GuitarPCB Guide - Courtesy of Tonmann:

GuitarPCB T&S Style Inputs & Outputs: The signal, which goes to the **tip of a jack plug** is marked **T**, the sleeve of the jack plug, which is grounded isn't marked. Both pads are bounded by a white box.

The pads are so arranged to make shielded cable, if used, easier to solder, also the pads are spaced so that a socket and plug system can be soldered directly to the board.

Switches Other Than Bypass Footswitch: these are usually two or three pad toggle switches or rotary switches when used. There is a small 1 to indicate lug 1. They are designated **SW.**

Bypass Footswitch: Wiring for the 3PDT Board footswitch is standard for all GuitarPCB boards.

1 Input to board
2 Input from jack
3 Bypass wire

4 LED cathode
5 Ground
6 2nd LED (bypass) cathode

7 Output from board
8 Output to jack
9 Bypass wire

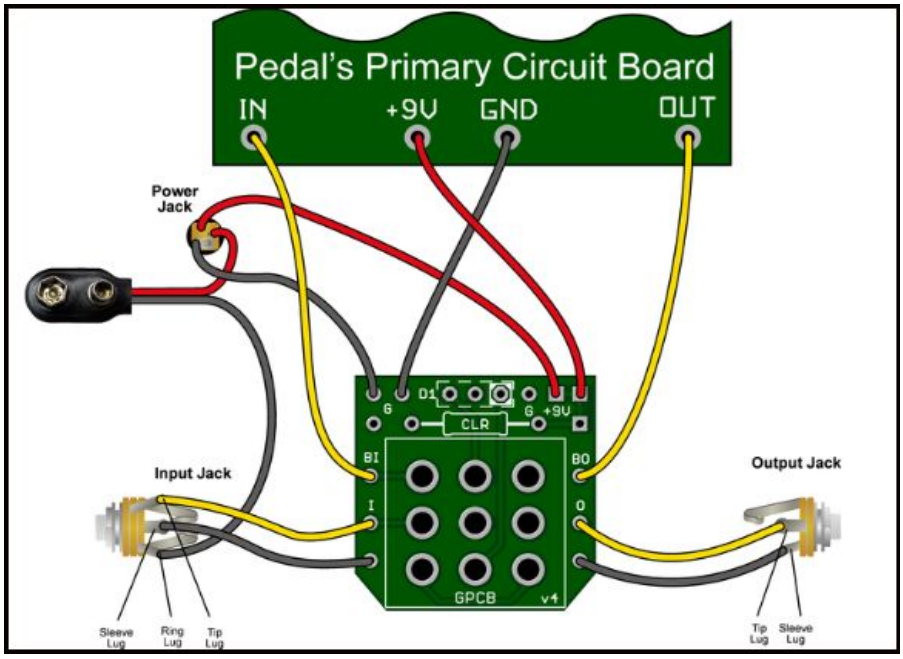
There are other ways to wire a footswitch. I think this is the best method to use, once you have wired a few footswitches it is easy to remember (left column inputs, middle column LEDs, right column outputs, top row board, middle row jacks, bottom row bypass). It is symmetrical as well.

The status LED wiring to the board depends on the type of LED you use for single LEDs you would use lugs 4 & 5, the LED lights when the pedal is in effects mode. For dual (or bi-color) LEDs you would use all three lugs - 4 & 5 (green) when in effects mode and lugs 5 & 6 (red) in bypass mode.

Rather than confuse the footswitch with a toggle switch, the footswitch is designated S instead of SW. The LED pads on the circuit board are labeled S4, S5 & S6.

Star grounding: There could be a long, technical discussion on why and when to use a star grounding, **in short it isn't needed for GuitarPCB circuit boards** as they all use a ground plane system, unless there is some compelling reason to star ground components I would suggest direct wiring to the board.

