- Nearly silent operation (no more mechanical “pops!”).
- Secondary “momentary” function.

The switching scheme utilizes a pre-programmed micro-controller to actuate a DPDT relay. This relay handles I/O functions for the (separate) audio effects boards. Therefore, the Switching Board must be wired to an audio board to complete the bypass switching for the effects.

VFE has also gotten very clever; in addition to the components necessary to operate the switching, other circuitry is included. These are power filtering for DC supply, an optional charge pump (since many of the VFE effects use a split-rail power supply), effect input and output pull-down resistors as well as on-board DC and I/O jacks. This greatly simplifies the design of the individual audio boards in each project since the common portions to all audio effects are handled by the Switching Board.

The Switching Board is held in place with (optional) board mounted audio jacks. The momentary switch is attached via two wires and is not directly mounted to the Switching Board. This means you will need precision when drilling your enclosure to ensure the jacks fit properly and the DC Jack clears its drill hole. Fortunately, Peter has been kind enough to make a demonstration video to show you how to build these projects to the VFE standard!

How to finish a VFE Pedal build - Peter Rutter

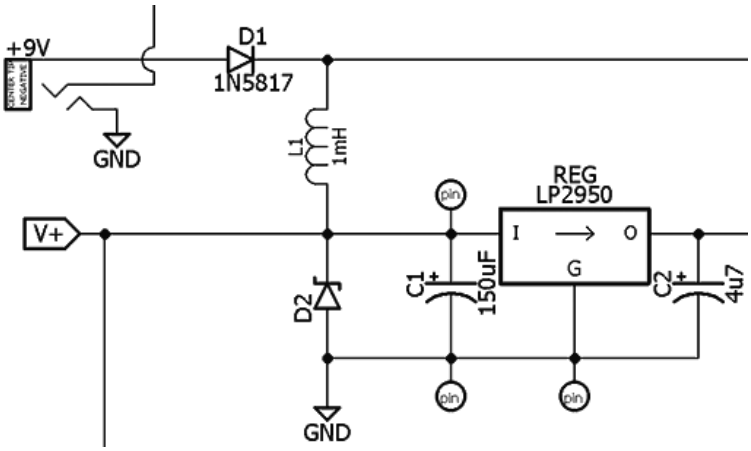
https://www.youtube.com/watch?v=vAvK-yB_29M

Notes:

The schematic lists TQ2-L-5v as the relay in this schematic, but VFE used the TQ2-L-4.5v as well. According to Peter both work fine but he tended to use the 4.5v relay. The 5v is listed in the Mouser BOM because it is more regularly stocked.

If using a battery, you must use board-mounted jacks to fit it all in. If using non-board mounted jacks you will probably not be able to fit a battery.

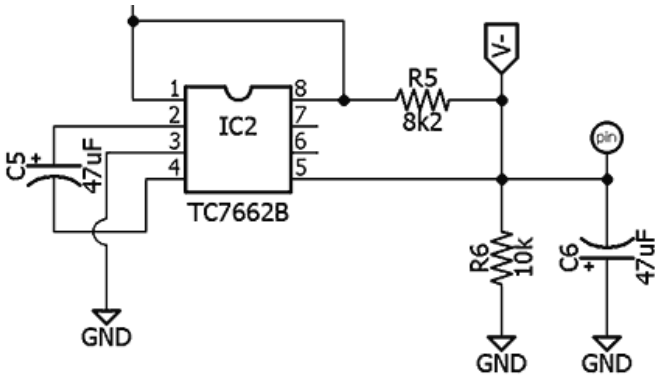
I Give You Infinite Powers



The DC Jack inserts into +9v. Power is reverse-polarity protected via D1. It then passes through a 1mH inductor which creates a low pass filter with the C1 decoupler. This helps reduce noise and minimize ripple on the DC power (additional 100n decoupling caps are used on the audio boards). A Zener diode is included to prevent over-voltage to both the audio PCB and the 7662 inverter (when used). Its value depends on which audio circuit is being built.

The power splits in two different directions: one goes to the audio board (pin above C1) and the second to the 5v regulator (LP2950). This regulator powers the micro-controller, which in turn activates the coil on the relay. It is decoupled with a 4u7 electrolytic and 100n MLCC.

Do You Like My Parts?

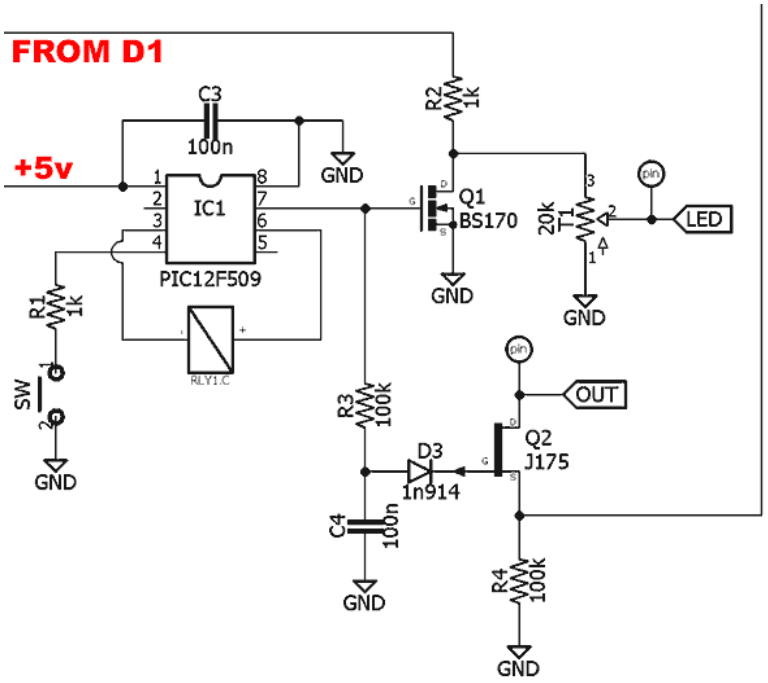


For audio effects that use a split-rail design, a 7662 is used as an inverter. Here the filtered DC is connected to the 7662 at pin8. Pin1 is shorted to pin8 to utilize the on-board frequency booster. This keeps the internal oscillator of the 7662 out of the audio range. Pin5 outputs a negative voltage (-9v) and is decoupled with a 47uF cap (C6). It supplies the audio PCB via the “V-” pad at the top of the board. The second 47uF cap (C5) is used to charge up the voltage inversion within the 7662.

In the Choral Reef the following exceptions are applied.

- **R5 (8k2) and R6 (10k) are only used in the Choral Reef. These resistors are left off in all other VFE projects.**
- IC2 AND C5 are also left off in the Choral Reef.
- C6 is still used, but it should be installed backwards. IOW, the + side of the cap goes to the round pad on the PCB and the – side to the square pad on the PCB.
- The V- pad on the switching board is still wired to the V- pad on the Choral Reef audio board. But, in this case it carries approximately +5v to the Choral Reef audio board instead of -9v that we would have when using the charge pump. This is to give the CF board a separate bias rail it needs to operate properly.

