Building the sMs Audio Electronics Appendage
Touch Ribbon Controller

Issue: 1.1

Building the Appendage Touch Ribbon Controller

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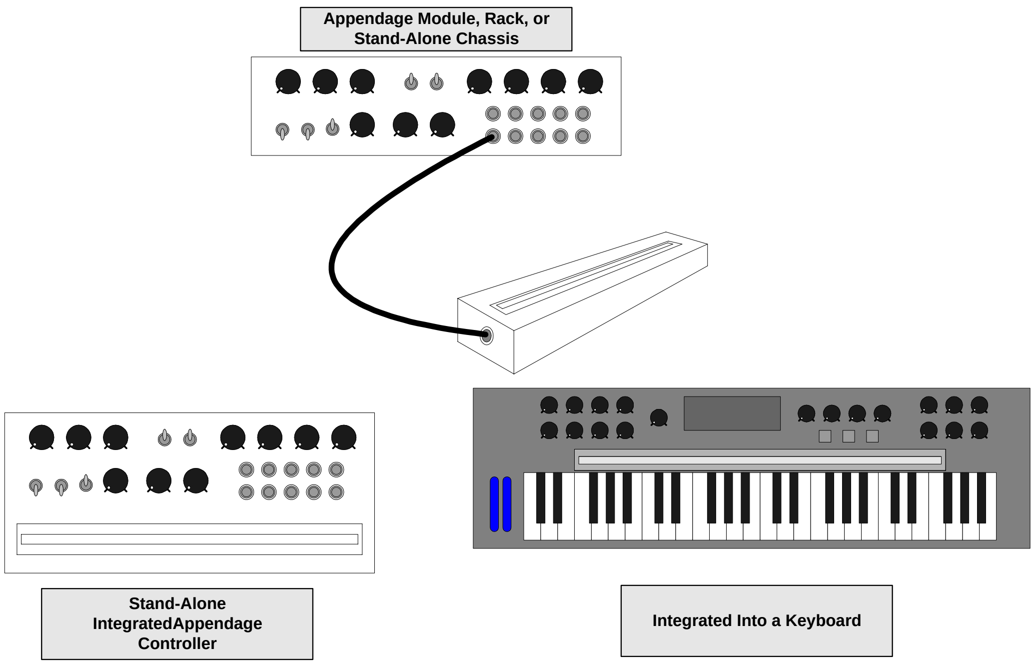
1. Planning Your Appendage

The main thing to keep in mind is that the Appendage is designed to do a lot of stuff, so it is not as uncomplicated as a "normal" ribbon controller build. By the same measure, the build is not nearly as complicated as, say, the Apollo command module or an electron microscope. This build document is written so that if a person starts at page one (this page) and works procedurally through to the last page, at the end of the rainbow one will have a shiny new Appendage Touch Controller that meets all expectations.



Appendage Configuration

Now that you have decided to build an Appendage (or at least are thinking about it, unless you're just really hard up for reading material and this tome was the first thing handy), you should probably start thinking about what you want your Appendage to do, and what you want it to look like. With this project, there really are two main elements – the portion of the Appendage that contains the controls – the circuitry, panel and associated spaghetti - and the playing surface (the ribbon itself) which interfaces with the portion of the Appendage that contains the circuitry, panel and spaghetti. If this approach is taken, the playing surface can be a separate entity that connects to the panel, so you can strap it on and hop around stage while playing the ribbon, like some unholy meld of Jimi Hendrix and Clara Rockmore.

While you're dealing with that mental imagery, consider, of course, if one should want to produce an Appendage that contains the controls, circuitry, spaghetti ***and*** the ribbon all in one unit, this would perfectly acceptable as well. This approach may make it more unlikely that one could simply strap it on and play it with one's teeth; the PCB is rather large, which would dictate at least a portion of the dimensions of the single-unit build, making it physically larger than if the ribbon were a separate, simple control surface. Additionally, the performer would likely be a layer closer to mains voltage, so playing it with moist surfaces (tongue, teeth, etc.) could conceivably put a player at risk of losing bodily control at some point, though admittedly still not as close as said technique using a Fender Stratocaster driving an amplifier powered by half of the New York metropolitan electrical grid.

Figure 1-1: A Ribbon Assembly Manufactured by RibbonControllers.com

Some intrepid builders may wish to incorporate the Appendage into a larger project, such as making it a component of a keyboard, such as the sMs Audio Electronics IKC keyboard. This, too, is perfectly fine, and perhaps even lawful in certain portions of the world, so have at it, if that is your predilection.

This all takes planning, because how you configure the Appendage determines, to some degree, what you leave in and what you leave out. For example, in the event that one wants build the ribbon and Appendage together as one integral unit, it should be realized that the Ribbon Input connector would not necessarily be needed. This build document is written with the intent of helping you make those life-changing decisions, and more.

For now, the main thing to keep in mind is that the Appendage experience is really made up of two elements – the electrical guts and the ribbon that controls the electrical guts. For expediency, in this build document the control portion (the electrical entrails, PCB, controls, switches, connectors, LEDs) will be referred to as the "Appendage" and the actual control surface will be referred to as the “Ribbon”, “Ribbon Assembly”, or “Flat Thingy That One Should Press to Actuate An Appendage Event”.

Ribbon Length

The Appendage is designed around the SoftPot® membrane potentiometer series manufactured by spectrasymbol™. The SoftPot® ribbons are available in a number of various lengths.

Spectrasymbol™ also manufactures the HotPot® line of membrane potentiometers, which also work with the Appendage circuit. These ribbons are specified for a much larger number of actuations (>10 million as compared to SoftPot® range of >1 million), and have a decidedly better surface feel. However, it takes a bit more force to actuate the HotPot® ribbon, but it is still playable, though perhaps less “agile” because of the increased force required. The non-glossy surface, however, is an advantage.

The length of the ribbon is obviously a major consideration during the planning phase of your Appendage. Generally, a longer ribbon makes it easier to control pitch across a wide range, whereas a smaller ribbon may be more suitable as a sort of bend or modulation controller, so one obviously must decide on what length of ribbon to use. This decision affects not only the physical dimensions and possible intended main use of the controller, but also the ultimate build of the PCB itself. Generally, SoftPot® ribbons 200mm in length and less have an overall resistance of 10 kΩ or less, while ribbons larger than 200mm (for example, the 500mm model) have an overall resistance closer to 20 kΩ. This affects how the ribbon will respond with the Appendage. The Appendage can accommodate either range of ribbon size/resistances; that determination is made by the selection of a jumper position on the Appendage PCB itself.

Figure 1-2: Available SoftPot® Ribbon Lengths

The Ribbon Assembly
The SoftPot® ribbons are self-contained units that adhere to a surface using an adhesive substance on the back of the ribbon. One merely strips the backing off the ribbon and applies it to a smooth surface –nice and straight, and smooth, with no bumps, ideally.

The surface the ribbon adheres to should be smooth and certainly must be sturdy. Another consideration is that if the ribbon is applied to a metal conductive surface, it may be essential to ground that surface in order to avoid any environmental electrical noise from being picked up by the ribbon. Wooden or hard plastic surfaces appear to reduce this risk and may be preferable in order to avoid any extra wiring that may need to be added in order to ground a metallic surface.

Figure 1-3: Example of a Pre-Manufactured Ribbon Assembly

A wonderful alternative to building the ribbon assembly would be to purchase a ribbon assembly built to interface with the Appendage. **Figure 1-1** and **Figure 1-3** both illustrate the quality of ribbon assembly that can be provided by RibbonControllers.com. If you would prefer to have an attractive ribbon assembly built and ready to go, you can order an assembly from RibbonControllers.com. Not only does RibbonControllers.com know what is required of the assembly to interface with the Appendage, they can also provide additional functionality such as a ribbon pressure output voltage to add to the selection of voltages supplied by the Appendage.

Inverted Voltage Control Outputs – Optional?
There are a number of voltages generated by the Appendage: Initial Voltage, Slide Voltage, Bend Voltage, TFS Voltage, and Mixed Voltage. The Appendage PCB supplies all of these voltages as well as the inverted copies of these voltages: Inverted Initial Voltage, Inverted Slide Voltage, Inverted Bend Voltage, Inverted TFS Voltage and Inverted Mixed Voltage. The normal voltage outputs range from 0V to a maximum positive voltage (standard configuration is 0 to +10V) with the exception of the Mixed Voltage, which can be offset to negative values, and the Bend Voltage, which goes negative as easily as it goes positive. The inverted copies of these signals therefore range from 0V to a *negative* maximum voltage (standard configuration would be 0 to -10V), again with the exception of the Inverted Mixed Voltage, which can be offset positive or negative, but will move in a direction opposite of the Mixed Voltage output and the Inverted Bend Voltage which is bipolar by nature, and which also moves in the opposite direction of the Bend Voltage output.

If your planned Appendage build has a limited amount of space for panel elements, the inverted voltages can generally be left out without too much loss of function – if one has a modular synthesizer, for example, the standard output voltages can be inverted by some type of processing within the modular, such as by a voltage inverter (imagine that!).

The one inverted voltage that is particularly useful is the Inverted Bend Voltage. Even though Inverted Bend, too, could be generated with an external module, you may find that you use it enough to keep it around as a dedicated output. In other words, if you must lop off the inverted voltages, but do have room for that one extra connector, we recommend the Inverted Bend Voltage output. A close second would be the Inverted Mixed Voltage.

Output Voltage Levels
The Appendage fixed output levels were designed to output a voltage in the range of 0 to 10V. The Mixed Output and Bend voltages are designed to output a range in a maximum range of -10V to 0V to +10V, because the Bend Voltage is an element of both signals, and is bipolar in nature.

Gate and Trigger signals are selectable between 0 to 10V or 0 to 5V levels through selection of resistor values when soldering up the Appendage PCB.

Connectors or Hardwire?
The Appendage PCB can be connected to the panel using cables made up of connector housings and crimp pins. These connectors can be eschewed for hardwire point-to-point connections as well, using this documentation as a guide. The advantage of using the connectors is that the panel can be easily strap-wired and connected to the PCB using the connectors, and the connectors allow the unit to be easily disassembled for servicing.

Power Requirements
The Appendage has been tested using both a +/- 12V power supply and a +/-15V supply.

The Appendage draws around 100 mA per voltage rail at +/-15V operation, with a power dissipation of approximately 1.5 Watt per rail (3W total). A linear supply is recommended, but it is possible to use an appropriate switching supply. If a switching power supply is used, it is recommended that one not use an open frame switching supply, and use ferrite beads on the power supply lines connecting to the Appendage. In any event, never bundle the power supply lines with the signal lines of the Appendage – keep them separate.

The Appendage has also been successfully tested using a wall adapter supplying 12VDC to a Cincon™ EC6A +/-15V DC to DC converter.

Power Connections
The Appendage PCB is designed to accommodate a number of different power connections in the attempt to make it compatible with the majority of modular systems available on the current market. The Appendage PCB can accept the following power supply connections:

Blacet™/PAiA™/MOTM™ style 4 pin connectors.

Doepfer™ Power Bus 6 pin connectors.

Synthesizers.com™ style 6 pin connectors.

4 Pin User Connection (two separate ground pins).

3 Pin User Connection (terminal block with a single ground pin).

Get Good Quality Parts
An extremely wise, venerated and incidentally quite handsome person once wrote "Sometimes, when you're looking for and buying parts, you may see a "good" deal on surplus parts. With the ICs, you're probably OK. The pots, maybe so. The switches? Do *not* risk it."

That maxim holds true, even on the Appendage. Get good name brand switches, really. The same goes for jacks. Replacing a crapped out jack is just no fun for most people, even demented DIY people such as our selves.

2. Designing the Appendage Panel

It's Your Appendage – Do What You Wanna Do, within Reason

While designing your Appendage panel, be aware there are number of elements that will need to be wired a certain way to make them do what they are intended to do when you tell them to do it. For pots, LEDs, and connectors, this process is a no-brainer. A pot generally makes something do its thing *more* when rotated clockwise and *less* when it's rotated anticlockwise. An LED turns on and turns off at the appropriate times. A connector transmits a signal when it's connected to some other connector. But a switch can be not so forgiving – it has to invoke one non-specific function when set to one position and something else when set to some other position. In other words, a switch doesn't have some more-or-less universal standard, because switches do all kinds of things. The thing to remember is that you want the switch to do a specific thing when it's pointing to some particular legend on your panel.

Why bring up all of this detail when one is ostensibly talking about designing a panel? Simply put, this build document deals with switch positions according to a specific panel legend orientation. This approach is necessary to reduce the complexity of the build document and the build itself. Some switches have more than one connection, some connect to other switches, and most of them have more than one section. The simplest approach is to depict the switches in one specific orientation (up it does this, down it does that). A DIY project is an open-ended thing – a lot of, if not all of, the decisions are left up to the builder. The approach in this document assumes everyone agrees that a switch will perform a specific function when in the up, down and (sometimes) middle positions. If you don't agree, and wish to make a switch do something in the down position that this documents says it will do in the up position, then have at it, we have no problem with that. Just make sure you are very careful about moving switch connections around to accommodate your twisted and unstable view of what the Appendage should do, heretic.

Appendage Panel Elements
To get an idea of the number and type of panel elements that make up the panel of the Appendage, and to give one a reference while building, the following tables are supplied indicating the type and number of panel components required on the Appendage panel.

Table 2-1 Pots

Label	Function	Position Legend
Initial Amount	Controls the amount of Inital Voltage present in the mixed output	Anti-Clockwise: No Initial Voltage Clockwise: Max Initial Voltage
Slide Amount	Controls the amount of Slide Voltage present in the mixed output	Anti-Clockwise: No Slide Voltage Clockwise: Max Slide Voltage
Bend Amount	Controls the amount of Bend Voltage present in the mixed output	Anti-Clockwise: No Bend Voltage Clockwise: Max Bend Voltage
TFS Amount	Controls the amount of TFS Voltage present in the mixed output	Anti-Clockwise: No TFS Voltage Clockwise: Max TFS Voltage
Mod Level	Controls the amount of external modulation signal present in the mixed output.	Anti-Clockwise: No External Mod Clockwise: Max External Mod
Coarse Offset	Mixes a large positive or negative DC offset voltage with the Mixed Output	Anti-Clockwise: Negative Offset Clockwise: Positive Offset
Fine Offset	Mixes a small positive or negative DC offset voltage with the Mixed Output	Anti-Clockwise: Negative Offset Clockwise: Positive Offset
Glide Amount	Controls the amount of AutoGlide on Slide and Bend Voltages.	Anti-Clockwise: No Autoglide Clockwise Max Autoglide
Sample Level	Controls the input level of the External Sample signal.	Anti-Clockwise: No Signal Clockwise Max Signal

Total Number of Pots: 9

Table 2-2 Toggle Switches

Label	Function	Position Legend
Trigger Mode	Selects Output Trigger Mode.	Up: **Re-Trigger** Middle: **Hyper** Down: **Single**
Gate Mode	Selects Gate Input Mode.	Up: **External** Middle: **Gated** Down: **Ribbon**
Input Mode	Specifies the type of voltage applied to the Sample Input connector.	Up: **Stepped** Down: **Universal**
Input	Selects input between ribbon and signal present at Sample Input.	Up: **Ribbon** Down: **Sample**
Ribbon Mode	Selects between Voltage and Current mode of ribbon operation.	Up: **Current** Down: **Voltage**

Total Number of Toggle Switches: 5

Table 2-3 Connectors

Label	Function	Type
Ribbon In	Connects to Ribbon Assembly	TRS Phone Plug or other three conductor type
Mixed Output	Outputs Mixed Output Signal	Phone, Banana, RCA, etc.
Inverted Mixed Output	Outputs Inverted Mixed Output Signal	Phone, Banana, RCA, etc.
Initial Output	Outputs Initial Output Signal	Phone, Banana, RCA, etc.
Inverted Inital Output	Outputs Inverted Initial Output Signal	Phone, Banana, RCA, etc.
Slide Output	Outputs Slide Output Signal	Phone, Banana, RCA, etc.
Inverted Slide Output	Outputs Inverted Slide Output Signal	Phone, Banana, RCA, etc.
Bend Output	Outputs Bend Output Signal	Phone, Banana, RCA, etc.
Inverted Bend Output	Outputs Inverted Bend Output Signal	Phone, Banana, RCA, etc.
TFS Output	Outputs TFS Output Signal	Phone, Banana, RCA, etc.
Inverted TFS Output	Outputs Inverted TFS Output Signal	Phone, Banana, RCA, etc.
Gate Out	Outputs Gate Signal	Phone, Banana, RCA, etc.
Trigger Out	Outputs Trigger Signal	Phone, Banana, RCA, etc.
Mod Input	Accepts External Modulation Signal	Phone, Banana, RCA, etc.
Mix In	Accepts Mix Input Signal	Phone, Banana, RCA, etc.
Sample Input	Accepts Sample Input Signal	Phone, Banana, RCA, etc.
Gate In	Accepts External Gate Signal	Phone, Banana, RCA, etc.

Total Number of Connectors: 17

It should be noted that all of the connectors, with the exception of the Ribbon Connector, can be the connector of choice for the builder. The Ribbon Connector, however, must be a three conductor type of connector (such as a ring-tip-sleeve connector) in order for the ribbon to function correctly. There are no switching jacks used in this project.

Table 2-4 Indicators

Label	Function	Type
Gate	Indicates Gate On	Any Color LED
Trigger	Indicates Trigger Event	Any Color LED

Total Number of LEDs: 2

The Appendage generates a number of different control voltages in addition to a gate signal and a trigger signal. Some of the control voltages the Appendage produces have no associated level controls. These voltages are sometimes referred to as “fixed” voltages, though they are not really “fixed” – these voltages, of course, will vary according to what is happening with the ribbon. “Fixed” actually infers that these voltage outputs have no level pots associated with them. However, the mixed output does have a number of controls associated with it.

Moreover, the Appendage also accepts input signals – control voltage and gate signals – and processes those signals. Again, there are a number of controls that determine what, if anything, the Appendage does when these signals are present.

In order to design a cohesive interface, it is helpful to divide the controls, indicators, and connectors into functional groups so that one has some idea of what would comprise an effective layout for the Appendage. This is not to say that the panel elements must be grouped specifically as detailed in this section; this grouping is more of an effort to allow the panel designer a logical overview of how the controls interact with the overall function of the Appendage.

Therefore, we'll divide the panel elements into three groups:

- The Mix Section
- The Control Section
- The Output Section

The Mix Section
At the heart of the Appendage is the mix section. This function is used to mix the generated control voltages, as well as external voltages, into a composite signal called, appropriately enough, the Mixed Output. When designing your Appendage panel, bear in mind it may be more intuitive to the operator to have the controls for the mix section grouped together.

Table 2-5 Controls and connectors associated with the Mix Section

Panel Element	Function
Initial Level Pot	Controls the amount of Initial Voltage applied to the mixed output signal.
Slide Level Pot	Controls the amount of Slide Voltage applied to the mixed output signal.
Bend Level Pot	Controls the amount of Bend Voltage applied to the mixed output signal.
TFS Level Pot	Controls the amount of TFS Voltage applied to the mixed output signal.
Mod Level Pot	Controls the amount of external modulation that is applied to the mixed output signal.
Mod Input Connector	Applies an external modulation signal, the level of which is set by the Mod Level Pot, to the mixed output signal.
Mix In Connector	Applies an external signal that is precisely calibrated to be mixed at its exact input level with the mixed output signal.
Coarse Offset Pot	Mixes a large range of positive to negative DC offset with the mixed output signal.
Fine Offset Pot	Mixes a small range of positive to negative DC offset with the mixed output signal.

The Control Section
The control section is comprised of panel elements that are used to set the operating conditions of the Appendage. It consists not only of the switches which set particular operating modes, but also the connectors used to accept signals used to control the Appendage itself.

Table 2-6 Controls and connectors associated with the Control Section

Panel Element	Function
Ribbon Mode Switch	Two position switch that selects between Voltage Mode or Current Mode when using the ribbon as the Appendage sample source.
Input Switch	Two position switch that selects between using the ribbon or a signal applied to the Sample Input connector as the Appendage sample source.
Input Mode Switch	Two position switch specifying to the Appendage circuit the type of external sample signal – whether it is a stepped signal (example: keyboard, sequencer) or universal (any type of voltage such as LFO, noise, VCO, keyboard or sequencer).
Ribbon Connector	Supplies the send and return for voltage applied to the ribbon – in other words, the Ribbon Assembly connects to this connector.
Sample Level Pot	Controls the amount of external sample signal that is applied to the Appendage.
Sample Input Connector	Routes an external sample signal to the Appendage circuit instead of the ribbon signal, as determined by the Input Switch.
Gate Mode Switch	Three position switch that selects between deriving a gate signal from the Ribbon Assembly or the signal applied to the Gate In connector, or a combination of the two.
Gate In Connector	Accepts an external signal to be used for gating the Appendage circuit, as determined by the Gate Mode Switch. This signal is used for internal timing of functions within the Appendage.
Trigger Mode Switch	Three position switch that selects between Single Trigger, Re-Trigger, or HyperTrigger modes.
Glide Amount	Pot that determines the amount of effect the AutoGlide function has on the Slide and Bend voltages.

The Output Section
The output section consists of the connectors used to output the various Appendage signals as well as the gate and trigger LED indicators.

Table 2-7 Controls and indicators associated with the Output Section

Panel Element	Function
Mixed Output Connector	Outputs the Mixed Output signal from the mix section.
Inverted Mixed Output Connector	Outputs an inverted copy of the Mixed Output signal from the mix section.
Initial Output Connector	Outputs the fixed Initial Voltage.
Inverted Initial Output Connector	Outputs an inverted copy of the Initial Voltage.
Slide Output Connector	Outputs the fixed Slide Voltage.
Inverted Slide Output Connector	Outputs an inverted copy of the Slide Voltage.
Bend Output Connector	Outputs the fixed Bend Voltage.
Inverted Bend Output Connector	Outputs an inverted copy of the Bend Voltage.
TFS Output Connector	Outputs the fixed TFS Voltage.
Inverted TFS Output Connector	Outputs an inverted copy of the TFS Voltage.
Gate Out Connector	Outputs the Gate Signal
Trigger Out Connector	Outputs the Trigger Signal
Gate LED	Indicates Gate Output High
Trigger LED	Indicates Generated Trigger Output

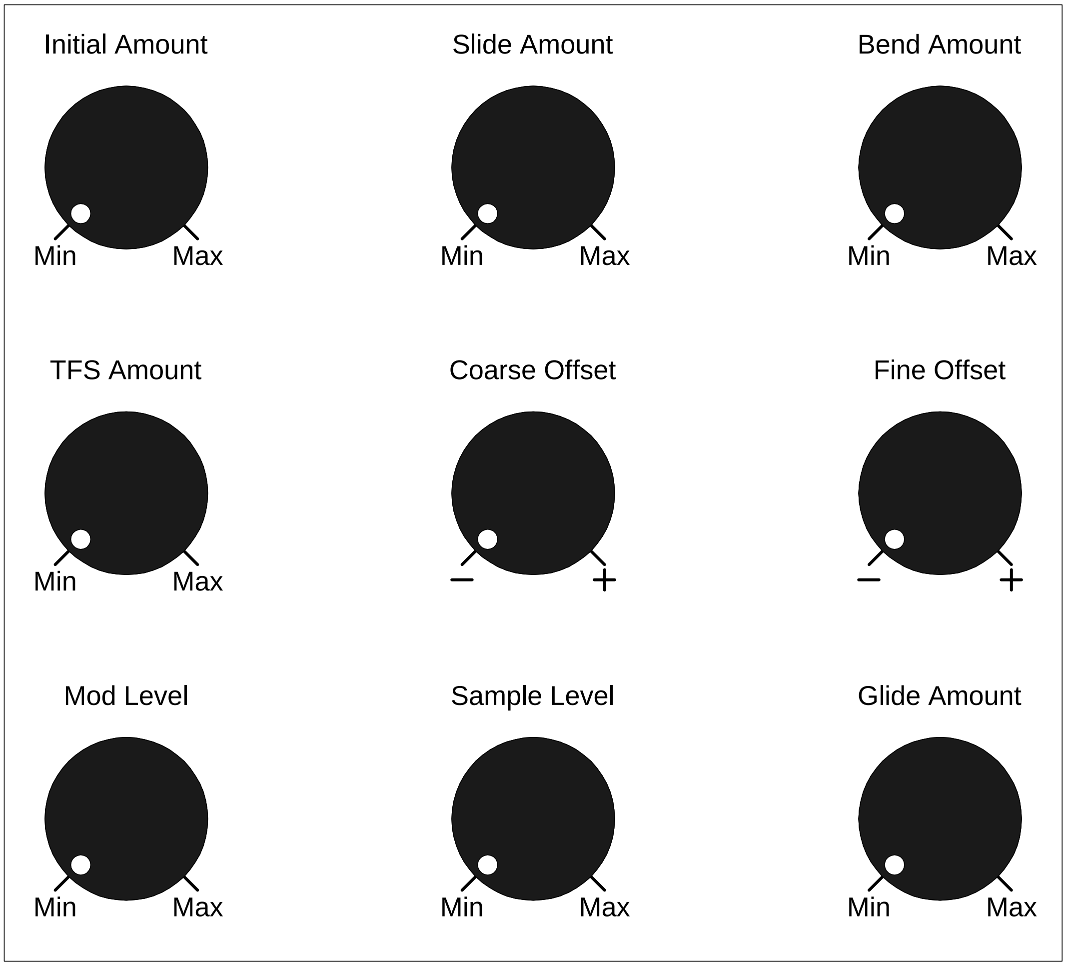


Figure 2-1: Orientation of Pots as Depicted in the Wiring Diagrams

Figure 2-1 is provided as a guide to laying out the potentiometers on the Appendage panel legend. The orientation of the legends depicts the action each pot will have if the panel is wired as depicted in this build documentation.

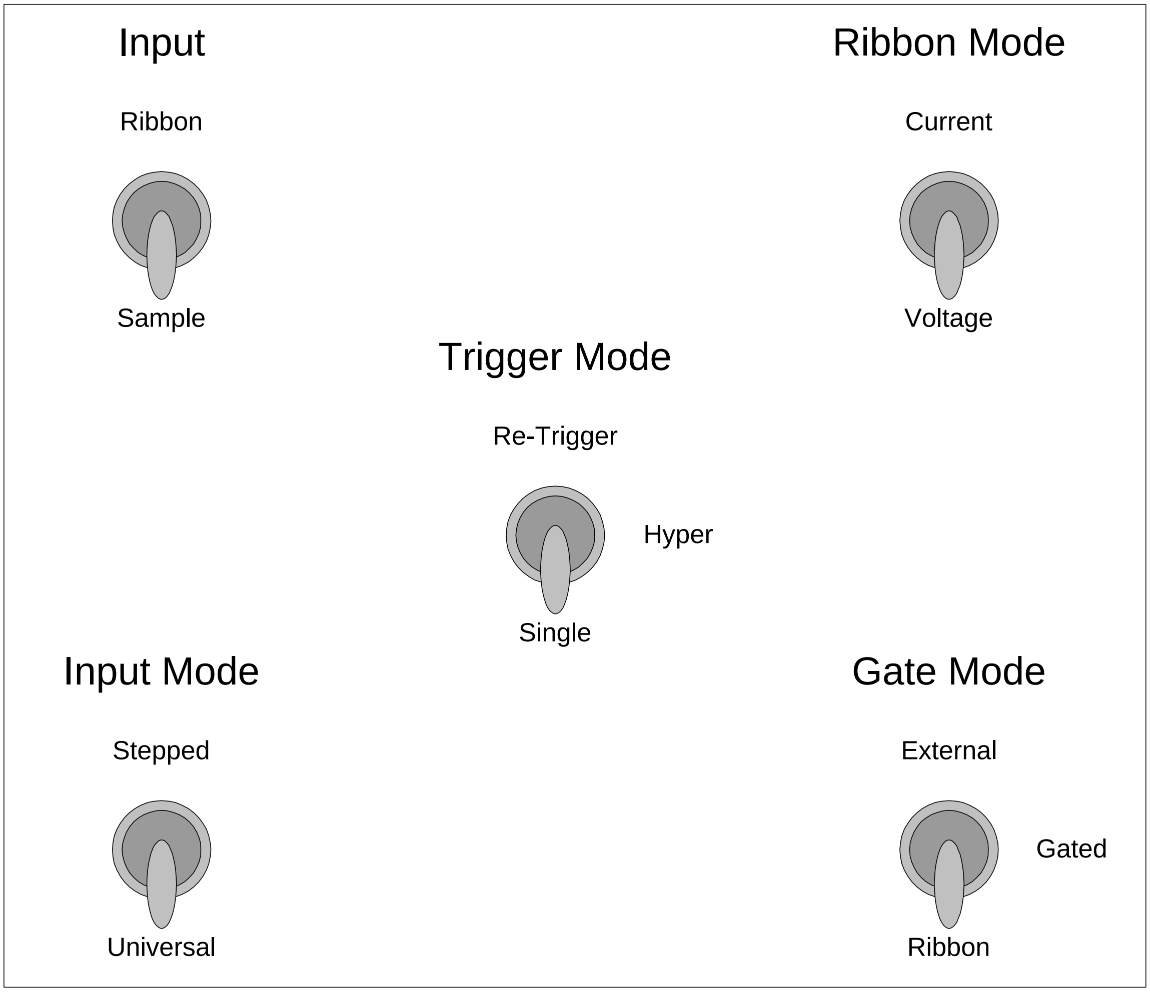


Figure 2-2: Orientation of Switches as Depicted in the Wiring Diagrams

Figure 2-2 is provided as a guide to laying out the switches on the Appendage panel legend. The orientation of the legends depicts the action each switch will have if the panel is wired as depicted in this build documentation.

3. Mounting Parts to the Front Panel

Once you've designed a panel for your Appendage, and you have actually manufactured the thing, it will be time to take that first step towards assembling the final product. That first step is, of course, getting all of your panel mount components mounted on the panel.

Preparation

Setting Landmarks
With this project, all of the wiring details are shown using the rear panel view, so it is always helpful to know what's happening on the front, public side of your panel while you're looking at it from behind. Obviously, once you've built your Appendage, you (hopefully) will never have to look at your panel from this angle ever again, but while you're actually building and (particularly) wiring the Appendage, being able to know where you're at without constantly having to turn the panel around and reference which component you're *really* dealing with can be a real plus.

The best way to know for sure which part you're mounting or wiring without having to flip the panel around is to just take some time with a permanent marker and carefully mark each hole on the rear side of the panel with the label of the component that will be installed there. Give your scribbling a bit of clearance so that, when you install the component, the back of the component will not cover up what you've written there.

Orienting, Testing and Mounting the Parts
Thankfully, the Appendage panel doesn't have a lot of parts you can just plain install *backwards*. In other words, there's really only one way your pots will install and only one way most of the switches will install that are actually physically going to affect how the wires will need to connect to them in order to correspond to the front panel legend.

The one switch that can potentially be installed backwards (or upside-down, actually) is the single SPST switch used on the Appendage: SW5, the Ribbon Mode Switch. The legend for this switch, used throughout this build document, is that the UP position is Current Mode and the DOWN position of this switch is Voltage Mode. The thing is, it's a 50/50 shot of installing it in the correct orientation if you don't take some precautions first. Let's not leave this up to chance, so right now, grab the single SPST switch that you have and let's get down to brass tacks.

On the rear of this switch are two terminals. This will be your first clue that you actually have the correct switch – all the other switches will have at least three terminals (or lugs) on the back of the switches, whereas this switch has only two. The two terminals of this particular switch are either shorted together (closed) or there is an open circuit between them (open), depending on how the bat handle is flipped on the switch. With these types of switches, it's hard to tell which position is which. Some manufacturers of switches may mark it on their terminals, others may not. It's up to you to determine which is which, and, to do that, it will be good to have either an ohmmeter or a continuity tester on hand. A continuity tester that beeps when you have continuity would be just a spiffy thing to use for this endeavor.

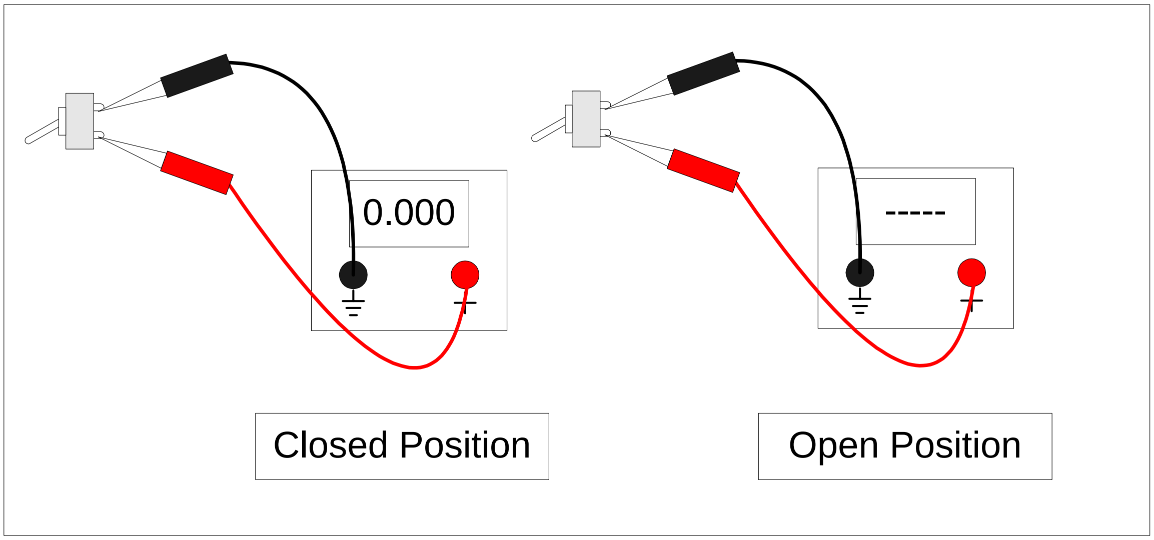


Figure 3-1: Figuring Out the SPDT Switch Orientation

Connect one test lead of the ohmmeter/continuity tester/DMM to one terminal of the switch, and connect the other lead to the other terminal of the switch. Flip the switch into one position – if the DMM/Ohmmeter reads zero Ohms or close to zero Ohms, or your continuity tester puts out a long tone, that's the closed position – there is continuity between the two terminals. This setting of the switch is the "Current Mode" setting, so if you install it now, and you're following the legend used in this build document with "Current Mode" being in the up position, then when you install the switch, the bat handle will be pointing up.

If your DMM/Ohmmeter reads infinite resistance or your continuity tester stays silent, that's the open position of the switch (there is no continuity between the two terminals). If you install the switch in this state, your bat handle better be pointing down to "Voltage Mode". Before you do install the switch, flip the switch to both positions to make sure it actually does flip between "Open" and "Closed". If you don't notice any change on your ohmmeter or continuity tester, either your meter is broke or the switch is. If that's the case, resolve the issue before you install the switch.

Though the orientation of the remaining switches does not matter at this stage, it's best to be sure you have the *right* switch in hand when you're ready to mount a switch, and it's not a bad idea to test your switches before you mount them on the panel and wire them up.

Go ahead and grab one of the DPDT ON-ON switches. You should have two of these – they're fairly easy to spot, because the back of these switches will have six lugs. However, there should also be a DPDT ON-OFF-ON switch in your pile of goodies, so make sure the switch moves into two positions only – in other words, ensure that it does not have a “middle” position – only up and down. If your switch lever does not move through three positions, then you are indeed actually holding (hopefully) a DPDT ON-ON switch. Go ahead and make sure it’s working by using your DMM.

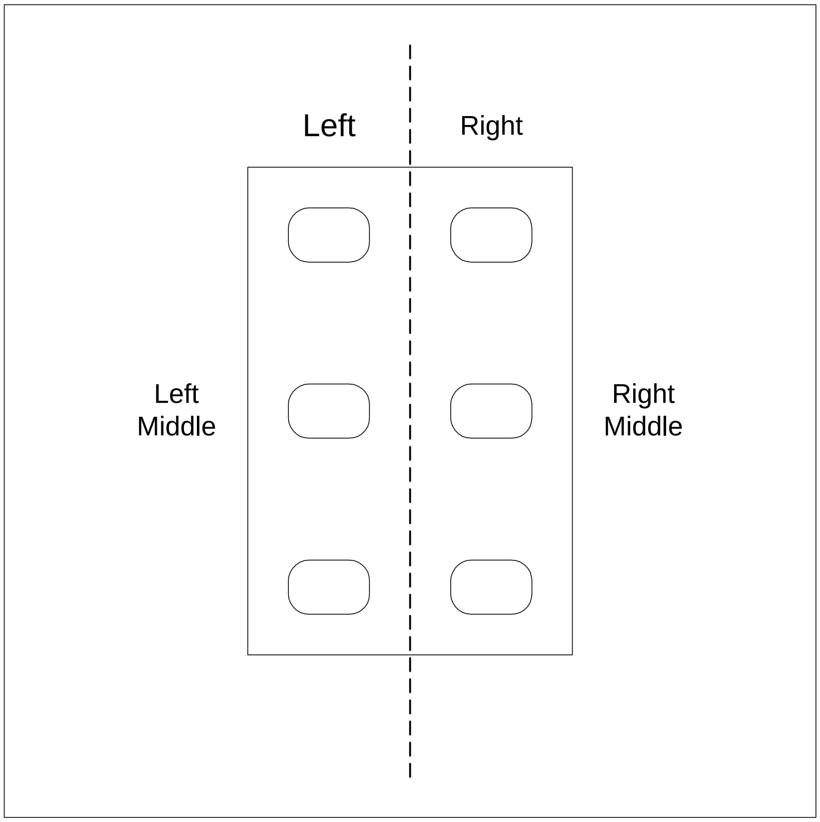


Figure 3-2: Right and Left Side of Rear of DPDT Switch

On the back of these switches are six terminals. It’s easier to think of the switch as having a “left” side and a “right” side, as viewed from the back. The center terminal of either side will be connected to either the upper terminal or the lower terminal of that side if the switch level is either full up or full down.   Attach one lead of your measuring device to the center terminal on left side of the switch and flip the lever to the “up” position. You should get continuity as depicted in **Figure 3-3** on the left side upper and lower terminals.

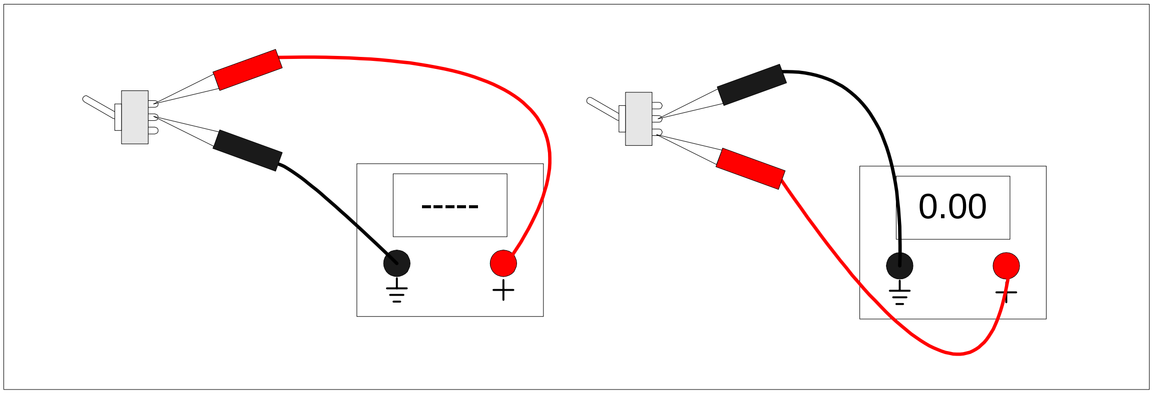


Figure 3-3: SPDT ON-ON Switch in "Up" Position

Move the lead from the left side center terminal to the right side center terminals. The reading should remain the same on the right side upper and lower terminals.

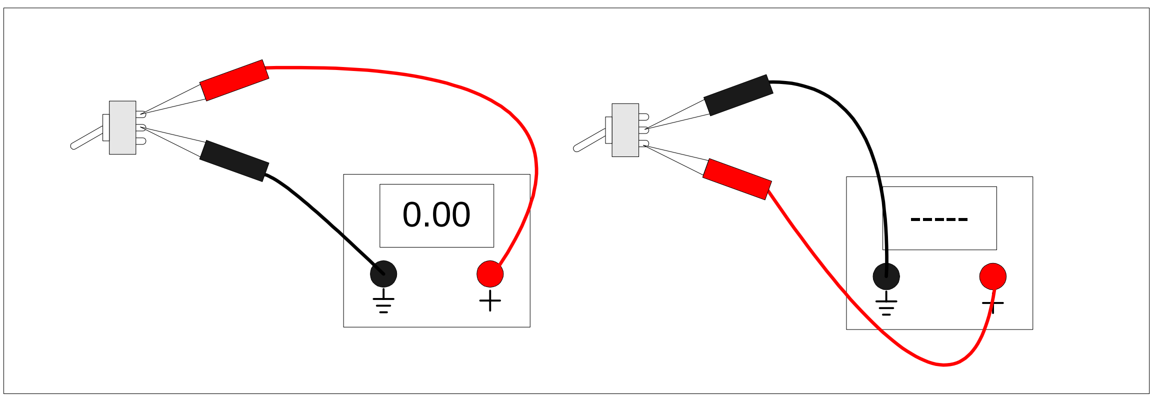


Figure 3-4: SPDT ON-ON Switch in "Down" Position

Now flip the same switch to the "down" position. Your readings should correspond to **Figure 3-4**. Move the leads to the left side of the switch and repeat the measurement. The measurements should be the same on those terminals.

You should have a DPDT ON-OFF-ON switch in your bag of goodies. This switch will likely look identical to your DPDT ON-ON switches, except this switch *will* have a third position – it should flip to the up position, flip to the *center* position, and flip to the down position.

The center position of this switch should disconnect the center terminals of the switch from both the upper and lower terminals on each respective side.

So, go ahead and measure the center pins on each side as before, while the switch is in the up position.

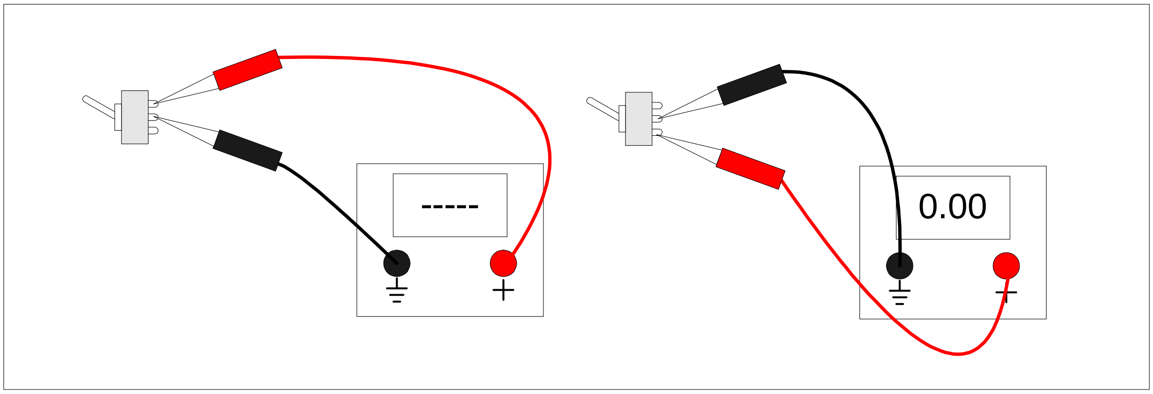


Figure 3-5: DPDT ON-OFF-ON in the "Up" Position

Now, move the switch lever to the center position. Now the center terminal on the right side will not connect to the upper or lower terminal on the right side, nor will the center terminal on the left side connect to the upper or lower terminal on the left side, as can be seen in Figure 3-6.

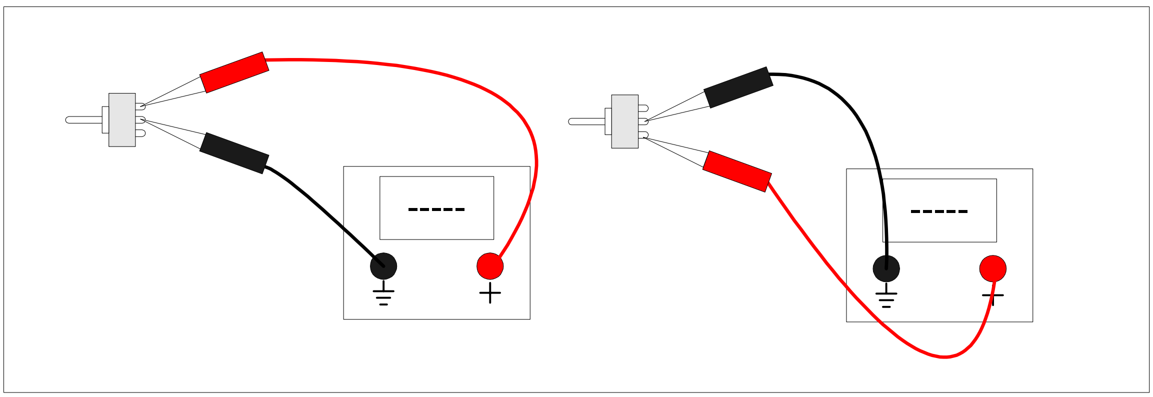


Figure 3-6: DPDT ON-OFF-ON in the Center Position

Now move the switch to the lower position, and you should get results identical to Figure 3-7 on both the right and left sides of the switch.

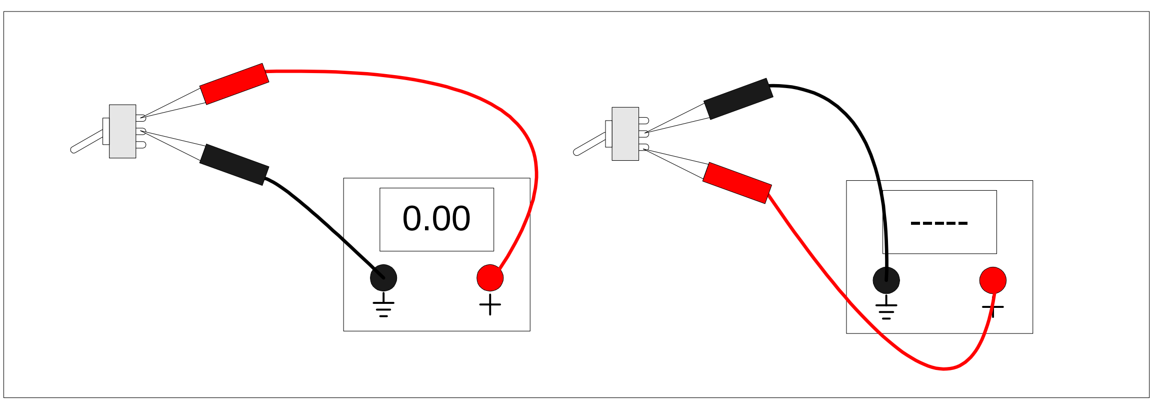


Figure 3-7: DPDT ON-OFF-ON in the "Down" Position

So far you've tested four switches: you've tested one SPST ON-OFF switch, two DPDT ON-ON switches, and one DPDT ON-OFF-ON switch. The final remaining switch should be a SPDT ON-OFF-ON switch. The testing for it is nearly identical to the process of testing the DPDT ON-OFF-ON switch, only this switch has one section, so there are only three terminals on it. Like the DPDT ON-OFF-ON switch, it should have three positions, with the center position disconnecting the middle terminal from both the upper and lower terminals.

As for the LEDs, it's a good idea to be sure which lead of the LED is the anode and which lead is the cathode. Generally, it's pretty damn easy to tell which is which on an LED: generally, LEDs will have the longer lead as the anode and the shorter lead as the cathode. The body of the LED will also give you a clue which is which – it will have a "flat" side, which will signify that's where the cathode is.

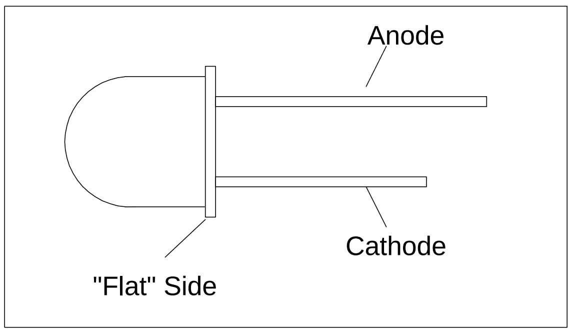


Figure 3-8: The LED Illustrated

If you are totally obsessed, you can usually double-check with a DMM to be sure. You'll need a DMM with a diode test function to figure this out. Connect the positive lead of your DMM to what you believe to be the anode of the LED. Connect the ground lead of your DMM to your idea of which lead is the cathode. A diode tester often will have enough current to slightly illuminate the LED as well – in a low light situation, you will see that.