If using our extremely handy 3PDT Wiring Boards here are a few tips:



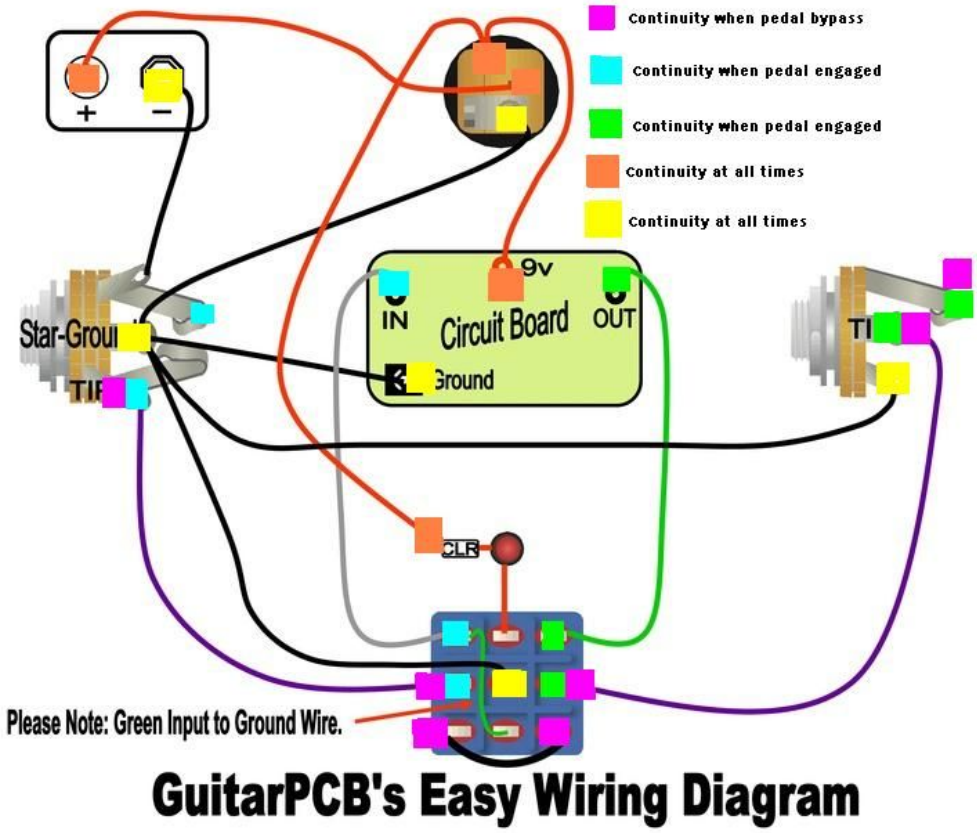
Here is a great tip if you did not already know...

Completely Wire your 3PDT Wiring board before soldering it to the switch!

1. Add Current Limiting Resistor
2. Add input and output wires to wiring board
3. Add Ground Wire and Power wiring
4. Finally loosely place in your LED choice

When everything is wired up the last thing to do is solder your 3PDT wiring board to your 3PDT switch then solder your LED in place for a super easy and super neat build!

Checking for Continuity Guide:



1. Continuity testing is a very valuable debugging tool which can used in conjunction with other debugging tools and can be carried out very quickly.
2. It is a way to check if two parts of a circuit that should be electrically connected are indeed connected.
3. You can also use it to check some components are working correctly such as switches and of course for internal breaks in wires etc. As well as a quick check for ground connections.
4. Using a schematic for your pedal build will show you which parts of the circuit should be connected and conversely which should not. You would simply follow the schematic for the particular part of the circuit you wish to check.

If there is no connection, no audible beep would be heard and the meter would display infinite resistance for an open circuit again different meters use different measurements usually either displaying a '1' or 'OL' indicating an open circuit in that part of the circuit usually caused by a poor solder joint and although possible very rarely a component problem or break in the wires or pcb traces. You can also use continuity testing to check if two parts of a circuit are connected that should not be connected indicating possible solder bridges etc.

To check ground connections you would put one probe on the ground pad or ground connection you wish to check and simply touch a metal part of the enclosure to quickly test for good grounding.
So if you suspect a poor grounding point e.g jack socket touch the jack ground lug with one probe and any other ground point with the other to very quickly check if you have a good ground connection. I always use a bare part of the enclosure for easy one handed testing.
So there you have it a brief look at continuity testing and its value to the DIY pedal builder.

Phase Determination Guide:

You can determine the input / output phase relationship for any circuit for yourself.

Transistors (BJT / FET).

The input is the base / gate of the transistor.
If the output of the transistor is taken from the emitter / source the output signal is **in phase** with the input signal. If the output of the transistor is taken from the collector / drain the output signal is **out of phase** with the input signal.

Op Amps

The input determines the output phase of the op amp.
If the non-inverting input (+) is used, the output is **in phase** with the input.
If the inverting input (-) is used, the output is **out of phase** with the input.

Now it is a matter of starting at the input of the circuit and going through each amplifier stage to see whether the stage output is inverted (out of phase) or not.