Controllers, Coils and Things



The 5v tap connects to the micro-controller (IC1: PIC12F509) for power. The relay coil (TQ2-L-5v) connects to pins 3 and 6 on the PIC. Pin4 of the PIC connects to ground via a 1k resistor and momentary switch. When the momentary switch is depressed, the PIC "reads" that input and sends a voltage pulse to the relay to activate the coil. This causes the internal DPDT of the relay to flip states (between bypass and effect in our case).

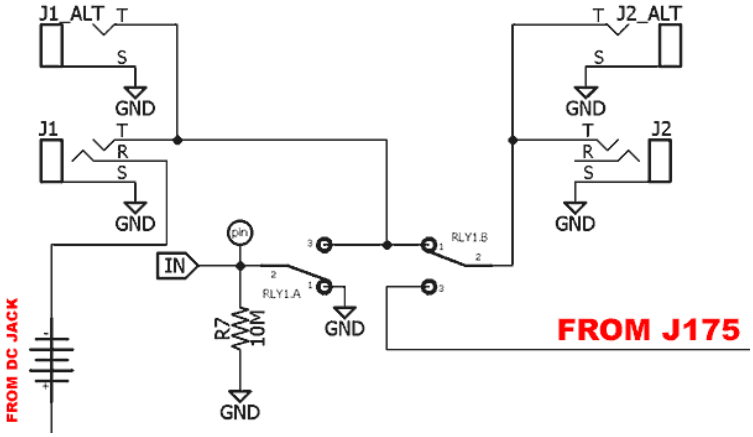
A couple other things happen at the same time when the switching engages.
Pin7 of the PIC is 0v in effect mode, 5v in bypass mode.

1) When the relay is in bypass-mode, pin7 of the PIC puts out a continuous 5v which is applied to the gate of Q1. This grounds the power rail created by R2 to turn off the bypass LED by using the mosfet as a switch. IOW, the nominal state for the LED is *on* and the mosfet "interrupts" (grounds) the power to the LED on bypass. The 20k trimmer is for the user to control their preferred LED brightness.

2) Q2 is used as a variable resistor. In effect-mode, pin7 grounds the gate of Q2 and the resistance between the drain and source is on the order of 120 Ohm. This acts as a small series resistance for the audio output and R4 behaves as output pull-down. From there, the audio output goes to the output jack.

3) In bypass mode, pin7 switches to 5v and the resistance between drain and source on Q2 goes to its nominal value (infinite for argument's sake). This mutes the OUT signal as the DPDT switches back to bypass-mode to prevent any noise from going to the output jack. When it goes back to effect mode, the 100k resistor (R3 grounds and the 100n cap begins to discharge. The slower discharge from the 100k/100n time constant may help create more consistent on/off action in the momentary mode (my guess).

Whar Signal Goes? Whar??!!!



The Switching Board utilizes an effect-input grounding scheme. IOW, when the audio circuit is bypassed its input is grounded. A 10M pull-down is used in all VFE projects.

For the v.2 board, J1_ALT and J2_ALT have been added. These are used for those who do not wish to use PCB mounted jacks and are duplicates of the J1 and J2 I/O connections. Please see the wiring diagrams for more explanation.

So Good, You Bought It Twice

The Switching Board has one other feature: a secondary momentary mode. In this mode, the switching behaves like a momentary on/off rather than a latching switch. Don't worry – it's still true bypass. In this mode the effect is only on while you have the foot-switch pressed.

To activate momentary mode, do not press the switch for 5 seconds. Then tap it twice quickly. Now press and hold for a few seconds until the LED starts to blink. You are not in momentary mode.

To de-activate momentary mode and go back to latching mode, do the same process again. Wait 5 seconds, tap, tap, hold. If you encounter problems switching back disconnect/reconnect the DC power.

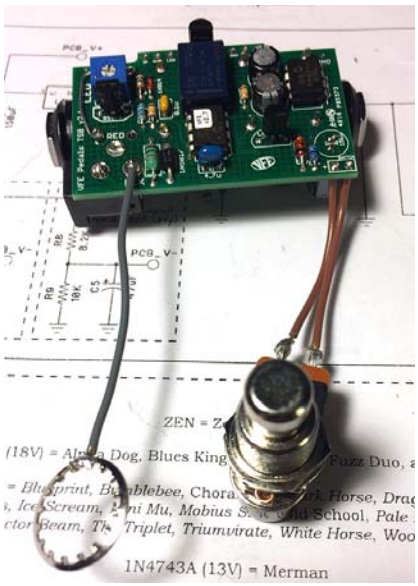
v.2 (2017) Update: Some of the initial batch of micro-controllers I received in 2016 seemed to have a problem with switching between the two modes and would only reset by unplugging and re-plugging the DC jack. This seems to no longer be a concern with the more recent batches I have received from VFE. TIP: when you are in "momentary mode" and trying to switch back to latching mode make those first two "taps" very fast. If you hold them too long it won't switch back to latching mode ☺

You Grounded, Bro?

You might realize at this point that the entire circuit it ground isolated. IOW, there is no chassis grounding point with the Switching Board or the hardware attached to it (same goes for the audio boards). Therefore, we need to create a ground path to the chassis.

Peter demonstrates his method in the video linked on pg.2 I suggest you watch the video and see how he does it (using a small bead of solder on the jack ferrule to ensure sleeve to chassis contact). No issue with doing it that way at all, but here is an alternative (I find this easier).

Use the ½" lock washer you get with foot-switches (some a serrated, others are link...doesn't matter) and solder a wire to it. Solder the other end to the "G" pad next to the inductor on the Switching Board. So, when your foot-switch is locked down the washer contacts the chassis and makes the ground connection. Either method is fine…it's up to your personal preference.



Lock washer soldered for chassis grounding. Shown on previous version of the switching board so it is wired to a different place, but you get the idea.

TIP: If you'd like to learn more about soft-bypass switching, check out these terrific tutorials available at Code Effects

http://www.coda-effects.com/2016/04/relay-bypass-conception-and-relay.html
http://www.coda-effects.com/2017/02/relay-bypass-final-code.html

I do not have the code to program the micro-controllers. This is proprietary to VFE.

B.O.M.