If you don't see any illumination, you may have the leads reversed, the diode tester doesn't have enough juice to slightly illuminate the LED or you have a bad LED. Switch the DMM leads around to the opposite legs of the LED. If you didn't have slight illumination before, and you do now, then your LED is good. Your positive lead is now connected to the Anode and your ground lead is connected to the cathode.

If there is no change in the reading either way you switch the leads around, either your diode checker doesn't have the juice to even slightly illuminate the LED, its battery is low, or the LED is toast. Toss any bad item away and get a new one, or put in new batteries, as the situation dictates.

If your diode check function just can't even get a glimmer out the LED, there is one other method that you can use to test your LEDs. If you have a breadboard, you can mount the LED on the breadboard, use a 2K2 current limiting resistor and apply either 15V or 12V, depending on what power supply you have handy.

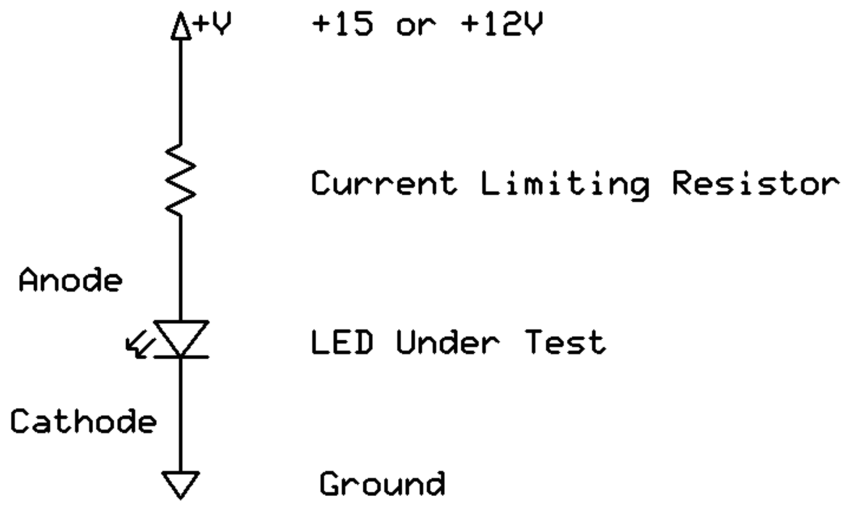


Figure 3-9: An LED Test

If your LED doesn't light up in either position using this method, then you quite likely have a very bad LED.

So, we've covered switches and LEDs. The last things we should probably check and become intimately familiar with are the jacks used for the input and output connectors.

If you're using banana jacks, you can pretty much skip this part – a banana jack has only one connection, so that leaves little up to chance. Just don't skip too far ahead, because, after this, we'll be discussing the Ribbon jack, and you won't be able to use your fancy-pants banana connector for that. At least certainly not a single banana jack.

Anyway, those who are using 1/4" or 3.5mm jacks for all those other gazzins and gazzouts, you're going to have be sure you know which lug of the jack is the "tip" and which is the "sleeve".

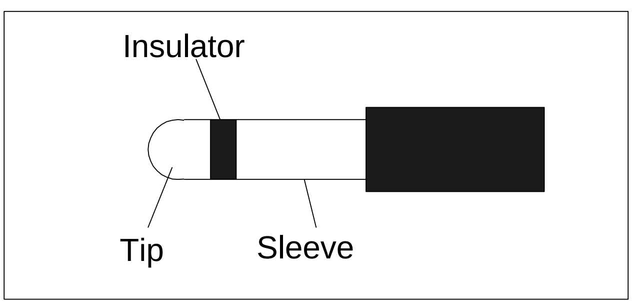


Figure 3-10: A 1/4" or 3.5 mm Cable Plug

Mono 3.5 mm and 1/4" plugs have two sections – the "tip" and "sleeve" connections. The "tip" provides the signal, and the "sleeve" provides the ground connection that mates the ground of your "send" device and your "receive" device. These two sections are separated by a non-conducting ring on the plug.

When you plug one of these plugs into a jack, the jack will provide the signal output on the "tip" lug of the jack and the ground reference on the sleeve lug of the jack.

BTW, your jack's lug orientation will likely in no way resemble the jacks depicted in these illustrations. Just so you know…..

So, to check which lug is which, plug a cable into your jack. Now, connect one lead of your DMM/continuity tester to the tip of your cable and probe one lug of the jack. If the lug you're probing gives a near zero ohm reading (or your continuity tester squawks in your ear) *that* is the "tip" lug. If the reading is open, move on to the next lug – if that one gives low ohms/beeps, then *that* is the "tip" lug.

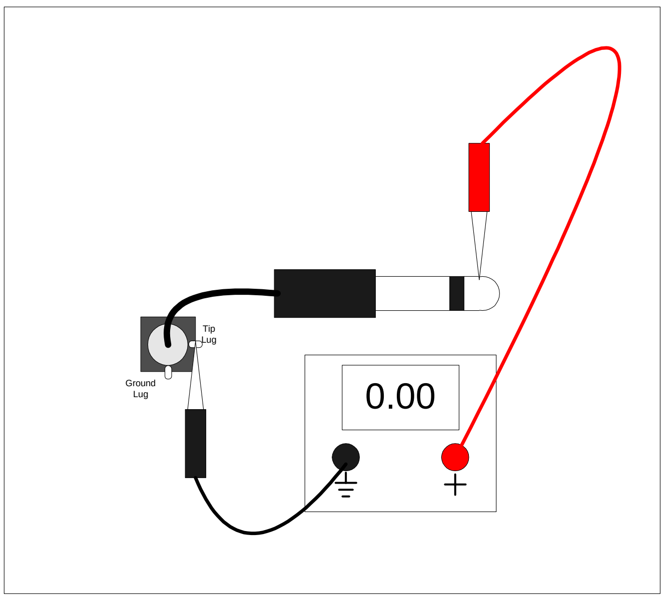


Figure 3-11: Locating the Tip Lug

You may be wondering why check the other lug if you know what the current lug already is? Certainly, if your jacks have only two lugs, you can be reasonably certain that the other lug is the ground lug, but why not check it now to make sure its good? And, if your jacks have more than two lugs, you better dang well check the other lugs just to be sure you know what each lug is for so you don't wire up to a lug that's not used.

Now that you know which lug is the "tip" lug, write it down in a little diagram for yourself. Move the DMM lead from the "tip" of the cable that's still plugged into your jack to the sleeve of the cable that's plugged into your jack. Repeat the process until you're sure which lug is the sleeve lug on your jacks.

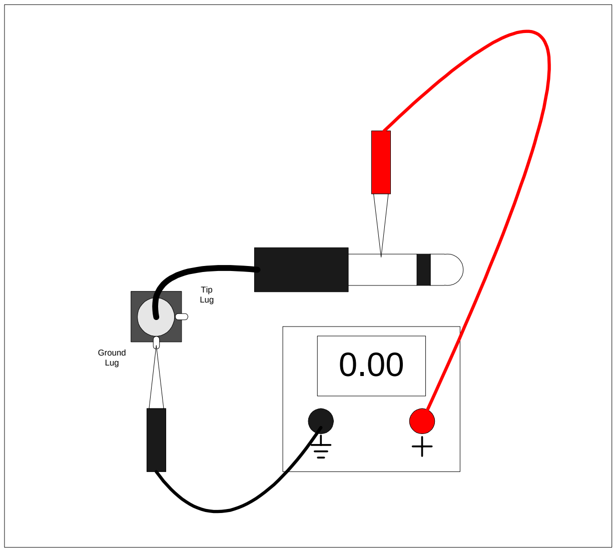


Figure 3-12: Locating the Sleeve Lug

Now is the time to check the ribbon jack. In this build document, the ribbon jack is specified as a ¼ inch RTS (Ring Tip Sleeve) jack. It should be noted that the builder is not constrained to using that type of jack. What is required is any type of jack (and corresponding cable) that is capable of carrying three separate signals. In other words, there must be at least three conductors to the jack. A DIN type of jack could just as easily be used, or even a 3.5mm TRS jack could be used. Be that as it may, the only type of jack discussed here (for simplicity, brevity, and sheer obstinacy) is the ¼ inch TRS jack.

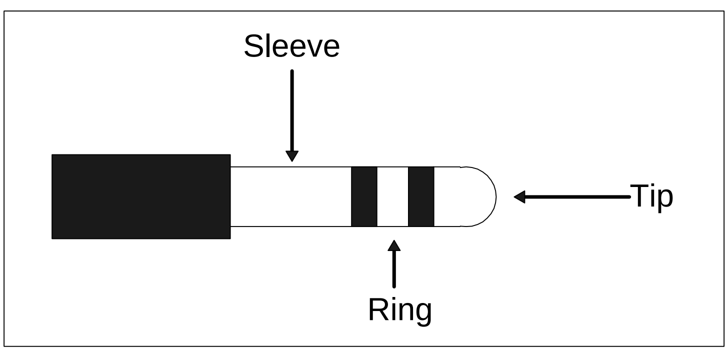


Figure 3-13: The TRS Plug

A TRS jack is meant to accommodate, of course, a TRS plug. Figure 3-13 illustrates a TRS plug. Generally a TRS plug is meant to carry a stereo signal, or is used to carry a balanced signal. In the case of the Appendage, the TRS plug /jack carries a voltage on the Ring conductor, connects to the wiper of the ribbon with the Tip connector, and provides a return (though not a ground return!) on the sleeve connector. On the plug, the

Ring, Tip and Sleeve are isolated from each other by insulators, which appear as black bands on the TRS plug. Now is the time to make sure you know definitively which lug is which on your TRS jack.

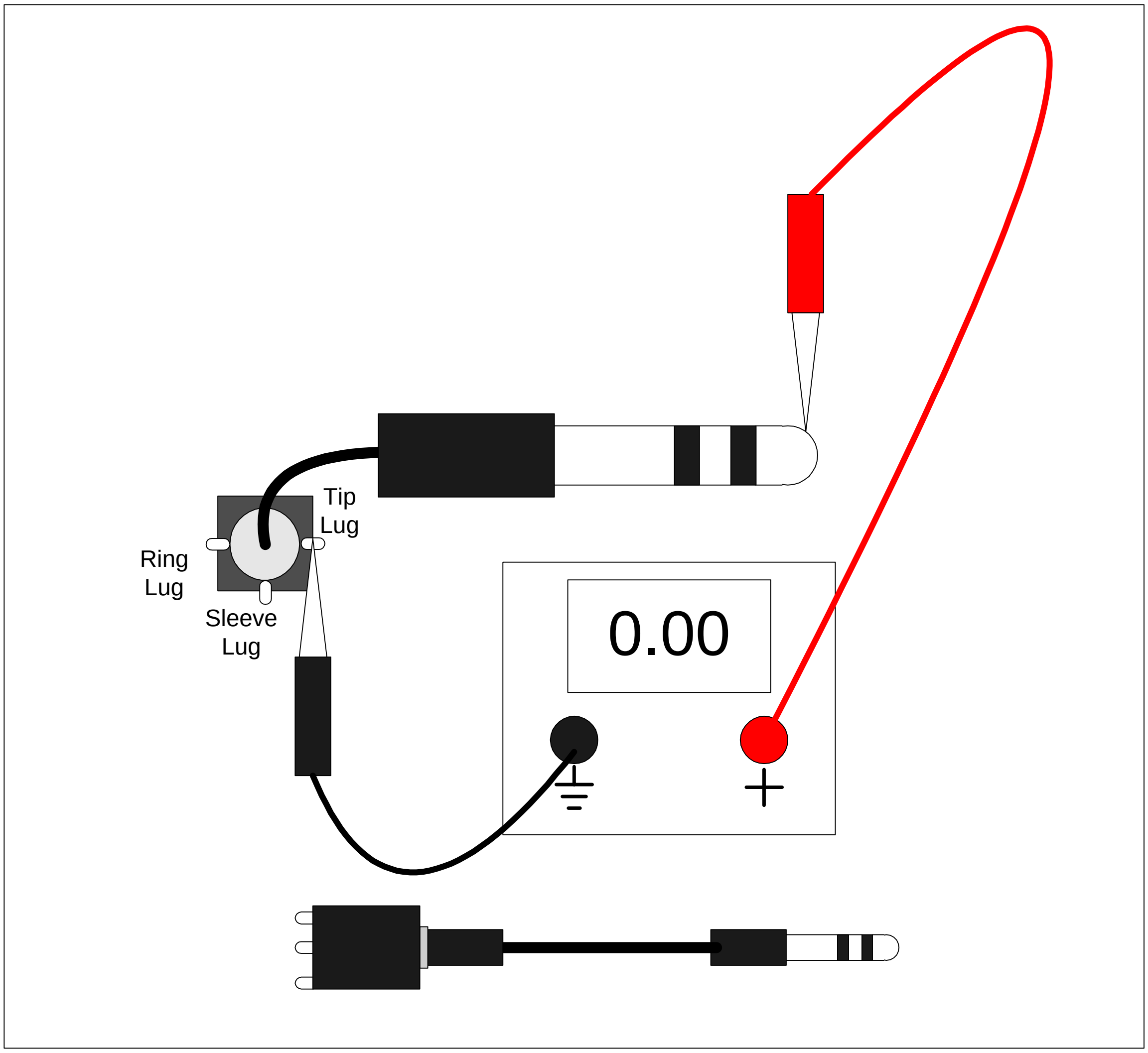


Figure 3-14: Finding the Tip Lug of the TRS Jack

To verify which lug of the jack is which, grab a balanced TRS cable (you probably have one around, because you will need this cable in order to use your Appendage after it's built) and plug one end of it into the TRS jack.

Using an ohmmeter or continuity checker, place one lead of the device to the tip of the cable. Place the other lead of the device on what you suspect to be the tip lug of the jack. If your ohmmeter/continuity checker indicates a short, then you know that you've found the right lug. If the device indicates an open circuit (no continuity), then move the lead to the next lug. Do this until you have found a lug that has continuity to the tip of the cable. Once you've found the lug, remember it – that is your "tip" connection! Make a note so that you'll not accidentally wire anything other than the "tip" connection to this lug when it comes time to wire up the panel.

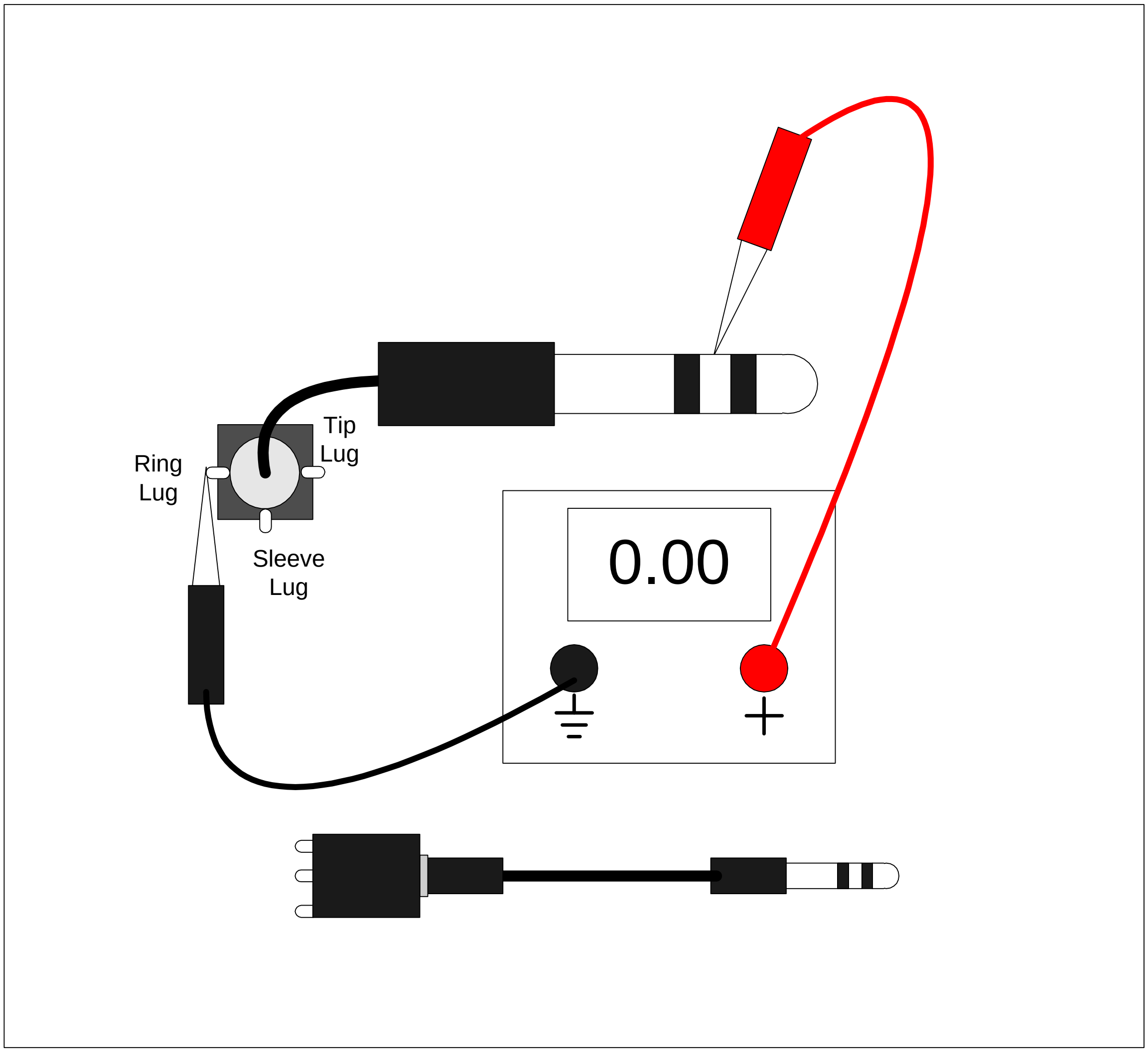


Figure 3-15: Finding the Ring Lug of the TRS Jack

Next, move the lead from the tip of the cable to the ring of the cable. Repeat the same process to find the ring lug of the TRS jack. Once you've found the ring lug of the jack, make a note so that you know exactly which lug to connect the ring wiring to.

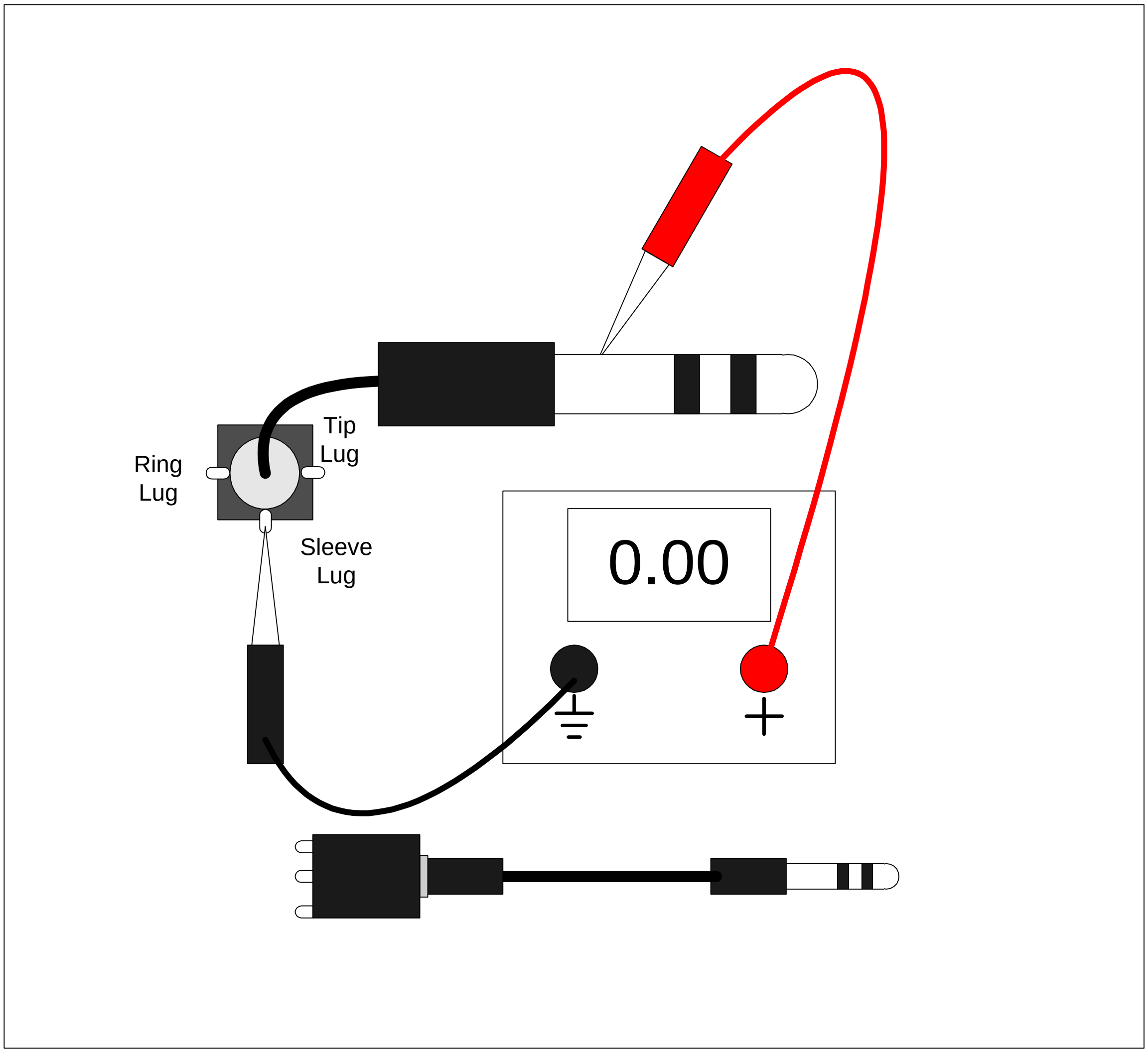


Figure 3-16: Finding the Sleeve Lug of the TRS Jack.

Once again, repeat the process to find the "sleeve" lug of the TRS jack. Move the lead from the ring of the cable to the sleeve, and use the continuity tester to find the jack lug that has continuity with the sleeve. Again, make sure you make a note of this so you know exactly which lug is the sleeve lug of the jack.

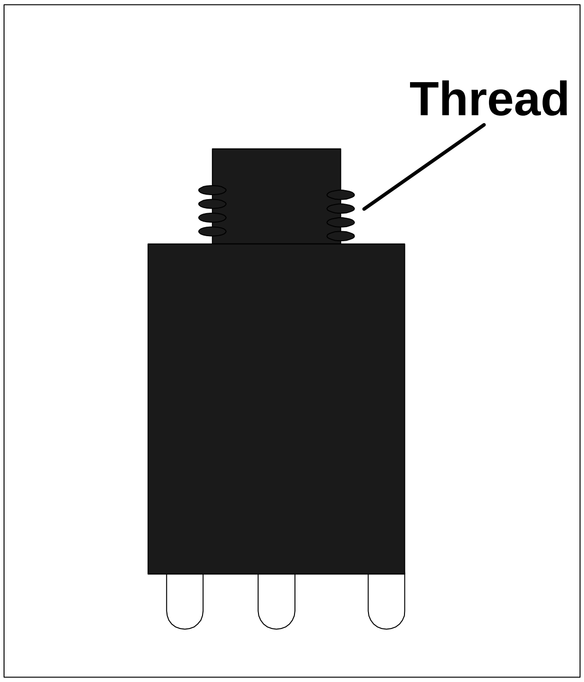


Figure 3-17: An Isolated TRS Jack

To prevent immediate hair loss once the Appendage is constructed and ready for use, it is imperative that the TRS jack does not in any way conduct the ground signal directly to the ribbon. In other words, it *must* be an isolated TRS jack to prevent the sleeve connection from shorting out to a metal panel. It is a simple matter to determine whether the jack is an isolated jack. Generally, a "normal" TRS jack will have a metal thread, and will have continuity with the sleeve lug. The thread of an isolated jack will, in all likelihood, be made of nylon or plastic. If the thread is metal, you will want to be sure, using your ohmmeter/continuity tester, the thread of the jack itself does not have continuity with any of the lugs you've identified as ring, tip and sleeve.

After All That: Mounting the Components

Once you're satisfied that you have all the parts, and know which parts are which (in other words, you read the preceding diatribe about knowing which switch is which), you finally are at the point that you can actually mount the panel components to your beautiful new Appendage panel.

Installing the Pots

We'll start with the pots. Fortunately, you don't have to worry about mounting the wrong value of pot in the right hole (or the right value in the wrong hole, for that matter): all of the pots used on the Appendage panel are 100K linear panel mount type pots. So, go ahead, have at it. You can use table 3-1 to make sure you get all of the pots installed.

Table 3-1: Panel Mount Potentiometer List

Label	Reference Designator	Type
Glide Amount	VR101	100K Linear Panel Mount Pot
Mod Level	VR102	100K Linear Panel Mount Pot
Slide Amount	VR103	100K Linear Panel Mount Pot
Initial Amount	VR104	100K Linear Panel Mount Pot
Coarse Offset	VR105	100K Linear Panel Mount Pot
Bend Amount	VR106	100K Linear Panel Mount Pot
Fine Offset	VR107	100K Linear Panel Mount Pot
TFS Amount	VR108	100K Linear Panel Mount Pot
Sample Level	VR109	100K Linear Panel Mount Pot

Toggle Switches

Next up are the toggle switches. You should have six toggle switches to install. If you followed the previous notes concerning toggle switches, you should have the switches separated out by type so you don't install the wrong one. All of the switches, with the exception of SW5, the Ribbon Mode Switch, can be installed without regard to whether the switch is upside down or not – it doesn't matter. When you install SW5, however, make sure that when the bat handle of the toggle switch is pointing towards the "Current" mode legend, the switch is actually closed (the two switch terminals are shorted together in that position).

When installing the switches, be careful as to not over-tighten them – it's possible to damage the switch assembly by tightening it too much. Make sure it's nice and firm and leave it at that. Be sure to use any locking nuts that may come with the switches.

Table 3-2: Panel Mount Toggle Switches

Label	Reference Designator	Type
Trigger Mode	SW101	SPDT ON-OFF-ON
Gate Mode	SW102	DPDT ON-OFF-ON
Input Mode	SW103	DPDT ON-ON
Input	SW104	DPDT ON-ON
Ribbon Mode	SW105	SPST ON-OFF

Once you have your switches mounted, as an extra measure of compulsive build mania, it doesn't hurt to re-test each switch to make sure it came through the process unscathed, and to triple-check that the Ribbon Mode switch is closed (shorted switch terminals) when pointing towards the "Current" setting, and open (no short between switch terminals) when pointing towards the "Voltage" setting.

Connectors

Next up are the connectors. If possible, it helps to mount the all jacks with the same orientation. This can make things more convenient when the time comes for strap wiring the ground connections. If you are using banana jacks, obviously you don't have to worry about that, because there is only one connection on a banana jack to worry about.

Use Table 3-3 to make sure you get all of the connectors you wish to install. If you have chosen not to install some of the inverting output connectors, just mark through them and proceed along your merry way.

Table 3-3: Panel Mount Connectors

Label	Reference Designator	Type
Mod Input	J101	Jack of Choice
Sample Input	J102	Jack of Choice
Mix Input	J103	Jack of Choice
External Gate Input	J104	Jack of Choice
Initial Output	J105	Jack of Choice
Slide Output	J106	Jack of Choice
Bend Output	J107	Jack of Choice
TFS Output	J108	Jack of Choice
Mixed Output	J109	Jack of Choice
Gate Out	J110	Jack of Choice
Trigger Out	J111	Jack of Choice
Inverted Inital Output	J112	Jack of Choice
Inverted Slide Output	J113	Jack of Choice
Inverted Bend Output	J114	Jack of Choice
Inverted TFS Output	J115	Jack of Choice
Inverted Mixed Output	J116	Jack of Choice
Ribbon In	J117	3 Conductor, Isolated Jack of Choice

This leaves the LEDs as the final component type to mount. However, because the LEDs may be a bit fragile, being bits of plastic with two spindly metal legs sticking out, you may want to actually mount the knobs to your pots before you install them – this will help to avoid smacking the LEDs around while you're flipping the panel around this way and that as you tighten and align the knobs.

Mounting the Knobs

Apply the knobs to the pots and align the knobs with the panel legend (if you're building this project, you likely know the drill). Tighten the knobs and make sure that each knob still aligns with the legend after being firmly tightened.

LEDs
Finally, it's time to install the LEDs. Mount the LEDs using your mount of choice – generally this involves mounting clips of either plastic our metal.

Table 3-4: LED Indicators

Label	Reference Designator	Type
Gate LED	D101	Any Color LED
Trigger LED	D102	Any Color LED

After the two LEDs are mounted, clip the LED leads to between one half and three quarters inch (13 to 19 mm). You don't want to let those LED leads to short together, which they, by natural law, eventually will do if they're too long. You'll be soldering wires to them, and moving those wires around, which will move the LED leads around too much if they're too long. Be sure you have a good idea which lead is the cathode and which lead is the anode on each LED. Otherwise your LEDs won't work, and you'll get all hot under the collar.

Once all of your panel components are mounted, you'll finally be able to see what your Appendage will look like from the business end of things. Before you can claim to be done with the panel, it will need to be strap wired, and then, ultimately, wired up to the Appendage, so don't make any exorbitant claims about it already working to your friends or spouse yet. They might call you on it.

4. Strap Wiring The Front Panel

The front panel will be wired to the Appendage PCB through a number of wires and connectors. There are some signals that are “shared” between the panel components. Rather than run a wire to and from the PCB for every signal connection, it’s more efficient to wire these common connections between the parts that share them, and then run a single wire back to the PCB. These common connections are referred to in this document as “strap” connections.

With this project, by far the most common connection is the ground signal. There are a few other connections that some of the switches share amongst themselves, but the vast majority of common “strap” connections carries the ground signal.

Strap wiring all of the common connections together on the front panel before any board connections are made makes assembly much easier. You can lay the panel on a piece of foam, or suspend it some way above your work surface to protect your already mounted panel components and solder the strap connections on before you have to deal with any of the wires that will connect to the printed circuit boards.

Materials
Any type of wire can be used. If insulated wire is used, one must cut, strip and tin the ends of the wire to connect each common point together. This has the advantage of being insulated from inadvertent shorting to any other point, but, at the same time, is a lot of work. Bare bus wire, on the other hand, has the twin advantages of easily being soldered without stripping or tinning, and allowing any point to be connected when it comes time to connect the common point to the PCB. The disadvantage is it is not insulated. Insulation can be purchased for it, but that may not be all that necessary.

If a bus wire of a suitable stiffness is used, say 22 gauge bus wire, the bus wire will stay in place and will not itself “move” and short out anything else. Several strapped connections will in turn need to be connected together, and insulated wire can easily be used to do that, when the wire will need to pass close to any point you *don’t* want connected together.

Using bus wire, one can connect the PCB connection to a central point, so the signal flow can follow a “star” pattern. For example, one could connect the insulated PCB connection for the ground signal in the middle of panel so that the ground does not feed from one end to the other, but “spreads out” from the middle. This method is often used to reduce ground interference between components on a PCB; it makes sense to use the same methodology on a panel as well.

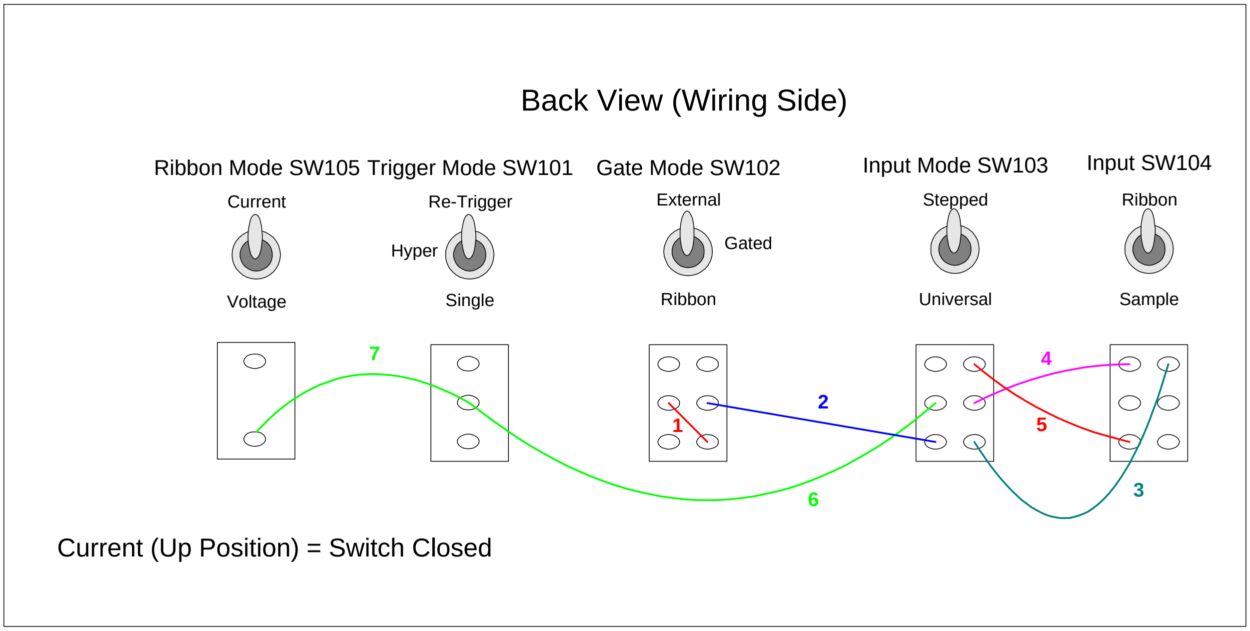


Figure 4-1: Strap Wiring the Switches

Switch Strap Connections

We'll begin with the switch strap connections. Refer to **Figure 4-1** as you put in these connections. As with all wiring diagrams in this build document, the connections are shown as you will see them from the back side of the panel.

1. Connect a wire between the left middle and lower right terminals of Switch 102, the Gate Mode Switch. Solder the connection on the left middle connection – do not solder the connection on the lower right connection – wrap the wire securely around the lower right terminal instead. This terminal will also connect to the P10 harness, so when the time comes to install that connection, both the strap wire and the P10 harness can be soldered together.

2. Connect a wire between the right middle terminal of Switch 102, the Gate Mode Switch, and the lower left terminal of Switch 103, the Input Mode Switch. Solder both ends of this wire; there are no further connections on either of these terminals.

3. Connect a wire between the lower right terminal of Switch 103, the Input Mode Switch, and upper right terminal of Switch 104, the Input Switch. Solder the connection on the upper right terminal of Switch 104, the Input Switch. Do not solder the connection on the lower right terminal of Switch 103, the Input Mode Switch – just wrap the connection securely around that terminal. Later this terminal will connect to the P8 wire harness, and at that time both wires will be soldered together on that terminal.

4. Connect a wire between the middle right terminal of Switch 103, the Input Mode Switch, and the upper left terminal of Switch 104, the Input Switch. Solder both ends of this wire; there are no further connections on either of these terminals.

5. Connect a wire between the upper right terminal of Switch 103, the Input Mode Switch, and the lower left terminal of Switch 104, the Input Switch. Solder the connection on the lower left terminal of Switch 104, the Input Switch. Do not solder the connection on the upper right terminal of Switch 103, the Input Mode Switch – just wrap the connection securely around that terminal. Later this terminal will connect to the P6 wire harness, and at that time both wires will be soldered together on that terminal.

Wires 6 and 7 provide a common ground connection for Switch 102, Switch 103 and Switch 105. Depending on how your particular panel is laid out, it may be easier to solder the wires in a different manner than the following instructions depict. The main thing is to remember is that the three ground connections will connect to the common ground connection of the panel.

6. Connect a wire between the middle terminal of Switch 101, the Trigger Mode Switch, and the left middle terminal of Switch 103, the Input Mode Switch. Solder the wire to the left middle terminal of Switch 103, the Input Mode Switch. Do not solder the connection on the middle terminal of Switch 101, the Trigger Mode Switch yet. This connection will be shared and soldered together with the next common ground wire to be added.

7. Connect a wire between the middle terminal of Switch 101, the Trigger Mode Switch, and the lower terminal of Switch 105, the Ribbon Mode Switch. Solder the connection on the middle terminal of Switch 101, the Trigger Mode Switch; soldering this connection will also solder the connection made to that terminal in 6 above. Do not solder the connection on the lower terminal of Switch 105, the Ribbon Mode Switch – just wrap the connection securely around that terminal. This connection will be connected to the common ground connection of the front panel.

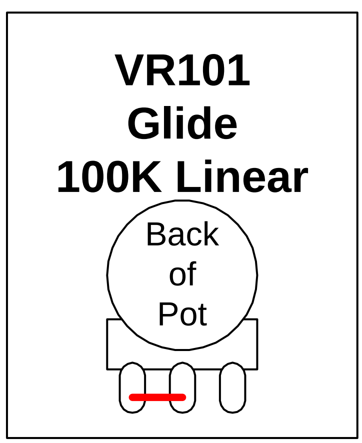


Figure 4-2: Strap Wiring the Glide Pot

Glide Pot Strap Wire
This strap wire can be installed or ignored. The Glide Pot acts as a variable resistor – the PCB connections that are wired to this pot connect to the tap (middle lug) of the pot and

the rightmost lug of the pot. **Figure 4-2**, which, like all of the wiring illustrations, shows the part as viewed from the backside of the panel. The strap wire from the left lug to the center tap lug of the pot is a precaution that allows the Appendage to continue to function should the pot malfunction. If the tap of the pot should become disconnected from the internal resistive strip of the pot, there is still a path for the signal to follow. If this state should ever occur, the AutoGlide function would be stuck to maximum glide, but the signal would not die altogether.

When installing this strap wire, be sure to solder only one side of it (for example, solder the strap to the left-most lug of the pot and just wrap the wire around the center tap lug of the pot). The reason for this is that there will be two wires on the P10 harness to connect to this pot. When these wires are soldered on, the other end of the strap will be soldered as well.

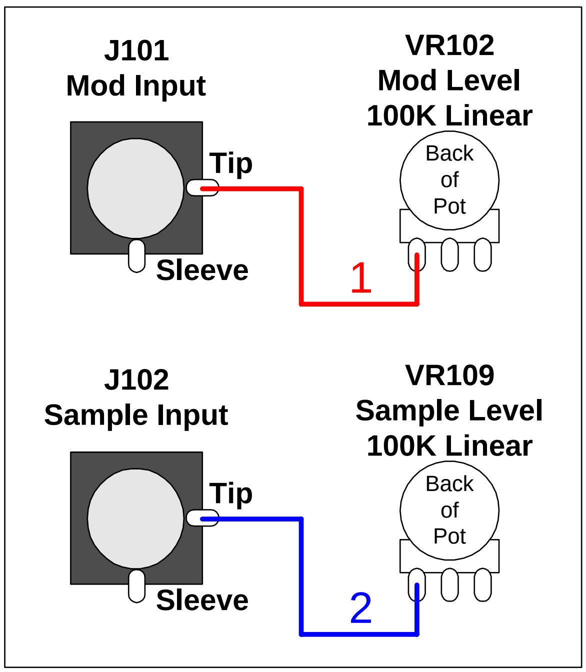


Figure 4-3: Strap Wiring the Jack to Pot Connections

Jack to Pot Strap Wiring
Two of the input jacks pass their tip signals directly to a panel pot. The Mod Input Jack, J101, passes the modulation input signal to the Mod Level Pot, VR102 and the Sample Input Jack, J102 passes the sample signal to the Sample Level Pot, VR109.

1. Connect the tip lug of the Mod Input Jack, J101, to the left-most lug (as viewed from the back) of the Mod Level Pot, VR102. Solder both ends of this strap wire.

2. Connect the tip lug of the Sample Input Jack, J102, to the left-most lug (as viewed from the back) of the Sample Level Pot, VR109. Solder both ends of this strap wire.

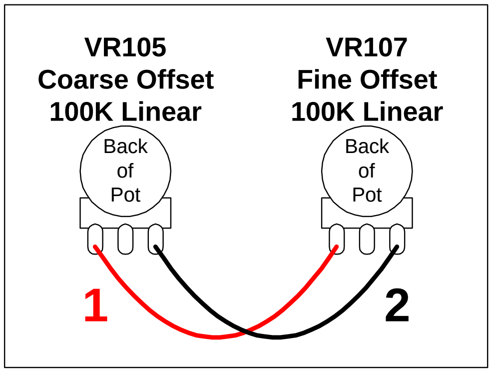


Figure 4-4: Strap Wiring the Offset Pot Common Connections

Strap Wiring the Offset Pots

The Coarse Offset Pot, VR105, and the Fine Offset Pot, VR107, each connect to a positive and negative voltage, supplied by the PCB, on their outside lugs. The center tap of each pot returns the voltage balance, as set by the pots, back to the PCB. So, both of these pots share a positive voltage connection and a negative voltage connection, which need to be strap wired.

1. Connect a wire between the left lug (as seen from the back) of the Coarse Offset Pot, VR105, and the left lug of the Fine Offset Pot, VR107. Solder one end of the wire to the left lug of one of the Fine Offset Pot (VR107), and secure the other end of the wire to the left lug of the Coarse Offset pot (VR105). Later, in this manual, you will be instructed to solder the positive voltage connection to the left lug of VR105, and this strap will also be soldered at that time.

2. Connect a wire between the right lug (as seen from the back) of the Coarse Offset Pot, VR105, and the right lug of the Fine Offset Pot, VR107. Solder one end of the wire to the right lug of one of the Fine Offset Pot (VR107), and secure the other end of the wire to the right lug of the Coarse Offset pot (VR105). Later, in this manual, you will be instructed to solder the negative voltage connection to the right lug of VR105, and this strap will also be soldered at that time.

Ground Strap Wiring

A good number of the panel components will share a common ground connection. There are a couple of ways of approaching the ground strap wiring: (1) All of the common ground connections can share a common ground, the "Analog" ground or (2) The common ground connections can be divided into "Analog" and "Digital" ground signals.

A bit of explanation may serve to help decide how you want to wire the common ground connections. The Appendage PCB divides the ground plane into two paths: the analog ground and the digital ground. These two paths are both at the ground potential, but they are routed such that the two paths only connect together at one point on the PCB. The purpose for dividing the grounds is so that signals that, by their nature, change state abruptly (such as gate and trigger signals) or that require more current than other signals (such as the LED signals) do not “dump” noise on the entire ground system. In other words, it’s a precaution taken to keep the Appendage signal voltages as “quiet” as possible through elimination of crosstalk.

When it comes to wiring up a panel, however, dividing these panel grounds may not be effective at all; it depends on the panel and the connector components (jacks) used. Banana jacks, by their nature, do not have a ground plane to come into contact with the panel. Quarter inch jacks, or 3.5 mm jacks, however, likely will, unless some isolation from the panel is provided. If one has a conductive metal panel and normal, un-isolated ¼” or 3.5 mm jacks, the ground lug of these connectors will be connected to the panel through the body of the jack. This means that, though one jack may have an “analog” ground connected to its lug, and another jack may have a “digital” ground connected to its lug, *they will actually be connected together through the panel itself*, thus rendering the division of the two ground signals pointless when wiring up the front panel. In this case, it makes sense to send only one ground signal, the analog ground, to the panel.

This is not to say one will get cross talk if only the analog signal is used. In the Appendage prototype testing phase, one analog ground signal was used, with a conductive panel, and there proved to be no crosstalk, so there is really little to worry about on this point. This build document will, however, divide the components that would connect to analog and digital ground for those who wish to follow that methodology – particularly those of you who use banana jacks, use isolated connectors, or use non-metallic, non-conductive panels.

Two notes should be made here for clarification:

1. It is not recommended to rely on the panel to transmit ground to the connectors if one has a conductive panel – use strap wiring instead.

2. The Ribbon In Jack, J117, **must** be an isolated jack, as mentioned previously in this document.

The ground strap connection portion of this strap wiring procedure will divide the common ground sections into analog and digital portions, and a single ground overall connection illustration and a dual ground connection illustration are provided.

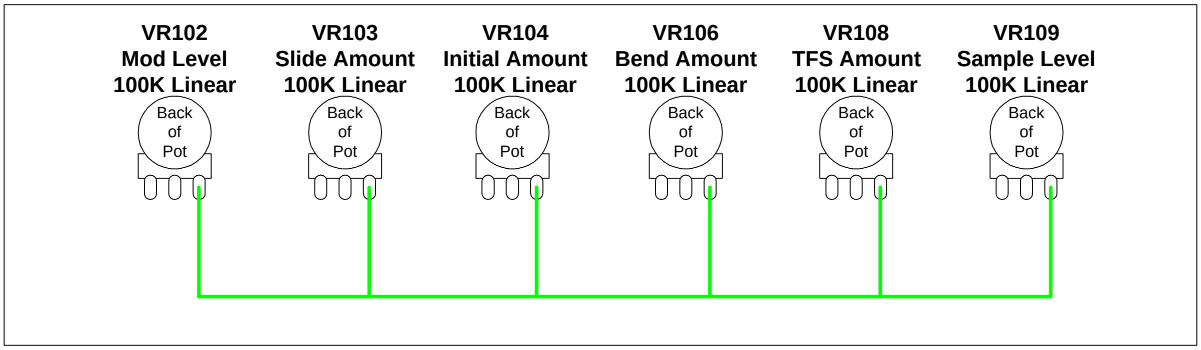


Figure 4-5: Strap Wiring the Pot Common Ground

Pot Ground Strap Wiring
There are seven pots on the Appendage front panel that require a ground reference connection. That means that there are three pots that do not have a common ground connected to them. Be sure you know which pots are which. Just as a reminder:

Do NOT wire a ground strap wire to that the following pots in this step:

- **Glide Pot, VR101**
- **Coarse Offset Pot, VR105**
- **Fine Offset Pot, VR107**

The ground connection for each of the pots that **do** require a ground connection will attach to the right-most lug of the pot, as viewed from the back of the panel. When making these connections, be sure to leave some point where this common ground can connect to the other common ground connections on the Appendage panel.

☐ **Right Lug VR102 Mod Level**
☐ **Right Lug VR103 Slide Amount**
☐ **Right Lug VR104 Initial Amount**
☐ **Right Lug VR106 Bend Amount**
☐ **Right Lug VR108 TFS Amount**
☐ **Right Lug VR109 Sample Level**

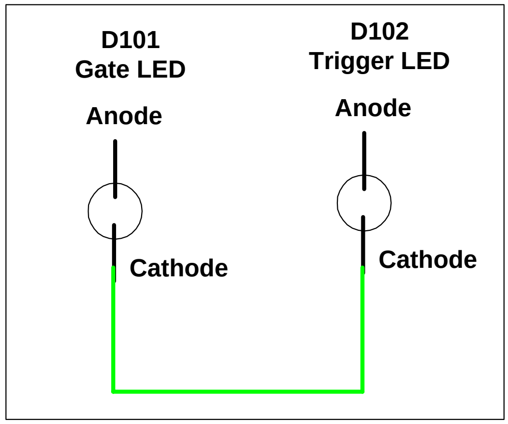


Figure 4-6: Strap Wiring the LED Common Ground

LED Common Ground Strap Wiring

Locate the cathode connections of each LED. Solder a strap wire connection between the two cathodes. Be sure to leave some means to connect this common ground connection to the panel ground connection.

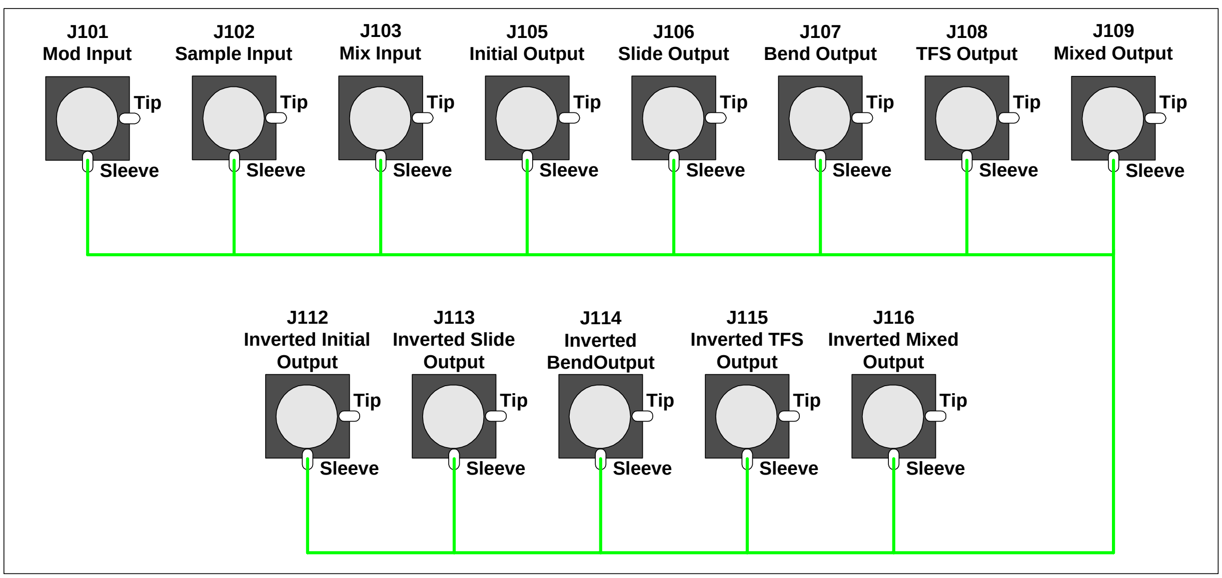


Figure 4-7: Strap Wiring the Continuous Signal Jack Common Ground

Strap Wiring the Continuous Signal Jack Ground Connections

The "continuous signal" jack group either provides the voltage control outputs generated by the Appendage, or accepts signal sources to be processed by the Appendage. Obviously, if you use banana jacks, you've got a pass on this section – you don't have a ground connection to solder to your jacks.