Remember from school math - two negatives make a positive; if you invert an inverted signal you get a non-inverted signal.

Ratt Deluxe:

The first stage, IC1, doesn't invert (+ input used) and the second stage, Q1, also doesn't invert (source output used). Result is the output is in phase with the input.

KOTB v3

Q1 - drain output inverts the signal (out of phase with circuit input)
Q2 - drain output inverts the signal (in phase with circuit input)
Q3 - drain output inverts the signal (out of phase with circuit input)
Q4 - source output doesn't invert the signal (out of phase with circuit input)
Q5 - drain output inverts the signal (in phase with circuit input)
Q6 - drain output inverts the signal (out of phase with circuit input)
Result; the output is out of phase with the input.

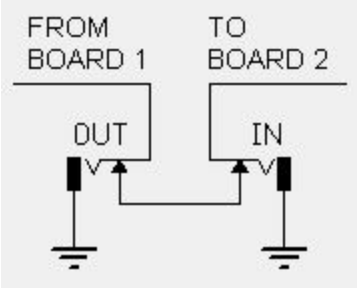
Although you can do most circuits in your head or mark pluses and minuses on your schematic, an easy way is to count the number of stages where the signal is taken from the collector / drain and the number of op amps that use the inverting input, if you get an odd number of stages the circuit output is **out of phase** with the circuit input - obviously an even number of stages means that the circuit output is **in phase with** the circuit input. Since the KOTB has **five** stages where the signal is taken from the drain, the circuit output is **out of phase** with the circuit input.

Next we will talk about adding an effects loop to your project...

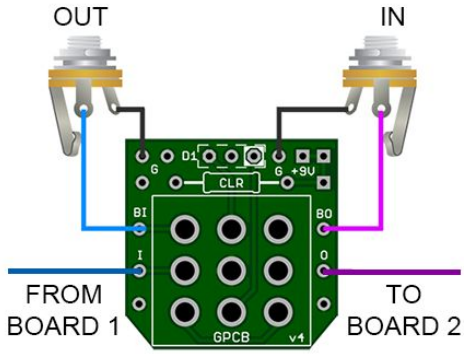
Add an effect loop to your project:

Use two mono jacks with normally closed switch.

Connect the switch lugs together and connect the tip lug of one jack to the output of board one and the tip lug of the other jack to the input of board 2 and both sleeve lugs to ground like this:



With nothing plugged into the jacks the signal passes from board 1 to board 2, when an effect is plugged into the jacks the signal passes through the effects.
A second method uses either a 3PDT bypass wiring switch arrangement or, to make things easier, use a GuitarPCB 3PDT board:



With this method any effects plugged into the effects loop are bypassed with a footswitch on your combo enclosure.

If you look at the schematic symbol above the tip is connected to the switch when nothing is inserted, the signal path is board 1 → out tip →switch→switch→in tip→ board 2.

When a plug is inserted the connection between tips and their associated switches is broken and the sign path is board 1 → out tip →effect input→effect output→in tip→ board 2.

Either / Or - Effect Order Switching using a 2 Knob Job board:

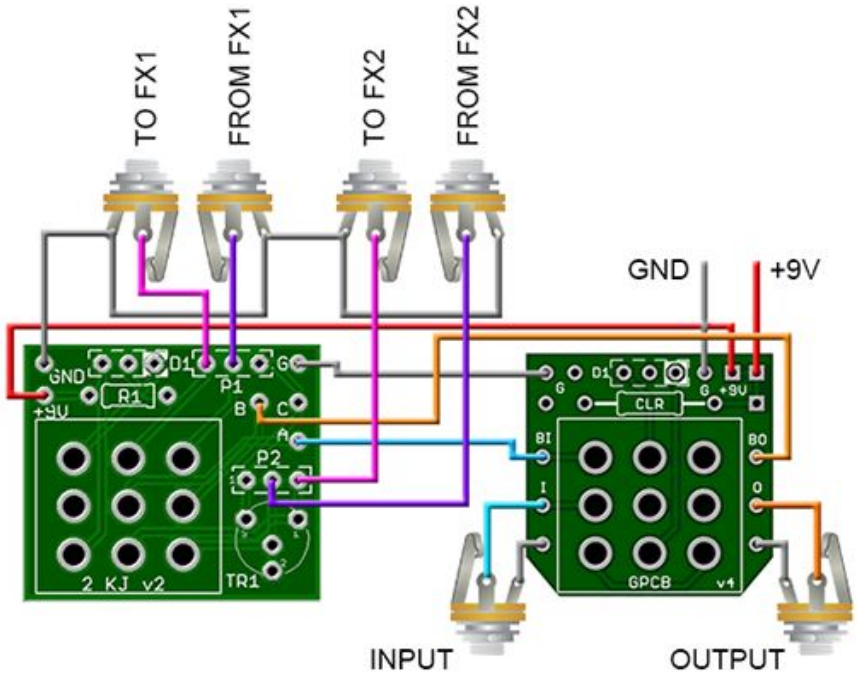
The original question was:

Is there a way to have an either/or pair of footswitches to control two circuits in a combo? Example: I have two modulation circuits in the same combo in series but I never want both to be on at the same time. I do want each to have its own footswitch and LED. I would like footswitch 1 to deactivate footswitch 2 and the LED to footswitch 2 while activating the circuit and LED wired to footswitch 1 while at the same time allowing any other circuits contained in the combo, whether trailing or preceding the others to function as normal.

So in short you want to be able to:

- Switch between two circuits, both will never be on at the same time
- Be able to true bypass both circuits
- Show the status of bypass / effects and circuit 1 / 2
- Use not more than two footswitches

While it is handy for an "either / or " effects in a combo enclosure you could also put this switching system in its own enclosure and keep things tidy you could use our **3PDT board** plus the **2 Knob Job** board:



While the wiring for the signals must be followed, the power supply and ground wires can be routed in different ways e.g. the +9V wiring can be done as in the diagram or both wires can be run to the +9V supply (whichever is shorter), the ground wires for the jacks can be connected to either board or run directly from power supply ground, again, whichever is shorter.

Connect your pedals as shown and leave them in effects mode, selecting the effects pedal with the 2 Knob Job switch and master bypass via the 3PDT board. Of course you are not limited to one effects pedal per loop, you can use a chain of pedals for FX1 and another chain for FX2.

FETs in pedal building:

There are three main uses for FETs in pedal building:

- **Amplification**
- **Buffering**
- **Variable resistances**

Amplification: Such as a clean boost (Stage 3) or distortion (KOTB) where distortion is achieved either by applying a large signal at the input or by adjusting the bias voltage so that the JFET operates in a non-linear fashion.

If the output is taken from the drain of a JFET it is being used as an amplifier.

Buffering: The idea behind buffering is to have a high input impedance (resistance) so that you can grab as much of the signal from your guitar or previous stage and a low output impedance so that you can deliver as much as the signal as possible to your amplifier or next stage.
Two circuits that use JFET buffers are the Dr Rock and the MoWah.

If the output is taken from the source of a JFET it is being used as a buffer.

Variable resistance: This falls into two categories:
Using the JFET as an On/Off switch where the drain - source resistance is very low which allows the signal to pass between the drain and source or where the drain-source resistance is massive which prevents the signal from passing between the drain and source. JFETs are used as the bypass switching system in Boss pedals.

Effects such as phasers (Dr Phybes) or tremolos (EA Tremolo) use a Low Frequency Oscillator (LFO) attached to the gate of the JFET to constantly vary the drain - source resistance of the JFET(s), effects such as some compressors (Julius) and noise gates (Maxon) use a control voltage to set the drain - source resistance.

So the question is which of the above need to be measured ? Unfortunately it's the politician's answer of *some of them, none of them, all of them*.

One of the main drawbacks of using JFETs is the very wide variance in some of their parameters - namely Vgs (off) and Idss.

Imagine that you are a small business that wants to sell a 2 JFET distortion pedal and, being a very good pedal, you decide to build 1,000 of them. Because of the need of repeatability i.e. all pedals sound the same and the wide variance in JFET parameters you would need quite a lot more than 2,000 JFETs to ensure they fall roughly within the tolerance required, you would then need to measure them and probably fine tweak each JFET bias point to ensure repeatability. Why you won't find many commercial JFET circuits!

So unless you need repeatability or you build a lot of JFET circuits there is no real need to measure each JFET, the obvious way to go is to use sockets and try different types of JFET plus adjusting the bias until you hear something you like. This holds true for amplifiers and buffers.

If you are building an effect that uses JFETs as variable resistors it might be a good idea to measure them and, of course, if you plan on building something like a phaser where matched JFETs will ensure strong phasing, buying from GuitarPCB will save you time and money.