Resistors		Diodes	
R1	1k	D1	1N5817
R2	1k	D2	Zener
R3	100k	D3	1n914
R4	100k	**Inductor**	
R5	8k2	L1	1mH
R6	10k	**Transistors**	
R7	10M	Q1	BS170
Caps		Q2	J175
C1	150uF	**ICs**	
C2	4u7	IC1	PIC12F509
C3	100n	IC2	TC7662B
C4	100n	**Relay**	
C5	47uF	RLY1	TQ2-L-5V
C6	47uF	**Regulator**	
		REG	LP2950
		Trimmer	
		T1	20k

Zener Chart	
18v	Alpha Dog, Blues King, Distortion3, The Scream
16v	Blueprint, Bumblebee, Choral Reef, Dark Horse, Fiery Red Horse, Focus, Mobius Strip, Old School, Pale Horse, Springboard, The Triplet, Triumvirate, Tractor Beam, White Horse
13v	Merman

Split Rail Projects

Blueprint, Bumblebee, Dark Horse, Focus, Mobius Strip, Pale Horse, Springboard, The Triplet, Triumvirate, Tractor Beam, White Horse

Shopping List

Value	QTY	Type	Rating
1k	2	Metal / Carbon Film	1/4W
8k2	1	Metal / Carbon Film	1/4W
10k	1	Metal / Carbon Film	1/4W
100k	2	Metal / Carbon Film	1/4W
10M	1	Metal / Carbon Film	1/4W
100n	2	MLCC	16v min.
4u7	1	Low Profile Electrolytic	16v min.
47uF	2	Low Profile Electrolytic - LOW ESR	16v min.
150uF	1	Electrolytic	16v min.
1N5817	1		
Zener	1	*see chart for values	
1n914	1		
1mH	1		
BS170	1		
J175	1		
TC7662B	1		
TQ2-L-5V	1	4.5v or 5v version can be used	
LP2950	1	LM78L05 can be used	
20k	1	Bourns 3362p	
PIC12F509	1	*included with project	

*used in all builds

**used in split-rail builds

***used in the Choral Reef

For convenience, I have created a MOUSER project for the Switching Board components. This is specifically for the "v2" board. If using the previous version of the switching board, please see the link to the Mouser project in that document.

Mouser Project: VFE_SwitchingBoard v.2
https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=361b06ad90

Notes:
- The Mouser project does not include the momentary switch, jacks, or battery clip.
- Mouser does not seem to have any low-profile LOW-ESR 47uF electrolytic caps. I have listed a different low-profile cap that I have used many times in voltage inverter circuits.
- It includes all the components for every switching board variation (including the three different types of Zener diodes) so be sure to remove parts you don't need when ordering for a particular VFE project.

Jacks

PCB Mounted
BLMS: https://lovemyswitches.com/1-4-stereo-switched-enclosed-jack-pcb-pins/
Smallbear: http://www.smallbear-electronics.mybigcommerce.com/1-4-enclosed-nmj6hcd2/
Mouser: https://www.mouser.com/ProductDetail/Neutrik/NMJ6HCD2/?qs=sGAEpiMZZMv0W4pxf2HiV5kIvuq9GNdIXM8aWl3faEo%3d
Pedal Parts Plus: http://www.pedalpartsplus.com/product-p/6013.htm
Tayda: http://www.taydaelectronics.com/6-35mm-1-4-stereo-insulated-switched-socket-jack-pcb.html

Wired Jacks
When using wired jacks, I recommend the Lumberg style:
http://www.smallbear-electronics.mybigcommerce.com/lumberg-1-4-compact-shrouded-mono-jack/

Metal frame jacks should fit fine…I just don't use these in most of my pedal building:
http://www.smallbear-electronics.mybigcommerce.com/1-4-in-mono-nys229/
http://www.smallbear-electronics.mybigcommerce.com/1-4-in-mono-switchcraft-11/

Momentary Switch

VFE uses this switch in their pedals:
http://smallbear-electronics.mybigcommerce.com/110-pm-off/
- These are more expensive, but are very rugged. They are momentary but provide a "click" when pressed.

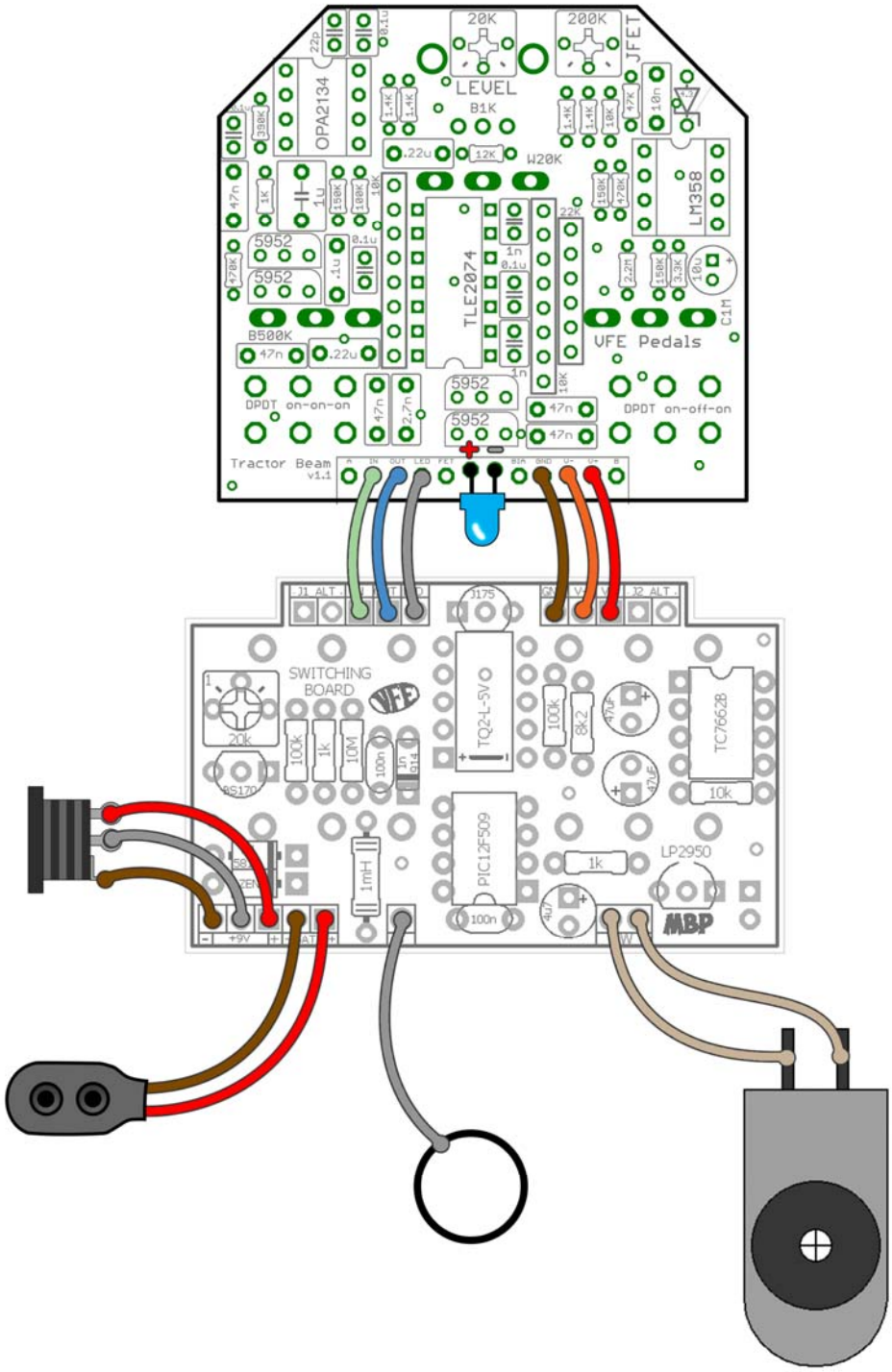
Regular soft touch momentary are less expensive and will work fine:
http://smallbear-electronics.mybigcommerce.com/momentary-spst-no-soft-touch/

If you want to go really cheap, I have tested these and they work fine:
https://lovemyswitches.com/spst-momentary-foot-switch-normally-open-soft-touch/

I don't know if these are "normally open" type but they look similar to the BLMS ones:
http://www.taydaelectronics.com/spst-momentary-soft-touch-push-button-stomp-foots-pedal-switch.html

Momentary switches for these projects should be "normally open".