All of these connections are made to the sleeve connection of the jacks, and they should all be connected together. Make sure you leave some way of connecting this ground system to the common ground connection of the panel.

☐ **Ground Lug J101 Mod Input**
☐ **Ground Lug J102 Sample Input**
☐ **Ground Lug J103 Mix Input**
☐ **Ground Lug J105 Initial Output**
☐ **Ground Lug J106 Slide Output**
☐ **Ground Lug J107 Bend Output**
☐ **Ground Lug J108 TFS Output**
☐ **Ground Lug J109 Mixed Output**
☐ **Ground Lug J112 Inverted Initial Output**
☐ **Ground Lug J113 Inverted Slide Output**
☐ **Ground Lug J114 Inverted Bend Output**
☐ **Ground Lug J115 Inverted TFS Output**
☐ **Ground Lug J116 Inverted Mixed Output**

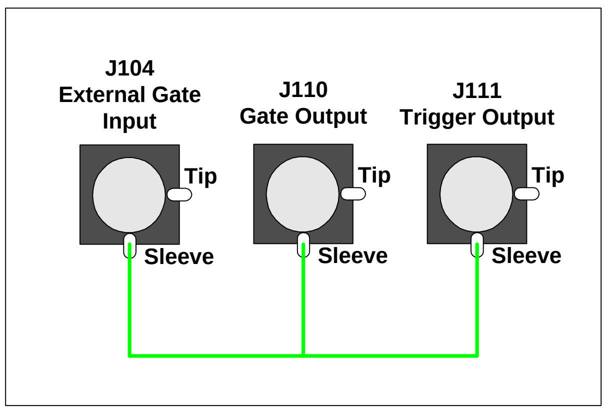


Figure 4-8: Strap Wiring the Control Signal Jack Common Ground

Strap Wiring the Control Signal Jack Ground Connections
The "control signal" jack group either provides the gate/trigger control outputs generated by the Appendage, or accepts an external gate signal to be processed by the Appendage. Once again, if you use banana jacks, don't worry about these connections.

All of these connections are made to the sleeve connection of the jacks, and they should all be connected together. Make sure you leave some way of connecting this ground system to the common ground connection of the panel.

☐ **Ground Lug J104 Gate Input**
☐ **Ground Lug J110 Gate Out**
☐ **Ground Lug J111 Trigger Out**

Connecting Together the Common Ground Points
Up to this point, the common ground connections have been implemented on panel component groups. Now connections from group to group must be made (and checked).

As mentioned before, there are two paths to choose from: One common ground connection to Analog Ground, or two different common ground connections, one to Analog Ground and one to Digital Ground.

Single Ground Connection to Analog Ground

If you plan on wiring the panel components up to the dual ground system (analog and digital ground) skip this section and go directly to the "Dual Ground Connection to Analog and Digital Ground" section following this section.

1. Solder a strap wire between a ground connection of the Switch Section (refer to **Figure 4-1**, green wire depiction) and a ground connection of the pot section (**Figure 4-5**).

2. Solder a strap wire between a ground connection of the pot section (**Figure 4-5**) and a ground connection of the LED section (**Figure 4-6**).

3. Solder a strap wire between a ground connection of the connector section of **Figure 4-7** and the ground connection of the connector section of **Figure 4-8**. This will provide a common ground between all of the connectors.

4. Solder a strap wire between the connector section of either **Figure 4-7** or Figure **4-8** (which are now connected together following step 3) and a ground connection of the pot section (**Figure 4-5**).

Finally, make sure you have one place left that you can connect the ground connection from the Appendage PCB.

All of the single ground connections should, at this point, be connected together. To ensure that everything is connected together, connect one lead of an ohmmeter or a continuity connector to a single ground point (for example, the cathode of one of the LEDs) and use the other lead to check each of the following points to make sure there is a continuous reading between all of the points. With each point measured, the ohmmeter should read close to zero ohms or, your continuity tester will beep with each point touched with the free lead. You can use Table 4-1 as a checklist for these connections.

Table 4-1: Single Analog Ground Strap Connection List

OK	Component
	Gate LED Cathode
	Trigger Cathode
	Ribbon Mode Switch, Lower Terminal
	Trigger Mode Switch, Middle Terminal
	Input Mode Switch, Left Middle Terminal
	Initial Amount Pot, Right Lug
	Slide Amount Pot, Right Lug
	Bend Amount Pot, Right Lug
	TFS Amount Pot, Right Lug
	Mod Level Pot, Right Lug
	Sample Level Pot, Right Lug
	Mod Input Jack, Sleeve Lug
	Sample Input Jack, Sleeve Lug
	Mix Input Jack, Sleeve Lug
	Gate In Jack, Sleeve Lug
	Initial Output Jack, Sleeve Lug
	Slide Output Jack, Sleeve Lug
	Bend Output Jack, Sleeve Lug
	TFS Output Jack, Sleeve Lug
	Mixed Output Jack, Sleeve Lug
	Inverted Initial Output Jack, Sleeve Lug
	Inverted Slide Output Jack, Sleeve Lug
	Inverted Bend Output Jack, Sleeve Lug
	Inverted TFS Output Jack, Sleeve Lug
	Inverted Mixed Output Jack, Sleeve Lug
	Gate Out Jack, Sleeve Lug
	Trigger Out Jack, Sleeve Lug

Figure 4-9 can be used as a guide to double checking the single analog bus ground strap connections.

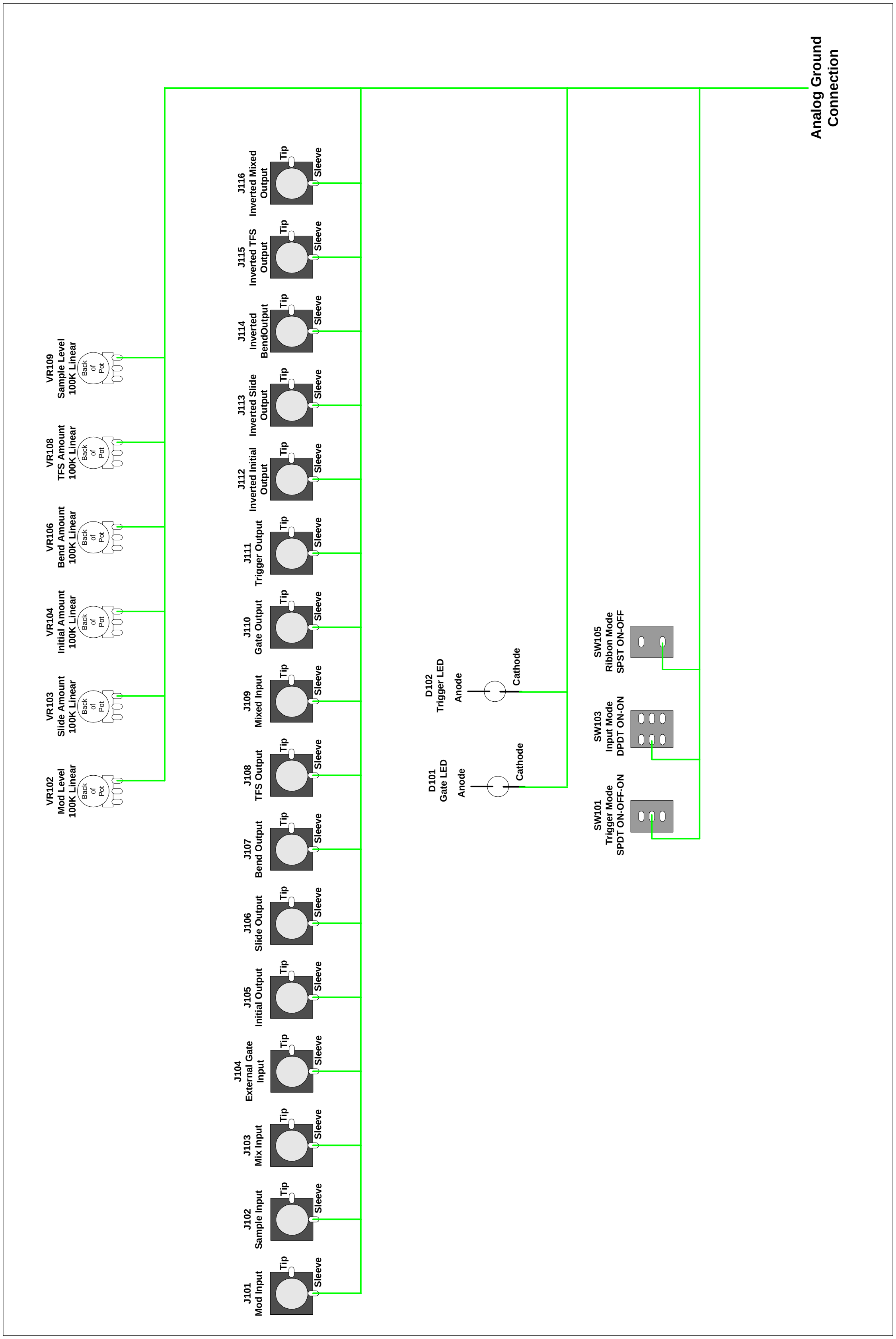


Figure 4-9: Analog Ground Strap Wiring

Dual Ground Connection to Analog and Digital Ground

If you plan on wiring the panel components up to the single ground system (analog ground) back up from this section and return to the "Single Ground Connection to Analog Ground" section preceding this section.

Digital Ground Connections
1. Solder a strap wire between a ground connection of the Switch Section (refer to **Figure 4-1**, green wire depiction) and the ground connection of the control connector section of **Figure 4-8.**

2. Solder a strap wire between a ground connection of the Switch Section (refer to **Figure 4-1**, green wire depiction) and a ground connection of the LED section (**Figure 4-6**).

Steps 1 and 2 above combine the ground connections of the LEDs, Switches, and Control Inputs/Outputs into a single digital ground bus connection. Make sure you leave a point in this network that you can solder in the connector for the digital ground connection from the PCB.

Now is a good time to ensure that things are connected together. Connect one lead of an ohmmeter or a continuity connector to a single ground point (for example, the cathode of one of the LEDs) and use the other lead to check each of the points to make sure there is a continuous reading between all of the points. With each point measured, the ohmmeter should read close to zero ohms or, your continuity tester will beep with each point touched with the free lead. You can use Table 4-2 as a checklist for these connections.

Table 4-2: Dual Ground Strap Connection: Digital Ground List

OK	Component
	Gate LED Cathode
	Trigger Cathode
	Ribbon Mode Switch, Lower Terminal
	Trigger Mode Switch, Middle Terminal
	Input Mode Switch, Left Middle Terminal
	Gate In Jack, Sleeve Lug
	Gate Out Jack, Sleeve Lug
	Trigger Out Jack, Sleeve Lug

Analog Ground Connections

1. Solder a strap wire between a ground connection of the pot section (**Figure 4-5**) and a ground connection of the continuous signal jack section (**Figure 4-7**).

All of the analog ground connections should, at this point, be connected together. Once again, ensure that all of the analog ground points are connected together. Connect one lead of an ohmmeter or a continuity connector to a single ground point (for example, the cathode of one of the LEDs) and use the other lead to check each of the following points to make sure there is a continuous reading between all of the points. With each point measured, the ohmmeter should read close to zero ohms or, your continuity tester will beep with each point touched with the free lead. Use Table 4-3 as a guide to the points that need to be checked.

Table 4-3: Single Analog Ground Strap Connection List

OK	Component
	Initial Amount Pot, Right Lug
	Slide Amount Pot, Right Lug
	Bend Amount Pot, Right Lug
	TFS Amount Pot, Right Lug
	Mod Level Pot, Right Lug
	Sample Level Pot, Right Lug
	Mod Input Jack, Sleeve Lug
	Sample Input Jack, Sleeve Lug
	Mix Input Jack, Sleeve Lug
	Initial Output Jack, Sleeve Lug
	Slide Output Jack, Sleeve Lug
	Bend Output Jack, Sleeve Lug
	TFS Output Jack, Sleeve Lug
	Mixed Output Jack, Sleeve Lug
	Inverted Initial Output Jack, Sleeve Lug
	Inverted Slide Output Jack, Sleeve Lug
	Inverted Bend Output Jack, Sleeve Lug
	Inverted TFS Output Jack, Sleeve Lug
	Inverted Mixed Output Jack, Sleeve Lug

Figure 4-10 can be used as a guide to analog and digital ground connections.

Finally, if all of the analog and digital ground connections check out on the individual continuity checks, check that the two ground systems are separate (after all, this is the whole point of using two common ground groups). Place a lead of the ohmmeter/continuity tester on the cathode connection of the Trigger LED (which is tied into the digital ground common connection) and place the other lead on the right lug of the Initial Amount Pot. If there is no continuity everything is just fine. If there is continuity, this means either a misplaced strap wire is connecting one group to the other, or you are using un-isolated connectors and a conductive panel, and that is providing continuity from the digital grounded connectors to the analog grounded connectors. This defeats the purpose, but is not necessarily much to worry about, as evidenced in the Appendage prototype phase of design.

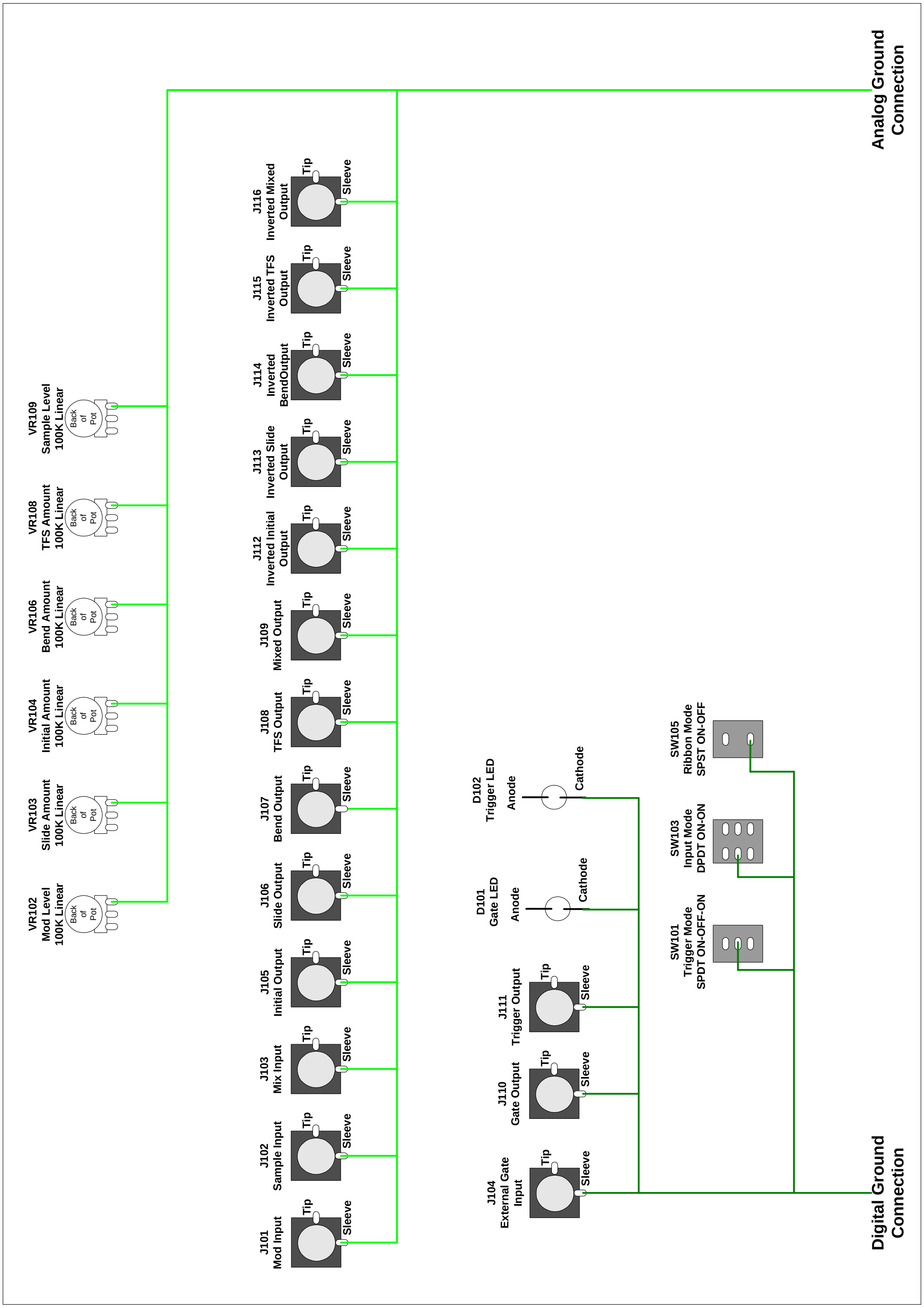


Figure 4-10: Digital and Analog Ground Strap Wiring

Congratulations, the panel components should now be mounted, and the strap wiring is complete. The next step is the construction of wire harness cables to connect to the panel.

5. Building The Cables

If you've made the decision to connect your front panel to your Appendage, you've come to the right page. Again, it cannot be stressed enough that using this system provides a number of advantages:

(1) Final Assembly of the Appendage is made much easier. If one is to hardwire the connections, the wires must be soldered to both the front panel and the PCB assembly. This involves point-to-point wiring which involves a considerable amount of effort over building the cables and wiring them to the front panel.

(2) Servicing/trouble-shooting the Appendage is made easier – the panel can be easily disconnected and re-connected to and from the PCB.

(3) It's easier to organize the wiring in a methodical manner, which leads to a neater, rats-nestless build.

This is not to say that building the cables cannot introduce problems – the cables must be built with care so they do not themselves create problems with intermittent connections.

Parts Used In the Cables

Each cable is comprised of three elements:

- The housing, which is a shell that the cables are "plugged into and which connects to the proper header on the PCB. There are different types of headers used on the Appendage – they differ by the number of wires they will accommodate. The Appendage uses 12 pin, 5 pin, and 4 pin, headers to connect signals to and from the Appendage panel.
- The crimp terminals, which are crimped or soldered **or** crimped **and** soldered to the ends of the wires, depending on your chosen technique.
- The wires themselves. Generally 22 gauge or 24 gauge <u>braided</u> wire is required. Do not use solid core wire.

Housings and Crimp Terminals

First of all, one must be aware that the housings will plug into the PCB headers in only one direction – this ensures the wire that is to attach to pin 1 of the PCB connector is the correct wire. So, you must become aware which "hole" in your housing will mate with pin 1. On the back of each PCB, you will notice that each header has a square pad to designate pin 1 of the connector. The connector is keyed so that the housing can only be plugged in with one orientation. In other words, the header is keyed so that the housing, which has a mating "key" will plug into it. On the housing, the key is a ridge running along the edge of the "bottom" of the housing.

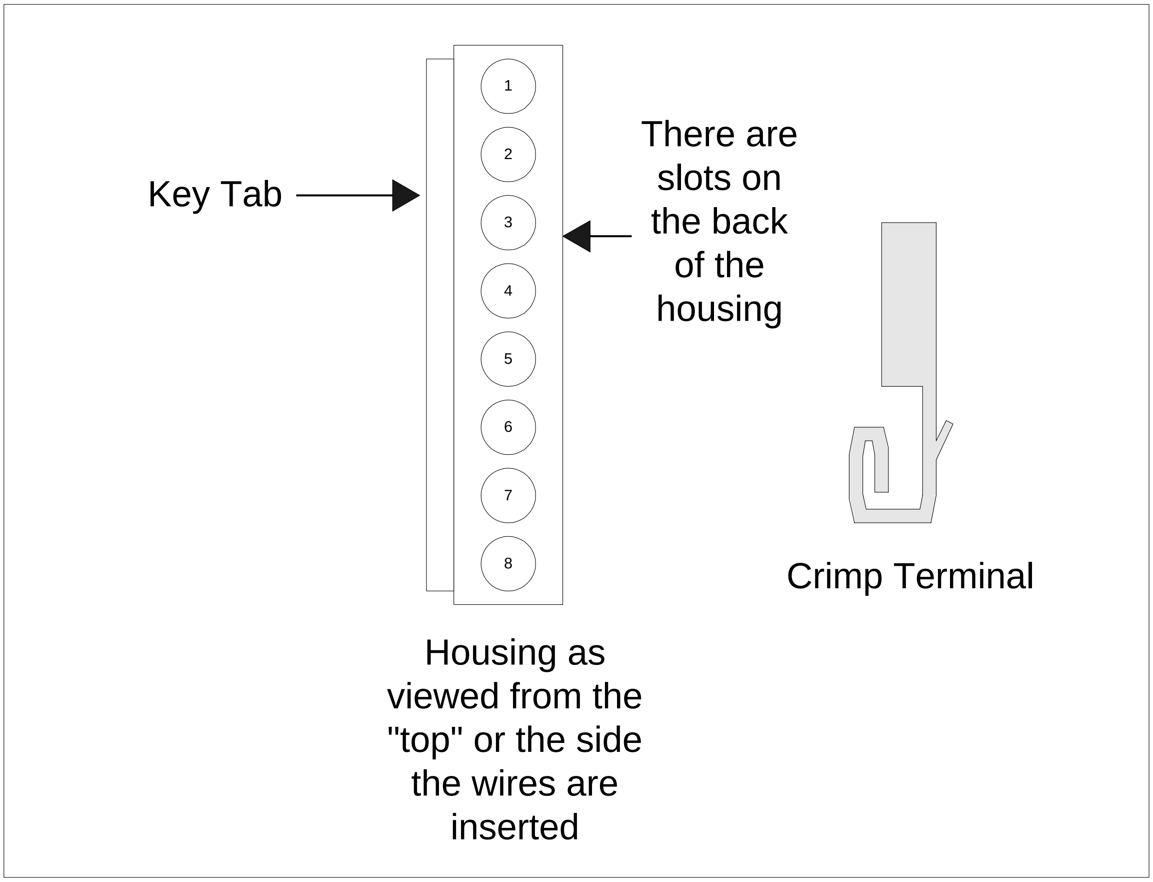


Figure 5-1: Housing and Crimp Terminal – A Graphic Anatomy

On the opposite side of the housing is a slot for each "hole" or terminal in the housing. These slots run along the bottom. The crimp terminals, which attach to the ends of the wire, have a small tab that protrudes from the "back" of the terminal. This small tab acts as sort of a fish hook and will "catch" in this slot when it is inserted into the housing.

Attaching the Crimp Terminals to the Wires

The crimp terminals attach to the ends of the wires, and are then inserted into the housing. The terminals have a couple of tabs at the top that are intended to be crimped, or folded over the insulation of the wire. The end of the wire is stripped **<u>and tinned</u>**, about ¼" from the end of the wire. This stripped and tinned part is to extend down so the "loop" of the crimp terminal compresses down onto the bare wire when the wire and crimp terminal are inserted into the housing.

Crimping tools can be expensive, though fairly inexpensive types that resemble a pair of wire cutters are available. In lieu of a crimping tool, many people will fold the tabs over the bare wire and put a *small* amount of solder there to hold it in place (a large "blob" of solder may prevent the crimp terminal from fitting into the housing). Generally, during the proto build process, it was found that the small amount of solder made a much more reliable connection.

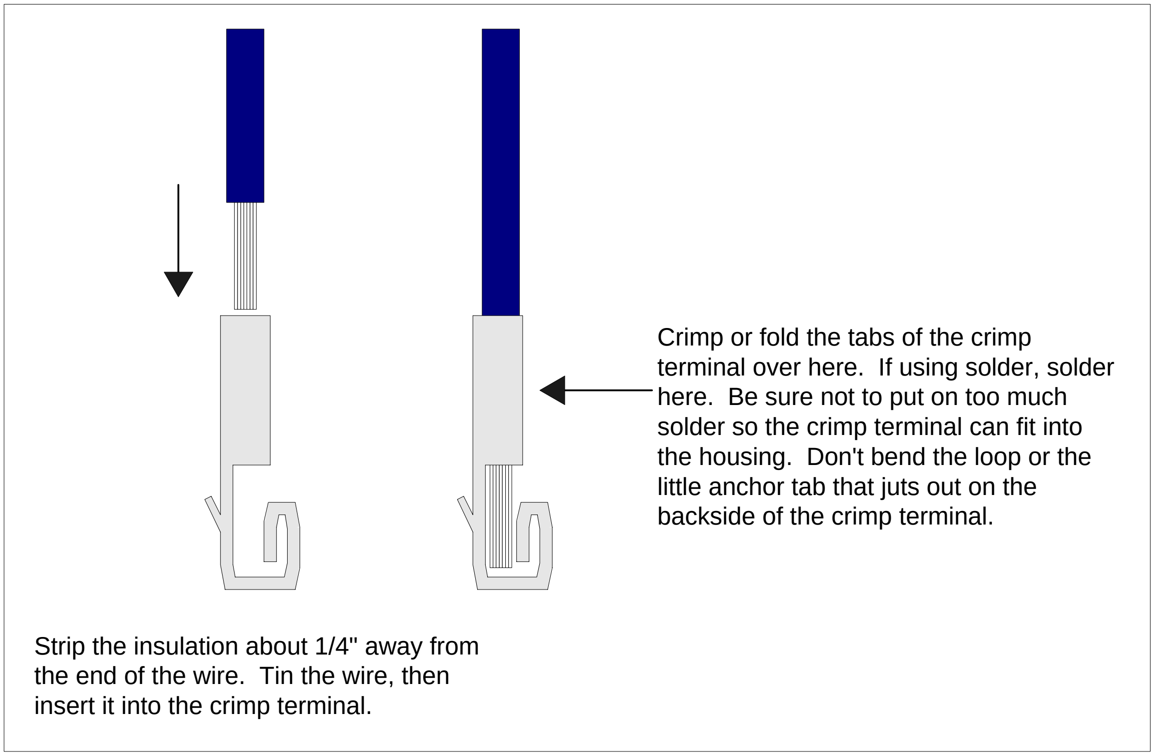


Figure 5-2: Putting the Crimp Terminals on Wires

It's a very good idea, if at all possible, to use a number of different colors of wire when building the cables. This helps you to determine very quickly which wire is pin 1, which wire is pin 2, etc. Otherwise, it's very easy to become confused which wire is which, and this can lead to errors when soldering the free ends of the cables to the front panel.

Also, make sure you provide plenty of length for the wires. By now, you've probably figured out how you're going to mount the PCB in the chassis. Making the wires longer than what you think may be needed allows you to measure them out by physically stretching them to where your boards will be and ensuring they will indeed reach before you actually do solder them to the front panel.

You can break the job down into separate tasks. For example, you can go through task of stripping all of the wires needed and attaching the crimp terminals. Then you can task yourself with inserting the wire/terminal into the housings, then you can task yourself with creating a neat looking cable by either wire-tying the cable wires together, or twisting the wires around each other to create a twisted-pair type thing. However, this last task may need to wait until after you've soldered the cables to the front panel – for now, it may be best to put a nice little twist-tie "collar" onto the cables just above the housing once the cable is assembled.

When you strip the wires, it's not a bad idea to strip just a tiny bit of the wire off the end that will connect to the panel. You can then use this exposed bit to attach a DMM or continuity checker to it and make sure your wire has continuity from the terminal to the end of the wire. A little care at these early stages can save a lot of headache at the final assembly and test stage of building your Appendage.

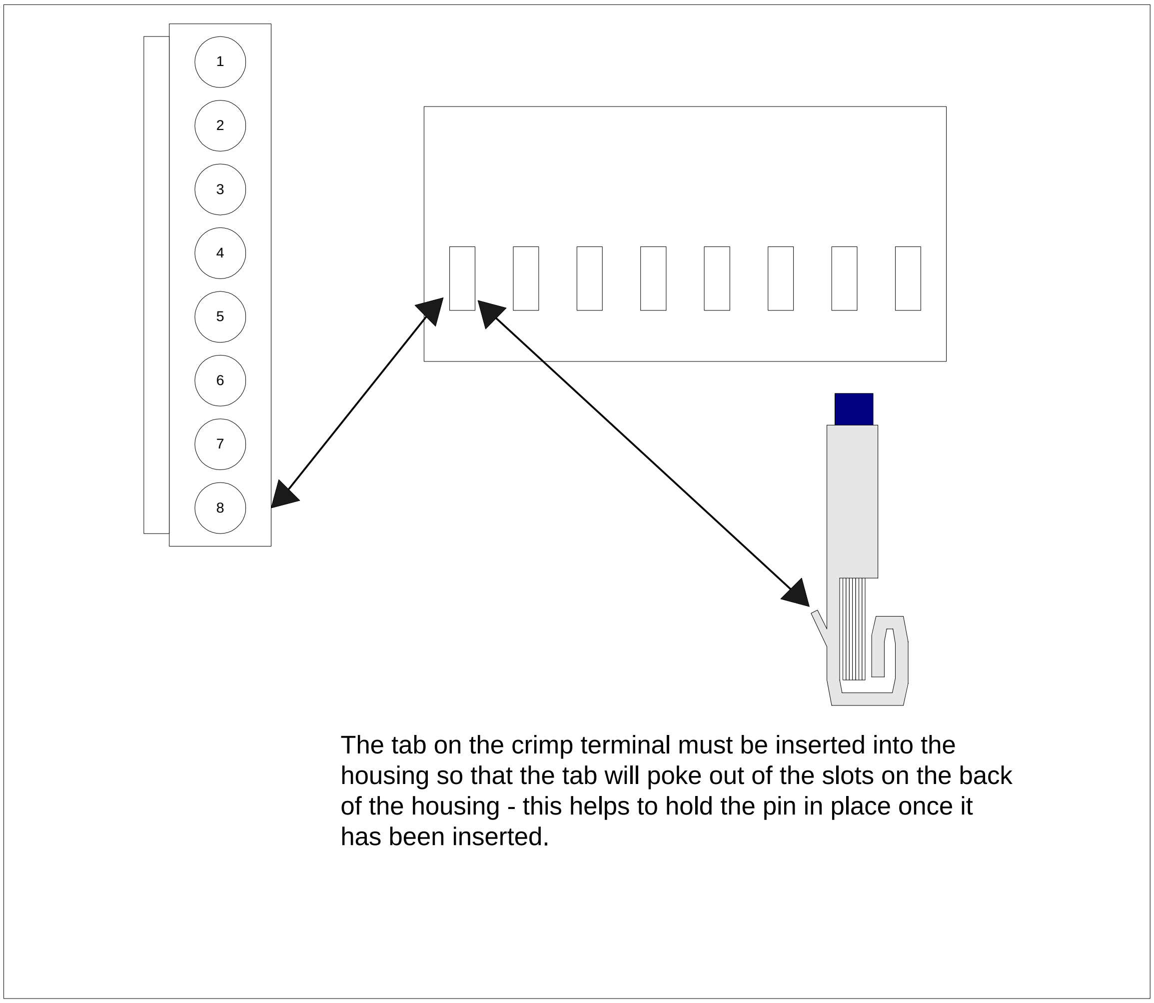


Figure 5-3: Crimp Terminal Orientation Before Insertion Into the Housing

Once you've got the terminal pins attached to your wires, you can insert them into the housings. When you insert the terminals into the housing, make sure that little barb on the back of the terminal is oriented towards the side of the housing that has the small "window" in it – the barb is designed to "catch" in that window like a hook in the mouth of a fish, and make it harder for Gorilla-Fist to yank it out at a later date. When the terminals are inserted into the housings, there should be the sensation of a soft "click" – this is a good sign that you've done a good job getting the terminals on the ends of the wires.

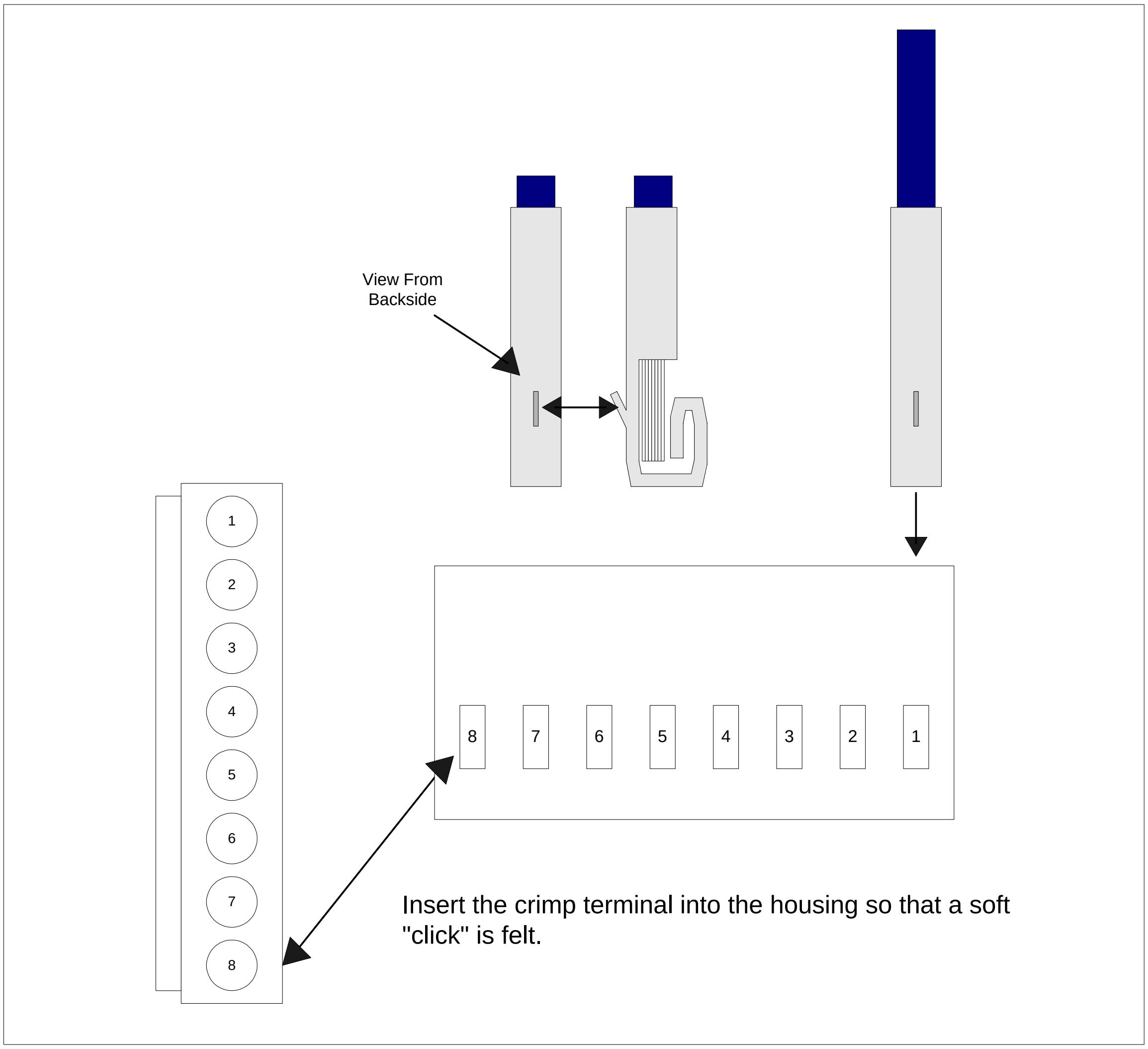


Figure 5-4: Inserting Crimp Terminals Into the Housing

Remember that "loop" on the terminal must not be crushed or misshapen – it is intended to compress down over the wire, making a good connection, and also provides a certain amount of tension that helps hold the terminal in the housing. And, again, too much solder (if you put solder on) or solder in the wrong place can inhibit the actual installation of the terminal into the housing.

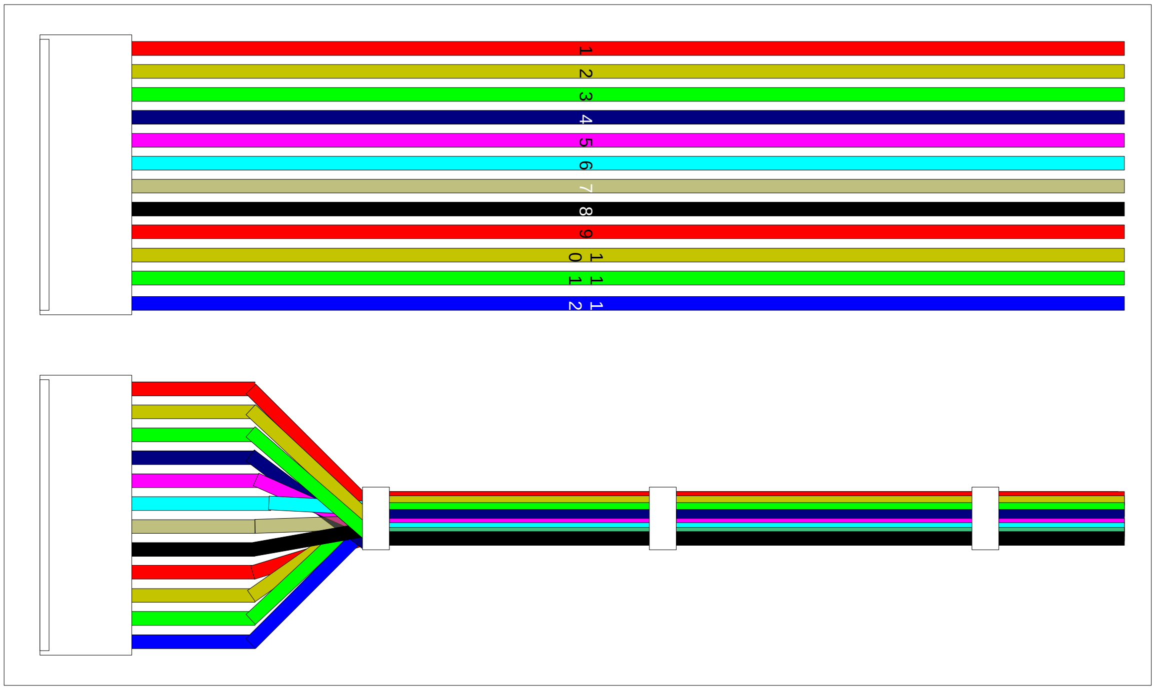


Figure 5-5: Assembled 12 Wire Cable

Once you've got all the wires into the housing, you can put a small collar onto the wires just above the housing. You may not want to add more at this time, because your wires will need to "fan out" in order to connect the all the disparate points they will connect to.

Once you've built your cables, you will find that soldering them to your strap-wired panel is a real cinch – very easy, and all the real work will be behind you.

So, now it's time to tuck into the cables. How big of a job will this be? How many cables will need to be built? You've come to the right section of this chapter to find out.

Here's the damage:

Required 12 Pin Cables: 3
Required 5 Pin Cables: 1
Required 4 Pin Cables: 2

It should be mentioned at this time that one of the four pin cables depends completely on what power supply connector is used to deliver the positive voltage, negative voltage and ground signal(s) the panel requires.

A long, long time ago, in a chapter, far, far away (Chapter 1 of this document specifically), it was mentioned that the Appendage is very accommodating to your power supply predilection. Rather than force you to trudge back to Chapter 1, that particular section will be mentioned here:

Power Connections
The Appendage PCB was designed to accommodate a number of different power connections in the attempt to make it compatible with the majority of modular systems available in the current marker. The Appendage PCB can accept the following power supply connections:

Blacet™/PAiA™/MOTM™ style 4 pin connectors.

Doepfer™ Power Bus 6 pin connectors.

Synthesizers.com™ style 6 pin connectors.

4 Pin User Connection (two separate ground pins).

3 Pin User Connection (terminal block with a single ground pin).

Why bring this up now? Because the power connector used to power the Appendage determines what connectors are available to supply power and ground to the Appendage panel.

All of the power connectors feed common points on the PCB, so one type of connector can be used as the power input of the Appendage, and another style of connector can be used to supply the power and ground signals to the Appendage panel For example, if the Blacet™/PAiA™/MOTM™ style connector is used, this leaves the choice of using the Doepfer™ style connector, the Synthesizers.com™ style connector, the 4 pin user connector, or the 3 pin user connector to supply power connections to the panel.

By the same token, if the Doepfer™ type connector is used to connect to your power supply, then the Blacet™/PAiA™/MOTM™, the Synthesizers.com™ style connector, the 4 pin user connector, or the 3 pin user connector can be used to supply power connections to the panel. And so on and so forth.

For the time being, we'll concentrate on the harnesses used to supply all signals except for power and ground between the PCB and the Panel.

And what better way to describe the cables than to use a table to describe the harnesses. Table 5-1 provides information not only about how many pins/wires a particular wire has, but also provides information as to which pin must be connected to what on the panel. The cables are named by the number the housing is assigned to a "P" followed by a designation. The "P" means "plug", and will plug into a corresponding "J" (jack) on the PCB. For example, P10 will plug into J10 on the PCB. Simple enough, right?

Table 5-1: Panel Cables

Plug/Cable Number	Pin Number/Panel Connections
P6	Pin1 - Ribbon In Jack, J117, Ring Lug Pin2 - Ribbon In Jack, J117, Tip Lug Pin3 - Ribbon In Jack, J1117, Sleeve Lug Pin4 - Ribbon Mode Switch, SW 105, Top Lug Pin5 - Input Mode Switch, SW 103, Upper Right Lug
P7	Pin1 - Inverted Slide Output, J113, Tip Lug Pin2 - Slide Output, J106, Tip Lug Pin3 - Slide Amount Pot, VR103, Left Lug Pin4 - Inverted Initial Output, J112, Tip Lug Pin5 - Initial Output, J105, Tip Lug Pin6 - Initial Amount Pot, VR104, Left Lug Pin7 - Inverted Bend Output, J114, Tip Lug Pin8 - Bend Output, J107, Tip Lug Pin9 - Bend Amount Pot, VR106, Left Lug Pin10 - Inverted TFS Output, J115, Tip Lug Pin11 - TFS Output, J108, Tip Lug Pin12 - TFS Amount Pot, VR108, Left Lug
P8	Pin1 - Mod Level Pot, VR102, Center Lug Pin2 - Slide Amount Pot, VR103, Center Lug Pin3 - Mix Input, J103, Tip Lug Pin4 - Initial Amount Pot, VR104, Center Lug Pin5 - Coarse Offset Pot, VR105, Center Lug Pin6 - Bend Amount Pot, VR106, Center Lug Pin7 - Fine Offset Pot, VR107, Center Lug Pin8 - TFS Amount Pot, VR108, Center Lug Pin9 - Inverted Mixed Output, J116, Tip Lug Pin10 - Mixed Output, J109, Tip Lug Pin11 - Sample Level Pot, VR109, Center Lug Pin12 - Input Mode Switch, SW103, Lower Right Lug
P9	Pin1 - Trigger Out, J111, Tip Lug Pin2 - Trigger LED, D102, Anode Pin3 - Gate Out, J110, Tip Lug Pin4 - Gate LED, D101, Anode

Plug/Cable Number	Pin Number/Panel Connections
P10	Pin1 - Input Switch, SW104, Center Right Lug Pin2 - Glide Pot, VR101, Center Lug Pin3 - Glide Pot, VR101, Right Lug Pin4 - Gate Mode Switch, SW102, Lower Right Lug Pin5 - Input Switch, SW104, Center Left Lug Pin6 - Input Switch, SW104, Lower Right Lug Pin7 - Gate Mode Switch, SW102, Lower Left Lug Pin8 - Gate Mode Switch, SW102, Upper Left Lug Pin9 - Input Mode Switch, SW103, Upper Left Lug Pin10 - Gate Input Jack, J104, Tip Lug Pin11 - Trigger Mode Switch, SW101, Lower Lug Pin12 - Trigger Mode Switch, SW101, Upper Lug

As mentioned before, one cable remains for interconnection between the Appendage panel and PCB – this cable supplies the positive and negative voltages for the Coarse Offset and Fine Offset pots, and supplies the ground signal(s) for the panel components. And, of course, the connector to be used is up to you to decide, based upon which connector you decide to use to supply power to the Appendage. It should go without saying the connector that is supplying power to the Appendage PCB cannot be used to supply these signals to the panel – you will need to use any of the other remaining power connectors to provide these connections.

Table 5-2: Ground/Voltage Cable To Panel Only

Plug/Cable Number	Pin Number/Panel Connections
P1 Power User J1	Pin1 - +V to Coarse Offset Pot, VR105, Left Lug Pin2 - Analog Ground Panel Connection Pin3 - Digital Ground Panel Connection (**If Used**) Pin4 - -V to Coarse Offset Pot, VR105, Right Lug
PTB1 Power User TB1	Pin1 - +V to Coarse Offset Pot, VR105, Left Lug Pin2 - Analog Ground Panel Connection Pin3 - -V to Coarse Offset Pot, VR105, Right Lug

Plug/Cable Number	Pin Number/Panel Connections
P2 Doepfer™ J2	Pin 1 - -V to Coarse Offset Pot, VR105, Right Lug Pin 2 - No Connection Pin 3 - Analog Ground Panel Connection Pin 4 - No Connection Pin 5 - No Connection or (Digital Ground Optional) Pin 6 - No Connection Pin 7 - No Connection Pin 8 - No Connection Pin 9 - +V to Coarse Offset Pot, VR105, Left Lug Pin 10 - No Connection Pin 11 - No Connection Pin 12 - No Connection Pin 13 - No Connection Pin 14 - No Connection Pin 15 - No Connection Pin 16 - No Connection
P3 Blacet™/PAiA™/MOTM™ J3	Pin1 - +V to Coarse Offset Pot, VR105, Left Lug Pin2 - Analog Ground Panel Connection Pin3 - Digital Ground Panel Connection (**If Used**) Pin4 - -V to Coarse Offset Pot, VR105, Right Lug
P4 Synthesizers.com™ J4	Pin1 - +V to Coarse Offset Pot, VR105, Left Lug Pin2 - No Connection (Key – Pin Removed) Pin 3 - No Connection Pin4 - Analog Ground Panel Connection Pin5 - -V to Coarse Offset Pot, VR105, Right Lug Pin 6 - No Connection

5. Installing the Panel/PCB Connection Wiring

The Final Panel Assembly Step

After you have finished the steps of this chapter of the Appendage Build Instruction, your panel, and a good chunk of the actual work of building the Appendage assembly will be completed.

For Those Not Using the Plugs and Headers
If you have decided to wire up the panel with point-to-point wiring, eschewing the use of headers, etc, this chapter will serve as your guide where to solder the wires to the Appendage PCB. Some builders likely prefer to hardwire, which is fine. In that case, the plug numbers (P numbers) will tell you where on the board to solder the wires. This information is part of these wiring diagrams – the “P” number (for plug) fits directly into the “J” (jack) of the same number on the board. In other words, if the illustrated plug is “P7”, then all of the corresponding pin numbers would solder directly into the pads for “J7” on the board. Remember, on the boards, pin 1 for each connector is a square pad, and the pin numbers count sequentially from there.

Wiring Diagrams
The wiring diagrams assume that the panel has already been strap wired – if you’re not strap wired by now, you probably should go back and do that before starting this portion of the build doc. Some connections may not jibe directly as illustrated with what you have already strap wired – particularly the common ground connections. In the strap wiring procedure, your common ground points should all be connected together, so you can attach the ground connection(s) from the PCB to any common ground point on the panel and you’ll be OK.

The illustrations cover each plug separately – you can follow through with each illustration and wire them up accordingly. Pay very close attention to the plug pin numbering as opposed to what you’re wiring up – things aren’t all that sequential, so don’t get caught up in assuming they are!

It is a very good idea to label your plug/ housings once the cable is wired to the panel. You will thank yourself profusely later if you do that now. If you don’t do this, when the time comes to plug everything into the boards, you will find yourself having to trace through the connections to see which plug is which. Use a sharpie or some other method to mark the plugs “P7”, “P8”, etc. In fact, mark both sides of them so they can be identified from any angle.