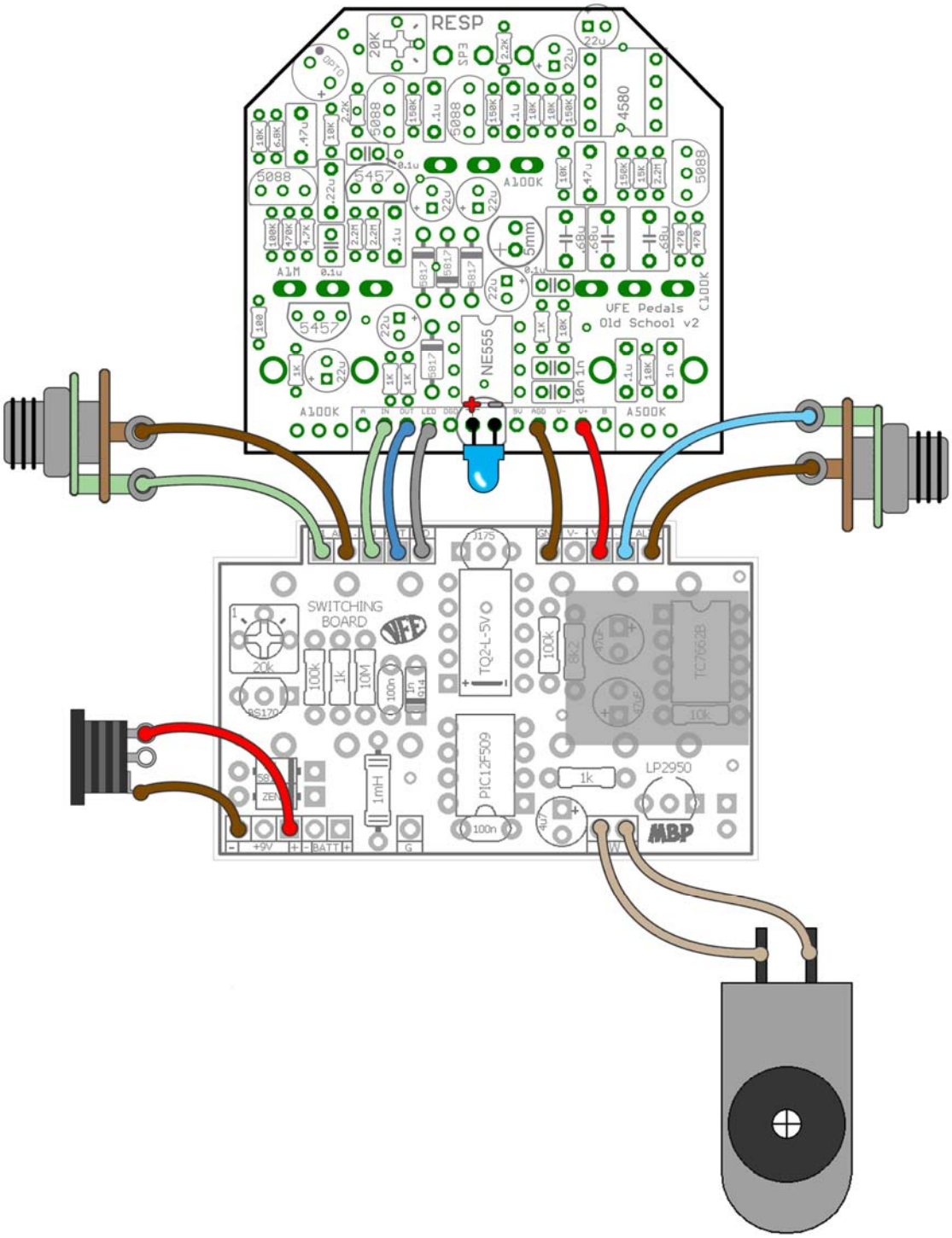
Wiring Diagram 1



This example shows the Tractor Beam wiring. It includes **split-rail power, PCB mounted input and output jacks and the battery hookup.** When using PCB mounted jacks, solder a wire from the “G” pad next to the inductor to the lock-washer of the momentary switch (which is inserted over the momentary switch when boxing it up). This ensures the enclosure gets grounded to the circuit and DC power since all the jacks are isolated (in this example).

The J1 ALT and J2 ALT pads are left empty. Additionally you can see several other pads on the Tractor Beam (A, FET, etc) which are also left empty. These extra pads are present in most of the VFE PCBs and should be ignored unless otherwise indicated in their project documents. Most likely they were used as test points or some other function not needed for us.