The wiring diagrams also have charts included with them that label each pin with the mnemonic label of the signal they carry. This information can be used in conjunction with the Appendage Schematics to help trace through any potential errors you may incur, or can be used to help understand exactly how the Appendage works, should you be curious and/or a glutton for punishment.

At this point, all of your cables will be housings that have an amount of wire attached to them. Hopefully you left enough length in the wires to “reach” from between the panel to where the boards will be situated. Before you solder each cable onto the panel, stretch the wires between the board locations and the panel components they will solder to. Leave enough “slack” on the wires so that there is no strain pulling on the connectors. When you’re sure that each wire has ample length to reach the boards (and the connectors on the boards!), cut them to size.

After you have cut each wire on the cable, strip and tin the ends of the wires that will connect to the panel components. Strip them about 1/4” from the end of the wire (that’s around 6.5 mm).

Again, take care that you don’t overheat the panel components as you solder. Pay particular attention to soldering the switches and LEDs.

All connections to the LEDs will be to the anode of the LED. Strap wiring should by now have taken care of the cathode connections. Solder onto the anode about 1/4” to 1/2” (6.5 mm to 13 mm) from the body of the LED and snip off the excess length of the anode.

One final thing – **as with this entire manual, all connections are illustrated as you would be looking at them on the rear panel.** This makes sense, unless, of course, you have a Plexiglass panel and can see either side of the component. Even then, don’t let your invisible panel fool you – look at it from the back.

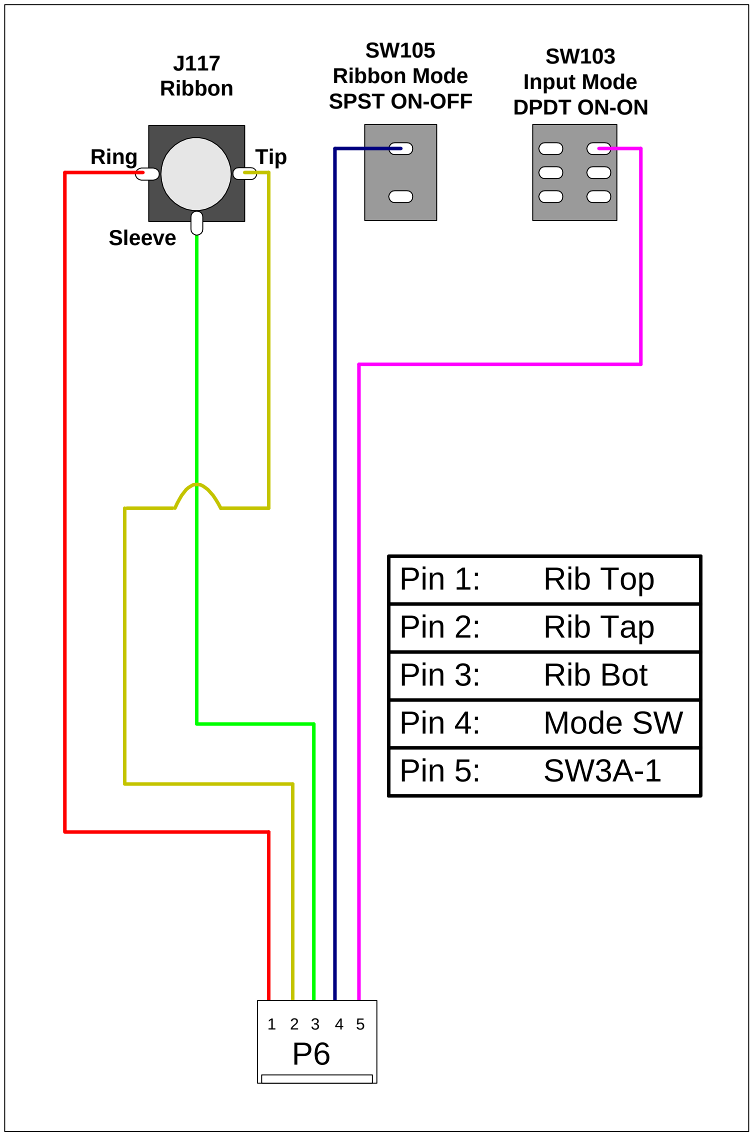


Figure 6-1: P6/J6 Connections

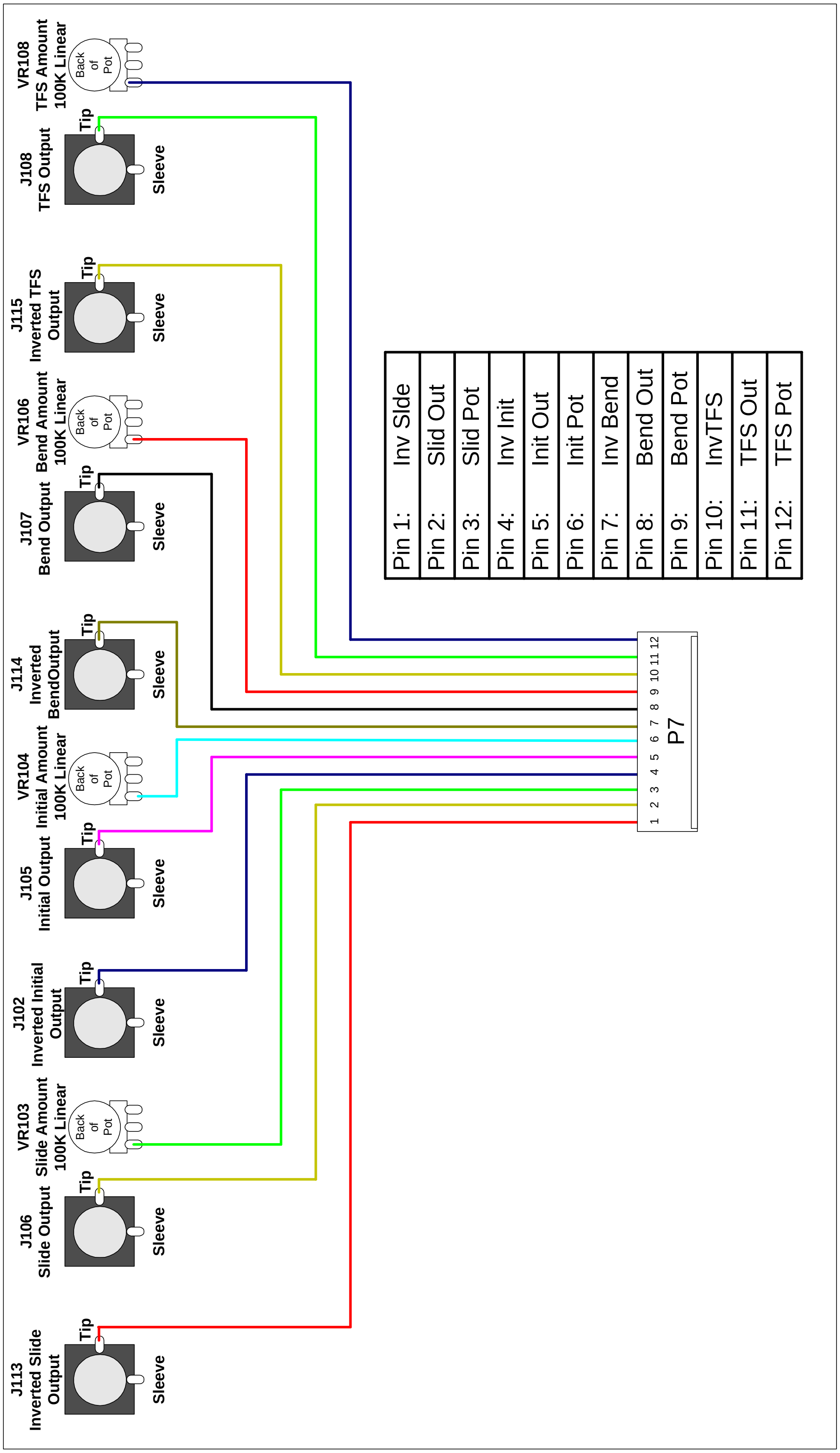


Figure 6-2: P7/J7 Connections

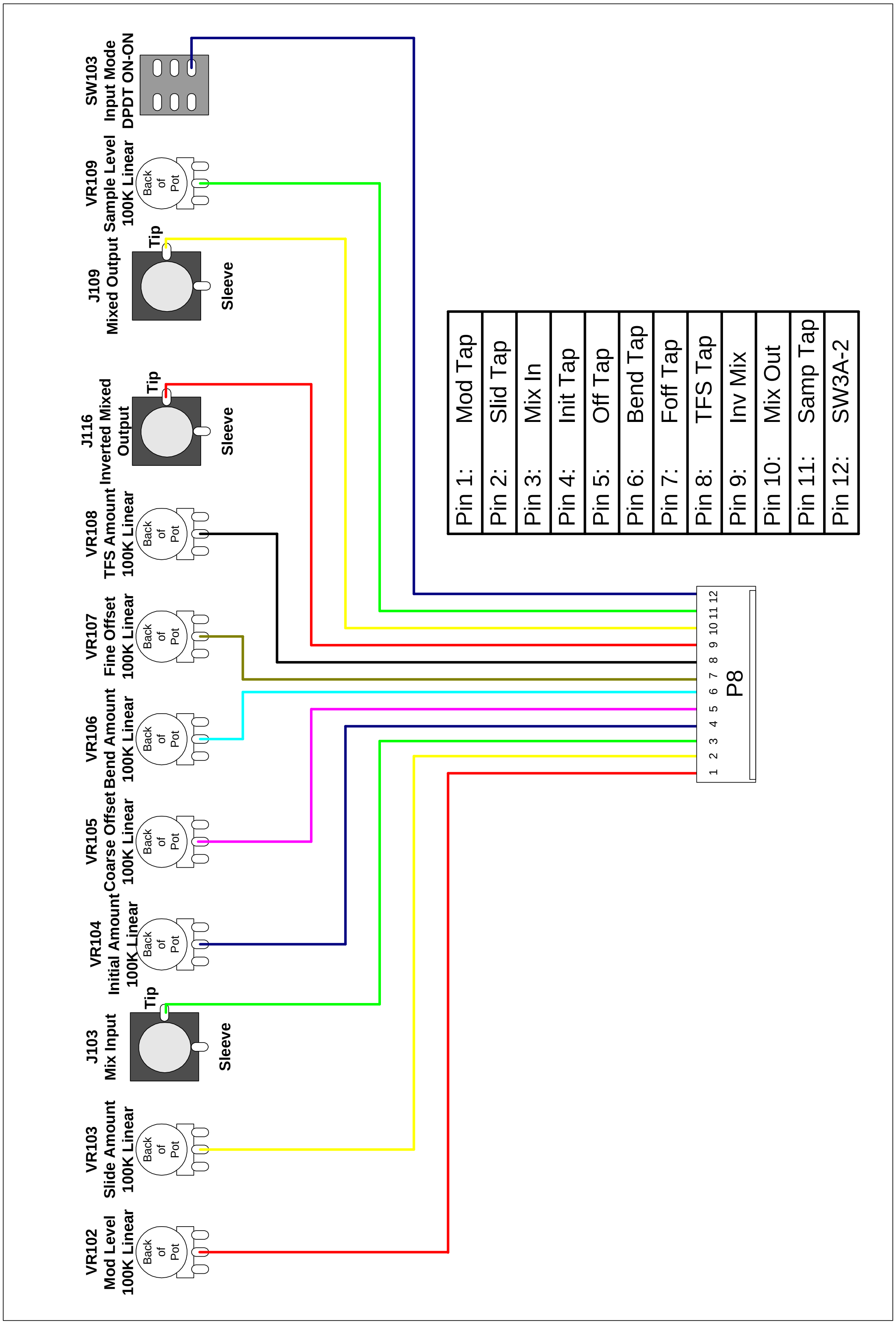


Figure 6-3: P8/J8 Connections

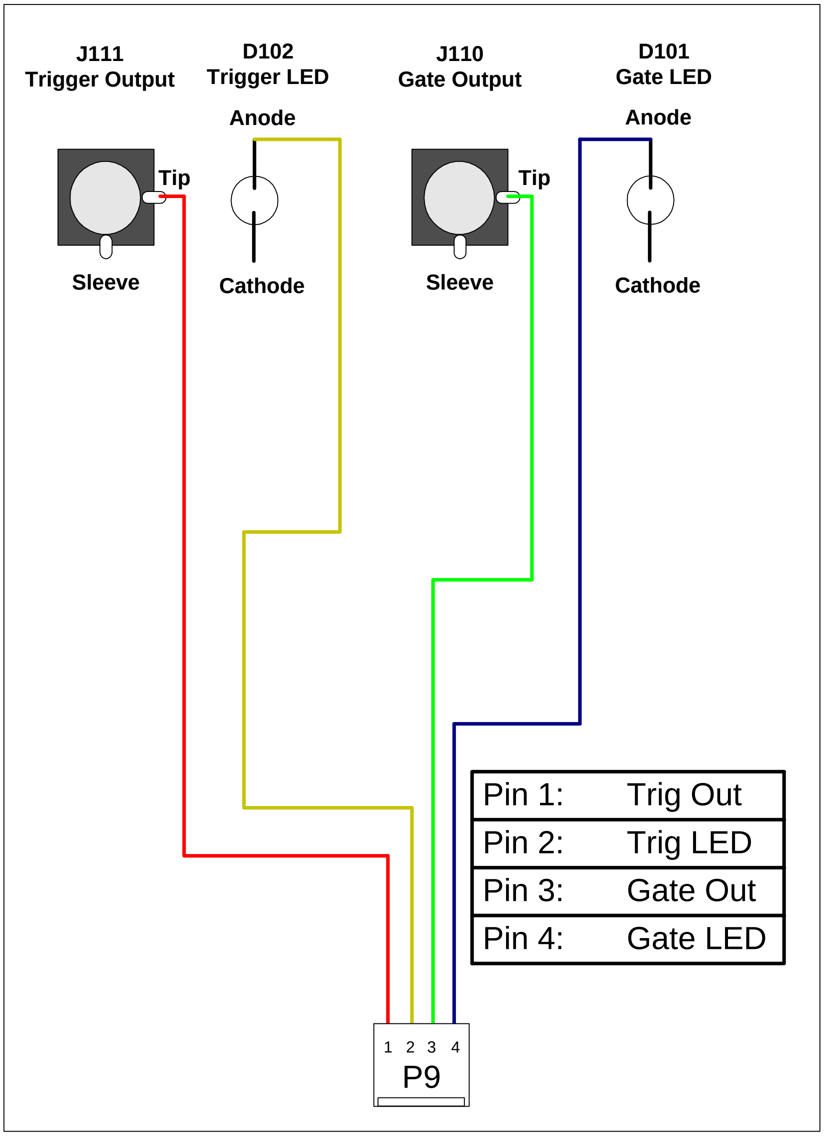
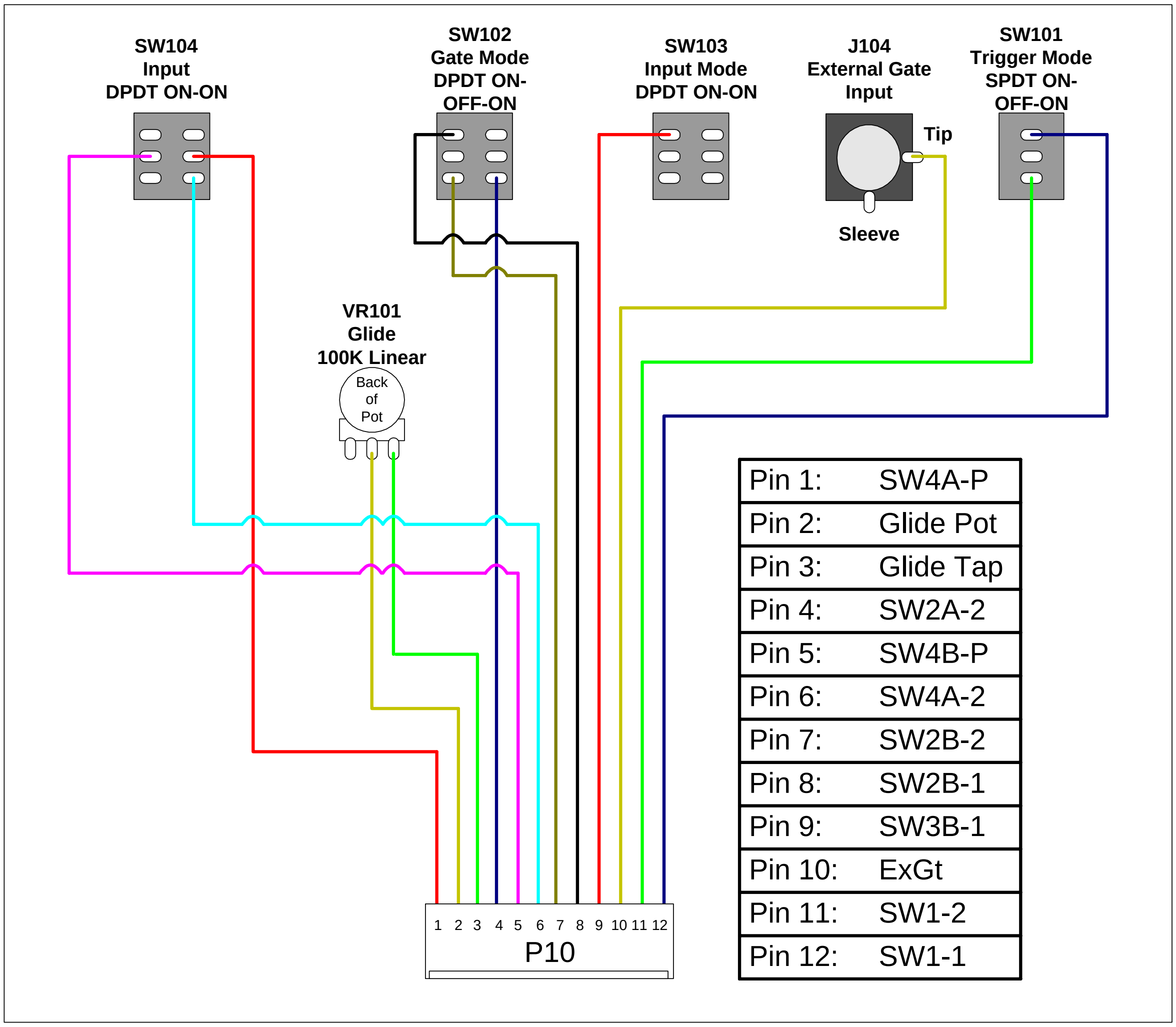


Figure 6-4: P9/J9 Connections



Pin 1:	SW4A-P
Pin 2:	Glide Pot
Pin 3:	Glide Tap
Pin 4:	SW2A-2
Pin 5:	SW4B-P
Pin 6:	SW4A-2
Pin 7:	SW2B-2
Pin 8:	SW2B-1
Pin 9:	SW3B-1
Pin 10:	ExGt
Pin 11:	SW1-2
Pin 12:	SW1-1

Figure 6-5: P10/J10 Switch Connections

PCB to Panel Voltage and Ground Connections

Figures 6-6 through 6-10 illustrate the cables one would build depending on which power connection is to be used to send the voltage and ground signals to the panel. In each case, +V is sent to the left lug of VR15 and –V is sent to the right lug of VR15.

All of the connector illustrations have a "Panel Ground (or Analog Ground)" connection. If a single ground system was strap wired, this wire should connect to a point that is connected in that strap wire system (do connect it directly to the panel). If you strap wired the ground signals on the panel with an analog ground system and a digital ground system, this wire should connect to the analog ground system. This is impossible if one is using P6/J6 or TB1 (neither of these connectors have more than one ground connection).

On the cables that do permit two ground connections, P1/J1 through P3/J3, an "Optional Digital Ground" wire is depicted. If you have strap wired an analog ground and a digital ground system, this wire should connect to the digital ground system. **If you strap wired a single ground system on the panel, then this optional "Optional Digital Ground" wire should not be included with the harness.**

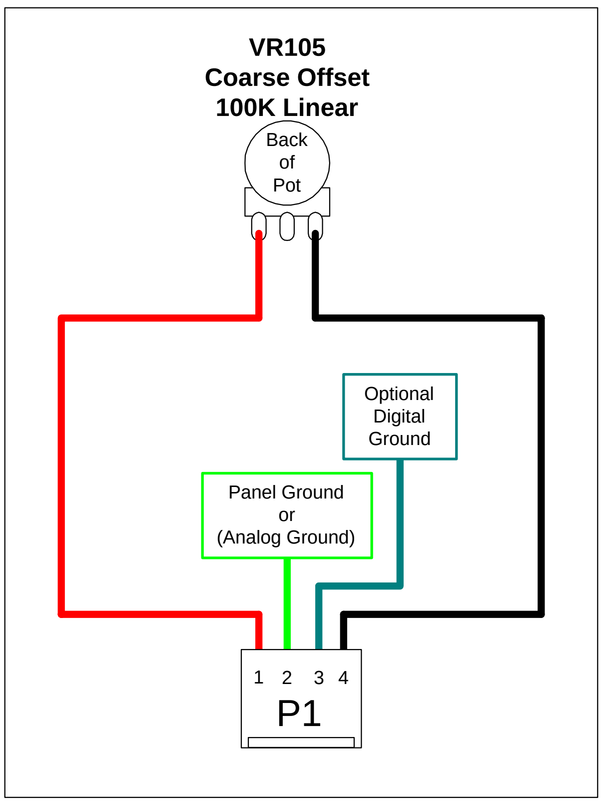


Figure 6-6: P1/J1 Panel Connections

The P1/J1 panel connection can be used if J1, the User Power connector, is **not** used as the connection between the Appendage PCB and the power supply.

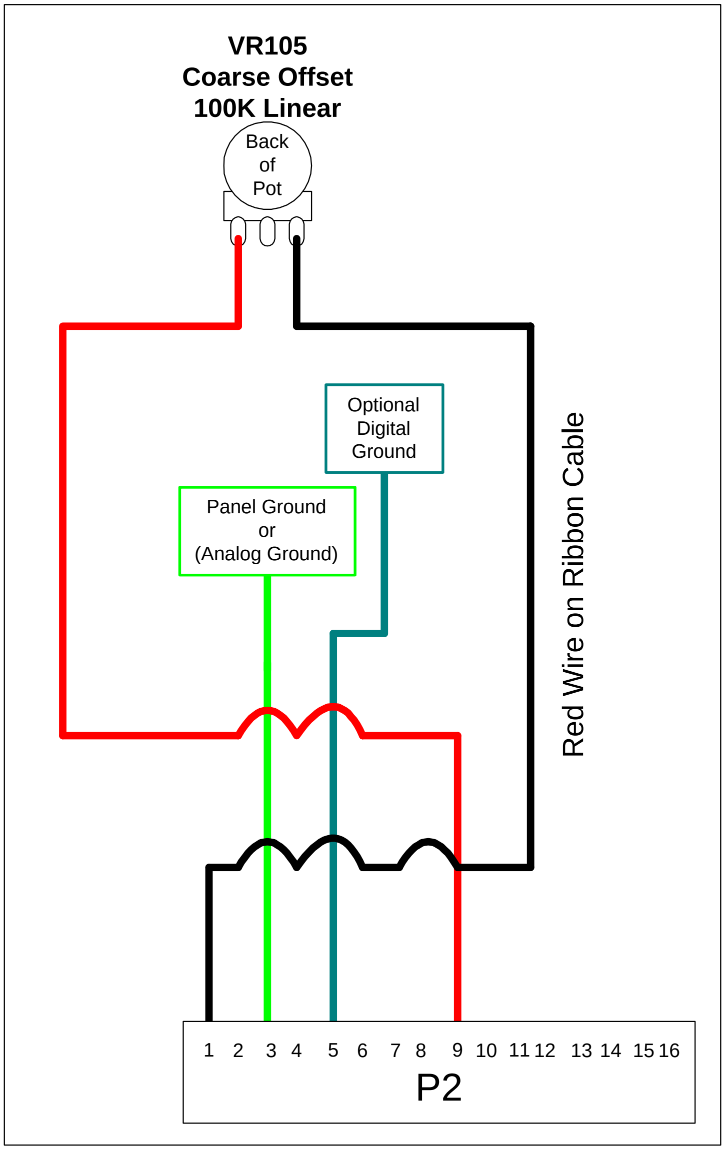


Figure 6-7: P2/J2 Panel Connections

The P2/J3 panel connection can be used if J2, the Doepfer™ power connector, is **not** used as the connection between the Appendage PCB and the power supply.

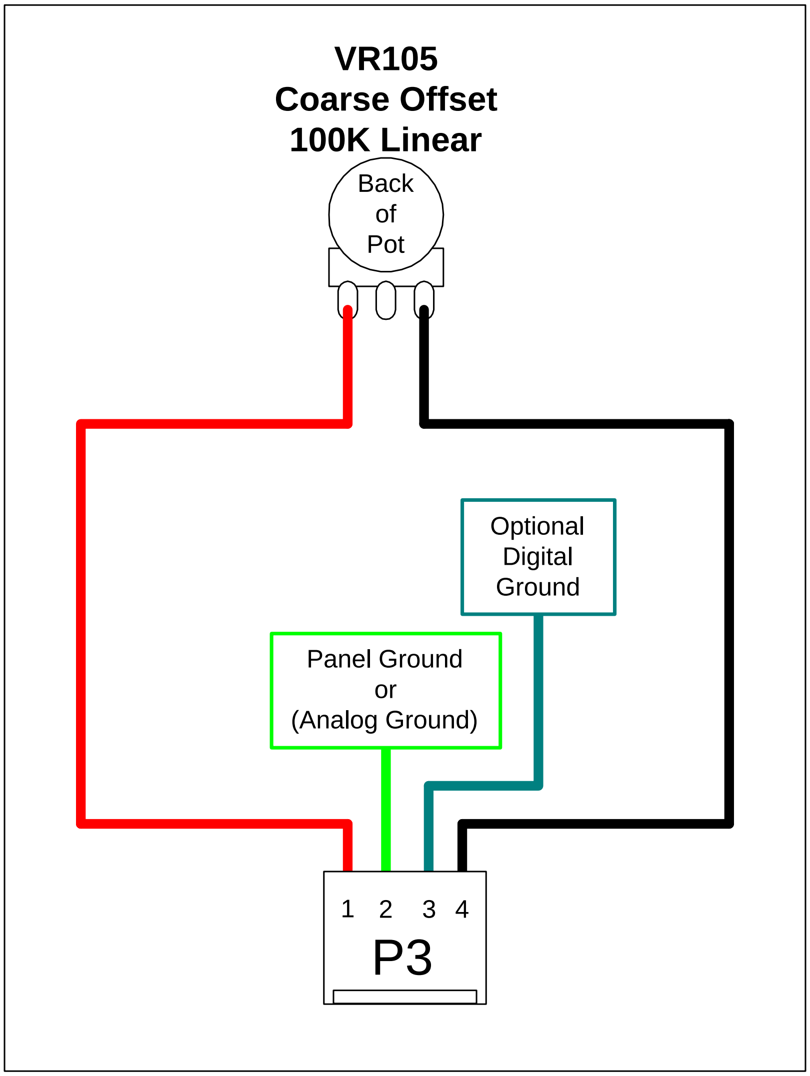


Figure 6-8: P3/J3 Panel Connections

The P3/J3 panel connection can be used if J3, the Blacet™/PAiA™/MOTM™ connector, is **not** used as the connection between the Appendage PCB and the power supply.

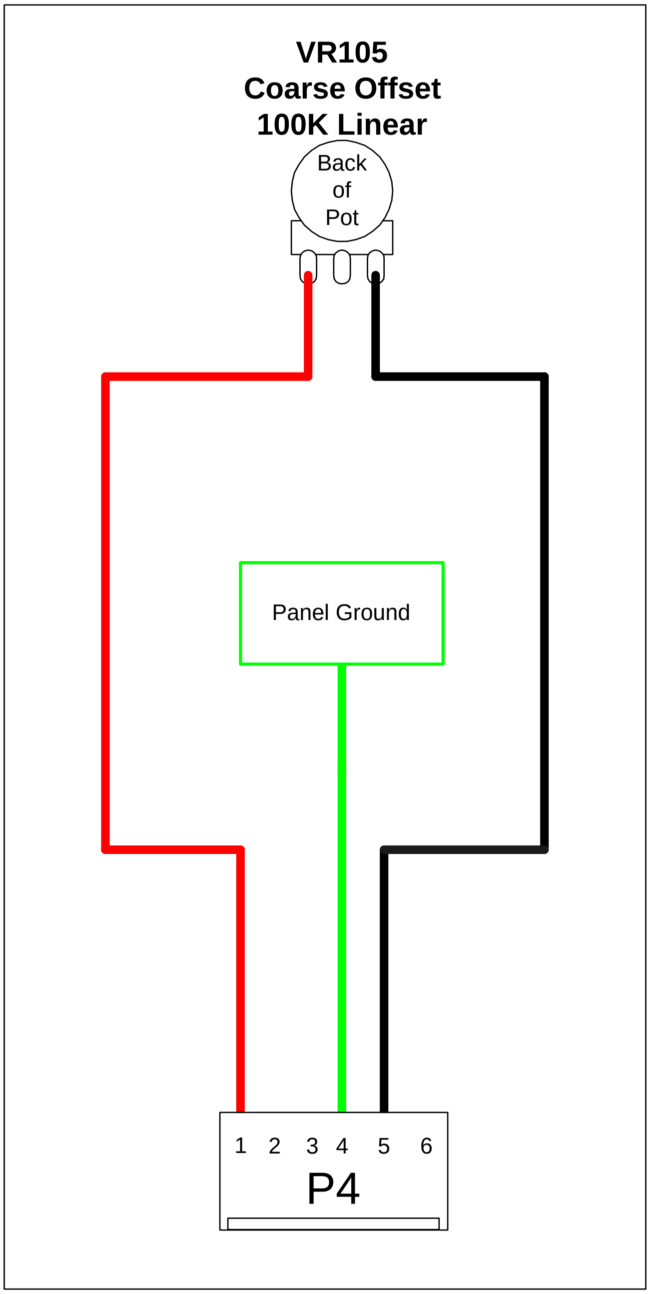


Figure 6-9: P4/J4 Panel Connections

The P4/J4 panel connection can be used if J4, the Synthesizers.com™ connector, is **not** used as the connection between the Appendage PCB and the power supply.

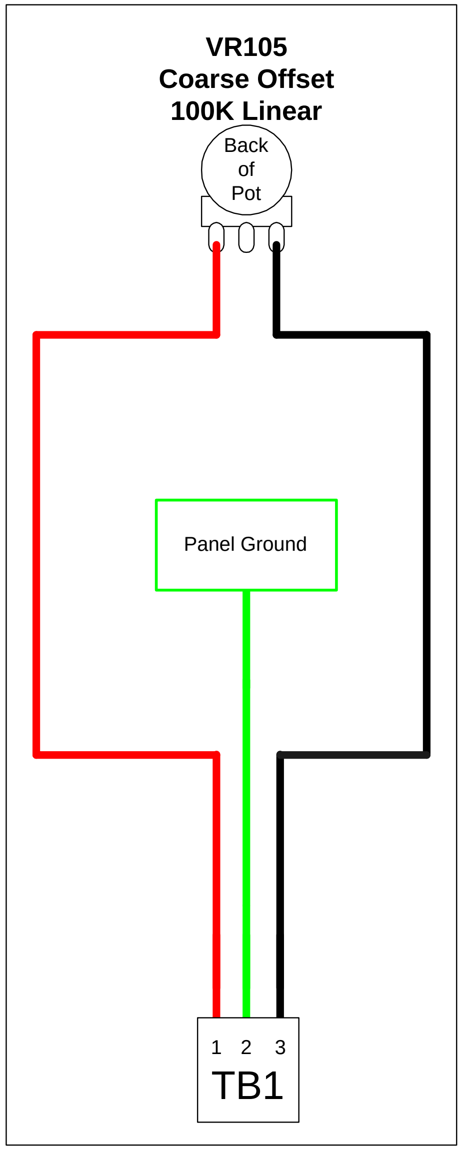


Figure 6-10: TB1 Panel Connections

The TB1 panel connection can be used if TB1, is **not** used as the connection between the Appendage PCB and the power supply. In the case of using TB1 as the connection, the wires on the panel can be soldered in place before connecting the panel to the PCB; TB1 is a terminal block, which allows the stripped and tinned ends of the wires to be inserted into the block and held in place with screws integral to the terminal block.

Congratulations. The most work-intensive phase of the project is over. If you are using the housings and headers, this is especially true. Once the PCBs are stuffed and you have a power supply ready to go, all you will need to do is plug these cables into the boards, plug the boards together, plug the power supply in and you'll be ready to calibrate the Appendage.

Fire up the soldering iron and get ready for stuffing the PCB. It's time for the fun part!

7. Building and Wiring the Ribbon Assembly

The Ribbon Assembly

The Appendage is designed to accommodate a ribbon controller using a SoftPot® linear membrane of any available size for whatever purpose a musician may intend to use it.

Any size of ribbon can be used as a modulation controller on a keyboard; the longer sizes available (such as a 200mm or, preferably a 500mm) can be used as modulation controllers and/or pitch controllers. How one may wish to utilize the Appendage PCB and panel is up to the builder. One may wish to attach the ribbon to a keyboard, or interface to the Appendage PCB built up as a module or built into a stand-alone chassis, or, perhaps, build the Appendage as a completely stand-alone controller with the ribbon integrated with the chassis that contains the Appendage PCB and panel elements.

Because of the open-ended nature of the application, little mechanical construction detail is given in this build document. This chapter will detail the electrical connections that will need to be made to the ribbon/ribbon assembly.

Figure 7-1: Example of a Ribbon Assembly

Figure 7-1 illustrates an example of a ribbon assembly. It is simply a wooden box with a SoftPot® ribbon adhered to the top of the box. A slit is carved through the top of the box, through which the leaded end of the ribbon passes to the interior of the box.

On the end of the box is a ¼" TRS connector. The TRS connector plugs into the pins of the ribbon via a small, three wire harness. With this setup, a stereo three-conductor cable, with stereo TRS plugs on either end, can be plugged between this ribbon assembly and the Appendage unit.

Getting Acquainted With the SoftPot® Linear Membrane Potentiometer (Ribbon)
The ribbon membrane is a flexible, linear pot. On one end of it are three connectors, which function just as the lugs of a rotary potentiometer. On the top side of the SoftPot®, one can see the actual active portion of the ribbon. On the bottom side of the ribbon is a self-adhesive strip. When the time comes to install the ribbon to whatever it is you plan on installing it to, the paper covering this strip is peeled off and the ribbon is adhered to the object. Never remove this paper until you are ready to adhere the ribbon to something!

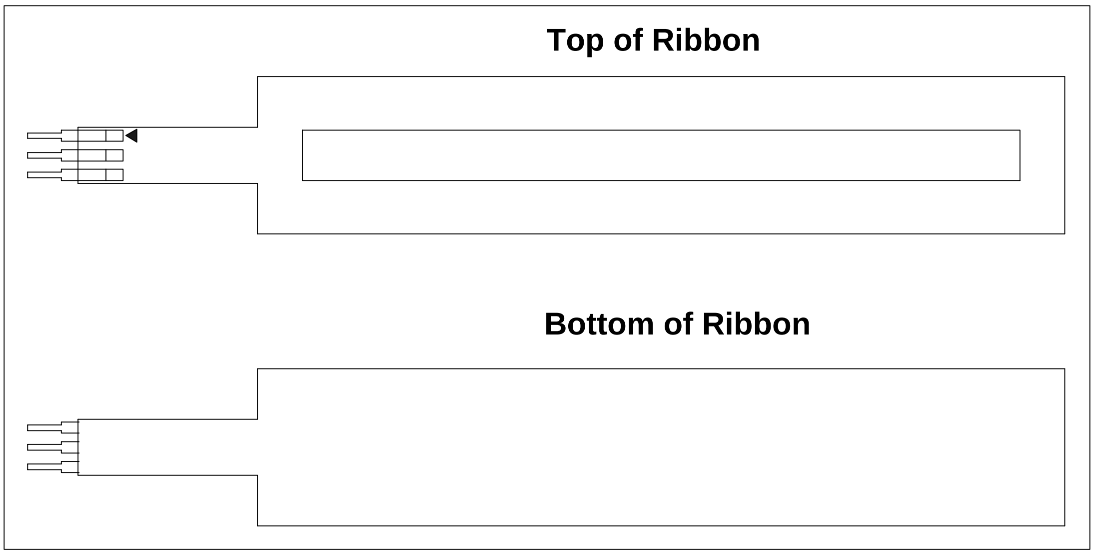


Figure 7-2: Top and Bottom Views of the SoftPot® Ribbon

Notice that on when viewing the top side of the ribbon, there is a small triangle beside one of the leads. In all of these wiring diagrams, that arrow should be pointing to the left, when viewed from the top of the ribbon.

Testing the Ribbon
To be totally sure that the ribbon is configured so that it will work as indicated in this document, you should go ahead and make sure the pins are connected to the right points on the ribbon. This will ensure that you have the correct type of ribbon. It is unclear whether any other configuration does exist; no other configuration was encountered during the prototype testing of the Appendage, but there are a few reports that indicate that (perhaps) some models of the ribbon do have a couple of the pins switched around. It's never a bad idea to be sure, so let's test the ribbon to make sure it's operational and configured to work as expected.

You'll need an ohmmeter for this procedure, and, if you have multi-meter leads that can clip onto small leads, grab those too. Otherwise, you may need three hands for this procedure.

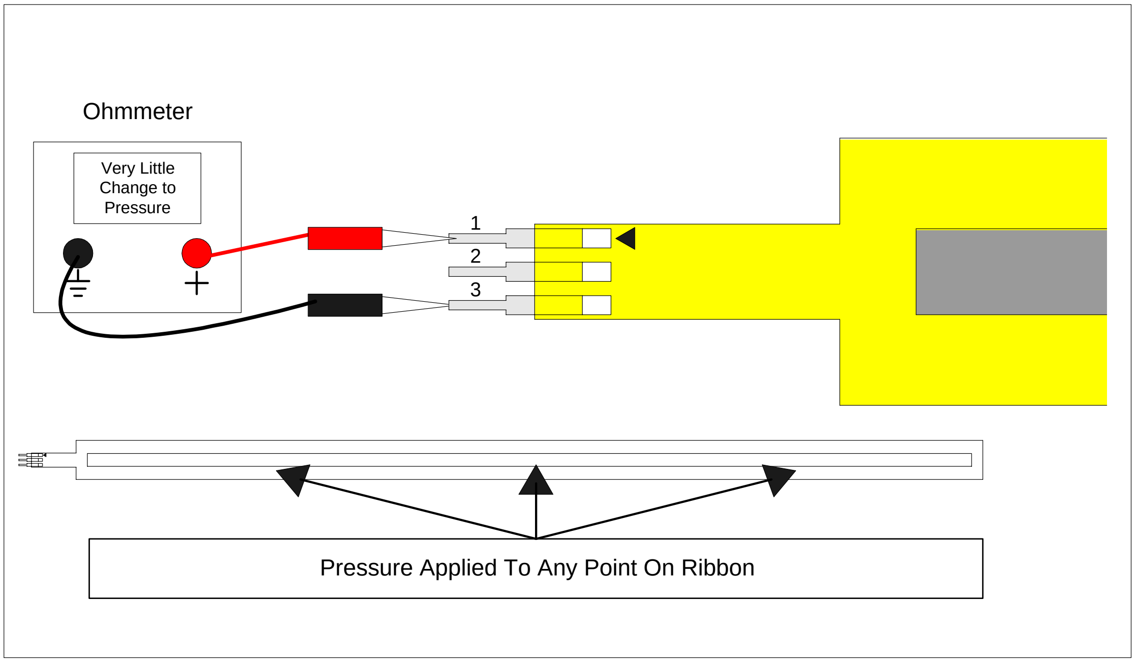


Figure 7-3: Testing the "Outside" Pins of the SoftPot®

Connect the positive and negative leads of the ohmmeter to the two outside pins of the SoftPot® (pins 1 and 3 according to **Figure 7-3**). The ohmmeter should indicate some value of resistance – anywhere from 25kΩ to as low as 5 kΩ, depending on the length of the ribbon. While the ohmmeter leads are attached to these pins, apply a single point of pressure to the ribbon using one of your fingers to the left side of the ribbon (now you can see why clip leads are handy here). You should see perhaps a slight drop in the reading on the ohmmeter. Now apply pressure to one point in the middle of the ribbon – again, you should only see a slight drop on the resistance reading. Now apply pressure to a single point on the right side of the ribbon. As observed with the other two pressure points, you will only see a slight drop (if any) on the Ohmmeter reading.

Now connect the positive and negative leads of the ohmmeter to the top and middle pins of the SoftPot® (pins 1 and 2 according to **Figure 7-4**).

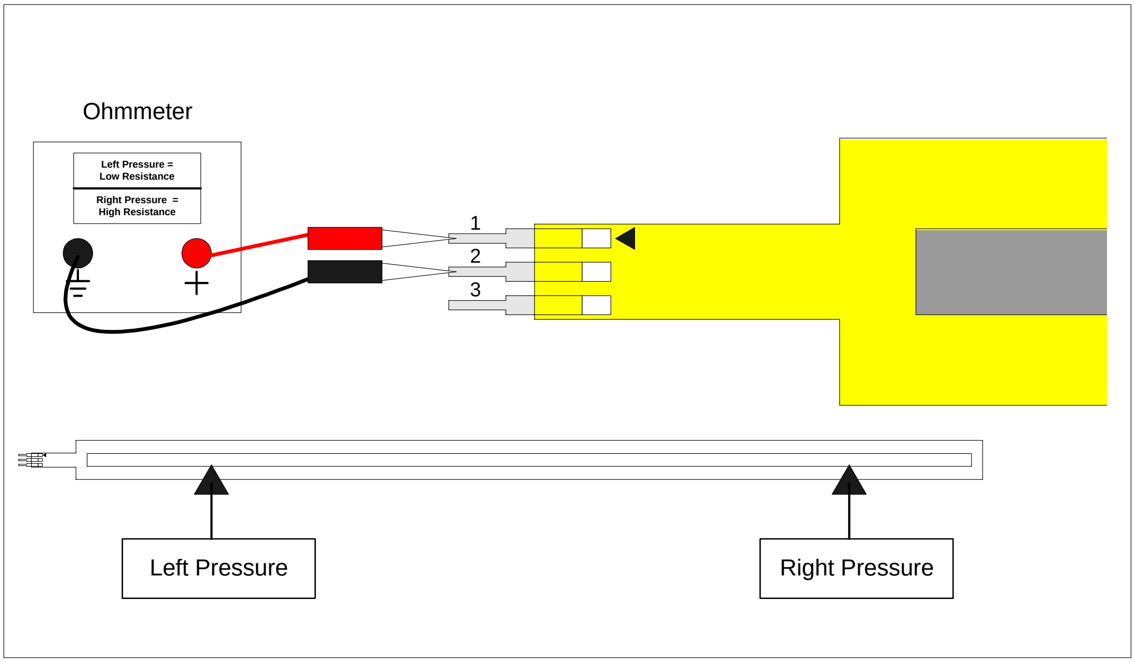


Figure 7-4: Testing the "Top and Middle" Pins of the SoftPot®

Now, while the DMM leads are connected, place a single pressure point on the left side of the ribbon. You should see the DMM reading drop to a very low value. Now place a single pressure point on the right side of the ribbon. You should see a significantly higher reading. If you slide your finger from right to left (be sure not to crinkle the ribbon!), you will see the resistance value drop further and further the more you slide to the left.

If the ribbon responds as described, you're good to go with the rest of this wiring procedure.

Connecting the Ribbon

During the prototype phase of the Appendage, the testers came to the conclusion that it is a very bad idea to actually solder the connections onto the pins of the SoftPot® ribbon. You may do an admirable job of controlling the heat, but we are of the opinion, at least for this application, that any heat has the very good chance of distorting the response of the ribbon to the point of where it becomes unusable in this application. SoftPot® ribbons are not inexpensive, as compared any other component in this project, so **we highly recommend the connections to the ribbon not be soldered, but rather connected with a plug attached to a wire harness.**

The leads of the SoftPot® ribbon are SIP (Single Inline Pin), with the same spacing as the ICs used in this project. The recommended connector is therefore a SIP socket that the end of the ribbon inserted into.

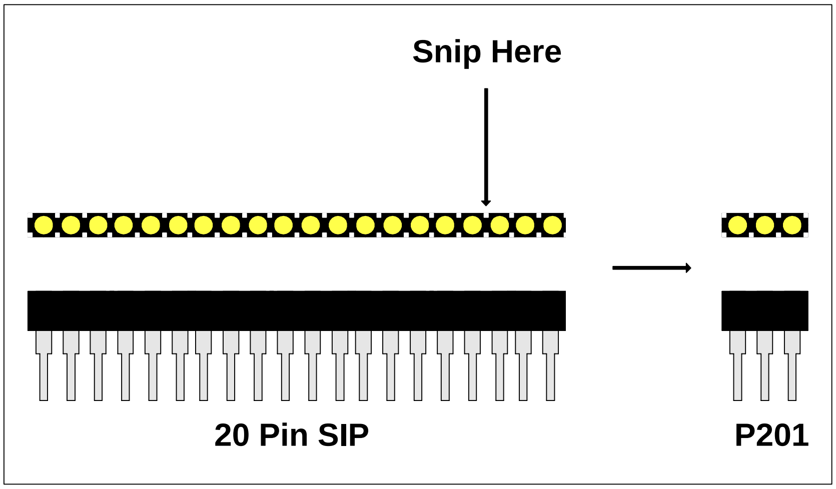


Figure 7-4: Creating P201 from a 20 Pin SIP

The plug that will connect to the ribbon carries the reference designator P201. Finding a 3 Pin SIP type of connector is likely impossible – usually the SIP connectors are sold in strips of twenty or so. These strips can then have sections with the needed number of pins "snipped" out of them. **Figure 7-4** shows just such a SIP connector. Notice that the last three pins are "snipped" using a pair of wire-cutters to snip the plastic body, or they can even be snapped off by carefully bending the SIP strip at that point. You wind up with a tiny, three pin connector which can now officially be called P201.

Figure 7-5: Ribbon with 3 Pin Sip Attached

Wiring P201 to a TRS Jack
The standard configuration in this document for interfacing a ribbon to the Appendage is via a three conductor cable, using TRS jacks. This is certainly not the only way of doing things – other connectors can be used, but this example will help understand the connections when using any type of connector.

First of all, one needs to know which lugs of the TRS jack are the Tip lug, the Ring lug and the Sleeve lug. If you do not know, refer back to Chapter 3 for the procedure that will get you to that point. It's vital that these connections be made to the correct lugs. Do not rely on any illustrations from this document to physically identify which lug is which on the TRS connector – that's something only you can figure out.

Second of all, be sure that the TRS connector is isolated from ground – none of the lugs that you are using for these signals can come into contact with ground. Doing so will not damage you Appendage, it just won't work right.

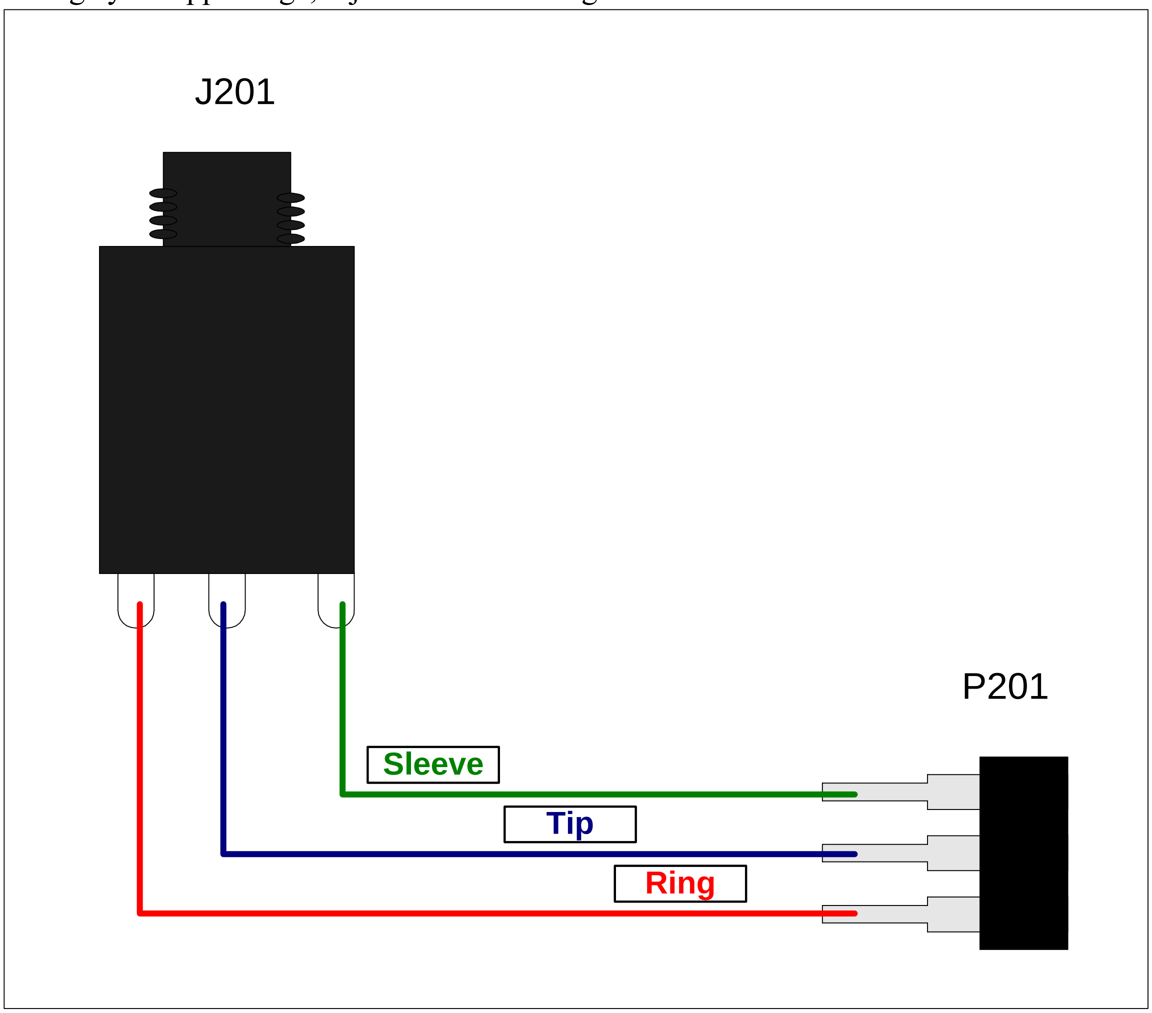


Figure 7-6: The J201/P201 Wire Harness

Now that you have P201 in hand, you're probably thinking "Man, this is a tiny little plug". You would be right. The easiest way to solder wires to the plug is anchor it with a small vise or some of those "Helping Hands" alligator clips you've seen while going through your electronic geek catalogs. If you don't have any of those, get some. They're quite helpful little hands indeed.

Solder the lugs of J201 to P201 exactly as depicted in **Figure 7-5**, using braided wire. Make sure the wires you use will be long enough to reach the ribbon from where J201 will be mounted.

When you solder the wires to P201, strip around a half inch to a quarter inch of insulation away from the end of the wire, and tin the exposed braid lightly. Hold your tongue just so as you carefully wind the wire around the leg of P201; be sure no stray bits of wire come into contact with the other legs of P201.

Before you solder any of the wires on P201, think about using some heat shrink tubing for those connections – this will help to keep any of the pins of P201 from coming into contact with each other. Slide the tubing on the wire, then solder the connection. After all of the connections are soldered, slide the heat shrink tubing down around the pins of P201 and use a heat gun or very hot hair drier to shrink the tubing solidly around the pins of P201.

When the time comes, you can then insert the pins of the Ribbon into P201. Grip P201 with one hand, and the end of the ribbon with the other hand as you do it.

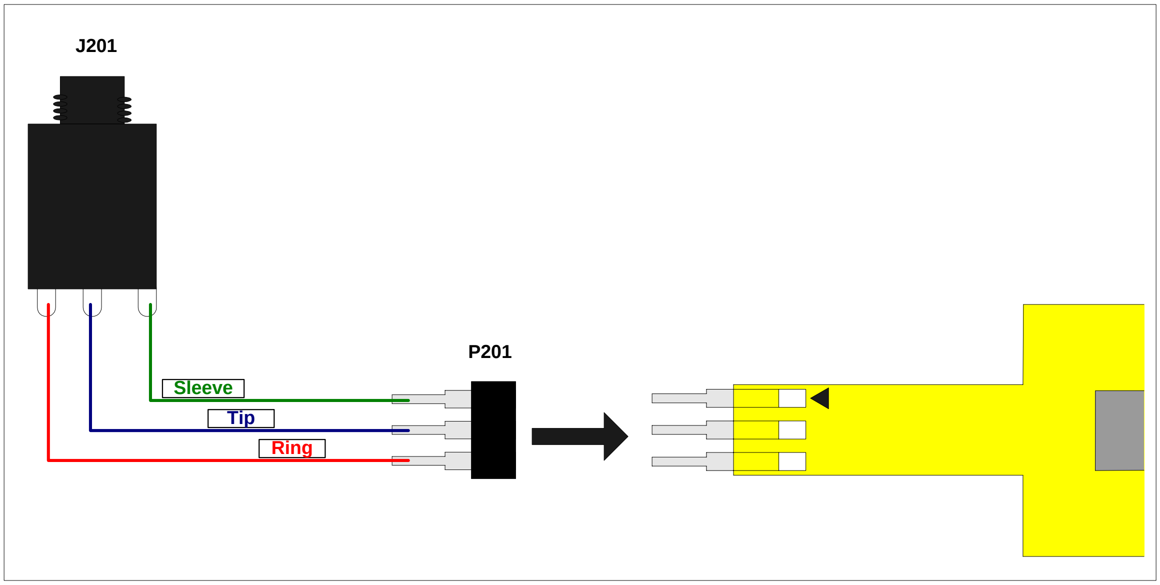


Figure 7-6: Connecting J201/P201 Onto the Ribbon

Make sure the ring connection is aligned with the top pin of the ribbon (as viewed from the top of the ribbon). This is the pin that is designated with a little triangle on the ribbon. You will feel the pins of the ribbon physically snap into place in the SIP connector. As tiny as P201 is, it's an amazingly tight and reliable connection.

8. Building the Appendage Board

The Appendage PCB

The first thing you may notice about the Appendage PCB is that it's big. Well, it's big in a Synth DIY way of thinking anyway – it would qualify as being rather normal sized if you were building, say, a computer or an Apollo control module. Don't be intimidated by the scale of the board – you will find that a methodical approach to putting it together is no more unpleasant than a prostate examination or root canal.

But, seriously folks, if you follow a divide-and-conquer approach, building up the board is really a piece of cake. It so happens that this build document does provide a step-by-step divide and conquer procedure in Chapter 8, which, coincidentally, you are reading now. The PCB is fully silk-screened with legends depicting which parts go where. In addition to that, the following procedure will also guide you to where each part is located on the PCB.

So, rest assured that after this chapter is finished, you will have a fully built-up Appendage PCB to interface to your Appendage panel and Ribbon Controller Assembly. During the process, you will have configured the PCB to accommodate the type of power supply you have, the length of the ribbon on your controller, and the level of the gate and trigger signals generated by the Appendage.

PCB Parts Considerations
The PCB is fairly straightforward as to which parts are installed onto it. The only parts variation that will apply is if one wishes gate and trigger signals to be 5V or 10V in level, which involves the value of two sets of resistors. The value of these resistors will vary upon whether the Appendage is powered by a +/-12V supply or a +/-15V supply.

Two other parameters are determined by jumper values:

1. The length of the ribbon will determine the placement of a jumper.
2. Whether the power supply has one or two ground lines will determine the placement of an additional jumper.

Other than those considerations, the build is pretty much a matter of putting the right value parts in the right holes. And soldering them down, of course. So let's get on with it!

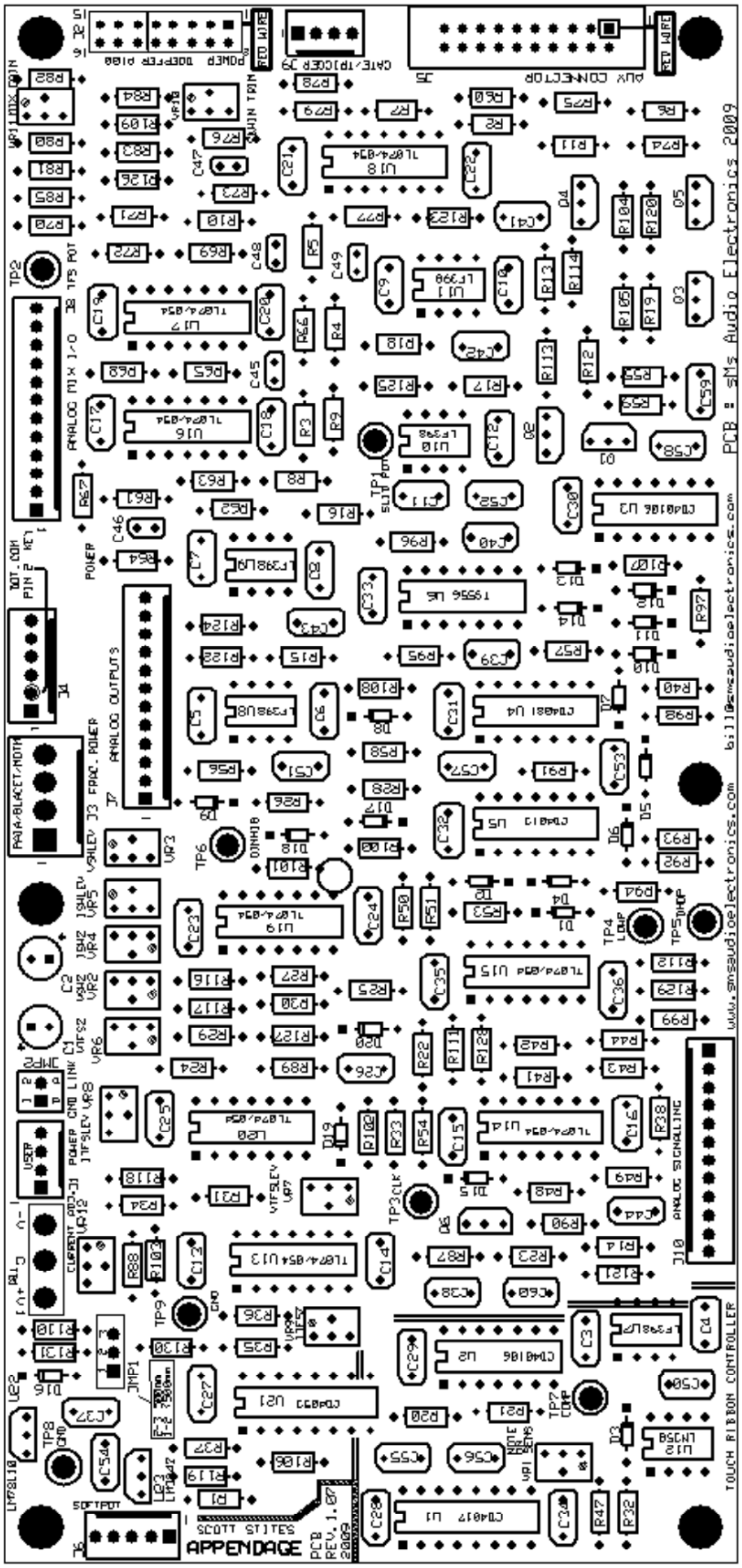


Figure 8-1: High Resolution Illustration of Appendage PCB Silkscreen Legend

Preparation
You should have all of your parts together before beginning this procedure. Nothing says "Make a mistake" better than skipping back and forth between steps that are intended to be sequential because you've ventured into a section of the procedure that requires parts you don't have on hand. If you didn't purchase a parts kit, you can gather the parts using the parts list in the Appendix of this document.

Organize your parts – the steps of this procedure are based on parts. It begins with header connectors, then moves on to IC sockets, and so on and so forth. So, having your parts staged for battle can't hurt.

Headers
The best place to begin is by soldering the header connectors to the boards, unless you don't plan on building cables and instead will wire everything to the panel point-to-point. If that's the case and you don't plan to use the connectors, obviously you **don't** want to install the connectors. In that case, the pads reserved for the connectors will in fact be the pads you will solder the wires to. On the silk-screening of the PCB, the header connectors are, of course, the parts with the "J" reference designator (and in one case "TB").

Putting in the connectors first will ensure they fit and are seated flatly. There are a lot of components on this board, and if you should install other parts first, they may come close enough to where the connectors are to be installed that they may prevent the connectors from seating flatly on the board.

Make sure, when you solder in the connectors, they do indeed sit flatly on the board, and are not jutting at some angle other than perfectly perpendicular to the board. A handy, if somewhat potentially painful method of doing this, is to put a dab of solder on the tip of your iron, place the header into position, and, while holding it, anchor one pin down with the dab of solder. You should be careful if you choose to use this method however – if an exposed finger or patch of skin is actually touching the pin that is being soldered, you'll feel it as a sort of intense, hot burning sensation specific to that patch of skin. It is not pleasant, so try to avoid that from happening if at all possible. You'll need those fingers to play the Appendage later.

Anyway, after the connector is held in place by this modest bit of solder you've just dabbed on, solder the other pins in, after which make sure this original pin has enough solder as well.

We'll begin with the Molex® style connectors J1 and J6 through J9. When installing these connectors, be careful to observe the orientation of the header.

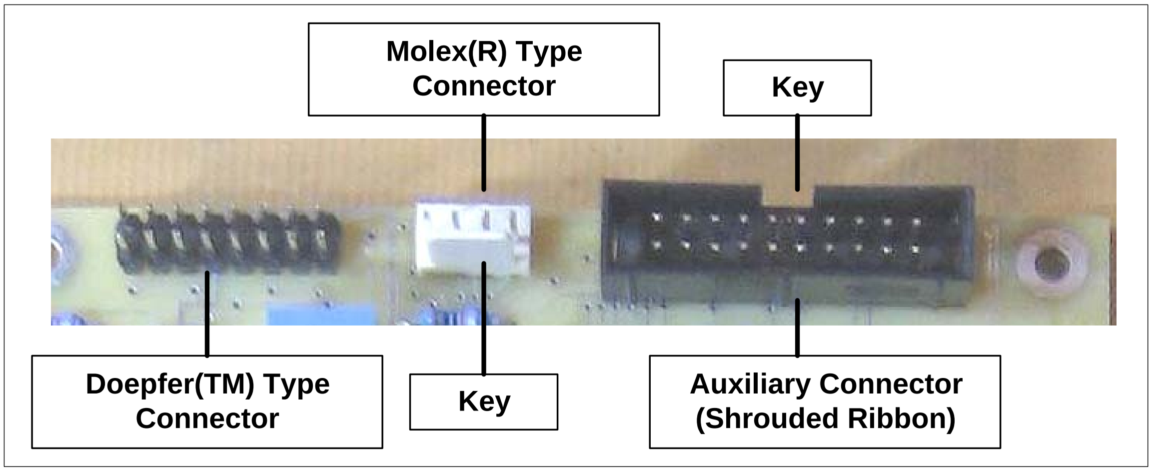


Figure 8-2: Un-shrouded Header, Ribbon and Small Molex® Type Connectors

Types of Header Connectors
As mentioned a few times in this procedure, the Appendage PCB was designed to accommodate a wide range of power options in addition to providing connector headers for panel connections. **Figure 8-2** illustrates three of the types of connectors that can be installed on the PCB.

Un-shrouded header: There is only one dual row un-shrouded header, which is J4. This connector is provided to interface with Doepfer™ synthesizer systems, and carries positive voltage, negative voltage, internal CV and internal gate, pursuant to the Doepfer™ standard.

Shrouded Ribbon Cable Header: There is only one Shrouded Ribbon Cable Header, which is J5. This connector is provided for the Auxiliary output of the Appendage PCB, and carries various signals to be used for future functional expansion.

Molex® Type Connectors: This is the most ubiquitous type of header connector used on the Appendage PCB. Some of these connectors provide interface between the panel components and the PCB, and others provide Power I/O for the power supply and/or front panel. One Molex® connector, J4, is provided for interface to the Synthesizers.com™ system.

There are actually two different sizes of the Molex® type connector – most of them are the "smaller" type as depicted in **Figure 8-2**. These connector pins have a .100" spacing, and are of a smaller diameter than the larger size.

There is one connector header, J3, which uses a larger type of Molex® Connector. This connector is a four pin header and has .156" spacing with larger pins. J3 is used for power interface using a standard Blacet™/PAiA™/MOTM™ type of power connector.

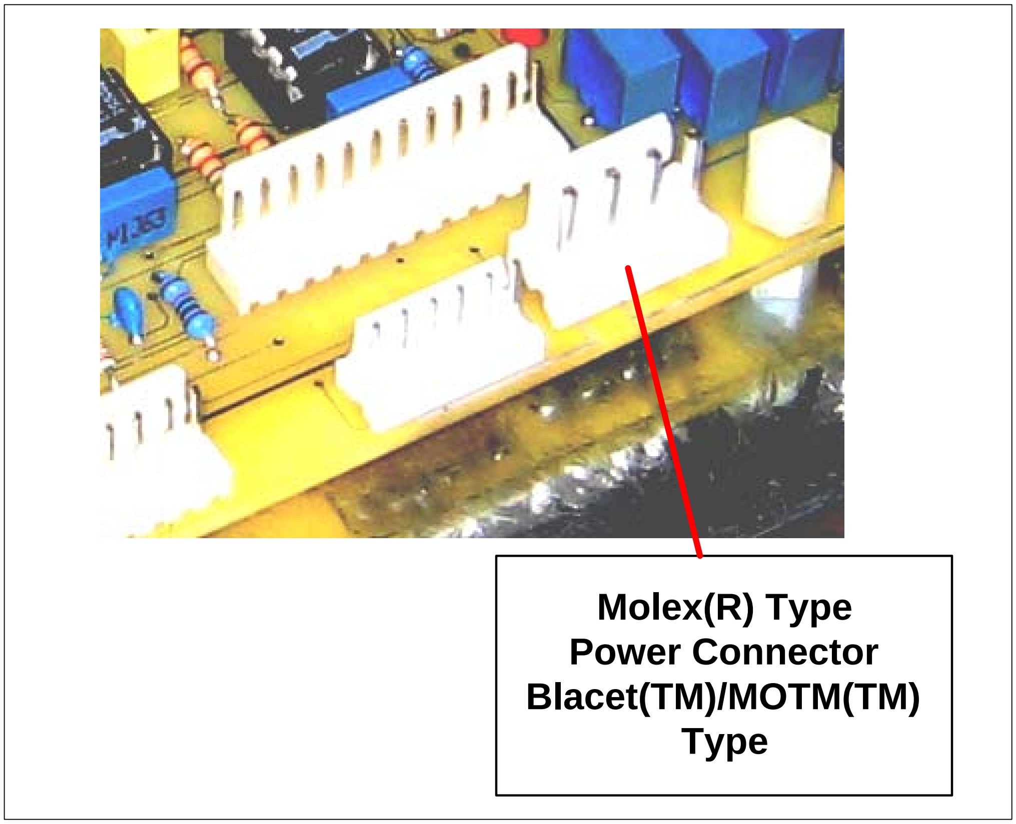


Figure 8-3: Larger Molex® Type Connector, J3

Figure 8-3 provides a view of the difference between this larger Molex® type connector.

Terminal Block Connector: There are pads provided for a terminal block connector, TB1. A terminal block connector allows one to insert stripped wires and use the included screws to clamp down on the connection. TB1 can be used for power/ground input to the board, or supply power/ground to the panel.

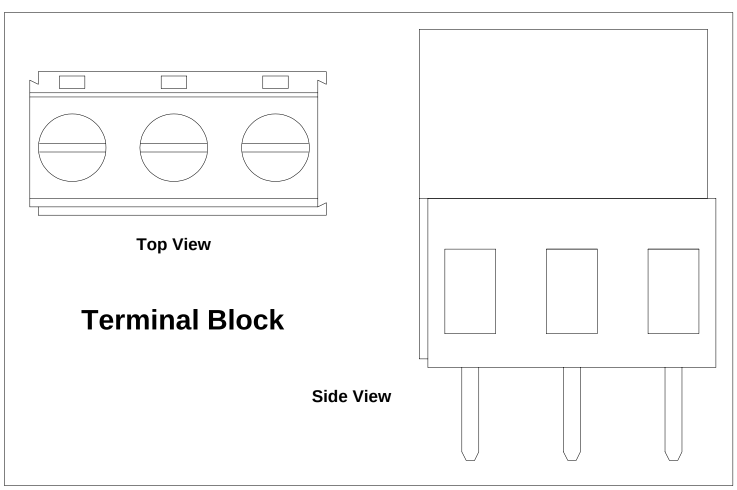


Figure 8-3A: Depiction of a Terminal Block Connector, Tyco® Part No. 796949-3

Installing the Small Molex® type connectors

We'll begin with installing the smaller Molex® connectors. J1, J4, and J6 through J10 all are this type of header connector.

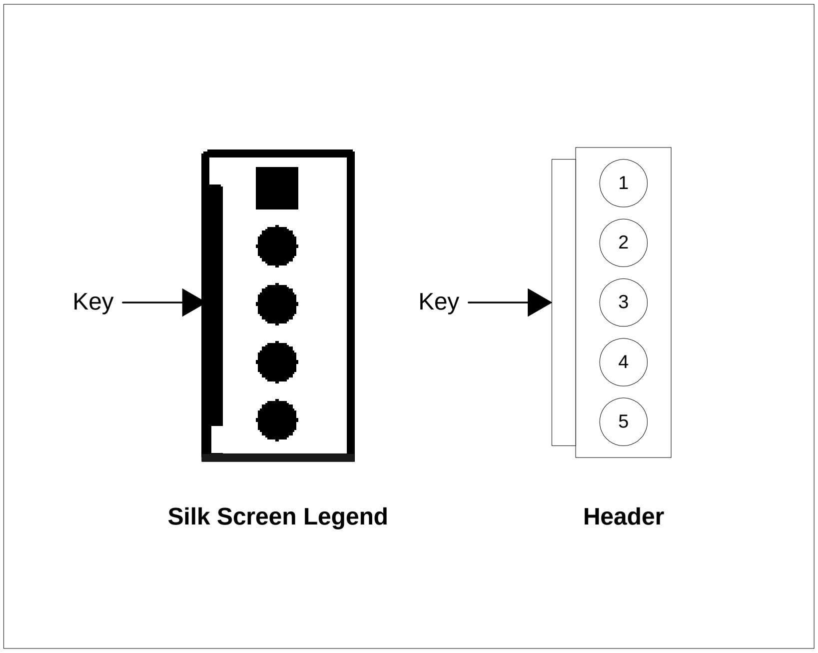


Figure 8-4: Orientation of Molex® Header Connectors

Refer to **Figure 8-5**: There is a pin 1 to each header, and that is indicated by a square pad on the PCB. The silkscreen also displays which side the header's key should be aligned to.

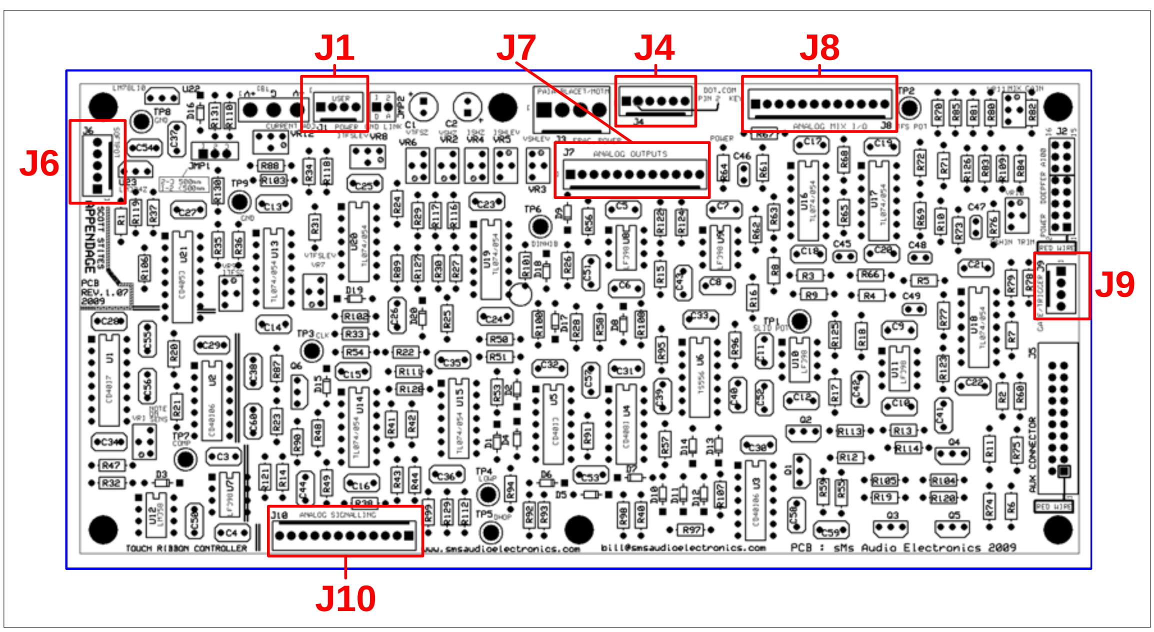


Figure 8-5: PCB Locations of Small Molex® Header Connectors

If the silk-screening is a bit much, and you find yourself hunting for just exactly where to put the connectors, use **Figure 8-5** to navigate the PCB and locate exactly where each Molex® Header goes. Use Table 8-1 as a checklist to ensure that all of the connectors are in place.

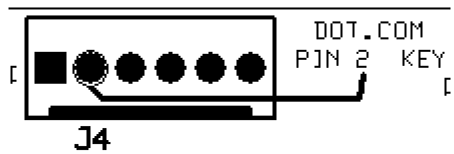


Figure 8-6: Remove Pin 2 of J4

Note: If you plan to use J4, the Sythesizers.com™ power interface, pin 2 of that connector should be removed, preferably before installation onto the board. The standard requires that the plug that is inserted in this header have a block installed into the pin 2 position. This is a safety precaution that prevents the plug from being installed backwards – it "keys" the plug/header so that the plug can only be installed with the proper orientation. The silk screen legend indicates pin 2, and you can refer to **Figure 8-6** as well.

Table 8-1: Molex® Connector Checklist

Small Molex® Headers		
Quantity of Pins	**Reference Designator**	**Done**
4	J1	
4	J9	
5	J6	
6	J4	
12	J7	
12	J8	
12	J10	

Power and Auxiliary Connector Headers
Next up are the power connection headers and the Auxiliary connection header.

This list includes the Auxiliary connector shrouded ribbon header J5, the Doepfer™ header connector J2, the Blacet™/PAiA™/MOTM™ connector, which is the large Molex® style header, J3, and the terminal block connector, TB1.

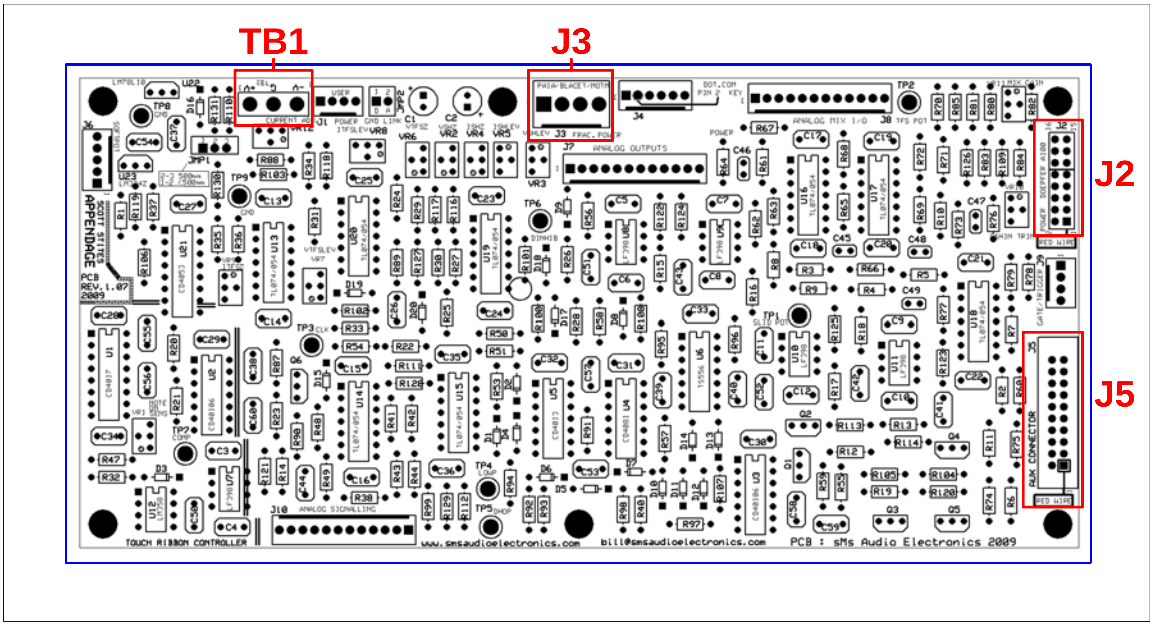


Figure 8-7: PCB Locations of Remaining Header Connectors

The silk screen legend of the PCB indicates the location and orientation of the headers. You can also use **Figure 8-7** to help locate the positions. Be sure to follow the orientation of the Molex® connector J3. The ribbon connector, J5 should be installed with the notch in the housing facing to the outside of the PCB (reference **Figure 8-2**). J2 has no specific orientation. Install TB-1 with an idea as to how you would like the wires to enter the terminal block (either from the "top" of the PCB, or from the "outside" of the PCB – because of parts clearance issues, do not route wires from the "inside" of the PCB to TB1).

Use Table 8-2 as a checklist to ensure that all of the required connectors are in place.

Table 8-2

Remaining Headers			
Quantity of Pins	**Reference Designator**	**Connector Type**	**Done**
20	J5	Shrouded Ribbon	
16	J2	Unshrouded Header	
4	J3	Large Molex® Type	
3	TB1	Terminal Block	

IC Sockets
Now that the header connectors are installed, the next step is to install the IC sockets.

The IC sockets will probably be keyed to go in a certain direction, telling you which way to install the IC, usually by a notch at the top of the socket. Be sure to install them pointing in the right direction. Pin 1 of the socket will be a square pad. The Appendage PCB is designed with all of the ICs and connectors pointing in the same direction, where pin 1 is pointed to the "top" of the board. So as long as the "notch" at the end of the socket is pointing up towards the top of the board, you know you've got the right orientation, and you can solder in the socket.

Again, make sure the sockets sit flat and level on the surface of the PCB. The same trick can be used to "tack" the IC sockets down before soldering the rest of the pins as was used to tack solder the header connectors. In this case, solder two pins in opposite corners of the socket to hold the socket in place. Solder the remaining pins, then return to the two corner pins and make sure they have an adequate amount of solder.

Though they don't appear on the schematics and prints, the IC socket reference designators begin with "X". X6 is the socket U6 plugs into, X4 is the socket U4 plugs into, and so forth.

There are three types of IC sockets used on the Appendage PCB, and these types vary in only the number of pins the socket has. There are two 16 pin sockets, six 8 pin sockets, and a whopping thirteen 14 pin sockets.

It's a fairly easy thing to accidentally install a 14 pin socket into the pads reserved for a 16 pin socket, and it's a very easy thing to install an 8 pin socket into the pads reserved for a socket with a larger number of pins, but it's impossible to solder a 16 pin socket into the pads reserved for a 14 pin socket, etc. So, we'll eliminate the possibility of such an error by installing the largest sockets first, and work down from there.

16 Pin IC Sockets
The largest IC sockets are the two 16 pin sockets, X1 and X21. Use can use Table 8-3 to document that you've installed the 16 pin sockets. **Figure 8-8** can be used to help locate the pads for these sockets.

Table 8-3: 16 Pin IC Sockets

16 Pin IC Sockets		
Quantity of Pins	**Reference Designator**	**Done**
16	X1	
16	X21	

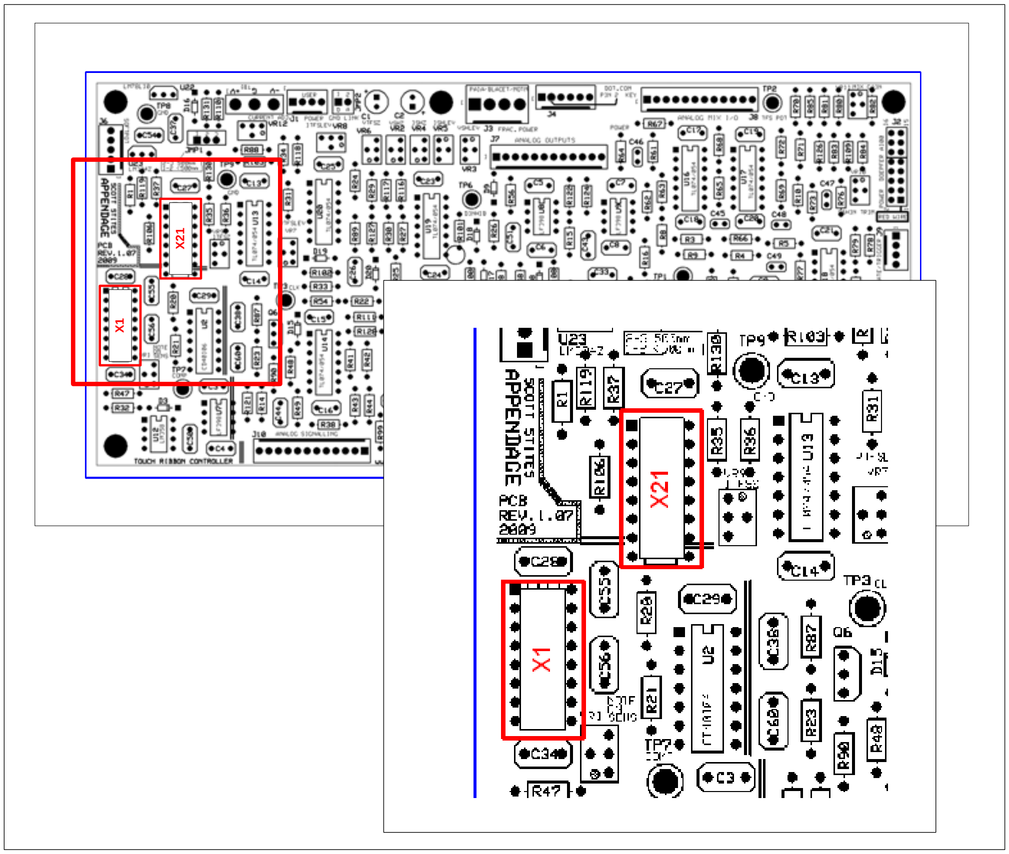


Figure 8-8: 16 Pin IC Socket Locations

14 Pin Sockets
There are thirteen 14 sockets to install: X2 through X6 and X13 through X20. Use Table 8-4 to ensure all of the 14 pin sockets are installed. **Figure 8-9** can be used to help locate the socket locations.

Table 8-4: 14 Pin IC Sockets

14 Pin IC Sockets		
Quantity of Pins	**Reference Designator**	**Done**
14	X2	
14	X3	
14	X4	
14	X5	
14	X6	
14	X13	
14	X14	
14	X15	
14	X16	
14	X17	
14	X18	
14	X19	
14	X20	

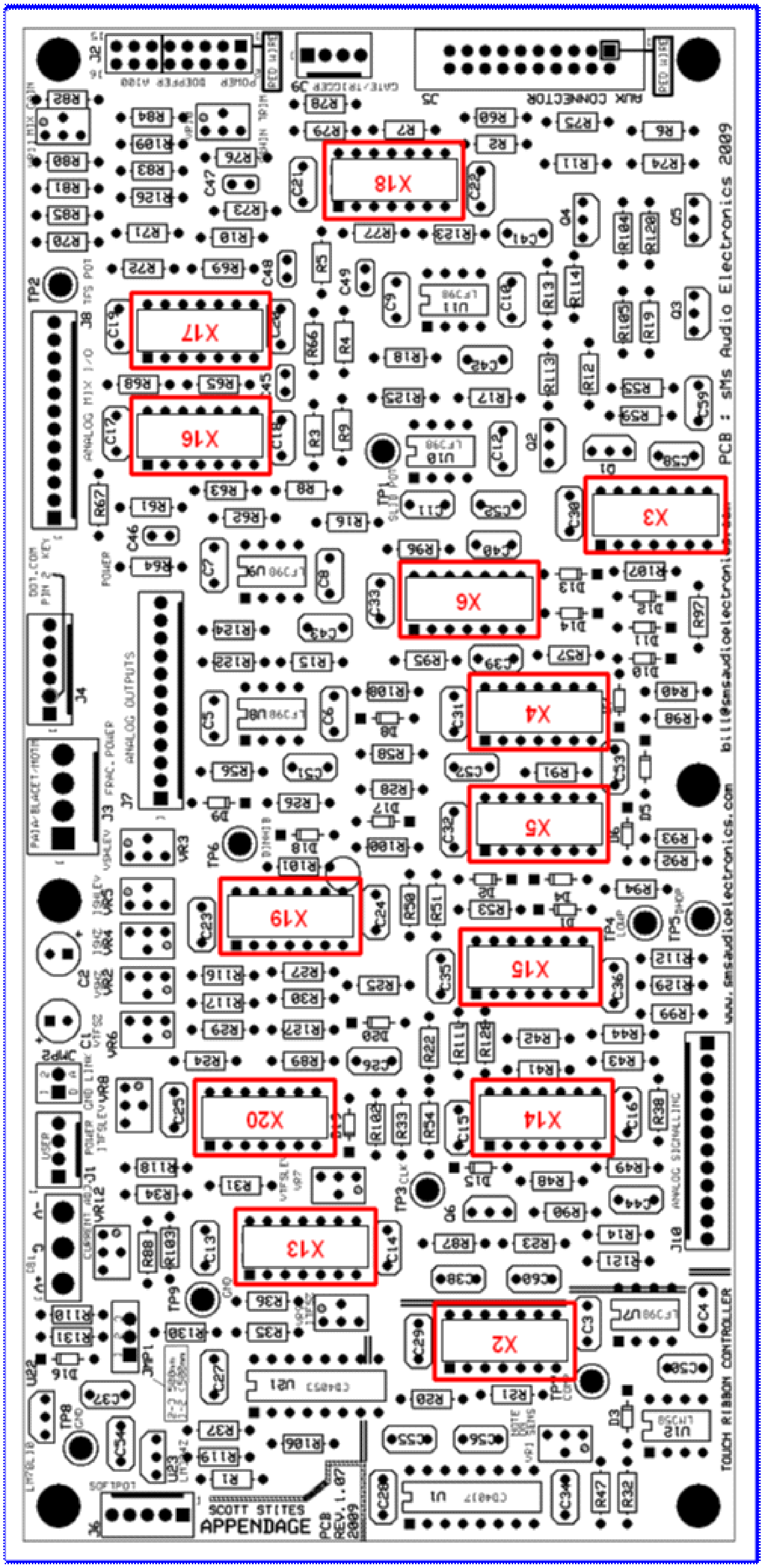


Figure 8-9: 14 Pin IC Socket Locations

8 Pin Sockets

The remaining sockets in your socket arts pile should now all be eight pin sockets. There should be six of them. The six 8 pin sockets are X7 through X12. Now is the time to install them.

Table 8-5: 8 Pin IC Sockets

14 Pin IC Sockets		
Quantity of Pins	**Reference Designator**	**Done**
8	X7	
8	X8	
8	X9	
8	X10	
8	X11	
8	X12	

Use Table 8-5 to ensure all of the 14 pin sockets are installed. **Figure 8-10** on the next page can be used to help locate the socket locations.

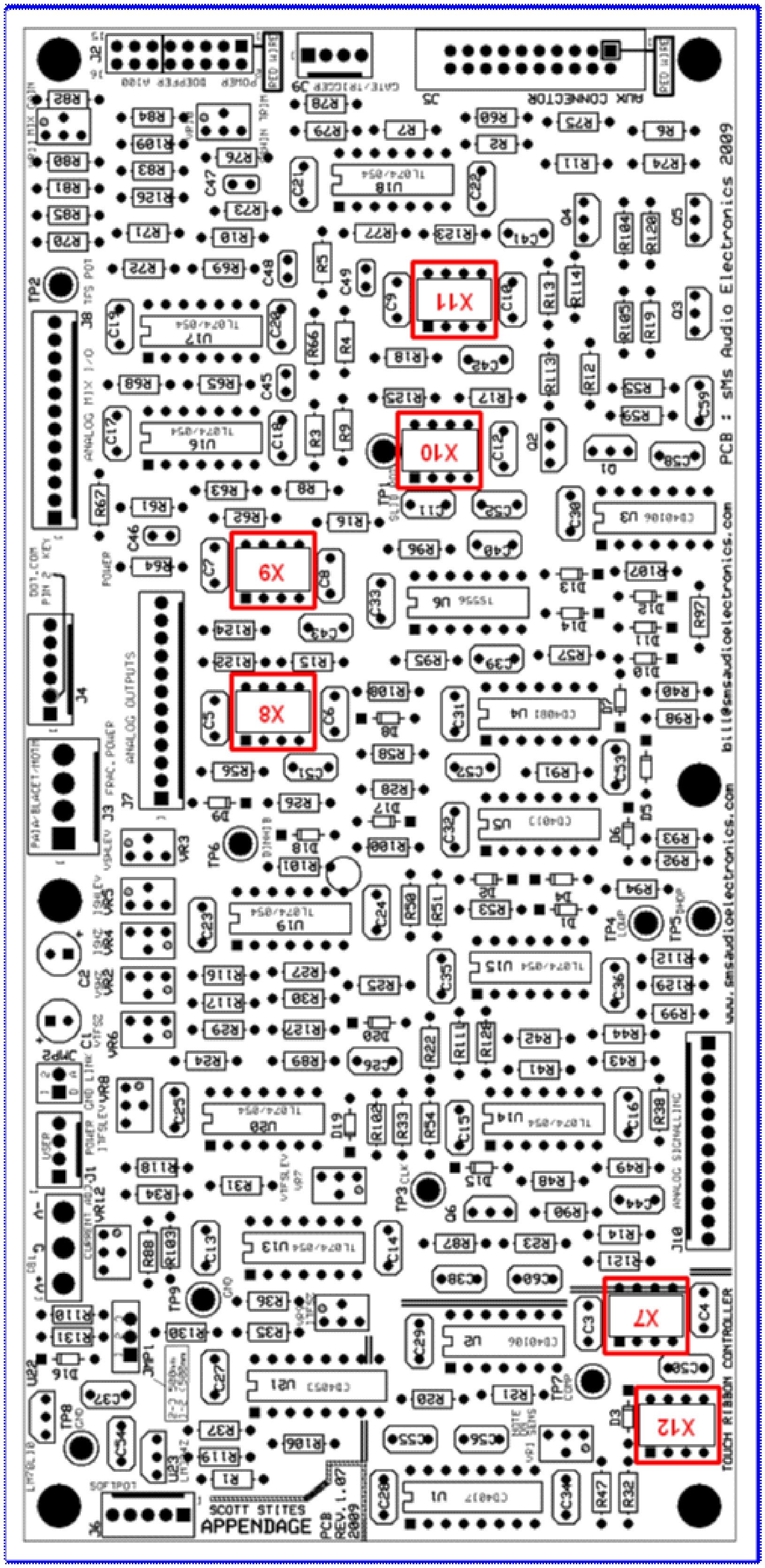


Figure 8-10: 8 Pin IC Socket Locations

Installing the Resistors

Now is the time to install the resistors, the most numerous of our many components.

Before plowing into the resistors, we should first select and install the resistors that will determine whether your Appendage is to put out 5V peak trigger and gate signals, or 10V peak trigger and gate signals. The value of resistors R12, R13, R113 and R114 will make this determination.

If your power supply is a +/-15V supply, and you desire 10V Gate And Trigger Signals, then use the following values:

R12 = 1K5
R13 = 1K5
R113 = 3K
R114 = 3K

If your power supply is a +/-15V supply, and you desire 5V Gate And Trigger Signals, then use the following values:

R12 = 3K
R13 = 3K
R113 = 1K5
R114 = 1K5

If your power supply is a +/-12V supply, and you desire 10V Gate And Trigger Signals, then use the following values:

R12 = 1K
R13 = 1K
R113 = 8K2
R114 = 8K2

If your power supply is a +/-12V supply, and you desire 5V Gate And Trigger Signals, then use the following values:

R12 = 2K2
R13 = 2K2
R113 = 1K8
R114 = 1K8

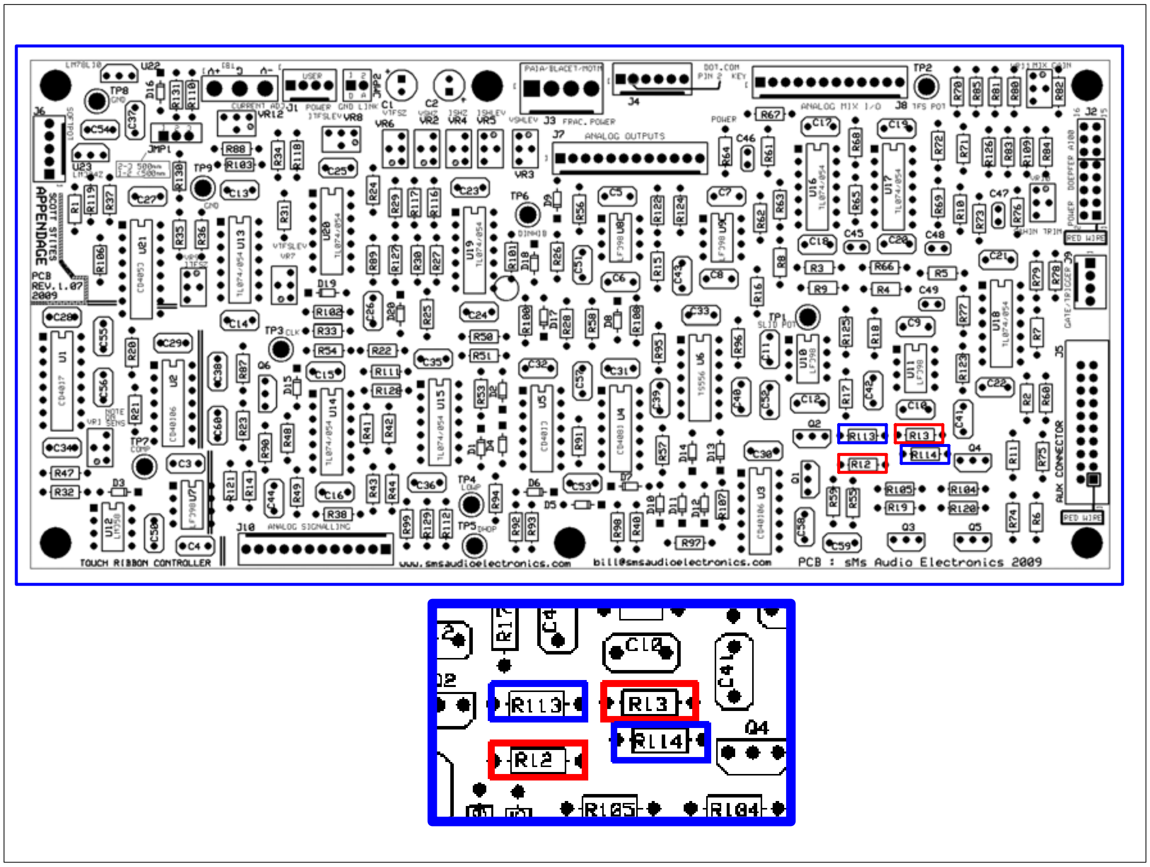


Figure 8-11: Gate/Trigger Level Resistor Locations

Once you have determined the value of gate and trigger resistors you wish to use, go ahead and install them. Solder them in place, and record the selected values in Table 8-6 for future reference.

Table 8-6: Gate and Trigger Level Resistors

Gate and Trigger Level Resistors		
Reference Designator	**Record Value Used**	**Done**
R12		
R13		
R113		
R114		

100K Resistors
There are several values of resistor used on the Appendage PCB. By far the most numerous value is 100K – there are a total of 61 100K resistors. We'll install all of them in a series of steps so that it is easier to ensure that all of them have been installed in the correct locations.

R24-R38: 15 Total 100K Resistors
We'll begin with the resistors R24 through R38. This is a total of 15 100K resistors, so count out 15 100K resistors and set them aside for this step. Use **Figure 8-12** to help locate the pads where these resistors are installed. Install and solder the resistors, using Table 8-7 to record that each and every resistor from this group has been installed.