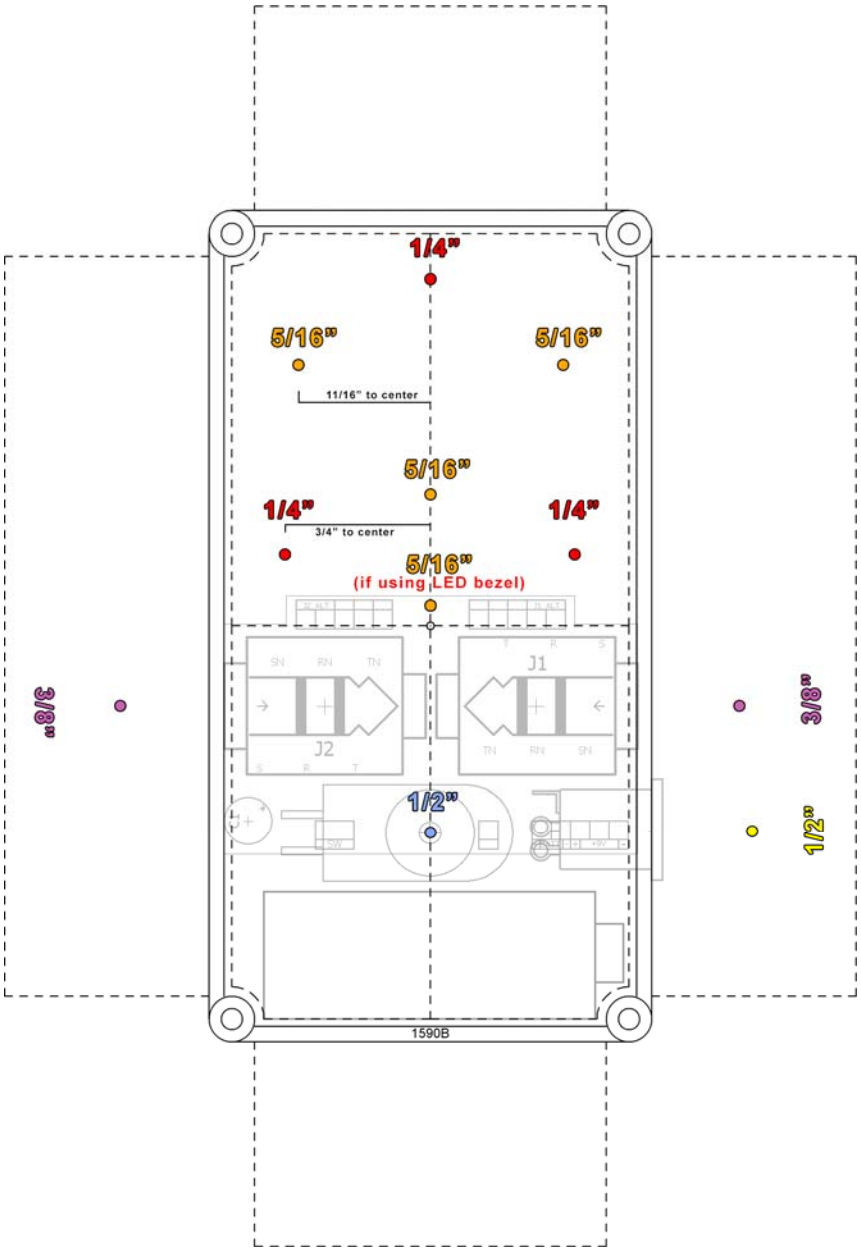
Wiring Diagram 2



This example shows the Old School. That project **does not use a split-rail power scheme** so all the stuff in the gray box is left off. Notice that there is no wire connecting the V- pads on the two boards since it doesn't need -9v. This example also shows how to wire non-pcb-mounted jacks (if that is your preference). Since these jacks are typically *not* isolated from the enclosure we also don't need the little grounded lock washer on the momentary switch. Lastly, the battery hook-up was left off in this example.

Drill Template 1

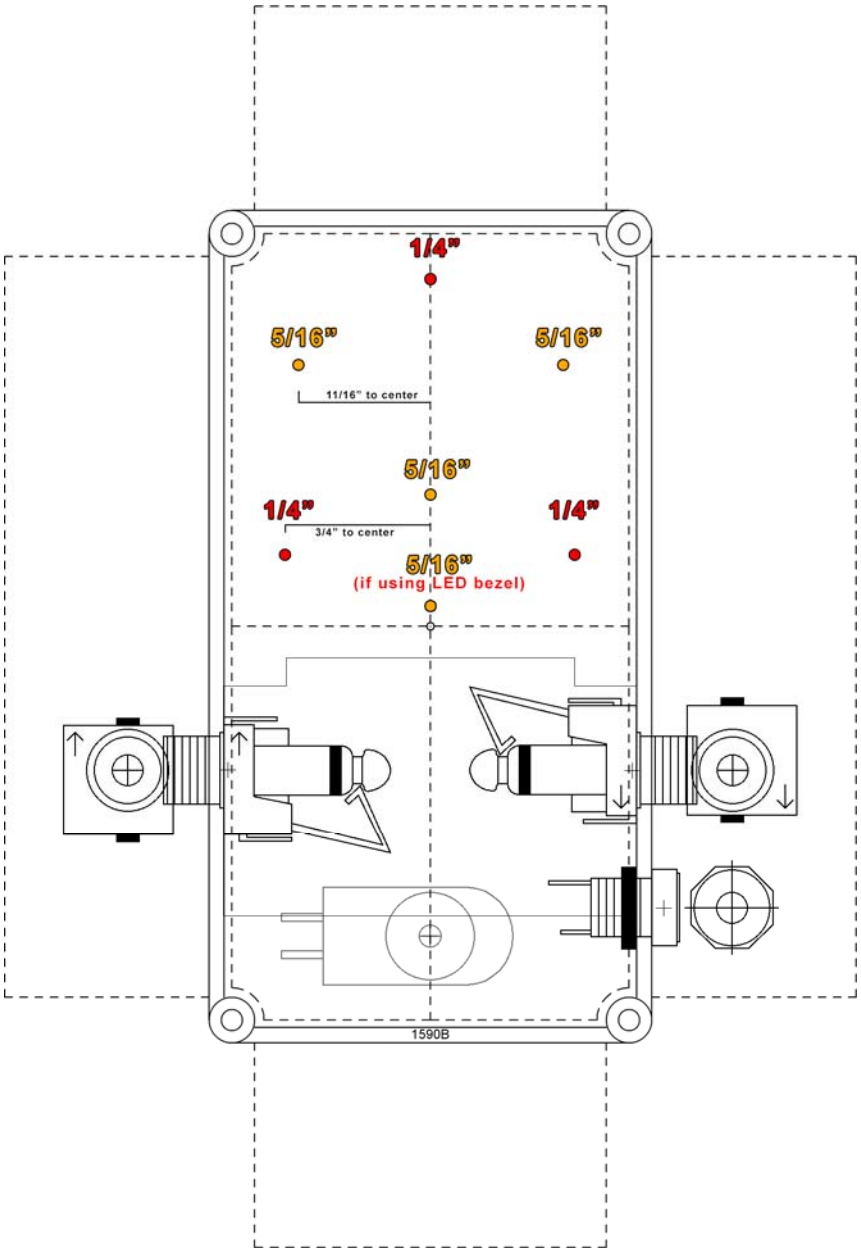
For use only with the v.2 Switching Board