Table 8-7: 100K Resistors R24 through R38 (15 Total)

100K Resistors R24 through R38 (15 Total)		
Reference Designator	**Value**	**Done**
R24	100K	
R25	100K	
R26	100K	
R27	100K	
R28	100K	
R29	100K	
R30	100K	
R31	100K	
R32	100K	
R33	100K	
R34	100K	
R35	100K	
R36	100K	
R37	100K	
R38	100K	

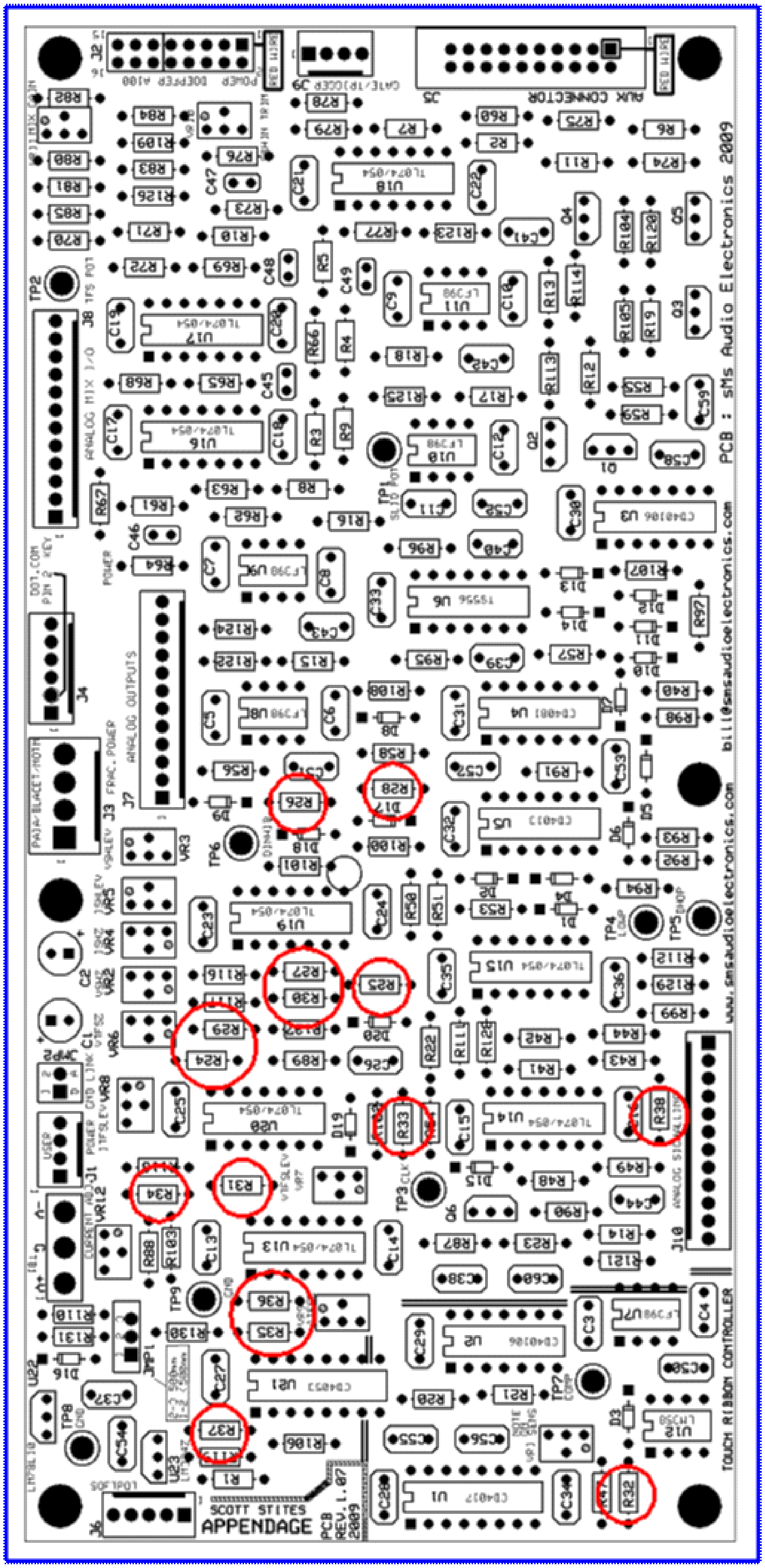


Figure 8-12: Locations for R24-R38

R40-R44, R47-R51, R53-R60: 18 Total 100K Resistors
Count out 18 100K resistors and install them in the locations marked for R40 through R44, R47 through R51, and R53 through R60. Use **Figure 8-13** to help locate the pads where these resistors are installed. Install and solder the resistors, using Table 8-8 to record that each and every resistor from this group has been installed.

Table 8-8: 100K Resistors R40-R44, R47-R51, R53-R60

100K Resistors R40-R44, R47-R51, R53-R60 (18 Total)		
Reference Designator	**Value**	**Done**
R40	100K	
R41	100K	
R42	100K	
R43	100K	
R44	100K	
R47	100K	
R48	100K	
R49	100K	
R50	100K	
R51	100K	
R53	100K	
R54	100K	
R55	100K	
R56	100K	
R57	100K	
R58	100K	
R59	100K	
R60	100K	

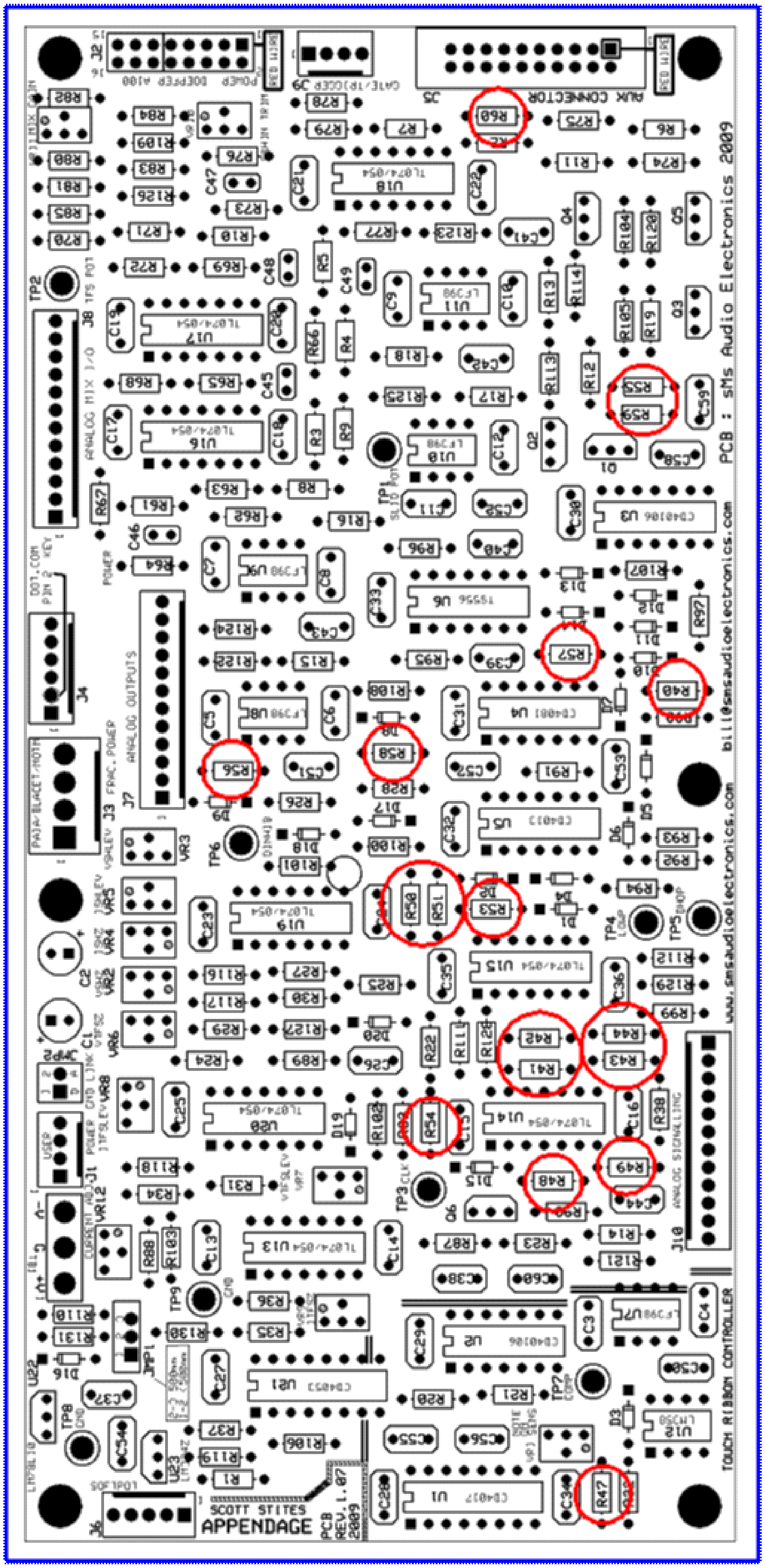


Figure 8-13: Locations for R40-R44, R47-R51, R53-R60

R62-R64, R66-R68, R70-R85: 22 Total 100K Resistors
Count out 22 100K resistors and install them in the locations marked for R62 through R64, R66 through R68, and R70 through R85. Use **Figure 8-14** to help locate the pads where these resistors are installed. Install and solder the resistors, using Table 8-9 to record that each and every resistor from this group has been installed.

Table 8-9: 100K Resistors R62-R64, R66-R68, R70-R85

100K Resistors R62-R64, R66-R68, R70-R85 (22 Total)		
Reference Designator	**Value**	**Done**
R62	100K	
R63	100K	
R64	100K	
R66	100K	
R67	100K	
R68	100K	
R70	100K	
R71	100K	
R72	100K	
R73	100K	
R74	100K	
R75	100K	
R76	100K	
R77	100K	
R78	100K	
R79	100K	
R80	100K	
R81	100K	
R82	100K	
R83	100K	
R84	100K	
R85	100K	

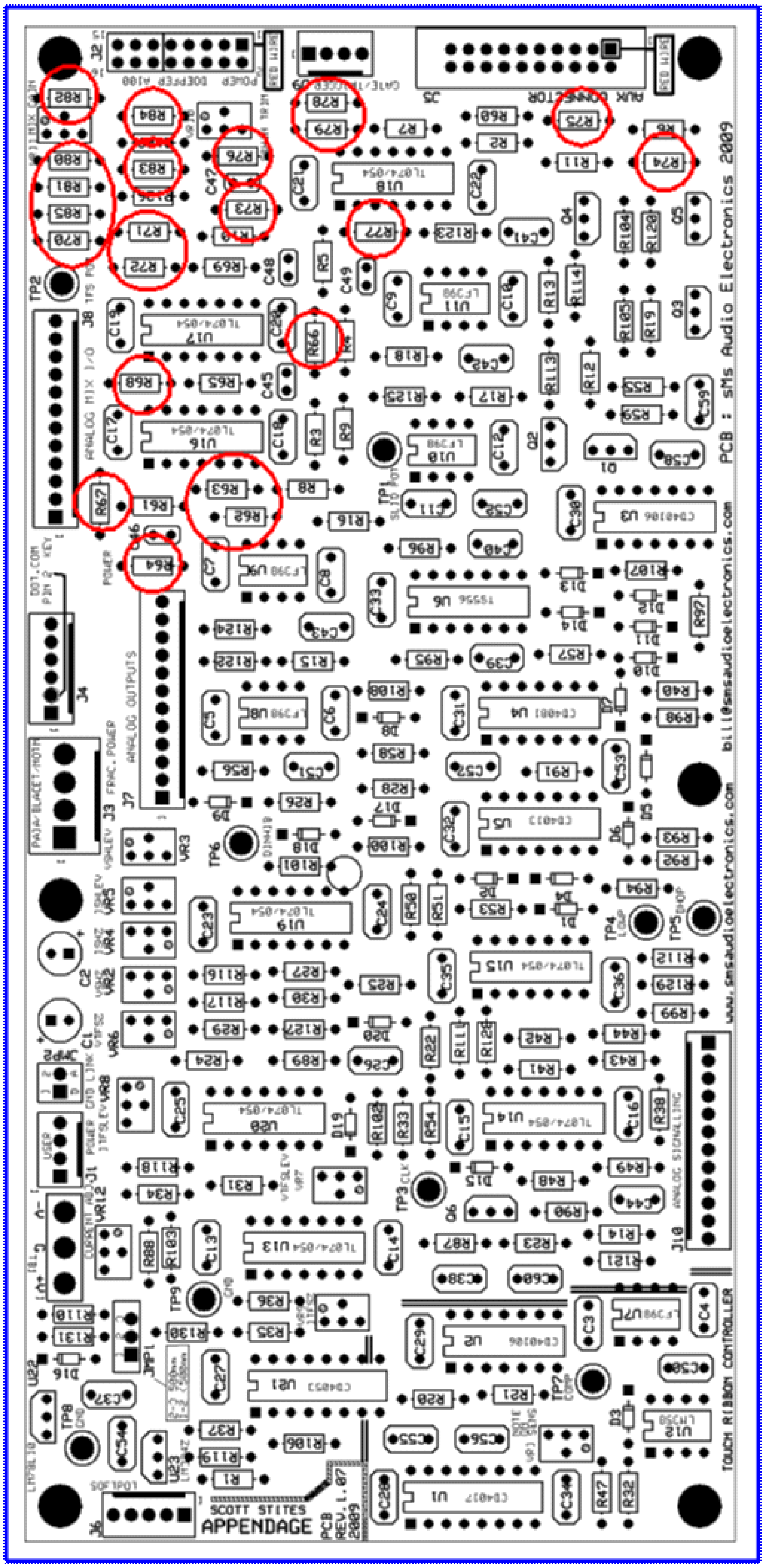


Figure 8-14: Locations for R62-R64, R66-R68, R70-R85

R87-R89, R103-R105: 6 Total 100K Resistors
This step will finish up all of the 100K resistors. Count out 6 100K resistors and install them in the locations marked for R87 through R89, and R103 through R105. Use **Figure 8-15** to help locate the pads where these resistors are installed. Install and solder the resistors, using Table 8-10 to record that each and every resistor from this group has been installed.

Table 8-10: 100K Resistors R87-R89, R103-R105

100K Resistors R87-R89, R103-R105 (6 Total)		
Reference Designator	**Value**	**Done**
R87	100K	
R88	100K	
R89	100K	
R103	100K	
R104	100K	
R105	100K	

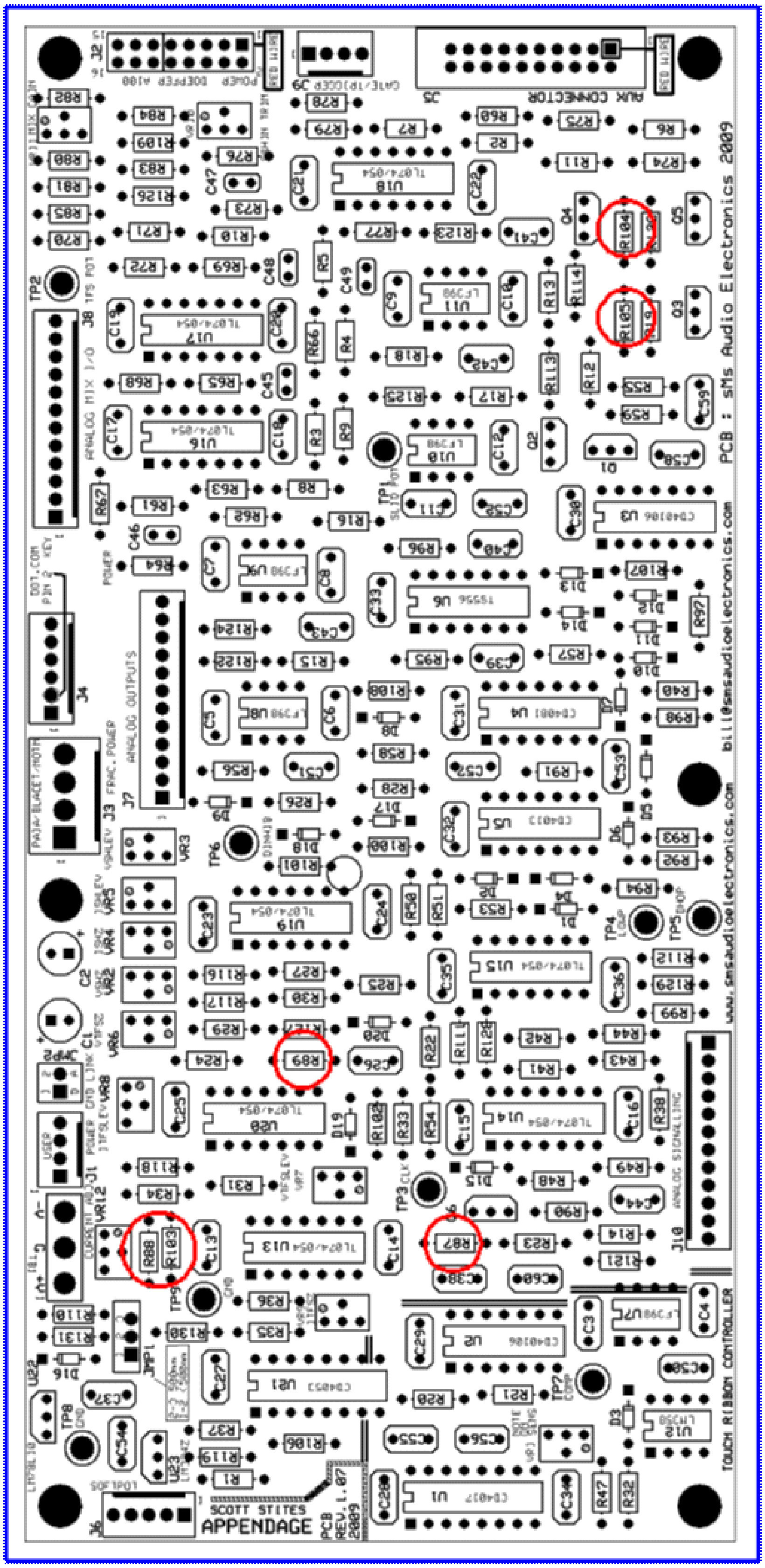


Figure 8-15: Locations for R87-R89, R103-R105

100 Ohm Resistors (100R Resistors): 11 Total Resistors

Find your 100 Ohm (100R) resistors. You should have 11 of them. These resistors have a reference designator series running from R1 through R11, so install them in the locations marked for R1 through 11. Install and solder the resistors, using Table 8-11 to record that each and every resistor from this group has been installed. **Figure 8-16** can be used to help locate the pads for the resistors.

Table 8-11: 100 Ohm (100R) Resistors R1-R11

100R Resistors R1-R11 (11 Total)		
Reference Designator	**Value**	**Done**
R1	100R	
R2	100R	
R3	100R	
R4	100R	
R5	100R	
R6	100R	
R7	100R	
R8	100R	
R9	100R	
R10	100R	
R11	100R	

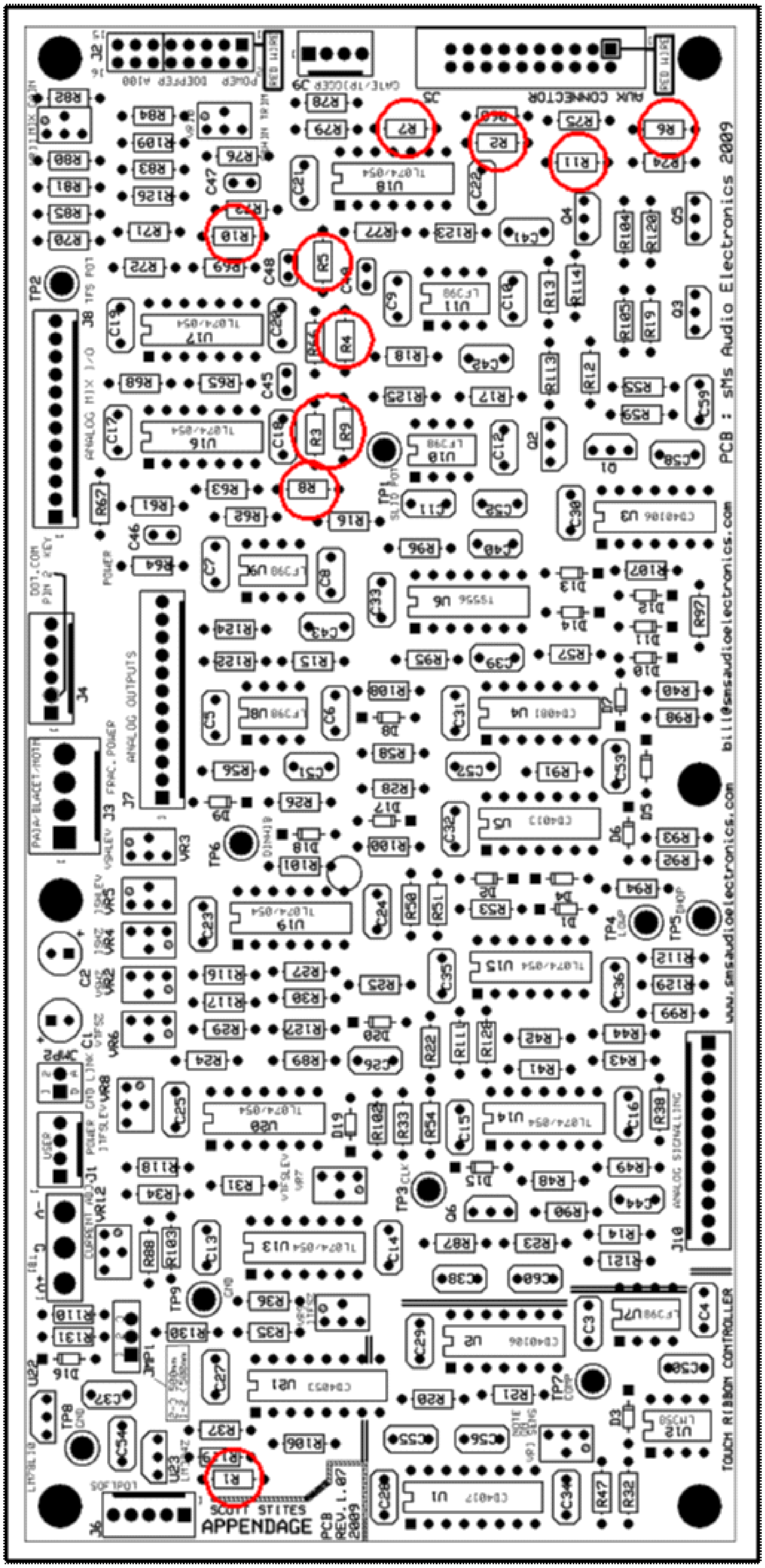


Figure 8-16: Locations for R1-R11

1.8K (1K8) Resistors: 5 Total Resistors
You should have five 1.8K (1K8) resistors ready for installation. These resistors have a reference designator series running from R14 through R18, so install them in the locations marked for R14 through 18. Install and solder the resistors, using Table 8-12 to record that each and every resistor from this group has been installed.   **Figure 8-17** can be used to help locate the pads for the resistors – the 1K8 positions are marked in red.

Table 8-12: 1.8K (1K8) Resistors R14-R18

1.8K (1K8) Resistors R14-R18 (5 Total)		
Reference Designator	**Value**	**Done**
R14	1K8	
R15	1K8	
R16	1K8	
R17	1K8	
R18	1K8	

10K Resistors: 4 Total Resistors
You should have four 10K resistors ready for installation. These resistors have a reference designator series running from R20 through R23, so install them in the locations marked for R20 through 23. Install and solder the resistors, using Table 8-13 to record that each and every resistor from this group has been installed.   **Figure 8-17** can be used to help locate the pads for the resistors – the 10K positions are marked in blue.

Table 8-13: 10K Resistors R20-R23

10K Resistors R20-R23 (4 Total)		
Reference Designator	**Value**	**Done**
R20	10K	
R21	10K	
R22	10K	
R23	10K	

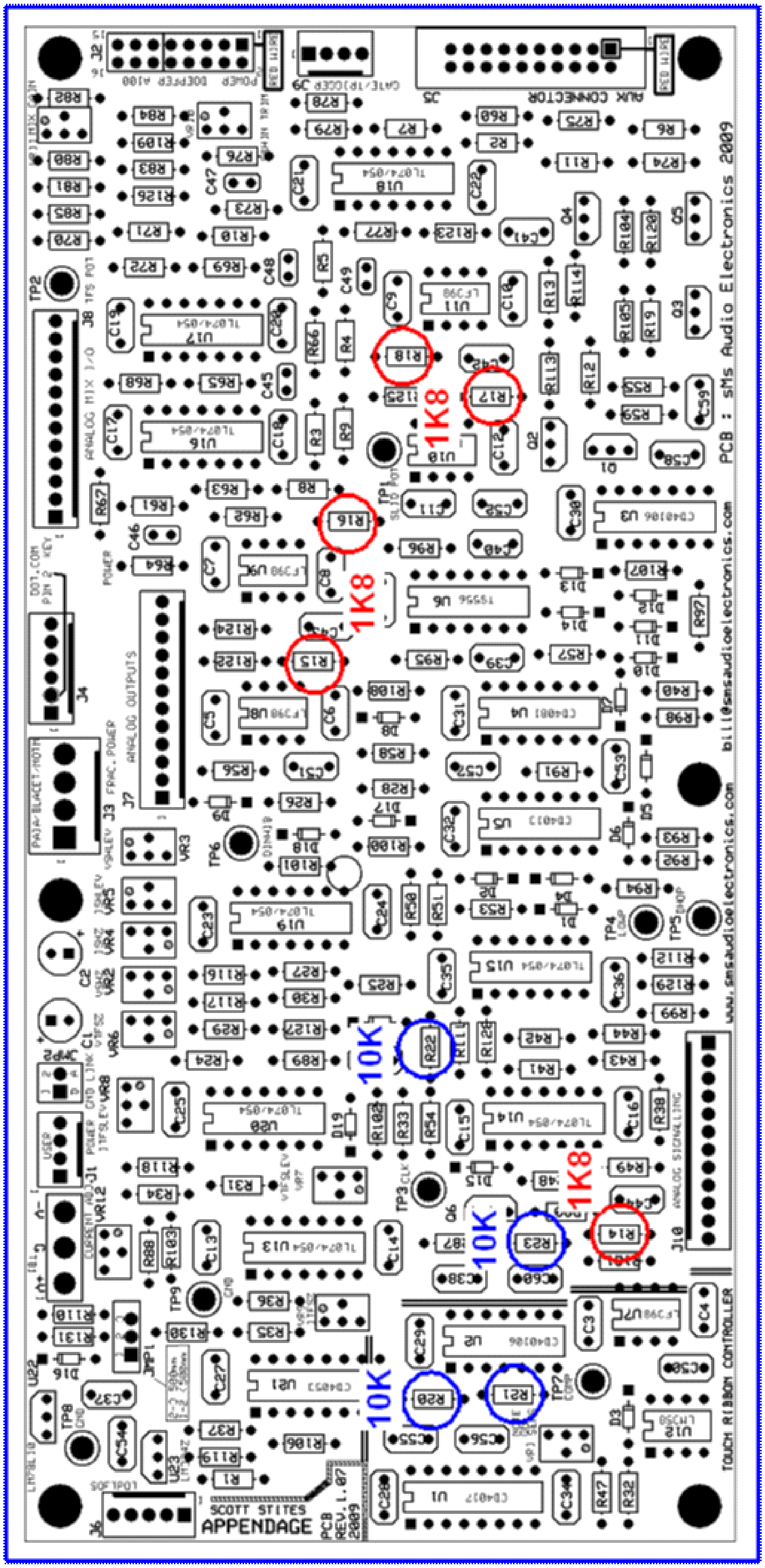


Figure 8-17: Locations for R14-R18 and R20-R23

120K Resistors: 3 Total Resistors
You should have three 120K resistors ready for installation. These resistors use non-sequential reference designators R61, R65, and R69. Install and solder the resistors, using Table 8-14 to record that each and every resistor from this group has been installed. **Figure 8-18** can be used to help locate the pads for the resistors – the 120K positions are marked in red.

Table 8-14: 120K Resistors R61, R65 and R69

120K Resistors R61, R65 and R69 (3 Total)		
Reference Designator	**Value**	**Done**
R61	120K	
R65	120K	
R69	120K	

1M Resistors: 5 Total Resistors
You should have five 1M resistors ready for installation. These resistors have a reference designator series running from R90 through R94. Install and solder the resistors, using Table 8-15 to record that each and every resistor from this group has been installed. **Figure 8-18** can be used to help locate the pads for the resistors – the 1M positions are marked in blue.

Table 8-15: 1M Resistors R90-R94

1M Resistors R90-R94 (5 Total)		
Reference Designator	**Value**	**Done**
R90	1M	
R91	1M	
R92	1M	
R93	1M	
R94	1M	

1.2M (1M2) Resistors: 2 Total Resistors
You should have two 1.2M (1M2) resistors ready for installation. These resistors use reference designators R95 and R96. Install and solder the resistors, using Table 8-16 to record that each and every resistor from this group has been installed. **Figure 8-18** can be used to help locate the pads for the resistors – the 1M2 positions are marked in green.

Table 8-16: 1.2M (1M2) Resistors R95 and R96

1M2 Resistors R95 and R96 (2 Total)		
Reference Designator	**Value**	**Done**
R95	1M2	
R96	1M2	

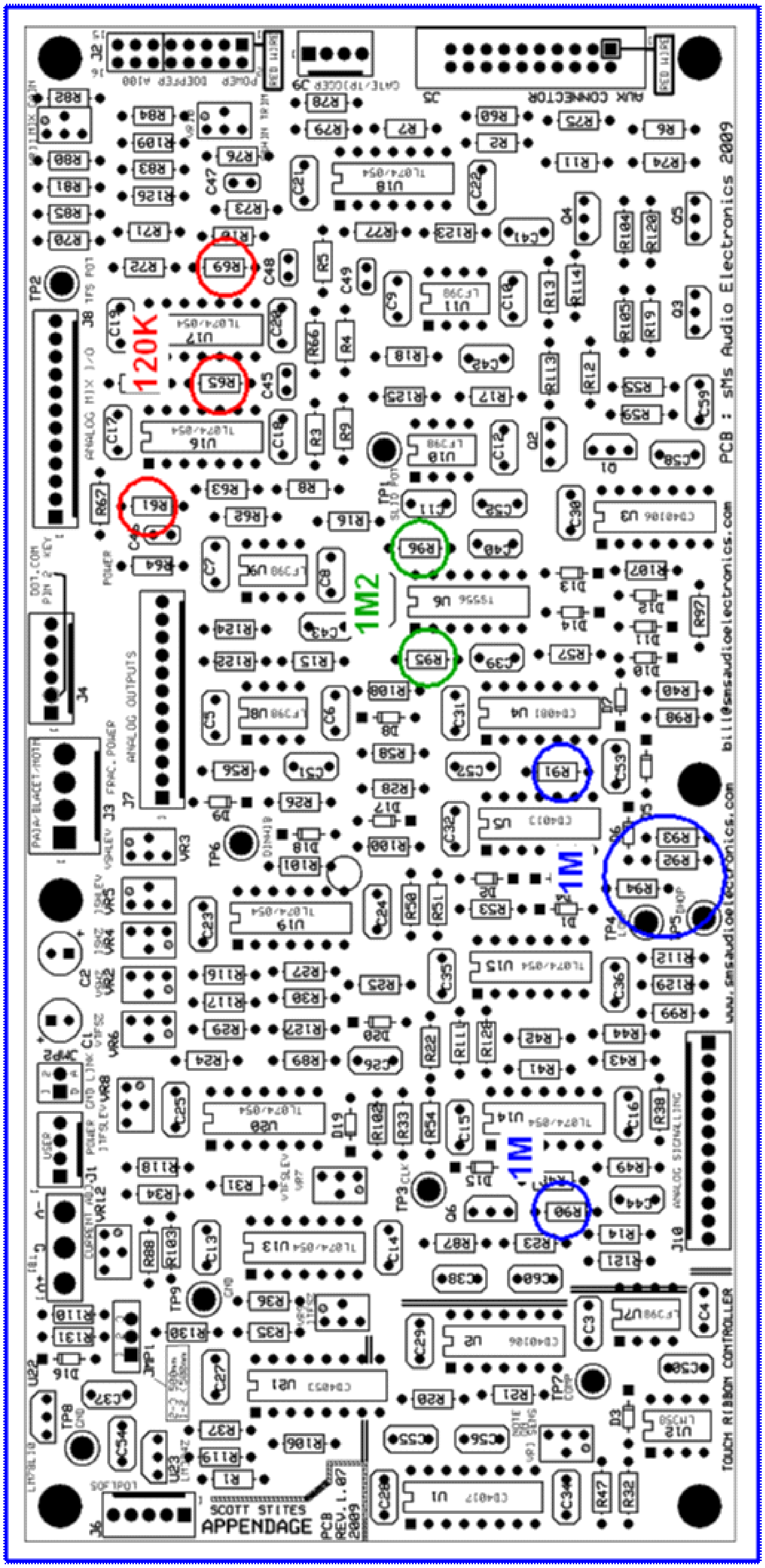


Figure 8-18: Locations for R61, R65, R69, R90-R94, R95, and R96

22K Resistors: 3 Total Resistors
You should have three 22K resistors ready for installation. These resistors use reference designators R97 through R99. Install and solder the resistors, using Table 8-17 to record that each and every resistor from this group has been installed. **Figure 8-19** can be used to help locate the pads for the resistors – the 22K positions are marked in red.

Table 8-17: 22K Resistors R97-R99

22K Resistors R97-R99 (3 Total)		
Reference Designator	**Value**	**Done**
R97	22K	
R98	22K	
R99	22K	

330K Resistors: 6 Total Resistors
You should have six 330K resistors ready for installation. These resistors use reference designators R100, R101, R116 through R118 and R126. Install and solder the resistors, using Table 8-18 to record that each and every resistor from this group has been installed. **Figure 8-19** can be used to help locate the pads for the resistors – the 330K positions are marked in blue.

Table 8-18: 330K Resistors R100, R101, R116-R118, R126

10K Resistors R100, R101, R116-R118, R126 (6 Total)		
Reference Designator	**Value**	**Done**
R100	330K	
R101	330K	
R116	330K	
R117	330K	
R118	330K	
R126	330K	

560K Resistor: 1 Total Resistor
You should have one 560K resistor ready for installation. This resistor uses reference designator R102. Install and solder the resistor, using Table 8-19 to record that this resistor has been installed. **Figure 8-19** can be used to help locate the pads for the resistor – the 560K position is marked in green.

Table 8-19: 560K Resistor R102

560K Resistor R102 (1 Total)		
Reference Designator	**Value**	**Done**
R102	560K	

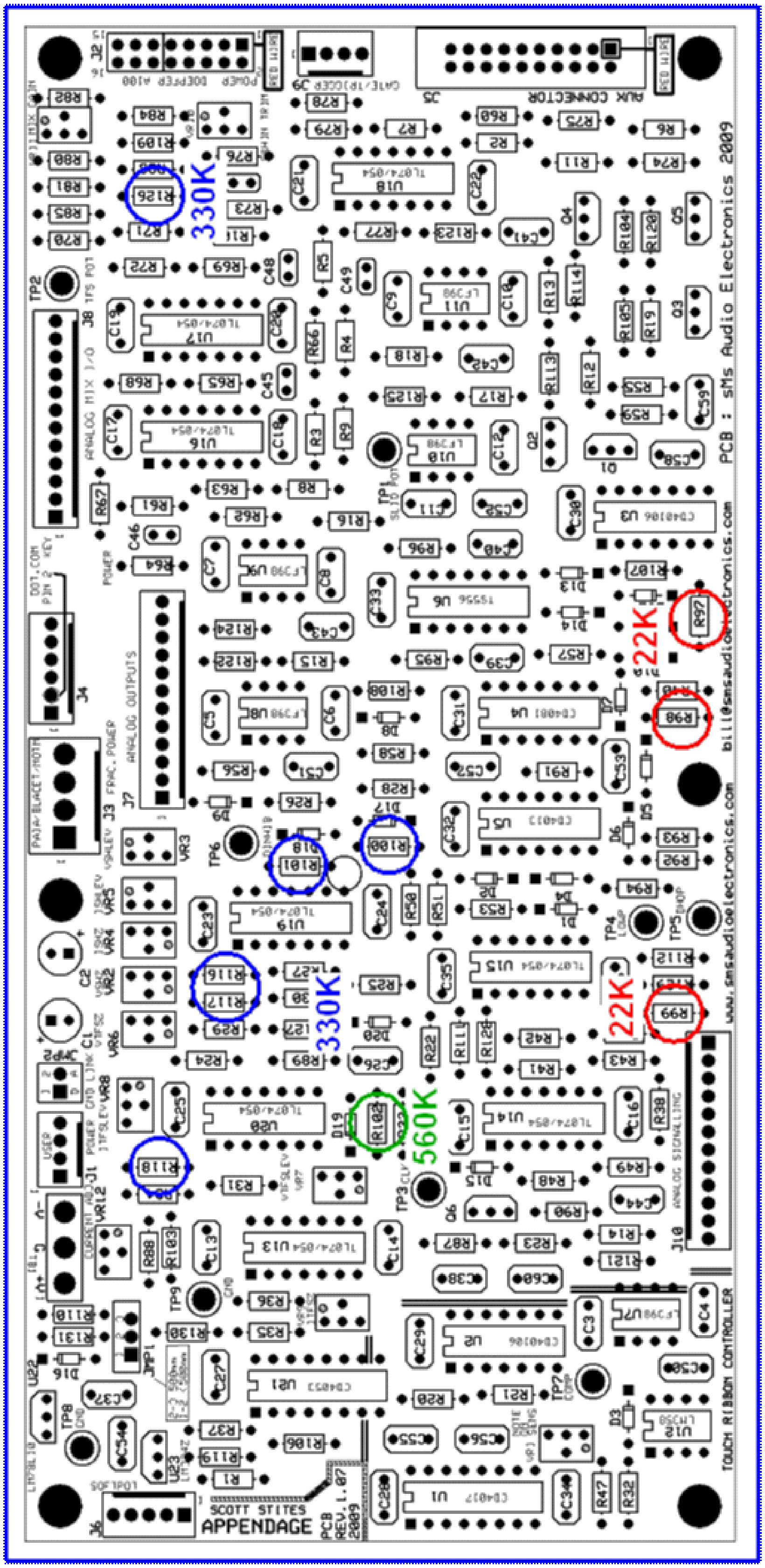


Figure 8-19: Locations for R97-94, R100, R101, R116-R118, R126, and R102

2.2M (2M2) Resistors: 4 Total Resistors
You should have four 2.2M (2M2) resistors ready for installation. These resistors use reference designators R106 through R109. Install and solder the resistors, using Table 8-20 to record that each and every resistor from this group has been installed.   **Figure 8-20** can be used to help locate the pads for the resistors – the 2M2 positions are marked in red.

Table 8-20: 2.2M (2M2) Resistors R106-R109

2M2 Resistors R106-R109 (4 Total)		
Reference Designator	**Value**	**Done**
R106	2M2	
R107	2M2	
R108	2M2	
R109	2M2	

330 Ohm (330R) Resistor: 1 Total Resistor
You should have one 330 Ohm (330R) resistor ready for installation. This resistor uses reference designator R110. Install and solder the resistor, using Table 8-21 to record that this resistor has been installed.   **Figure 8-20** can be used to help locate the pads for the resistor – the 330R position is marked in blue.

Table 8-21: 330 Ohm (330R) Resistor R102

330R Resistor R102 (1 Total)		
Reference Designator	**Value**	**Done**
R110	330R	

470 Ohm (470R) Resistors: 2 Total Resistors
You should have two 470 Ohm (470R) resistors ready for installation. These resistors use reference designators R111 and R112. Install and solder the resistors, using Table 8-22 to record that each and every resistor from this group has been installed.   **Figure 8-20** can be used to help locate the pads for the resistors – the 470R positions are marked in green.

Table 8-22: 470 Ohm (470R) Resistors R111, R112

470R Resistors R111, R112 (2 Total)		
Reference Designator	**Value**	**Done**
R111	470R	
R112	470R	

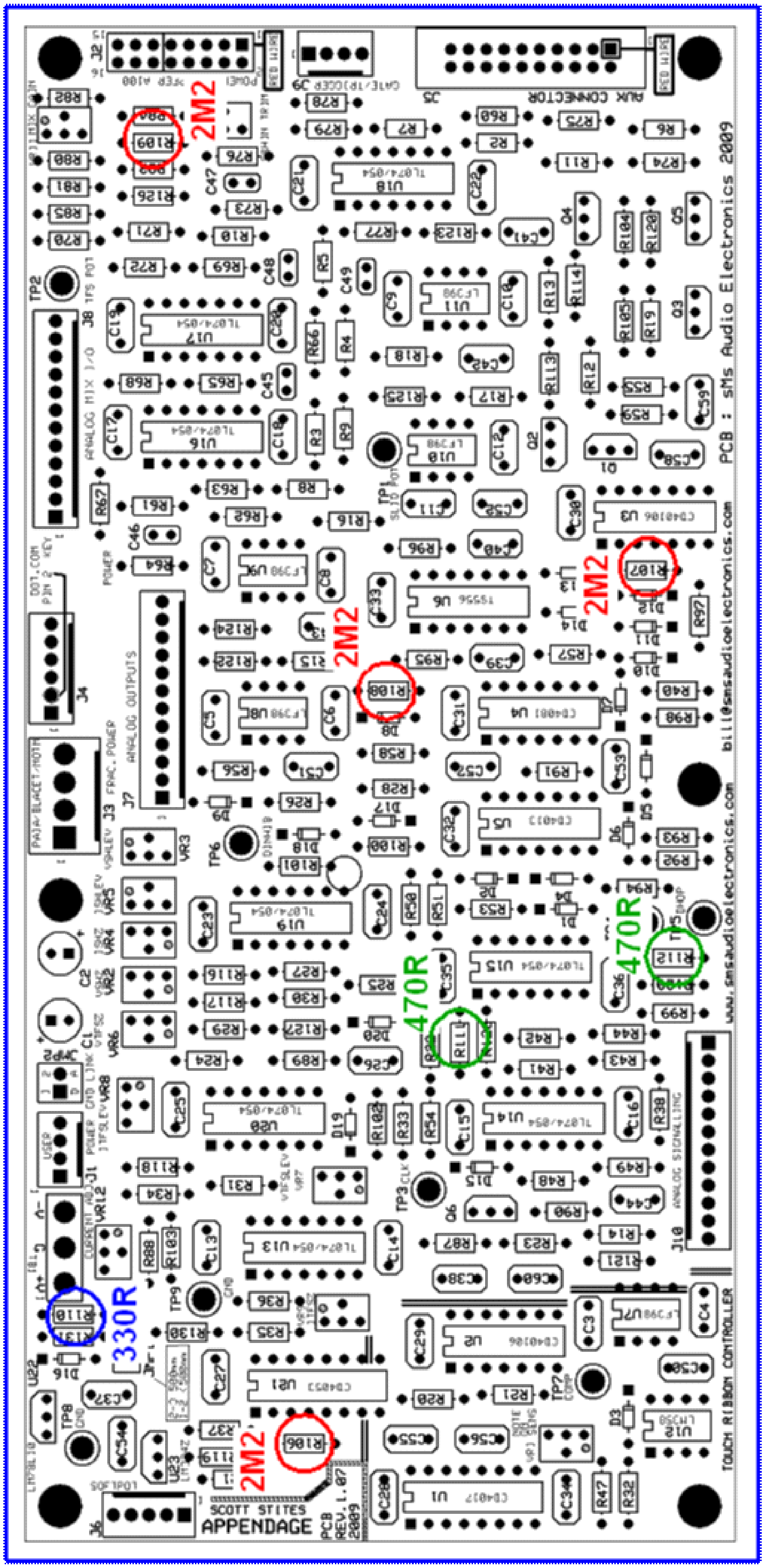


Figure 8-20: Locations for R106-R109, R110, R111, and R112

4.7K (4K7) Resistors: 3 Total Resistors

You should have three 4.7K (4K7) resistors ready for installation. These resistors use reference designators R19, R119, and R120. Install and solder the resistors, using Table 8-23 to record that each and every resistor from this group has been installed. **Figure 8-21** can be used to help locate the pads for the resistors – the 4K7 positions are marked in red.

Table 8-23: 4.7K (4K7) Resistors R19, R119, R120

4K7 Resistors R19, R119, R120 (3 Total)		
Reference Designator	**Value**	**Done**
R19	4K7	
R119	4K7	
R120	4K7	

5.6K (5K6) Resistors: 6 Total Resistors

You should have six 5.6K (5K6) resistors ready for installation. These resistors use reference designators R121 through R125 and R130. Install and solder the resistors, using Table 8-24 to record that each and every resistor from this group has been installed. **Figure 8-21** can be used to help locate the pads for the resistors – the 5K6 positions are marked in blue.

Table 8-24: 5.6K (5K6) Resistors R121-R125, R130

5K6 Resistors R121-R125, R130 (6 Total)		
Reference Designator	**Value**	**Done**
R121	5K6	
R122	5K6	
R123	5K6	
R124	5K6	
R125	5K6	
R130	5K6	

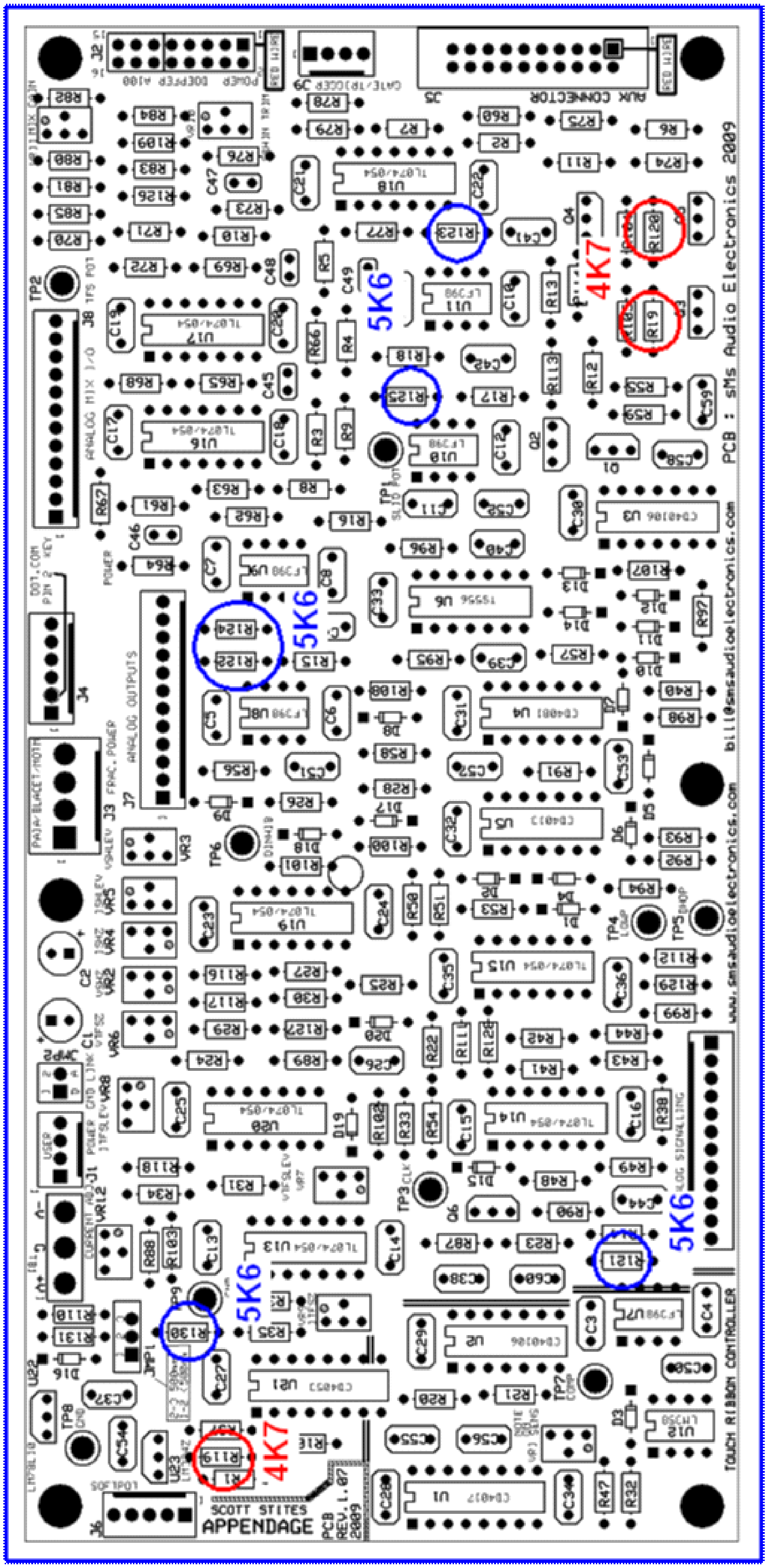


Figure 8-21: Locations for R19, R119, R120, R121-R125, and R130

470K Resistor: 1 Total Resistor
You should have one 470K resistor ready for installation. This resistor uses reference designator R127. Install and solder the resistor, using Table 8-25 to record that this resistor has been installed. **Figure 8-22** can be used to help locate the pads for the resistor – the 470K position is marked in red.