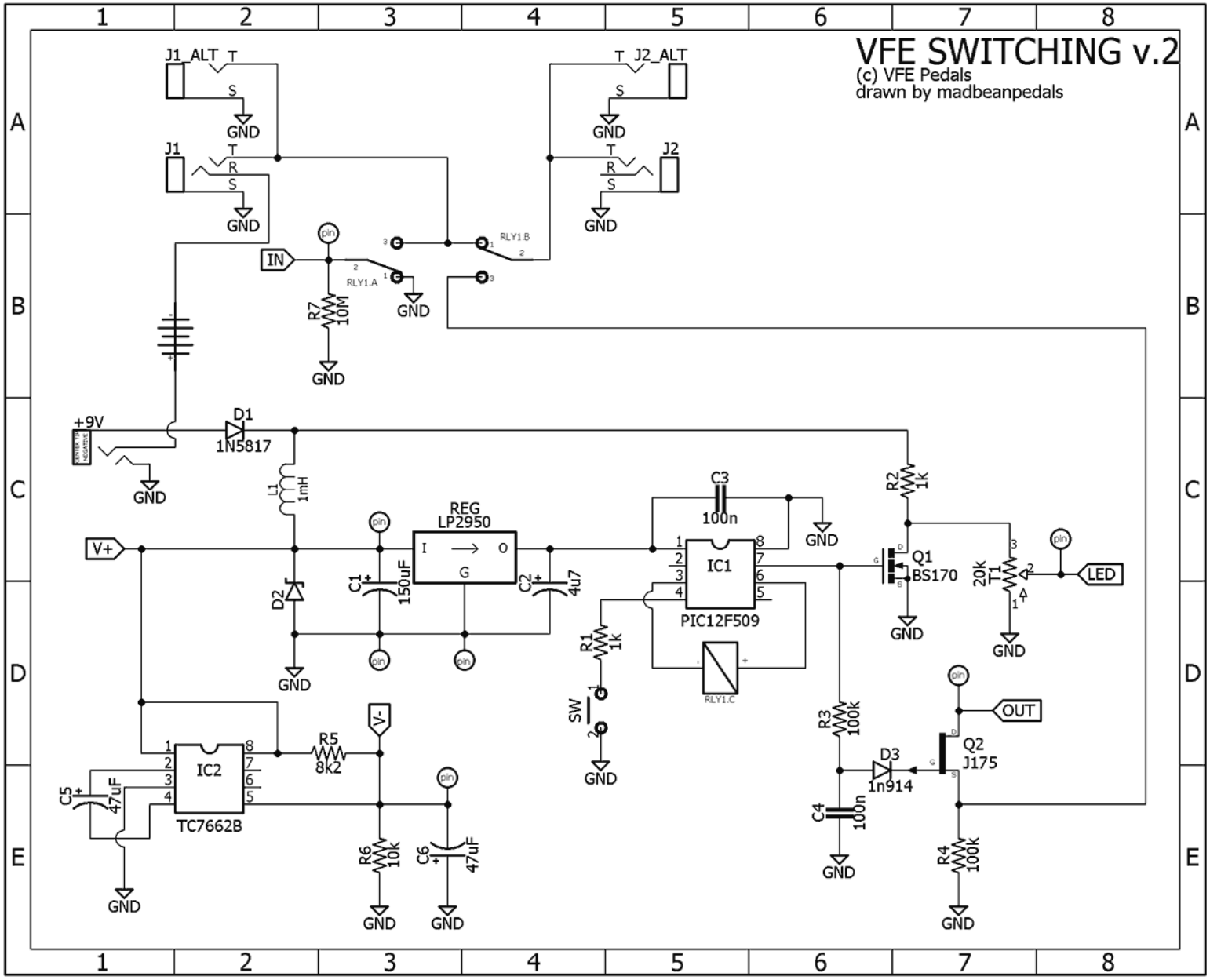
Use this template for board-mounted jacks and battery.

Drill Template 2

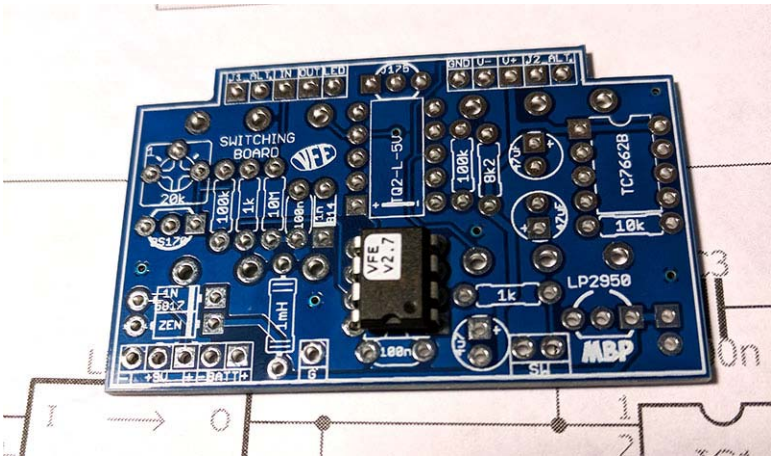
For use only with the v.2 Switching Board



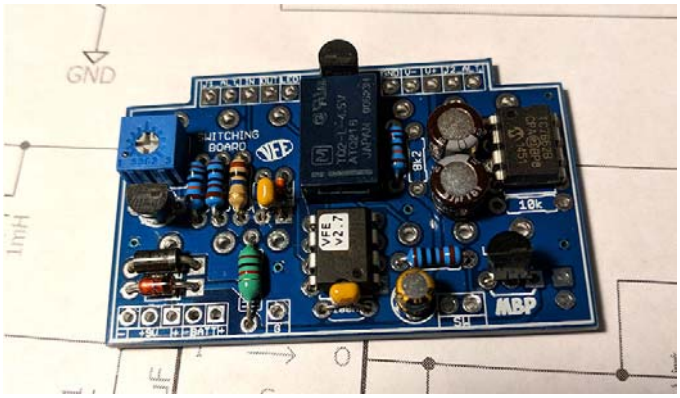
Use this template for wired jacks and no battery.

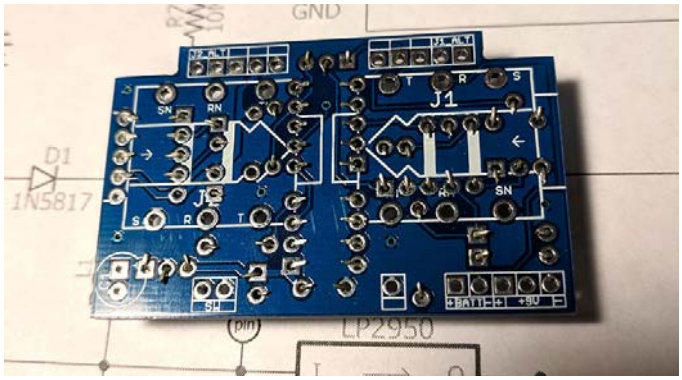

VFE SWITCHING v.2
(c) VFE Pedals
drawn by madbeanpedals
J1_ALT
J2_ALT
J1
J2
GND
IN
RLY1.A
RLY1.B
R7
10M
+9V
D1
1N5817
L1
1mH
REG
LP2950
V+
C1
150uF
C2
4u7
D2
C3
100n
IC1
PIC12F509
RLY1.C
R2
1k
Q1
BS170
20k
T1
LED
R1
1k
SW
R3
100k
D3
1n914
Q2
J175
OUT
C4
100n
R4
100k
V-
R5
8k2
IC2
TC7662B
C5
47uF
R6
10k
C6
47uF

Building the Board

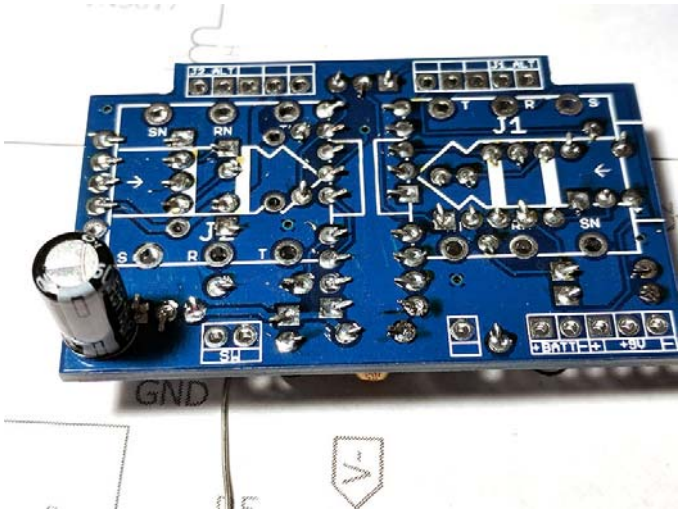


This is how you get the board, with the VFE PIC already installed. You do not want to use IC sockets on the Switching Board because the PCB sits on top of the momentary switch and there won't be enough room if sockets are used.