Table 8-25: 470K Resistor R102

470K Resistor R102 (1 Total)		
Reference Designator	**Value**	**Done**
R127	470K	

150K Resistors: 2 Total Resistors
You should have two 150K resistors ready for installation. These resistors use reference designators R128 and R129. Install and solder the resistors, using Table 8-26 to record that each and every resistor from this group has been installed. **Figure 8-22** can be used to help locate the pads for the resistors – the 150K positions are marked in blue.

Table 8-26: 150K Resistors R128,R129

150K Resistors R128,R129 (2 Total)		
Reference Designator	**Value**	**Done**
R128	150K	
R129	150K	

220 Ohm (220R) Resistor: 1 Total Resistor
You should have one 220 Ohm (220R) resistor ready for installation. This resistor uses reference designator R131. Install and solder the resistor, using Table 8-27 to record that this resistor has been installed. **Figure 8-22** can be used to help locate the pads for the resistor – the 220R position is marked in green.

Table 8-27: 220 Ohm (330R) Resistor R102

220R Resistor R102 (1 Total)		
Reference Designator	**Value**	**Done**
R131	220R	

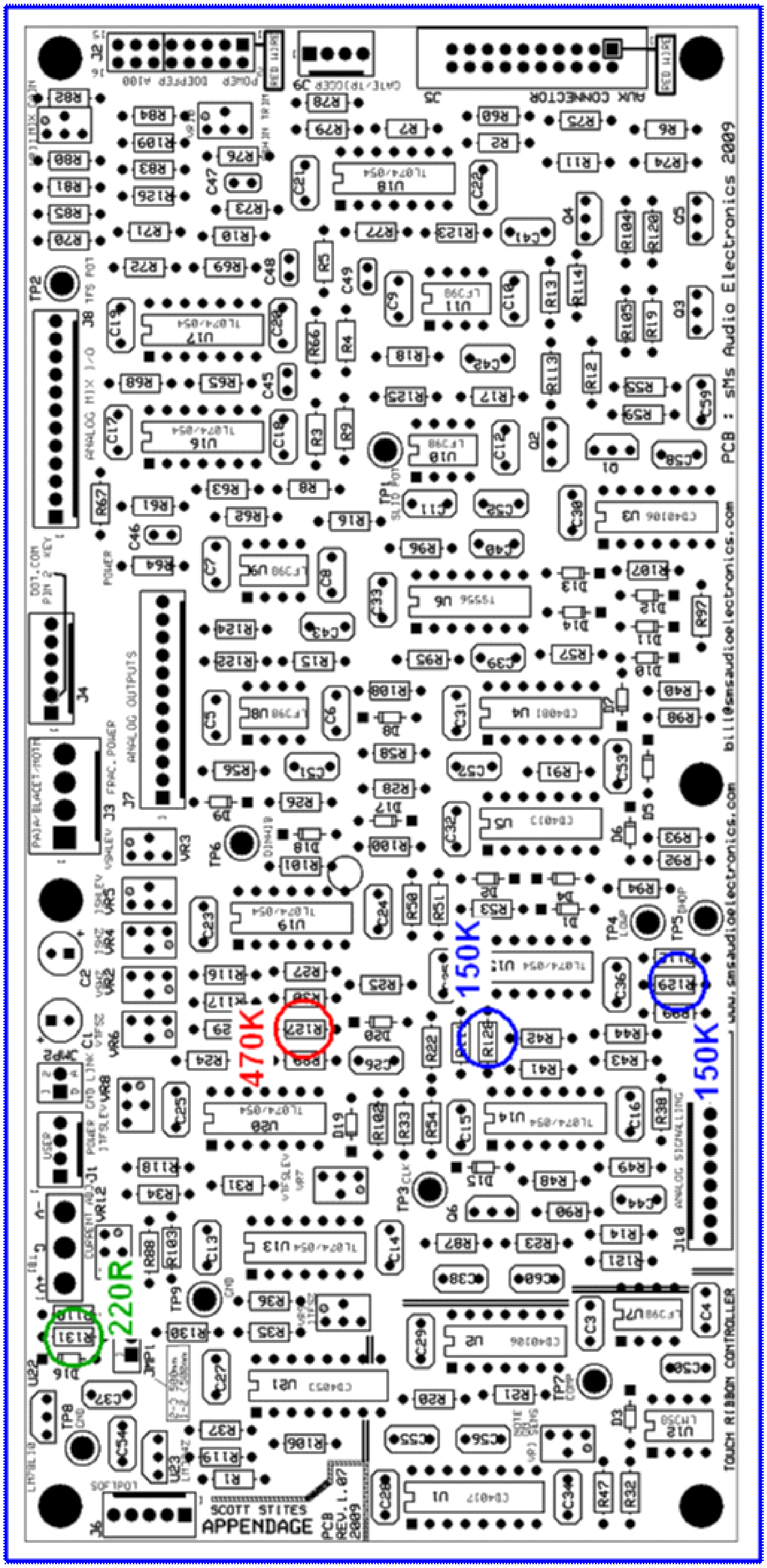


Figure 8-22: Locations for R127, R128, R129, and R131

This completes the installation of all of the resistors used on the Appendage PCB. Next up will be all of the capacitors used by the Appendage.

Installing the Capacitors

There are a number of different kinds of capacitors used by the Appendage PCB. Normally, it's possible to have different types of capacitors that have the same value of capacitance, but differ in *type* of capacitor. The Appendage is a bit different in this respect – all of the capacitors of a particular value are of the same type, so there is no chance of using the wrong type of capacitor for a particular value.

0.1 µF (100 nF) Metal Poly Caps
There are thirty five 0.1 µF (100 nF) capacitors on the Appendage. We'll divide these up into two steps, to make it easier to ensure all of the caps are installed where they should be installed.

C3-C20: 18 Total 0.1 µF (100 nF) Metal Poly Caps
We'll begin with the capacitors C3 through C20. This is a total of 18 capacitors, so count out eighteen 0.1 µF (100 nF) capacitors and set them aside for this step. Use **Figure 8-23** to help locate the pads where these capacitors are installed. Install and solder the capacitors, using Table 8-28 to record that each and every capacitor from this group has been installed.

Table 8-28: 0.1 µF (100 nF) Metal Poly Caps C3-C20 (18 Total)

0.1 µF (100 nF) Capacitors C3 through C20 (18 Total)		
Reference Designator	**Value**	**Done**
C3	0.1 µF (100 nF)	
C4	0.1 µF (100 nF)	
C5	0.1 µF (100 nF)	
C6	0.1 µF (100 nF)	
C7	0.1 µF (100 nF)	
C8	0.1 µF (100 nF)	
C9	0.1 µF (100 nF)	
C10	0.1 µF (100 nF)	
C11	0.1 µF (100 nF)	
C12	0.1 µF (100 nF)	
C13	0.1 µF (100 nF)	
C14	0.1 µF (100 nF)	
C15	0.1 µF (100 nF)	
C16	0.1 µF (100 nF)	
C17	0.1 µF (100 nF)	
C18	0.1 µF (100 nF)	
C19	0.1 µF (100 nF)	
C20	0.1 µF (100 nF)	

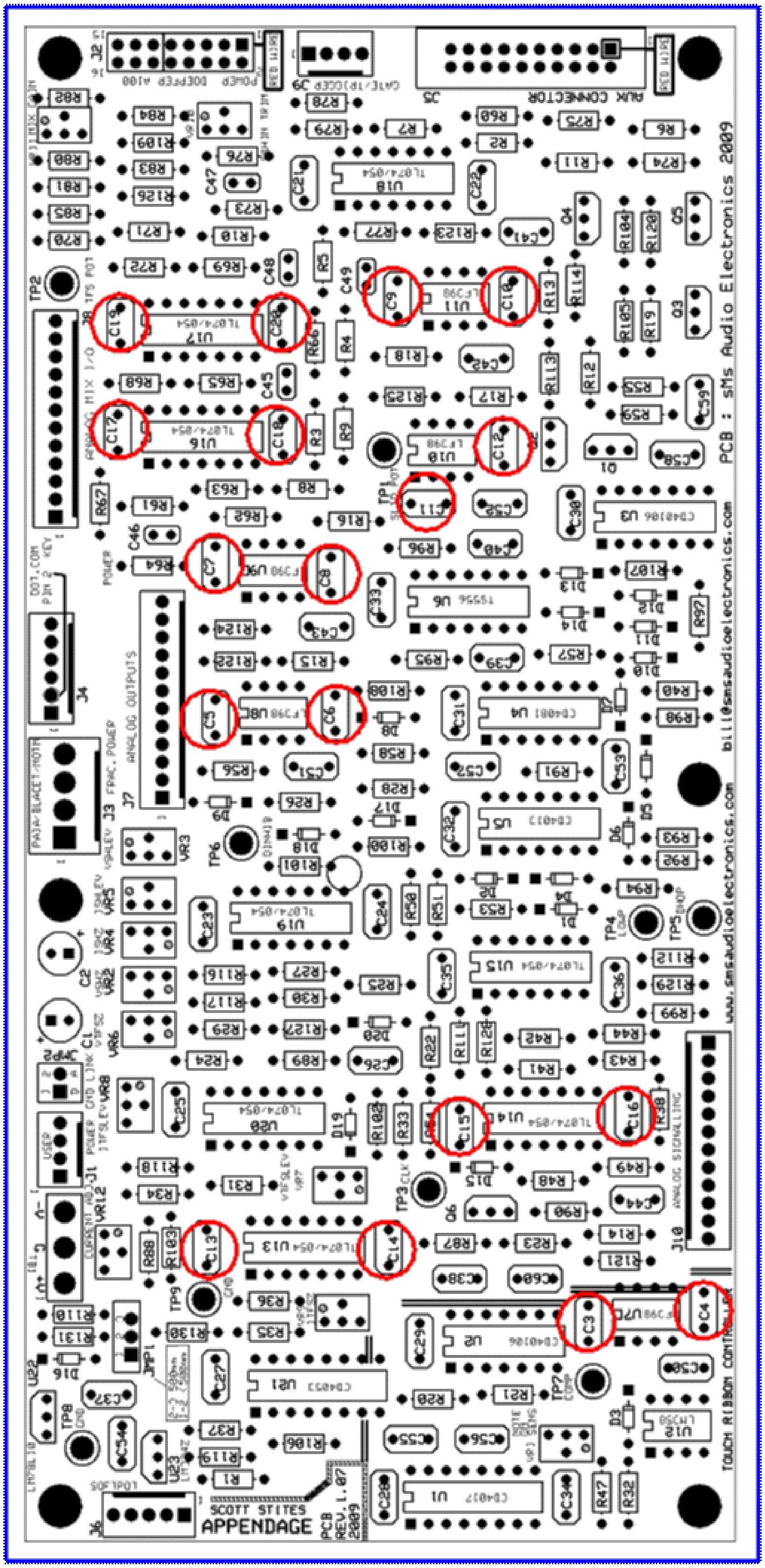


Figure 8-23: Locations for C3-C20

C21-C37: 17 Total 0.1 μF (100 nF) Metal Poly Caps

Now install capacitors C21 through C37. This is a total of 17 capacitors, so count out seventeen 0.1 μF (100 nF) capacitors and set them aside for this step. Use **Figure 8-24** to help locate the pads where these capacitors are installed. Install and solder the capacitors, using Table 8-29 to record that each and every capacitor from this group has been installed.

Table 8-29: 0.1 μF (100 nF) Metal Poly Caps C21-C37 (17 Total)

0.1 μF (100 nF) Capacitors C21 through C37 (17 Total)		
Reference Designator	**Value**	**Done**
C21	0.1 μF (100 nF)	
C22	0.1 μF (100 nF)	
C23	0.1 μF (100 nF)	
C24	0.1 μF (100 nF)	
C25	0.1 μF (100 nF)	
C26	0.1 μF (100 nF)	
C27	0.1 μF (100 nF)	
C28	0.1 μF (100 nF)	
C29	0.1 μF (100 nF)	
C30	0.1 μF (100 nF)	
C31	0.1 μF (100 nF)	
C32	0.1 μF (100 nF)	
C33	0.1 μF (100 nF)	
C34	0.1 μF (100 nF)	
C35	0.1 μF (100 nF)	
C36	0.1 μF (100 nF)	
C37	0.1 μF (100 nF)	

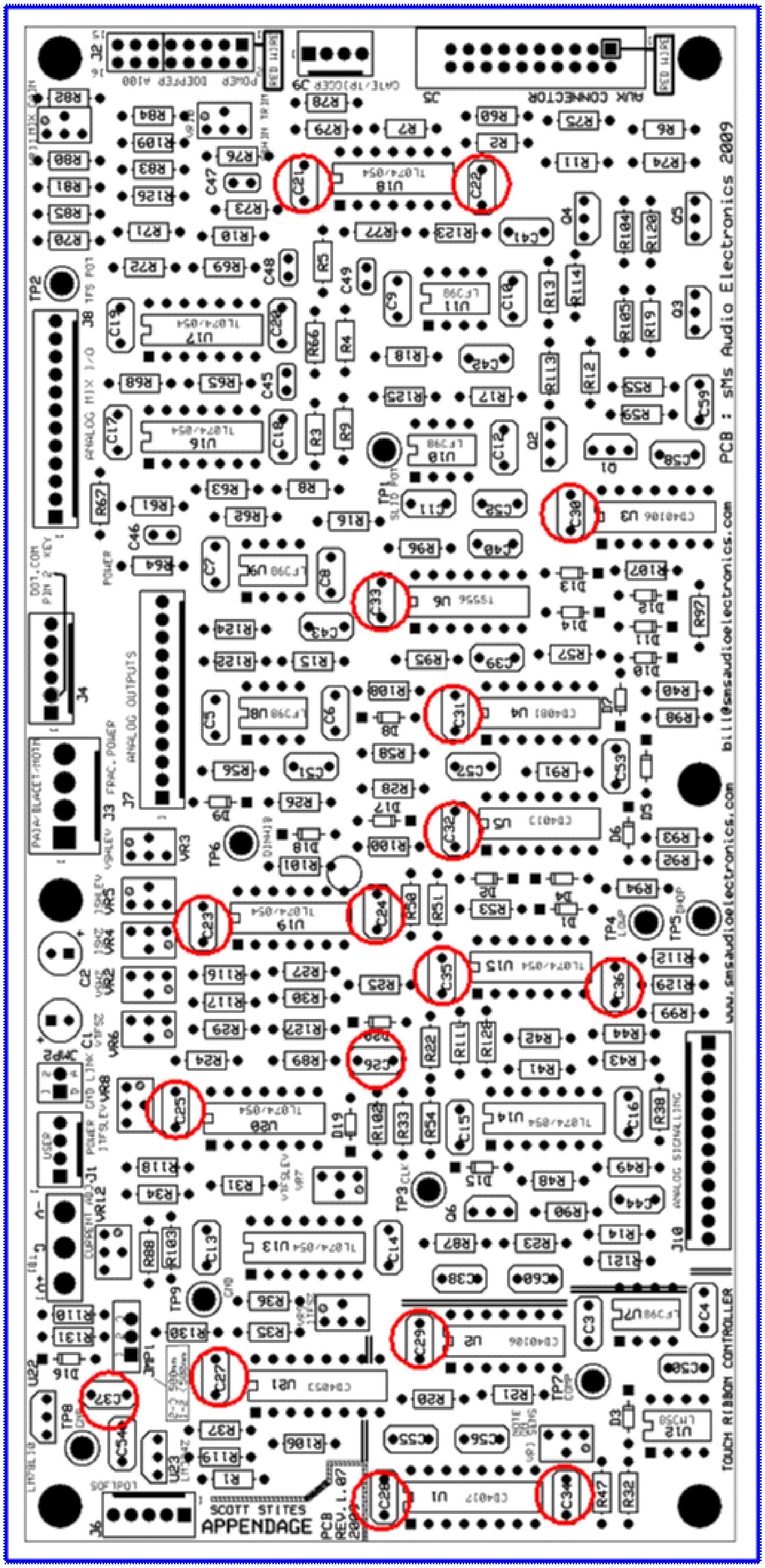


Figure 8-24: Locations for C21-C27

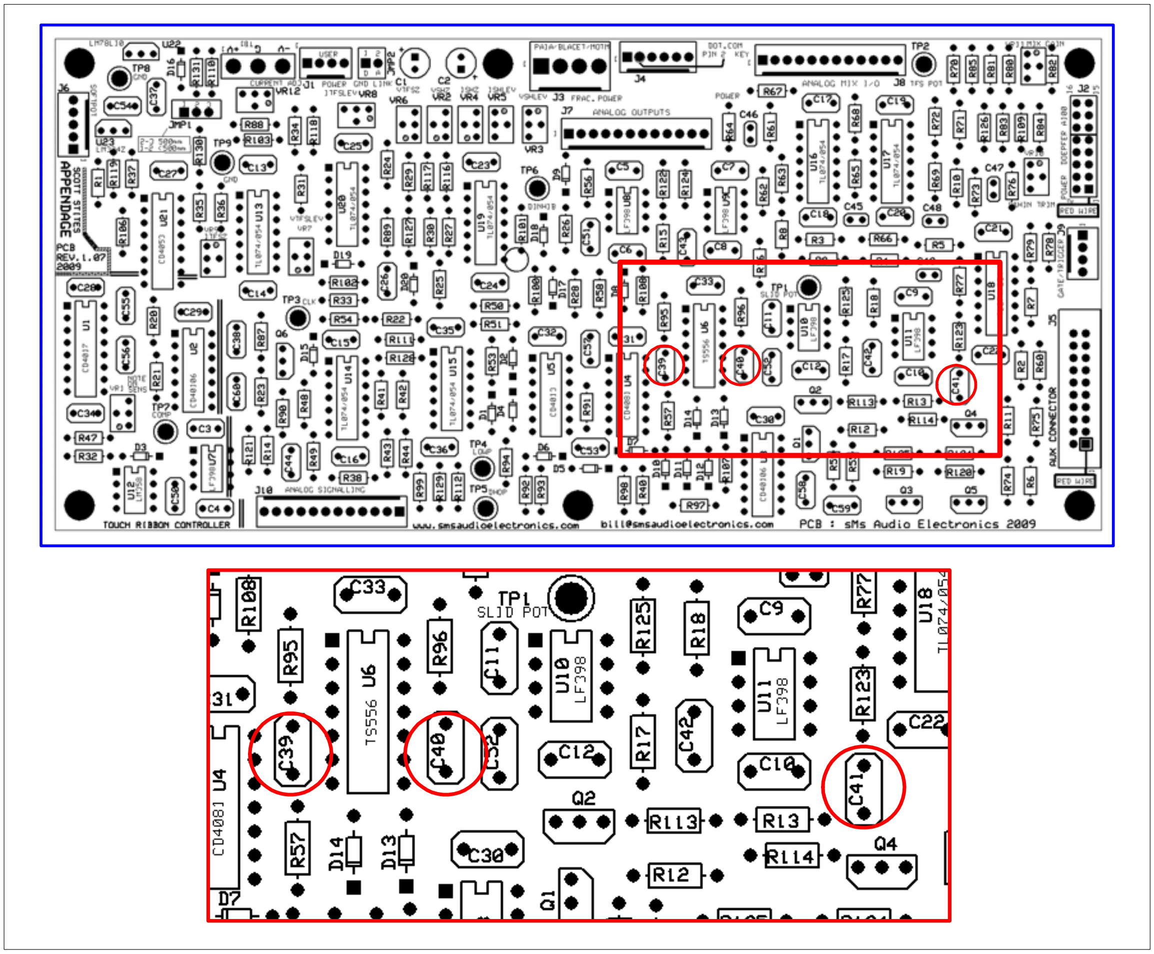


Figure 8-25: Locations for C39-C41

10 nF Ceramic Radial Capacitors: 3 Total Capacitors

You should have three 10 nF capacitors. These capacitors use reference designators C39 through C40. Install and solder the capacitors, using Table 8-30 to record that each and every capacitor from this group has been installed. **Figure 8-25** can be used to help locate the pads for the capacitors.

Table 8-30: 10 nF Capacitors C39-C41

10 nF Capacitors C39-C41 (3 Total)		
Reference Designator	**Value**	**Done**
C39	10 nF	
C40	10 nF	
C41	10 nF	

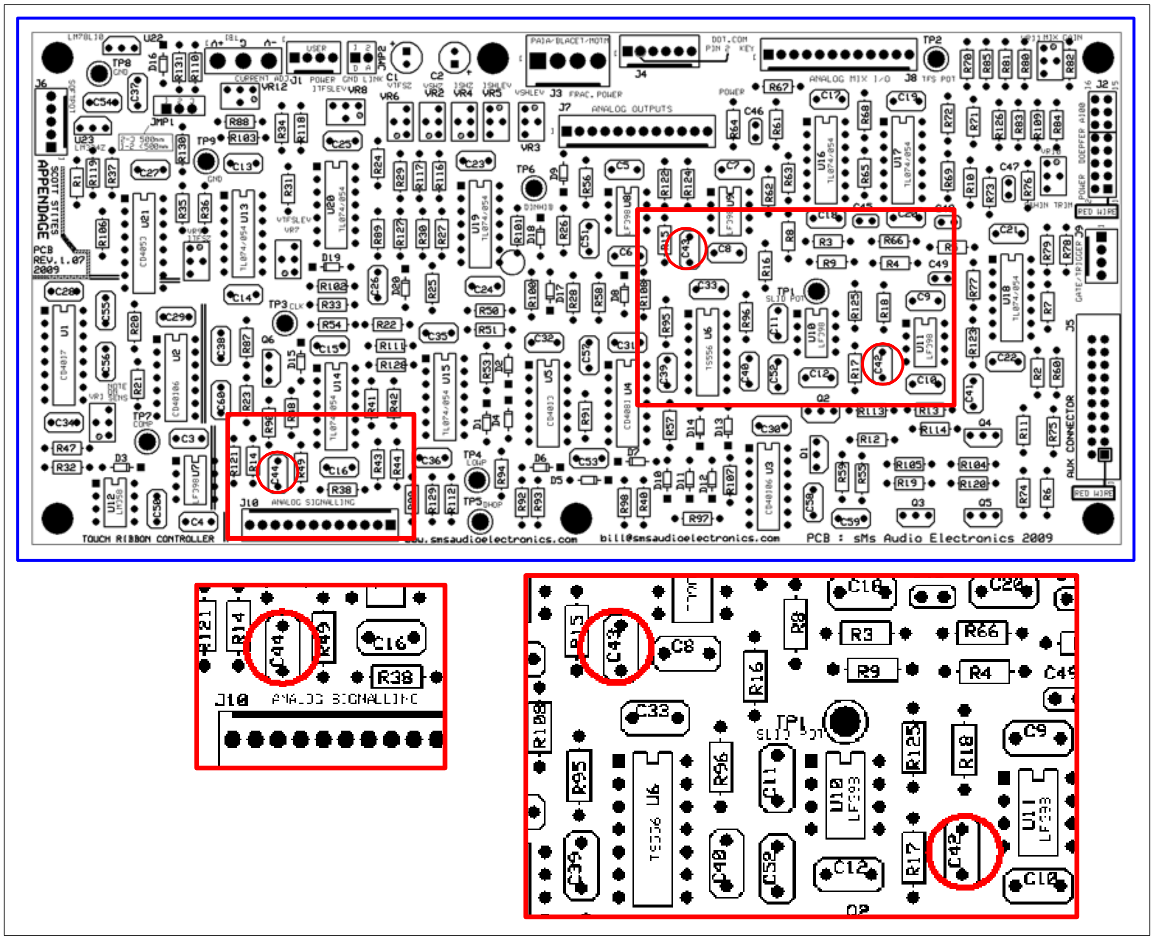


Figure 8-26: Locations for C39-C41

1 µF Polyfilm Box Capacitors: 3 Total Capacitors

You should have three 1 µF capacitors polyfilm box capacitors. These capacitors use reference designators C42 through C44. Install and solder the capacitors, using Table 8-31 to record that each and every capacitor from this group has been installed.   **Figure 8-26** can be used to help locate the pads for the capacitors.

Table 8-31: 1 µF Capacitors C42-C44

1 µF Capacitors C42-C44 (3 Total)		
Reference Designator	**Value**	**Done**
C42	1 µF	
C43	1 µF	
C44	1 µF	

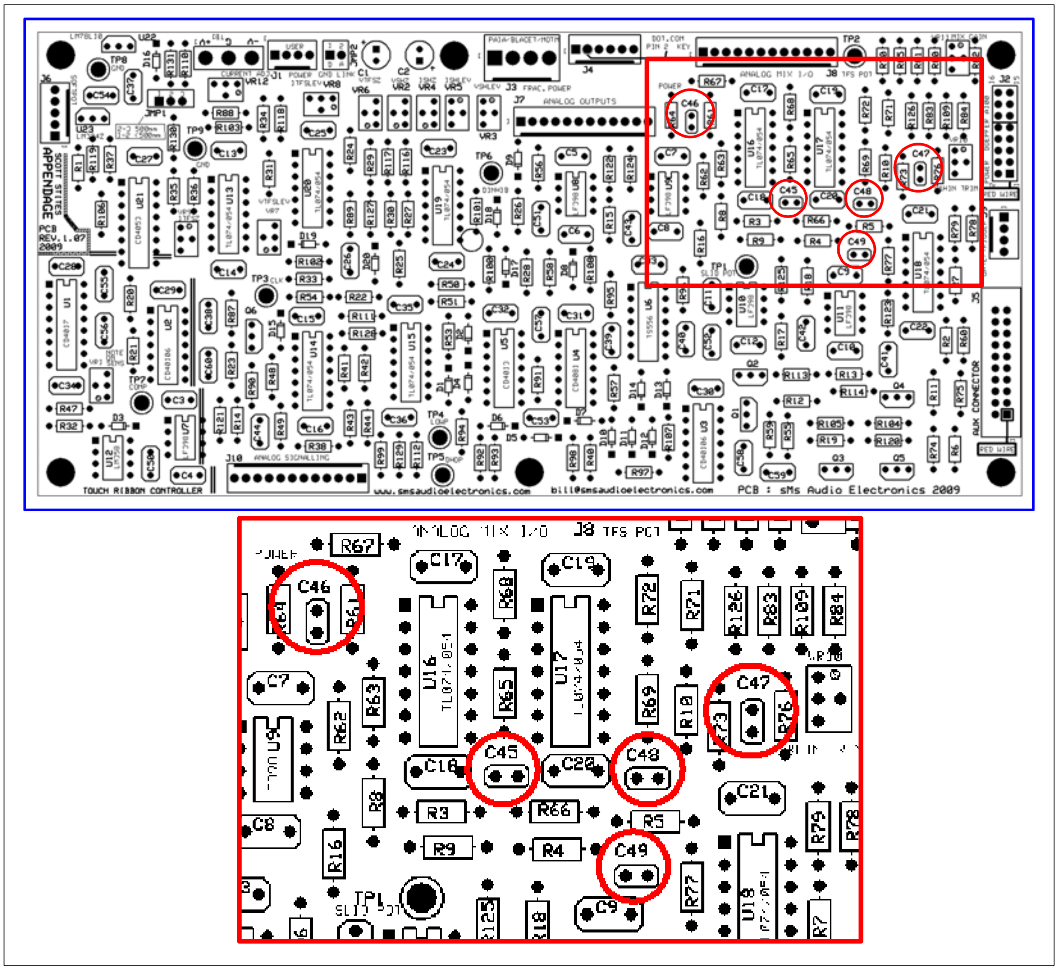


Figure 8-27: Locations for C45-C49

220 pF Ceramic Radial Capacitors: 5 Total Capacitors

You should have five 220 pF ceramic capacitors. These capacitors use reference designators C45 through C49. Install and solder the capacitors, using Table 8-32 to record that each and every capacitor from this group has been installed. **Figure 8-27** can be used to help locate the pads for the capacitors.

Table 8-32: 220 pF Capacitors C45-C49

220 pF Capacitors C45-C49 (5 Total)		
Reference Designator	**Value**	**Done**
C45	220 pF	
C46	220 pF	
C47	220 pF	
C48	220 pF	
C49	220 pF	

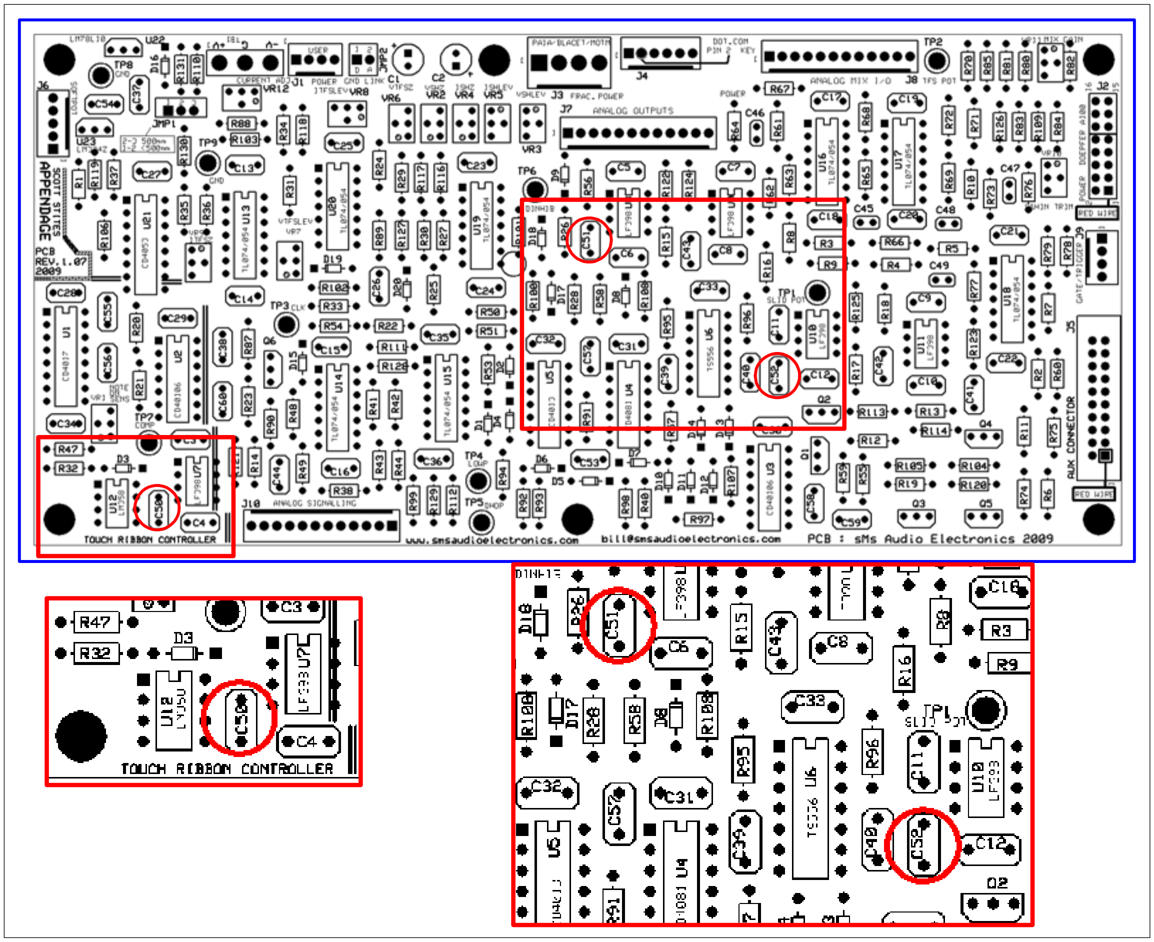


Figure 8-28: Locations for C50-C52

2 nF Polypropylene Capacitors: 3 Total Capacitors

You should have three 2 nF polypropylene capacitors. These capacitors use reference designators C50 through C52. Install and solder the capacitors, using Table 8-33 to record that each capacitor has been installed. **Figure 8-28** can be used to help locate the pads for the capacitors.

Table 8-33: 2 nF Capacitors C50-C52

2 nF Capacitors C50-C52 (3 Total)		
Reference Designator	**Value**	**Done**
C50	2 nF	
C51	2 nF	
C52	2 nF	

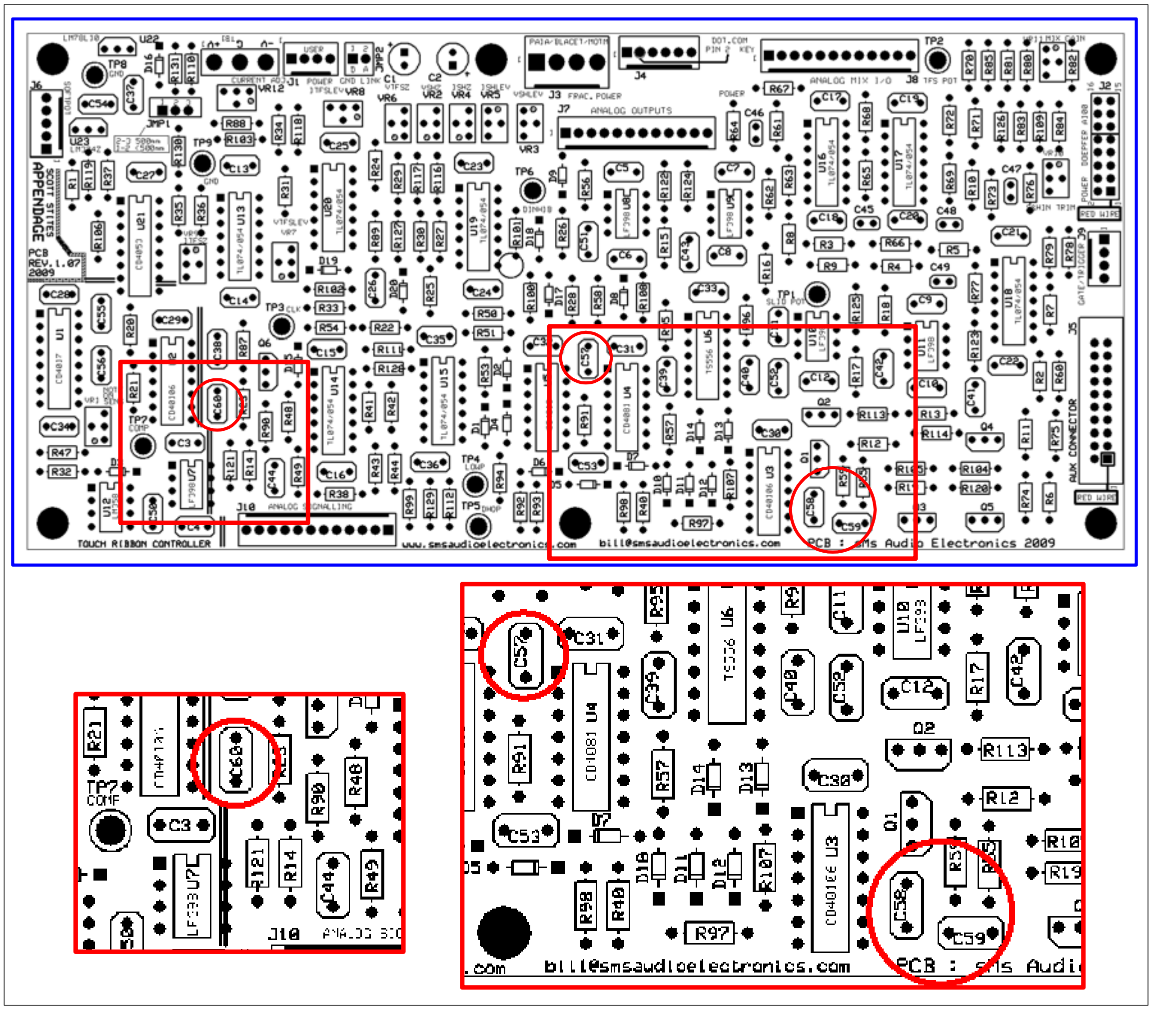


Figure 8-29: Locations for C57-C60

47 nF Ceramic Capacitors: 4 Total Capacitors

You should have four 47 nF ceramic capacitors. These capacitors use reference designators C57 through C60. Install and solder the capacitors, using Table 8-34 to record that each and every capacitor from this group has been installed. **Figure 8-29** can be used to help locate the pads for the capacitors.

Table 8-34: 47 nF Capacitors C57-C60

47 nF Capacitors C57-C60 (4 Total)		
Reference Designator	**Value**	**Done**
C57	47 nF	
C58	47 nF	
C59	47 nF	
C60	47 nF	

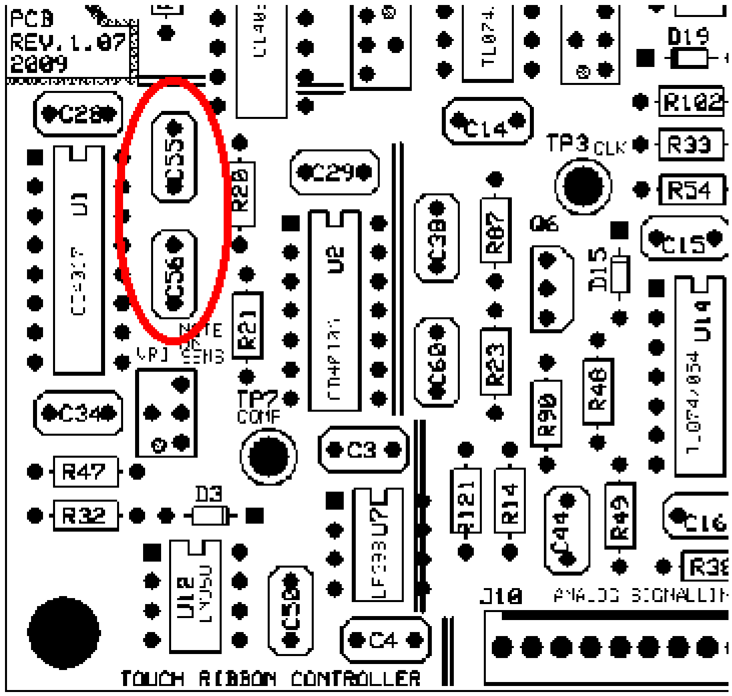


Figure 8-30: Locations for C55, C56

4.7 nF (4n7) Ceramic Capacitors: 2 Total Capacitors

You should have two 4.7 nF (4n7) ceramic capacitors. These capacitors use reference designators C55 and C56. Install and solder the capacitors, using Table 8-35 to record that each capacitor has been installed. **Figure 8-30** can be used to help locate the pads for the capacitors – they're located in the lower left quadrant of the PCB.

Table 8-35: 4.7 nF (4n7) Capacitors C55, C56

4.7 nF Capacitors C55, C56 (2 Total)		
Reference Designator	**Value**	**Done**
C55	4.7 nF	
C56	4.7 nF	

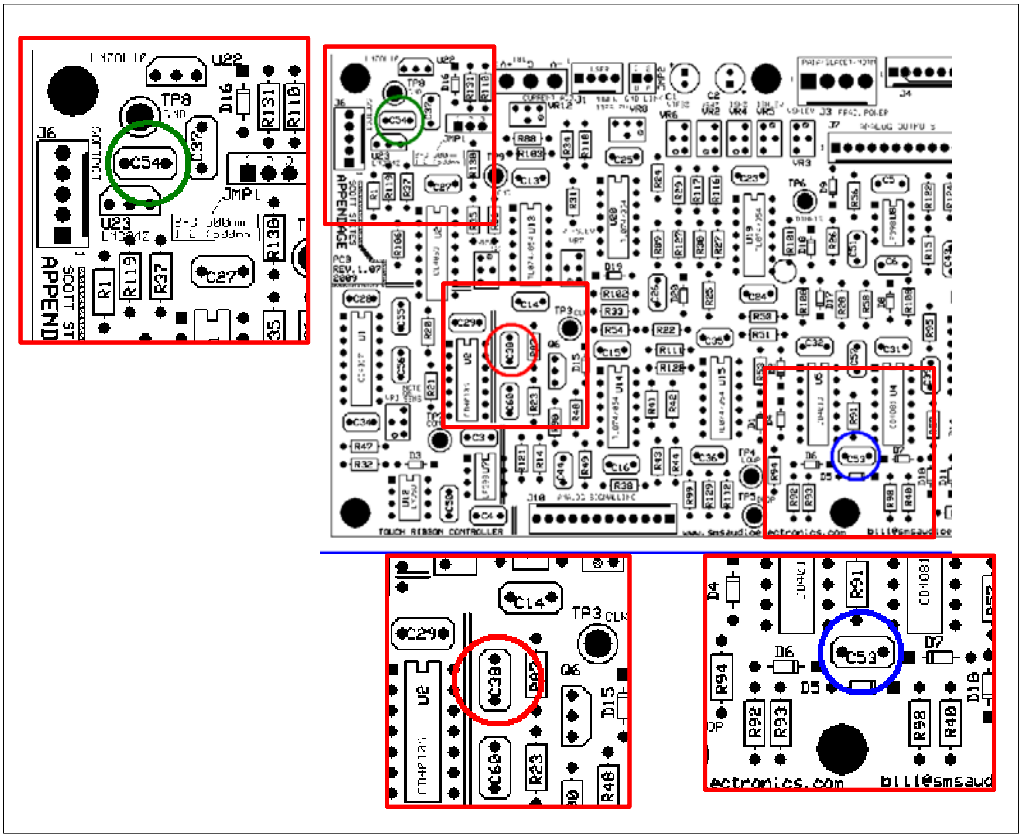


Figure 8-31: Locations for C38, C53 and C54

Single Capacitor Values 1 nF, 33 nF and 330 nF
You should have one each of the following capacitors:

- 1 nF ceramic capacitor – Install in the C38 location.
- 33 nF metal film box capacitor – Install in the C53 location.
- 330 nF ceramic capacitor – Install in the C54 location.

Use Table 8-36 to record and check the installation of these capacitors. **Figure 8-31** can be used to help locate the pads that the capacitors install to.

Table 8-36: 1 nF C38, 33 nF C53, 330 nF C54 (3 Total Capacitors)

Reference Designator	Value	Done
1 nF Ceramic Capacitor C38 (1 Total)		
C38	1 nF	
33 nF Metal Film Box Capacitor C53 (1 Total)		
C53	33 nF	
330 nF Ceramic Capacitor C54 (1 Total)		
C54	330 nF	

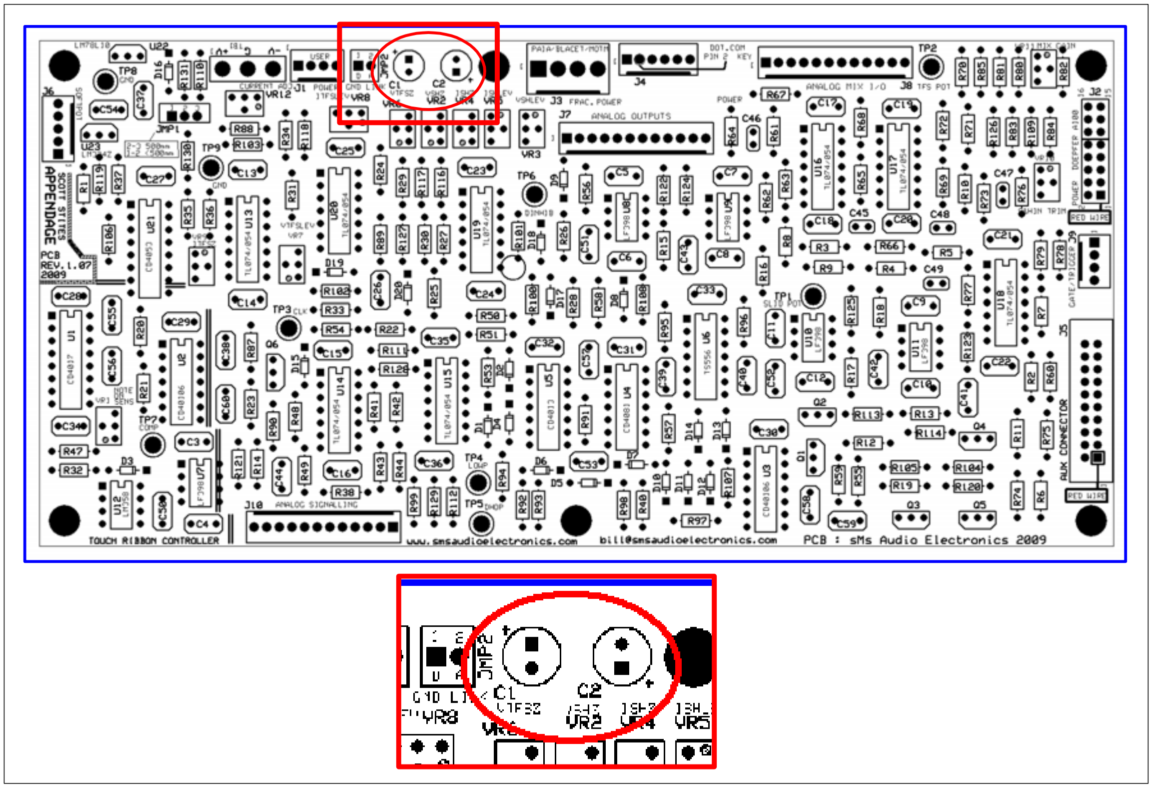


Figure 8-32: Locations for C1, C2

47 µF 35V Electrolytic Capacitors: 2 Total Capacitors

You should have two 47 µF electrolytic capacitors. These capacitors use reference designators C1 and C2. Be sure to observe the proper polarity when installing these electrolytic caps. Fortunately, the silk-screening indicates the positive side of the electrolytic caps, as well as specifying the correct pad by its shape (square as opposed to round). Install the positive lead of the capacitor in the square pad.

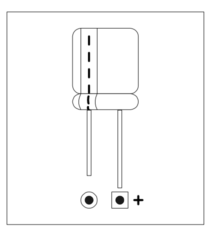


Figure 8-33: Electrolytic Capacitor Orientation

Install and solder the capacitors, using Table 8-37 to record that each capacitor has been installed. **Figure 8-32** can be used to help locate the pads for the capacitors.

Table 8-37: 47 µF Capacitors C1, C2

47µ Capacitors C55, C56 (2 Total)		
Reference Designator	**Value**	**Done**
C1	47 µF	
C2	47 µF	

This completes the installation of all of the capacitors used on the Appendage PCB. Next up will be the installation of all the diodes used by the Appendage, which promises to be a rollicking good time

Installing the Diodes

Know Thy Diodes
Before we even begin the process of Appendage Diode Installation, now would be a very good time to sit down and **be sure that you have your diodes separated out into the three types the Appendage uses**: fifteen 1N4148 silicon diodes, one 1N457 silicon diode and four BAT85 Schottky diodes. This is a very important point, indeed. The Appendage can suffer the accidental substitution of a silicon diode with a Schottky diode – it wouldn't be healthy, but it likely wouldn't damage any parts. However, if one were to accidentally install a silicon diode in the place reserved for a Schottky diode, this would result in the death of U21, the CD4053 switch IC that switches things back and forth between voltage and current mode. There's absolutely no maybe about it – the IC will die. It's imperative to be sure that the BAT85s (there are four of them) go where they're supposed to go, in the right direction, and that the 1N4148s (there are sixteen of those boys in the Appendage) go where they're supposed to go, in the right direction of course.

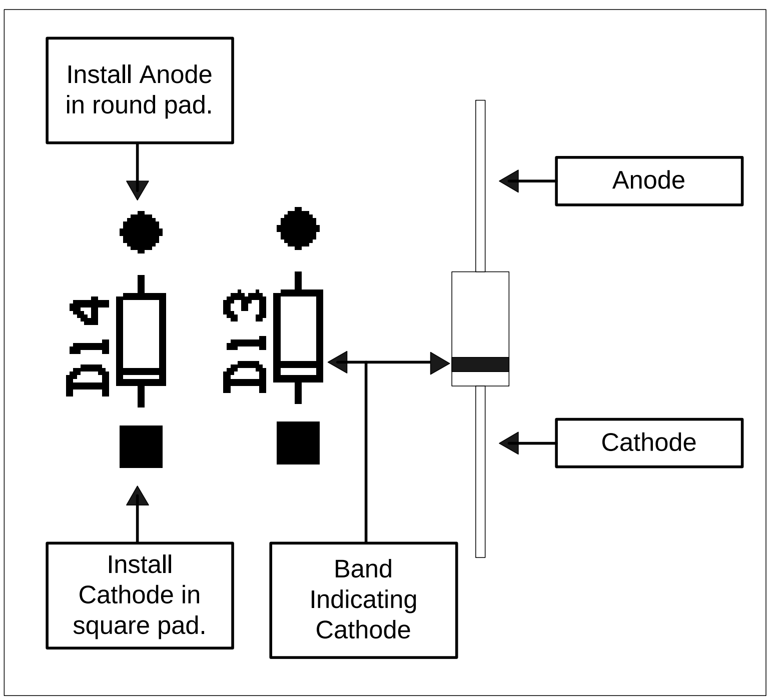


Figure 8-34: Installing Diodes Following the Silk-Screen Legend

Just to be sure we're all on the same page, **Figure 8-34** illustrates the silk-screen legend used for diodes. The cathode of the diode is indicated by a "bar", and the square pad of the diode legend also indicates the cathode connection.