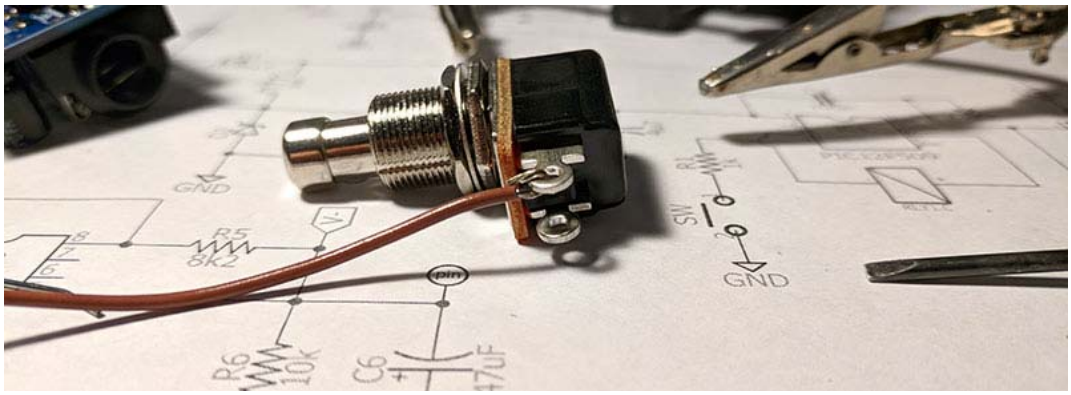


I generally load almost everything and solder in one go. You can do it however you like; if you prefer to do one components at a time or a small batch that's fine. TIP: when soldering the ICs and relay do not solder all the pins at once. Do a couple of pins, move on to another component, then come back. This prevents the parts from getting too hot.

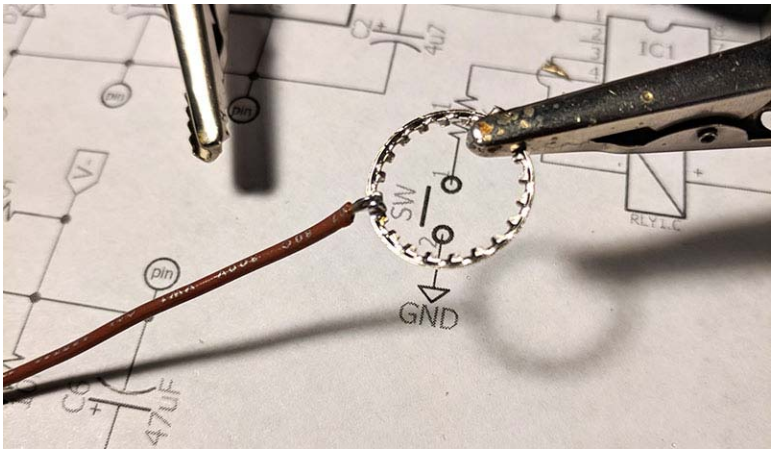


All the installed parts soldered up. I went ahead and put on the 150uF decoupling cap which goes on the bottom side of the board.

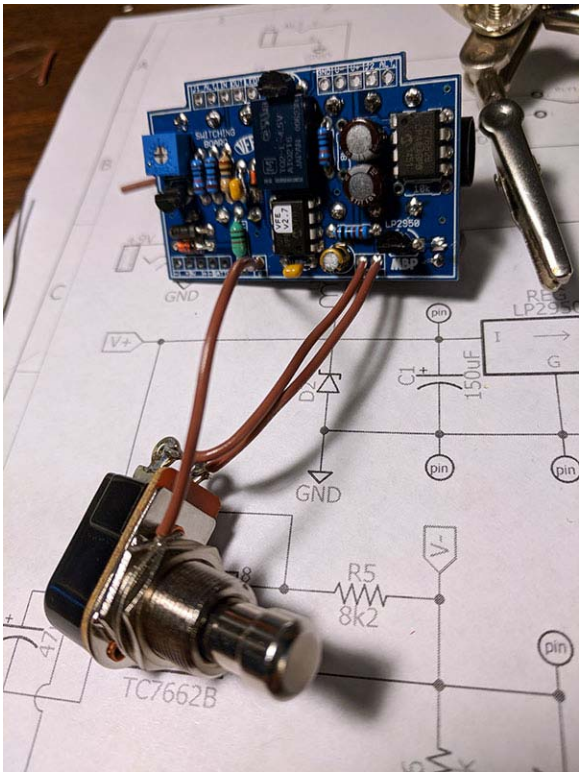
When soldering on the jacks, I use a little bit of BluTac to hold them in place.



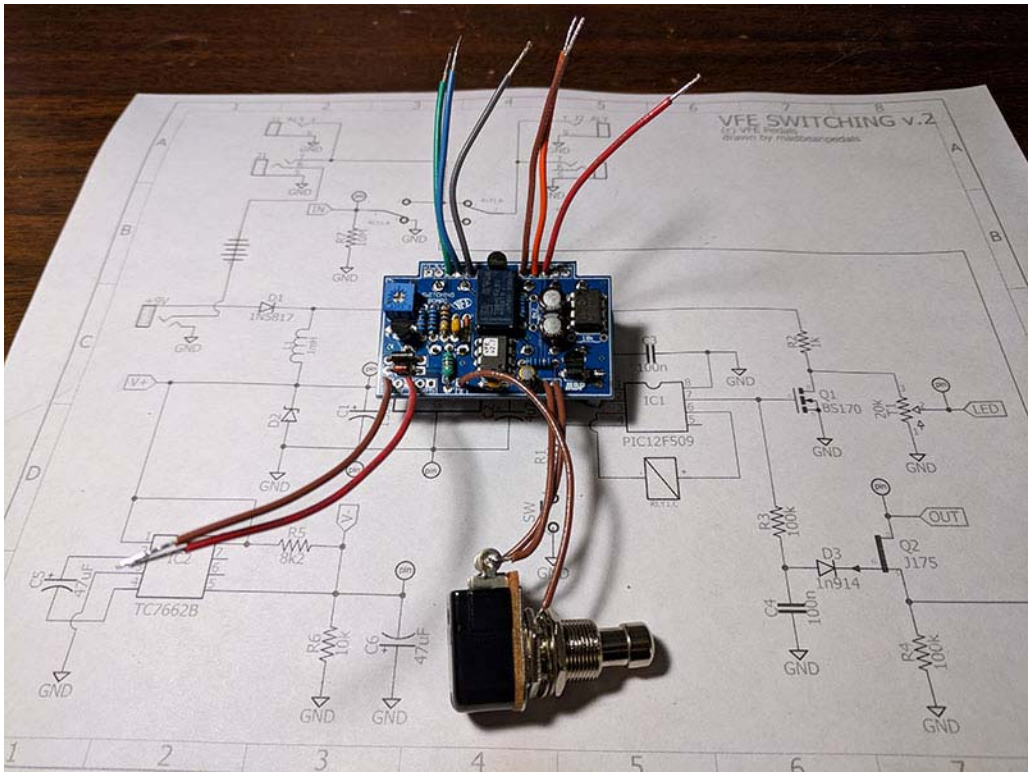
For the switch, I recommend soldering on the two wires facing up like this. The switch and 150uF cap will be close together when things are boxed up, and having the wires out of the way will help a lot.



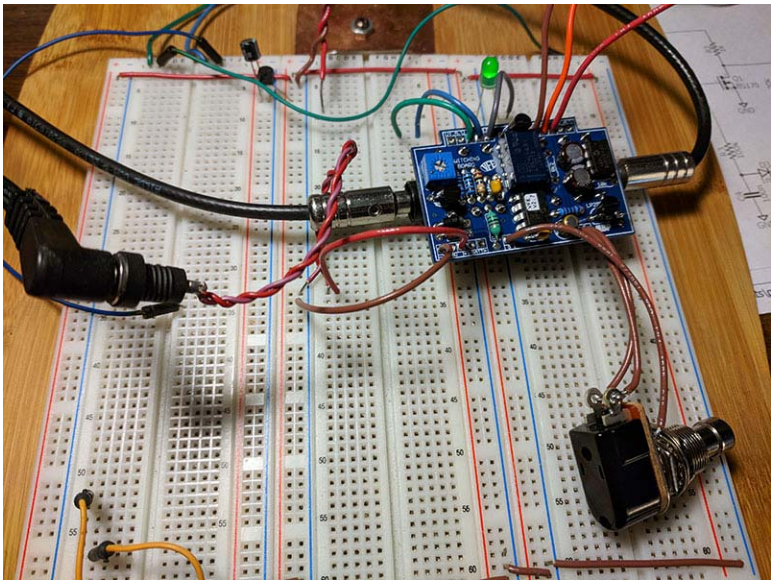
For the grounding, solder a wire to a lock washer like so. I bought my momentary switches from BLMS and the do not come with lock washers. Luckily I have some extras which I bought from smallbear. The BLMS switches do have a flat washer which you can use instead. You only need to do this when using PCB mounted jacks.



Lock washer temporarily put on the switch to keep it out of the way while the build is completed.

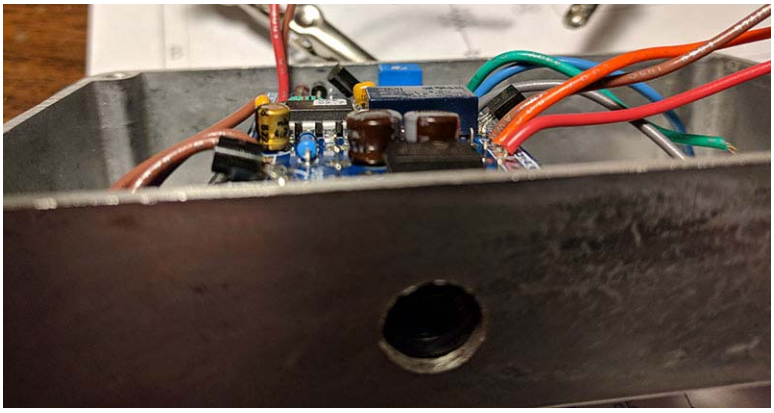


All the wires are installed and the whole thing is ready for testing.

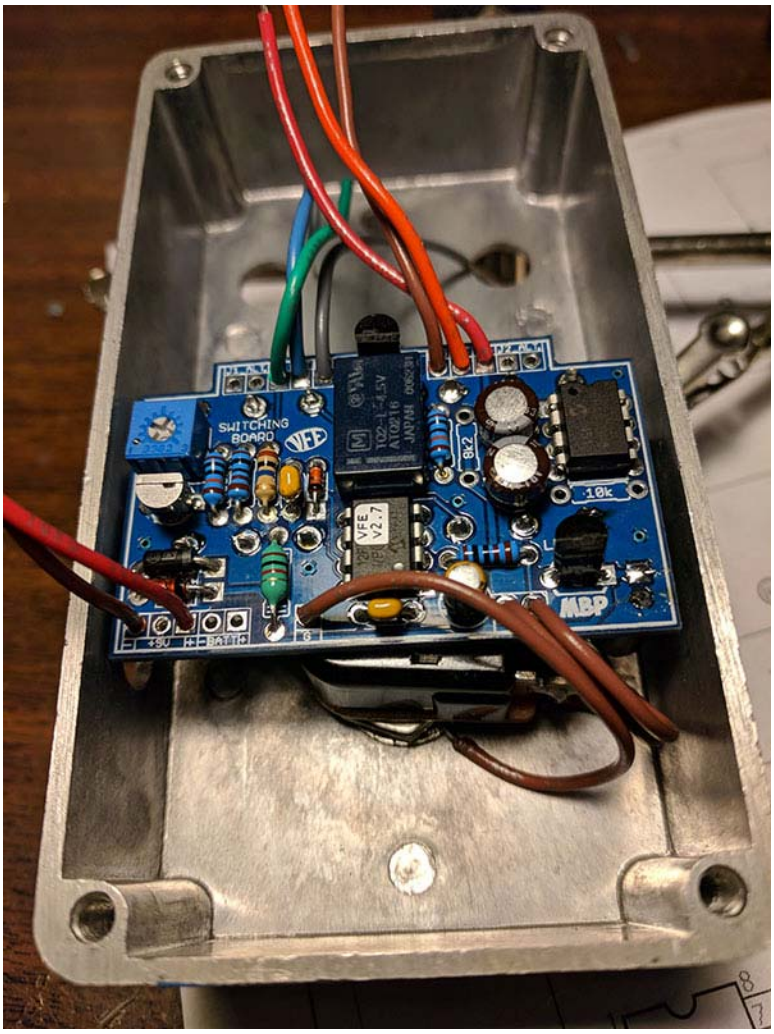


You don’t necessarily have to test the switching separate from your entire build. You can just as easily wire everything to your audio board and test everything at once. I did it this way because this was built specifically for this guide. I hooked the effect input and output wires on the breadboard so I could test that signal was passing in both states: bypass and effect.

Voltages off the V+ and V- pads. Everything checks out. There is no load on the supply rails now so these values will go down once it is used to power an audio board.



Once the board is installed, the three transistors should be pushed down on their sides a bit. This ensures the don’t butt up against the bottom plate.



The board goes over the momentary switch. This is an older enclosure drilled to spec on the previous Switching Board, so the DC jack is drilled for the wrong spot. No worries, the Drill Guide in this doc works just fine for this board.

Here is a quick video of the board being tested and a demo of how to switch between latching and momentary modes:

https://www.youtube.com/watch?v=WvKMa8v0OvE