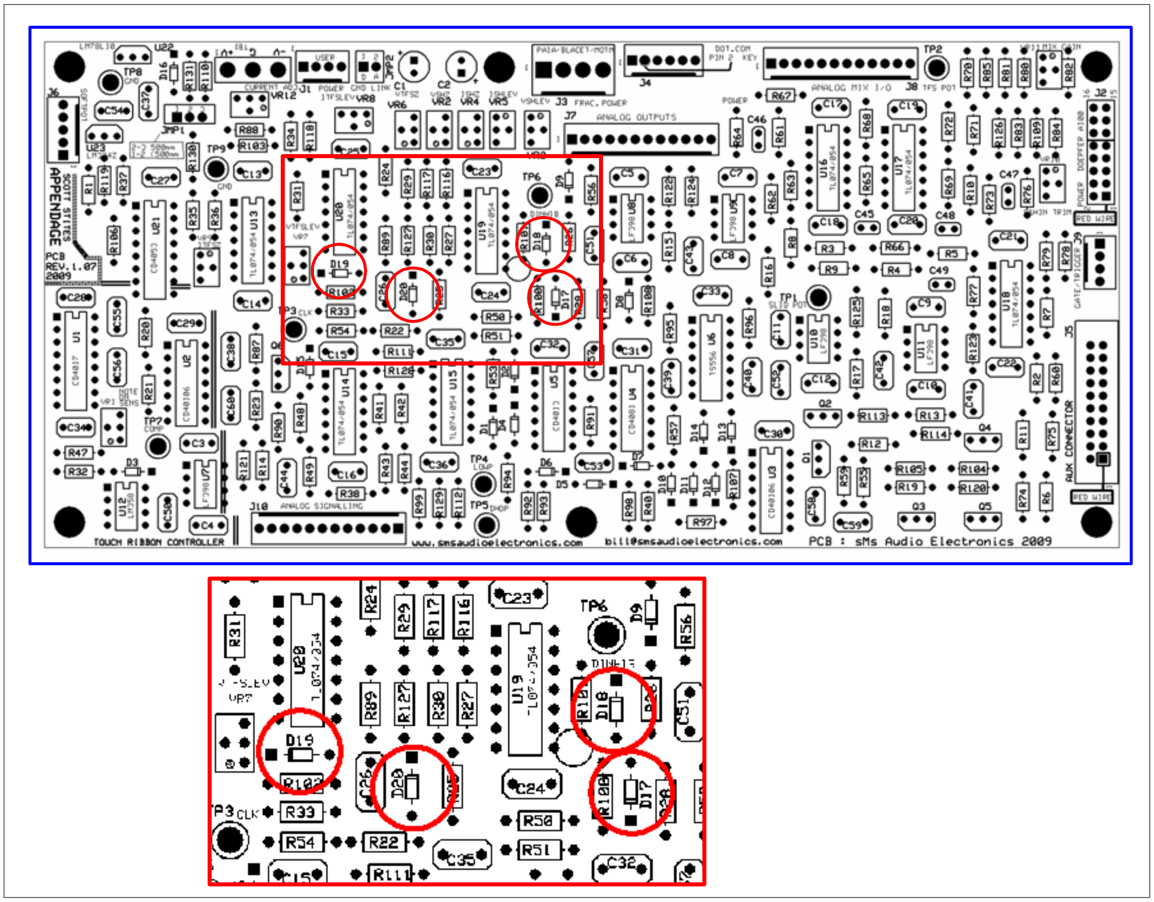


Figure 8-35: Locations for D17 through D20 (BAT85 Schottky Diodes)

BAT85 Schottky Diodes: 4 Total Diodes

Especially after the preceding harangue, you should have four BAT85 diodes sorted out and ready to install. These diodes use reference designators D17 through D20. Be sure to observe the proper polarity when installing these diodes. The silk-screening indicates the cathode of the diode, as well as specifying the correct pad by its shape (square as opposed to round). Install the cathode lead of the diode in the square pad.

Install and solder the diodes, using Table 8-38 to record that each diode has been installed. **Figure 8-35** can be used to help locate the pads for the diodes.

Table 8-38: Bat85 Schottky Diodes D17 through D20

BAT85 Schottky Diodes (4 Total)		
Reference Designator	**Value**	**Done**
D17	BAT85	
D18	BAT85	
D19	BAT85	
D20	BAT85	

1N457 Silcon Diode: 1 Total Diodes
You should have one 1N457 diode in your dwindling parts pile. Go ahead and install this diode. The 1N457 uses reference designator D16. Be sure to observe the proper polarity when installing this diode. The silk-screening indicates the cathode of the diode, as well as specifying the correct pad by its shape (square as opposed to round). Install the cathode lead of the diode in the square pad. Install and solder the diodes, using Table 8-39 to record that it has been installed. **Figure 8-32** can be used to help locate the pads for this diode: the location is the upper right quadrant of the board; **Figure 8-36** has the location marked in blue.

Table 8-39: 1N457 Silicon Diodes D16

1N457 Silicon Diode (1 Total)		
Reference Designator	**Value**	**Done**
D16	1N457	

1N4148 Silcon Diodes: 15 Total Diodes
You should have fifteen 1N4148 diodes in hand and ready to install. These diodes use reference designators D1 through D15. Be sure to observe the proper polarity when installing these diodes. The silk-screening indicates the cathode of the diode, as well as specifying the correct pad by its shape (square as opposed to round). Install the cathode lead of the diode in the square pad.

Install and solder the diodes, using Table 8-40 to record that each diode has been installed. **Figure 8-36** can be used to help locate the pads for this diode: the locations are marked in red.

Table 8-40: 1N4148 Silicon Diodes D1 through D15

1N4148 Silicon Diodes (15 Total)		
Reference Designator	**Value**	**Done**
D1	1N4148	
D2	1N4148	
D3	1N4148	
D4	1N4148	
D5	1N4148	
D6	1N4148	
D7	1N4148	
D8	1N4148	
D9	1N4148	
D10	1N4148	
D11	1N4148	
D12	1N4148	
D13	1N4148	
D14	1N4148	
D15	1N4148	

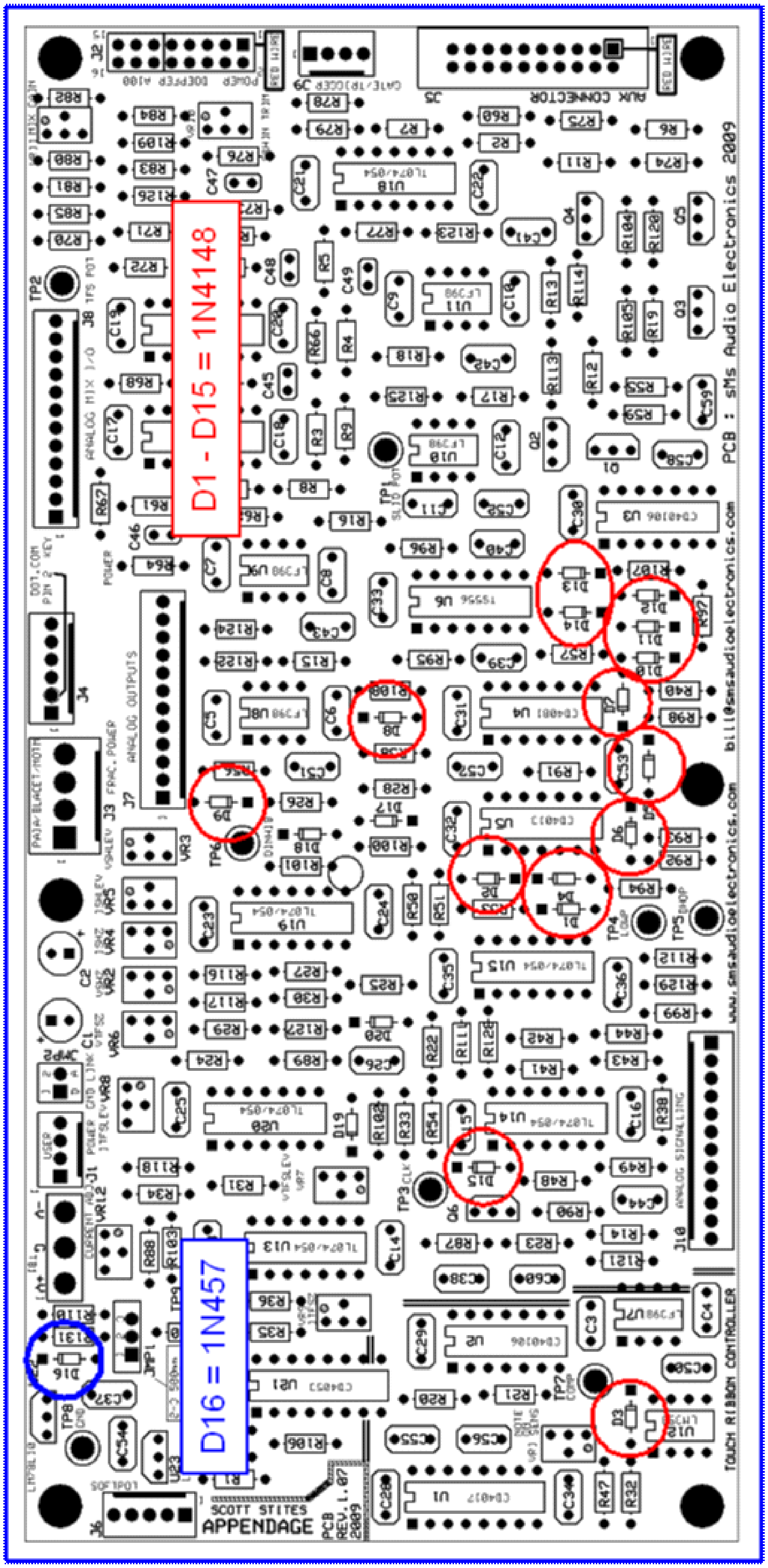


Figure 8-36: Locations for D1-D15 (1N4148) and D16 (1N457)

Now that the diodes have all been installed, we'll turn our attention to three-legged devices that the Appendage uses to do its Appendagy thing.

Installing Transistors and Other Three Leaded Devices

Sort Thy Parts
The Appendage uses two types of transistors (five 2N3904 NPN transistors and one MPF102 FET transistor). But, these are not the only three leaded, transistor looking devices that the Appendage uses, so be careful that you have everything sorted to begin with.

The two other three leaded parts, which look like transistors, are actually ICs: U22, a **78L10** Voltage Regulator and U23, an **LM334Z** Current Source. Before beginning, sort your 2N3904s and set them aside. Then find your MPF102 FET and separate it out. The same goes for the 78L10 and LM334Z – sort them out and make sure they're segregated individually so you don't have any chance of mistaking them for 2N3904s or each other.

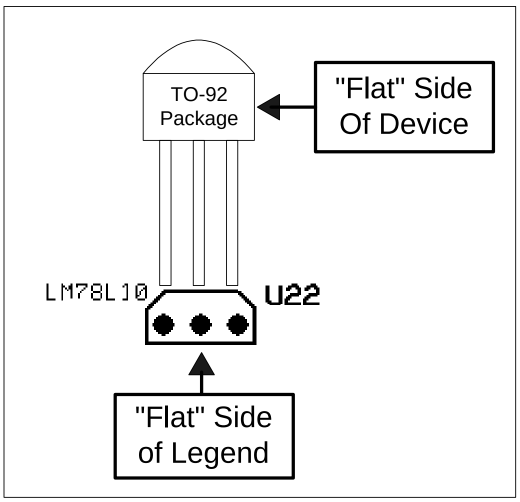


Figure 8-37: Orientation of T0-92 Devices

Obviously the reason that transistors and the ICs mentioned above look alike is because they share a common type of package called "T0-92". This package makes it easy to install the parts with the proper orientation. The T0-92 package has a "flat" side, and the silk-screened legend of the Appendage PCB reflects this flat side. When you install the TO-92 parts, ensure that the "flat side" of the part is aligned with the "flat side" of the legend.

If you should get a wild hair and decide to substitute a different type of NPN or FET transistor, be aware that, though the package looks the same, the actual function of the pins of the device may be assigned differently – a collector pin on one NPN may be an emitter pin on a different type of NPN. The same applies to the FET used on the Appendage. To be totally sure, use 2N3904s and an MPF102 if at all possible. U22 and U23, in all cases, must be a 78L10 and LM334Z, respectfully.

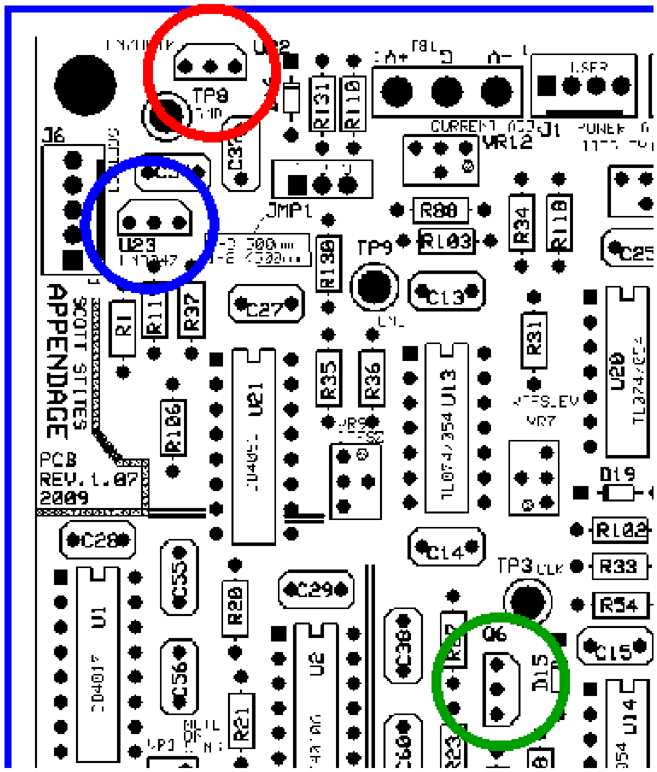


Figure 8-38: Location of U22 (LM78L10), U23 (LM334Z) and Q6 (MPF102 FET)

U22 LM78L10, U23 LM334Z, and Q6 MPF102
Make sure you have the **LM7L10** in hand, and install it in the U22 position on the upper left portion of the Appendage PCB. You can use **Figure 8-38** to help locate the position (it is marked in red). Be sure to install and solder the package with the flat side aligned with the flat portion of the silk-screened legend, and record it in Table 8-41.

Make sure you have the **LM334Z** in hand, and install it in the U23 position on the upper left portion of the Appendage PCB. You can use **Figure 8-38** to help locate the position (it is marked in blue). Be sure to install and solder the package with the flat side aligned with the flat portion of the silk-screened legend, and record it in Table 8-41.

Ensure that you have the **MPF-102** in hand, and install it in the Q6 position on the left portion of the Appendage PCB. You can use **Figure 8-38** to help locate the position (it is marked in green). Be sure to install and solder the package with the flat side aligned with the flat portion of the silk-screened legend, and record it in Table 8-41.

Table 8-41: U22 (LM78L10), U23 (LM334Z) and Q6 (MPF102 FET) – One Each

U2 (LM78L10), U23 (LM334Z) and Q6 (MPF102 FET) – One Each		
Reference Designator	**Value**	**Done**
U22	LM78L10	
U23	LM334Z	
Q6	MPF102	

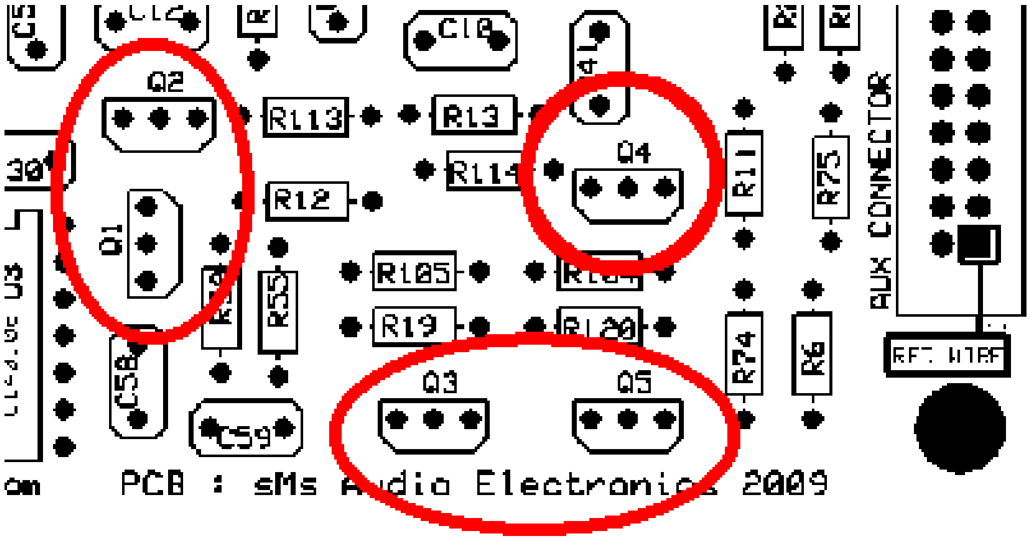


Figure 8-39: Locations for Q1-Q5

2N3904 Transistors: 5 Total

You should have five 2N3904 NPN transistors. These transistors use reference designators Q1 through Q5. Be sure to install and solder the transistors with the flat side of the package aligned with the flat portion of the silk-screened legend, and record each and every transistor from this group in Table 8-42. The transistors are all located on the lower right quadrant of the Appendage PCB. You can use **Figure 8-39** to help locate the pads.

Table 8-42: 2N3904 Transistors Q1 through Q5

2N3904 Transistors Q1 through Q5 (5 Total)		
Reference Designator	**Value**	**Done**
Q1	2N3904	
Q2	2N3904	
Q3	2N3904	
Q4	2N3904	
Q5	2N3904	

After this step, all of the three-leaded T0-92 devices will have been installed.

The next order of business is the installation of the trim pots.

Installing the Trim pots

The Appendage PCB contains pads for twelve multi-turn trim pots. These trim pots are used to calibrate the Appendage operation once everything is put together and ready.

The Appendage PCB can accommodate trim pots that have leads that are in a single row, and it can accommodate trim pots that have the "triangular" arrangement of leads.

The calibration procedure of the Appendage is predicated on the fact that turning the adjustment screw one specific way (such as clockwise) will result in a predictable response, and, thus, turning the adjustment screw the other way will also result in a predictable response. Because it's possible to install trim pots that have the leads arranged in a straight line in either direction, the silkscreen legend of the trim pots indicates the correct alignment of the trim pot by placing a symbol of the adjustment screw on the PCB.

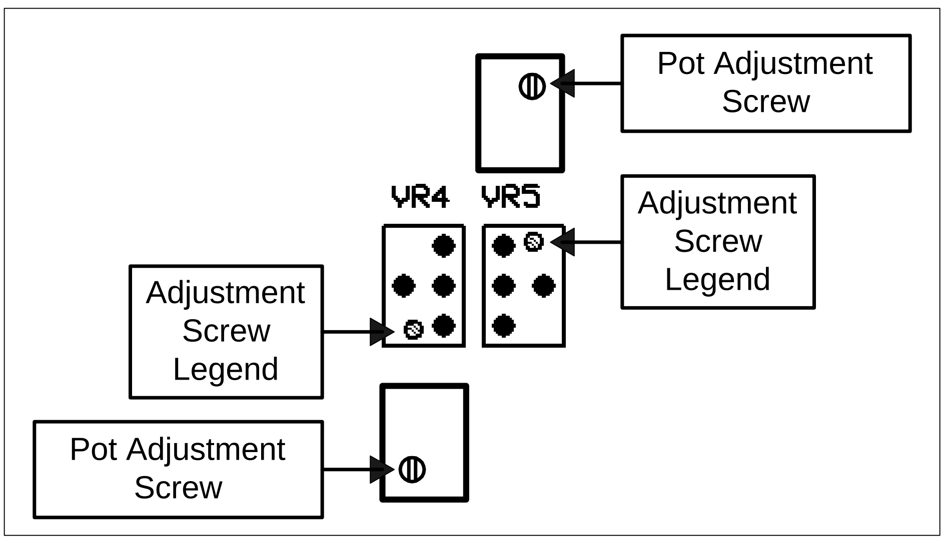


Figure 8-40: Trim Pot Orientation

Figure 8-40 illustrates the correct orientation of VR4 and VR5. The silkscreen legend for VR4 indicates that, when installed, VR4 should have its adjustment screw pointing towards the "bottom" of the board. The silkscreen legend for VR5 indicates that its adjustment screw should be pointing towards the top of the board when it is installed.

In short: in order for the calibration procedure to work as written, be sure to observe the orientation of the trim pots when installing them.

Before installation, sort your trim pots out. You should have ten 100K trim pots, one 200K trim pot, and one 10K trim pot.

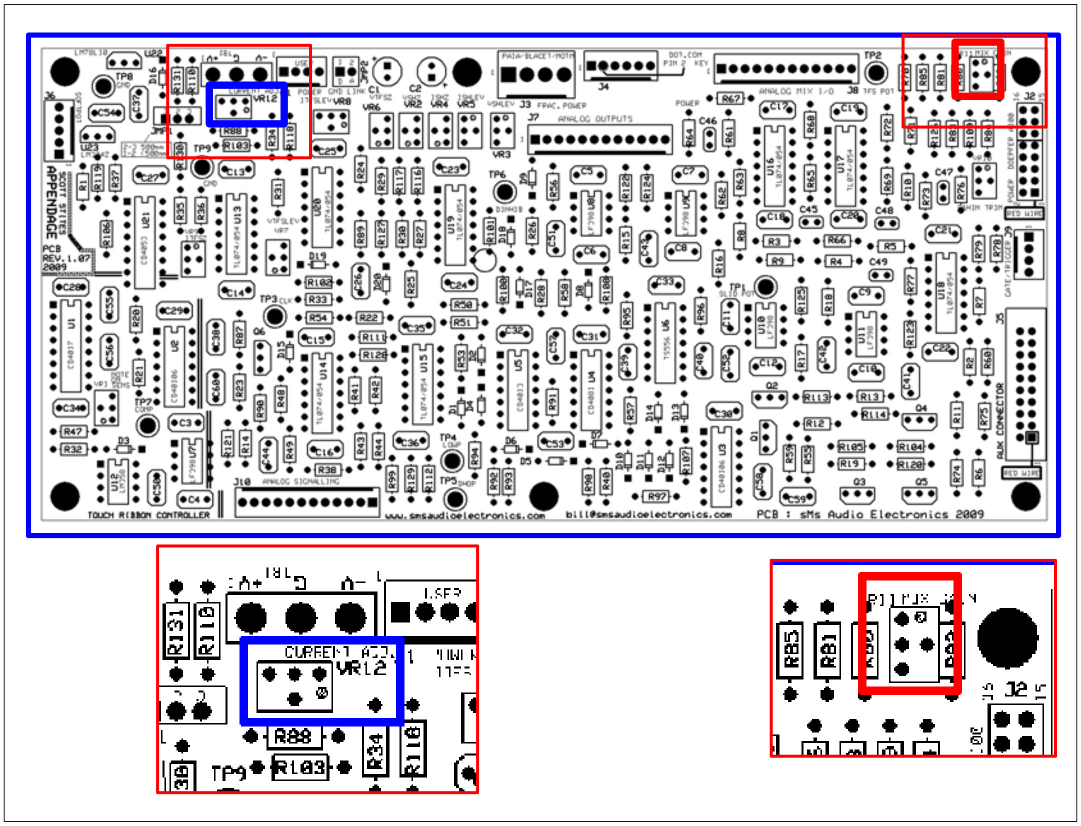


Figure 8-41: Locations of VR11 (200K Trim) and VR12 (10K Trim)

VR11 (200K Trim)
You should have one 200K multi-turn trim pot. This should be installed in the pads reserved for VR11 on the **upper right** portion of the Appendage PCB. You can use **Figure 8-41** to help locate the position (it is marked in red). Be sure to install and solder this 200K trim pot so that the adjustment screw of the trim pot corresponds to the adjustment screw depicted on the silk screen legend. After you have installed VR11, record it in Table 8-43.

VR12 (10K Trim)
You should have one 10K multi-turn trim pot. This should be installed in the pads reserved for VR12 on the **upper left** portion of the Appendage PCB. You can use **Figure 8-41** to help locate the position (it is marked in blue). Be sure to install and solder this 10K trim pot so that the adjustment screw of the trim pot corresponds to the adjustment screw depicted on the silk screen legend. After you have installed VR12, record it in Table 8-43.

Table 8-43: VR11 (200K Trim Pot) and VR12 (10K Trim Pot) – One Each

VR11 (200K Trim Pot) and VR12 (10K Trim Pot) – One Each		
Reference Designator	**Value**	**Done**
VR11	200K Multi-Turn Trim Pot	
VR12	10K Multi-Turn Trim Pot	

100K Trim Pots: 10 Total
You should have ten multi-turn 100K trim pots. These trim pots use reference designators VR1 through VR10. You can use **Figure 8-42** to help locate the position of each trim pot. Be sure to install and solder these 100K trim pots so that the adjustment screw of each trim pot corresponds to the adjustment screw depicted on the corresponding silk screen legend. After you have installed each trim pot, record it in Table 8-44.

Table 8-44: 100K Trim Pots VR1 through VR10

100K Trim Pots VR1 through VR10 (10 Total)		
Reference Designator	**Value**	**Done**
VR1	100K Multi-Turn Trim Pot	
VR2	100K Multi-Turn Trim Pot	
VR3	100K Multi-Turn Trim Pot	
VR4	100K Multi-Turn Trim Pot	
VR5	100K Multi-Turn Trim Pot	
VR6	100K Multi-Turn Trim Pot	
VR7	100K Multi-Turn Trim Pot	
VR8	100K Multi-Turn Trim Pot	
VR9	100K Multi-Turn Trim Pot	
VR10	100K Multi-Turn Trim Pot	

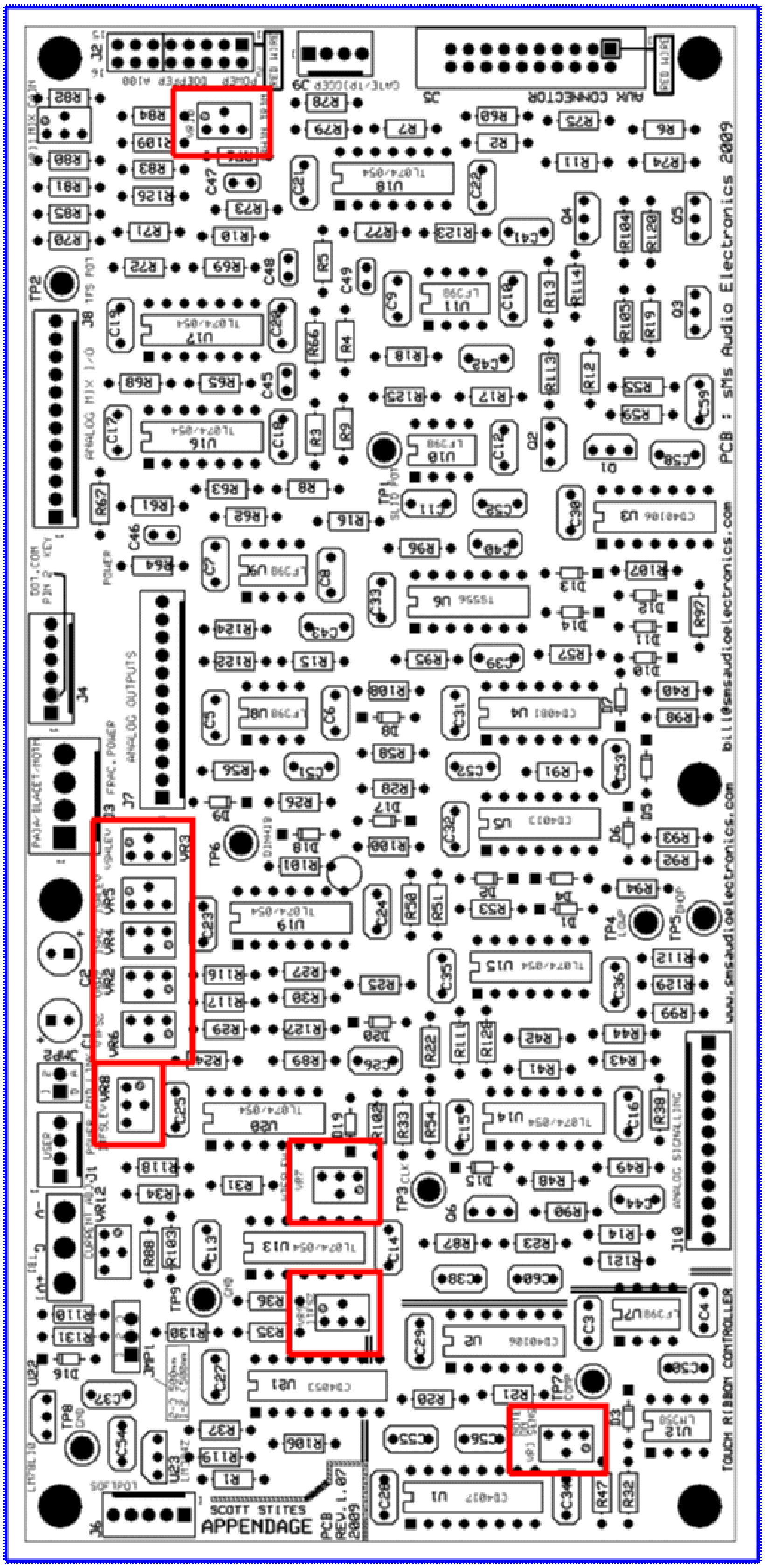


Figure 8-42: Locations of 100K Trim Pots VR1 through VR10

Installing Test Points

Test Points
The Appendage PCB contains a total of nine test points that are used during calibration and provide signal points for trouble-shooting. These test points are handy for clipping multi-meter and oscilloscope leads to, leaving the hands free to adjust trim pots or control settings on test equipment.

Test Points: 9 Total
You should have nine test point leads. These test points use reference designators TP1 through TP9. You can use **Figure 8-43** to help locate the position of each test point. After you have installed and soldered each trim test point, record it in Table 8-45.

Table 8-45: Test Points TP1 through TP9

Test Points TP1 through TP9 (9 Total)		
Reference Designator	**Value**	**Done**
TP1	Test Point	
TP2	Test Point	
TP3	Test Point	
TP4	Test Point	
TP5	Test Point	
TP6	Test Point	
TP7	Test Point	
TP8	Test Point	
TP9	Test Point	

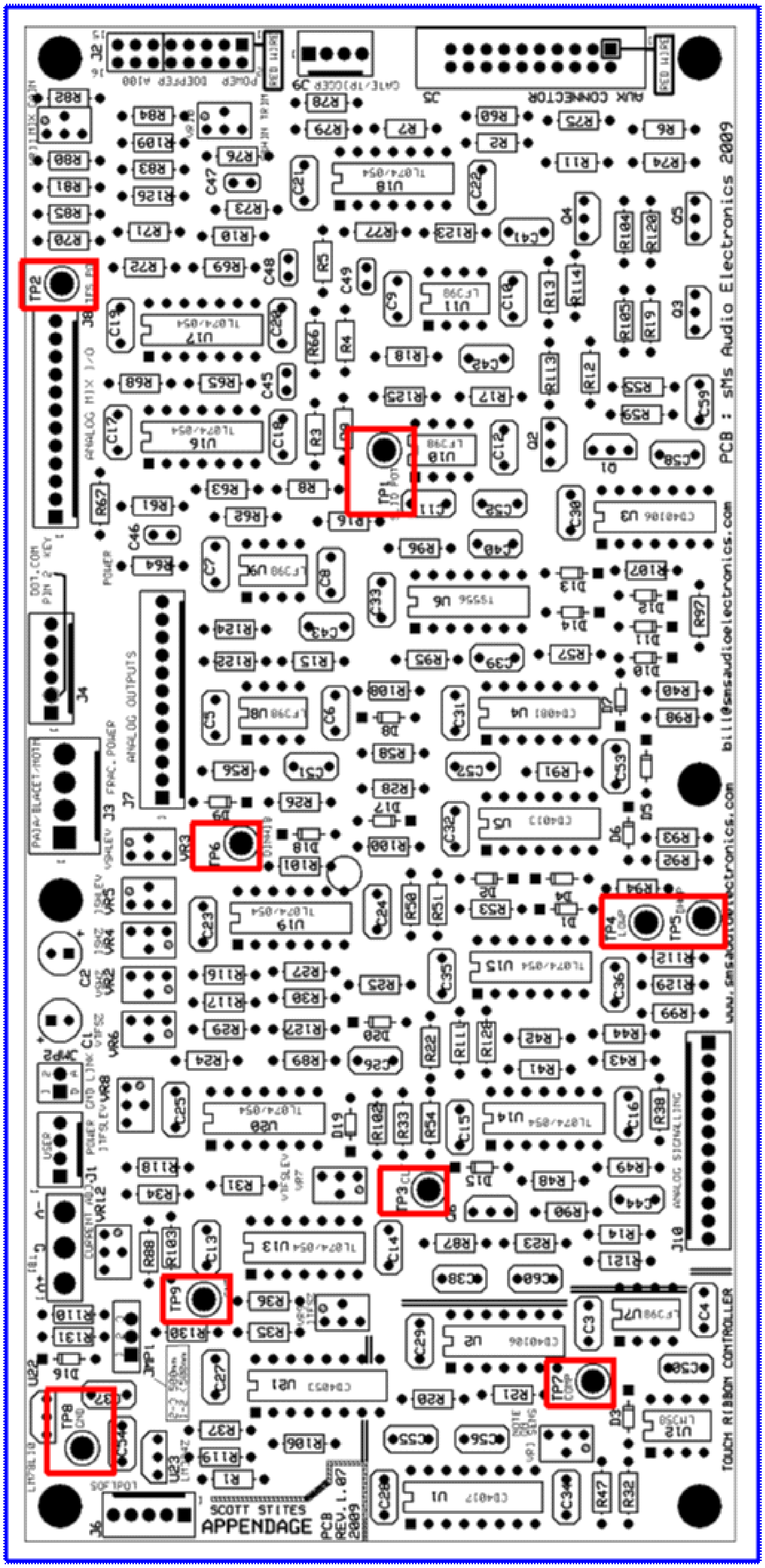


Figure 8-43: Locations of Test Points TP1 through TP9

Installing Configuration Jumpers

There are two jumper wires that require installation: JMP1 and JMP2. Each jumper is used to determine an operating characteristic of the Appendage. At this time, you should have a pretty good idea of how your ultimate Appendage will be configured. If you do not, you can hold off on this decision, but rest assured your Appendage will not be ready for operation until at least one of these two jumpers is installed.

JMP1
Jumper 1 (JMP1) is used to configure the Appendage to accommodate either a 500mm SoftPot® ribbon or a SoftPot® ribbon that is less than 500mm in length, because the overall resistance of the ribbon is tied to the length of the ribbon. JMP1 configures the Appendage circuitry to accommodate one of the two possible choices (500mm length or less than 500mm length). Generally, the next step down from a 500mm ribbon is 200mm.

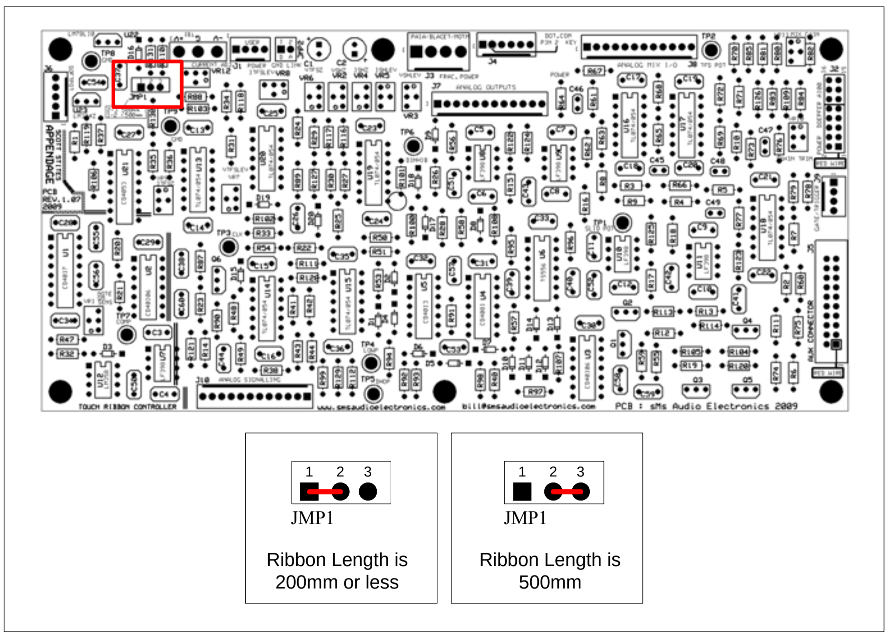


Figure 8-44: Jumper 1 (JMP1) Installation

Refer to **Figure 8-44** to locate the JMP1 pads. The pad numbers are silkscreened on the Appendage PCB.

- If the ribbon length is 200mm or less, solder a piece of bus wire between pad 1 (square pad on the left) and pad 2 (middle round pad).
- If the ribbon length is 500, solder a piece of bus wire between pad 2 (middle round pad) and pad 3 (round pad on the right).

Mark the configuration of JMP1 in Table 8-46.

Table 8-46: JMP1 Installation

JMP1 Installation	<500mm Length ☐	500 mm Length ☐

JMP2

Jumper 2 (JMP2) is used to configure the Appendage to accommodate either a dual ground power supply line or a single ground power supply line.

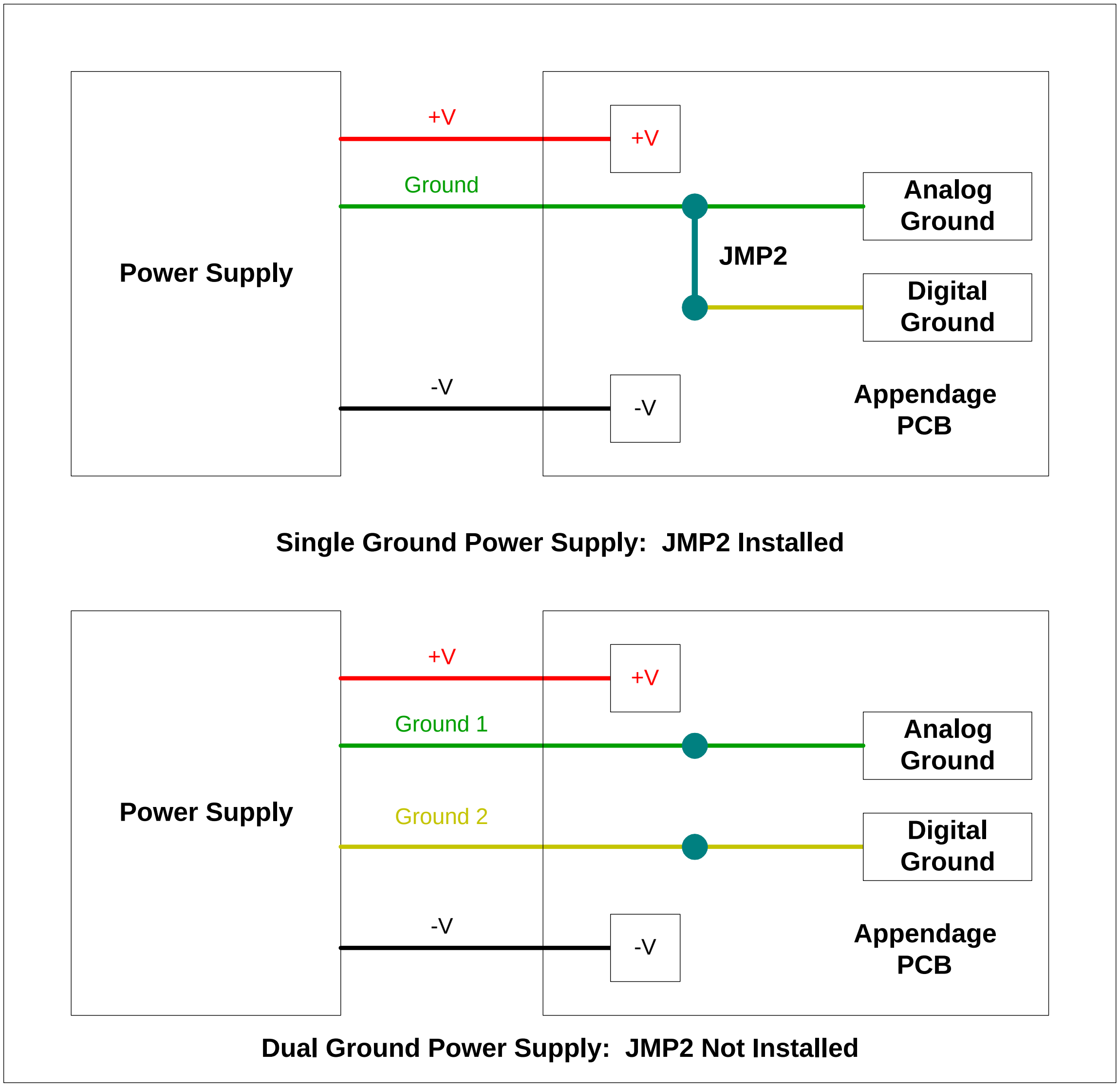


Figure 8-45: Purpose of Jumper 2

Figure 8-45 illustrates the purpose JMP2 serves. Internally, the Appendage PCB uses two ground planes – one is labeled "Analog Ground" and the other is labeled "Digital Ground". The Analog Ground signal serves components that depend on as "quiet" of a ground as possible. The Digital Ground signal is used to reference components that may dump transients onto the ground system which might disturb the tenants of the Analog Ground system. This concept is not unique to the Appendage – many systems accommodate an Analog (or "Quiet") Ground and a Digital (or "Noisy") ground, and some do so in spades.

In reality, both ground systems are at the same potential – they both originate and diverge from the same source. Some systems split the ground signal at the board level – the power supply may supply only a single ground, and it is on the PCB that the ground is split into two paths. The Appendage PCB performs this task when JMP2 is installed. In **Figure 8-45**, the "single ground" example at the top shows how this is accomplished. The depicted power supply has only one ground connection. That single connection is connected to the ground input of the Appendage. If JMP2 is not in place, the Digital Ground path of the Appendage PCB is physically disconnected from this input, and things will not work. By installing JMP2, the Digital Ground system shares the power supply ground input with the Analog Ground System. The two systems are only connected together at that one spot (JMP2), which accomplishes the goal of keeping any interaction between the two systems at a bare minimum.

The lower portion of **Figure 8-45** depicts the connection using a power supply that has separate ground lines. In this case, JMP2 is not needed – the Digital Ground path will connect all the way back to the power supply before it is joined with Analog Ground, thus theoretically improving the isolation between the two systems.

A dual ground feed from the power supply will work if JMP2 is installed or not. However, JMP2 **must** be installed if a single power ground feed is connected to the Appendage PCB.

Only two power connectors accommodate two different ground signals: J1, the smaller User Power Molex® connector, and J3, the larger Blacet™/PAiA™/MOTM™ style Molex® connector.

The decision to install JMP2 boils down to the following:

- **<u>If you are not using J1 or J3 as your power input connector, then you need to install JMP2</u>**

- **<u>If you are using J1 or J3 as the power input connector, but only have one ground line connected from the power supply to only one of the middle ground connection pins of J1 or J3, then you need to install JMP2.</u>**

- **<u>If you are using J1 or J3 as the power input connector, and your power supply has two ground signals supplying both middle ground connection pins on J1 or J3, then you do not install JMP2.</u>**

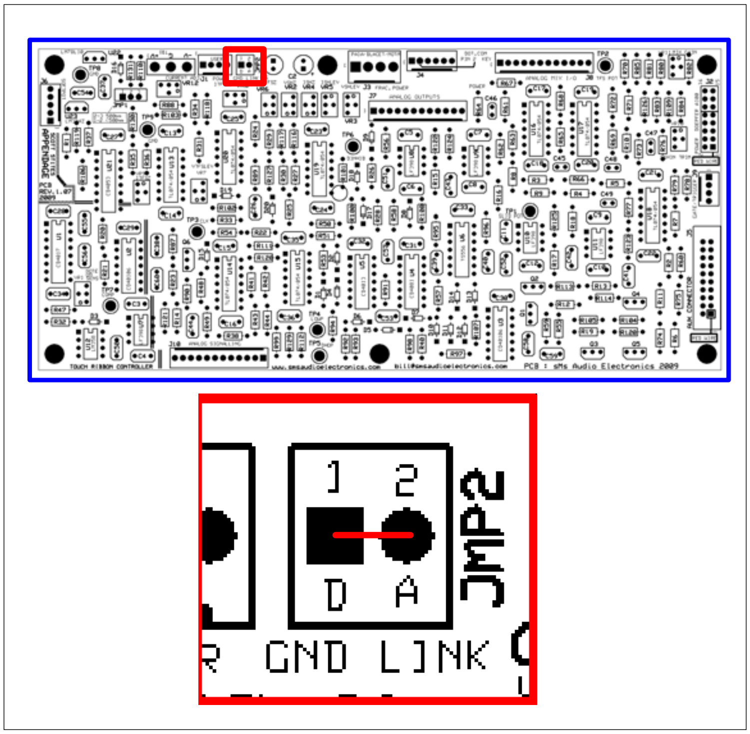


Figure 8-46: Jumper 2 (JMP2) Installation

Installing JMP2
Refer to **Figure 8-46** to locate the JMP1 pads. The pads are silkscreened with letters “D” and “A”.

- If power supply connection to the Appendage PCB has only one ground line feeding the PCB, install JMP2 (a bus wire soldered to the “D” and “A” pads).
- If power supply connection to the Appendage PCB has two ground lines feeding the PCB using J1 or J3, do not install JMP2.

Mark the configuration of JMP2 in Table 8-47.

Table 8-47: JMP2 Installation

JMP2 Installation	Installed ☐	Not Installed ☐

Clean the Board

If you have followed the PCB procedure up to this point, and plan to use the connector system to interface to the front panel, you can hang up your soldering iron. From here on out it's plug, baby, plug. Well, also calibrate, baby calibrate, and assemble, baby, assemble, and…well, anyway, you're done soldering, unless you need to go back and fix something, so you're *likely* done soldering anyway.

Before proceeding any further, though you still need to install the ICs into their sockets, let's go ahead and clean the solder residue off the board first. Depending on the type of solder used, you will need either harsh chemicals or clear mountain spring water. Whatever method you've chosen, the main thing is you want to get that excess flux off of the Appendage PCBs undercarriage. Any flux gathered around those S&H IC pins is *not* your friend.

Install the ICs

Now that the board is cleaned of all flux, and is dry and free of corrosive chemicals, it's time to install the ICs into their sockets.

Installing the ICs
Remember to follow ESD (Electro Static Discharge) precautions while doing installing the ICs. We're dealing with CMOS and high impedance analog parts here, so be sure you're nice and grounded when handling these ICs.

With each IC you install, be sure to check for the common screw-ups that so seem to plague so many IC-Socket Installation parties:

- Make sure the IC is pointing in the right direction. On the Appendage PCB, the notch at the top of the IC is always pointing towards the top of the board, and pin 1 is always the upper left pin (as indicated by the square pad that's nearly impossible to see now that a socket is installed there).

- Make sure that all of the IC leads have inserted successfully into their respective slots. Check for pins that may have curled under the IC, or are sticking outside of the socket, or are sharing a slot with another pin. An IC pin straightening device is a real nice investment for helping to prevent this phenomenon. Look into getting one if you don't have one already.

- Ensure that each IC is fully seated in its socket. Apply firm force, even force on the IC (but don't flex the board!) to ensure that it's inserted completely into the socket.

- Be sure to put the right IC into the right socket. Double-check.

Seeing as how the sockets are installed, there's not much of a chance to install a 14 pin part into a 16 pin socket, unless the installer is incapable of seeing that there is more socket there than IC. So, we'll start inserting ICs according to IC type. We'll begin with the most numerous of ICs on the Appendage, the TL074.

Inserting TL074s Into the IC Sockets: 8 Total

You should have eight 14 pin TL074 ICs. These ICs use reference designators U13 through U20. Install the ICs in their respective sockets, using Table 8-48 to record and verify that each IC has been installed. **Figure 8-47** can be used to help locate the correct socket and location for each IC. The TL074s are marked in red.

Table 8-48: TL074 ICs U13 through U20

TL074 ICs U13 through U20 (8 Total)		
Reference Designator	**Value**	**Done**
U13	TL074	
U14	TL074	
U15	TL074	
U16	TL074	
U17	TL074	
U18	TL074	
U19	TL074	
U20	TL074	

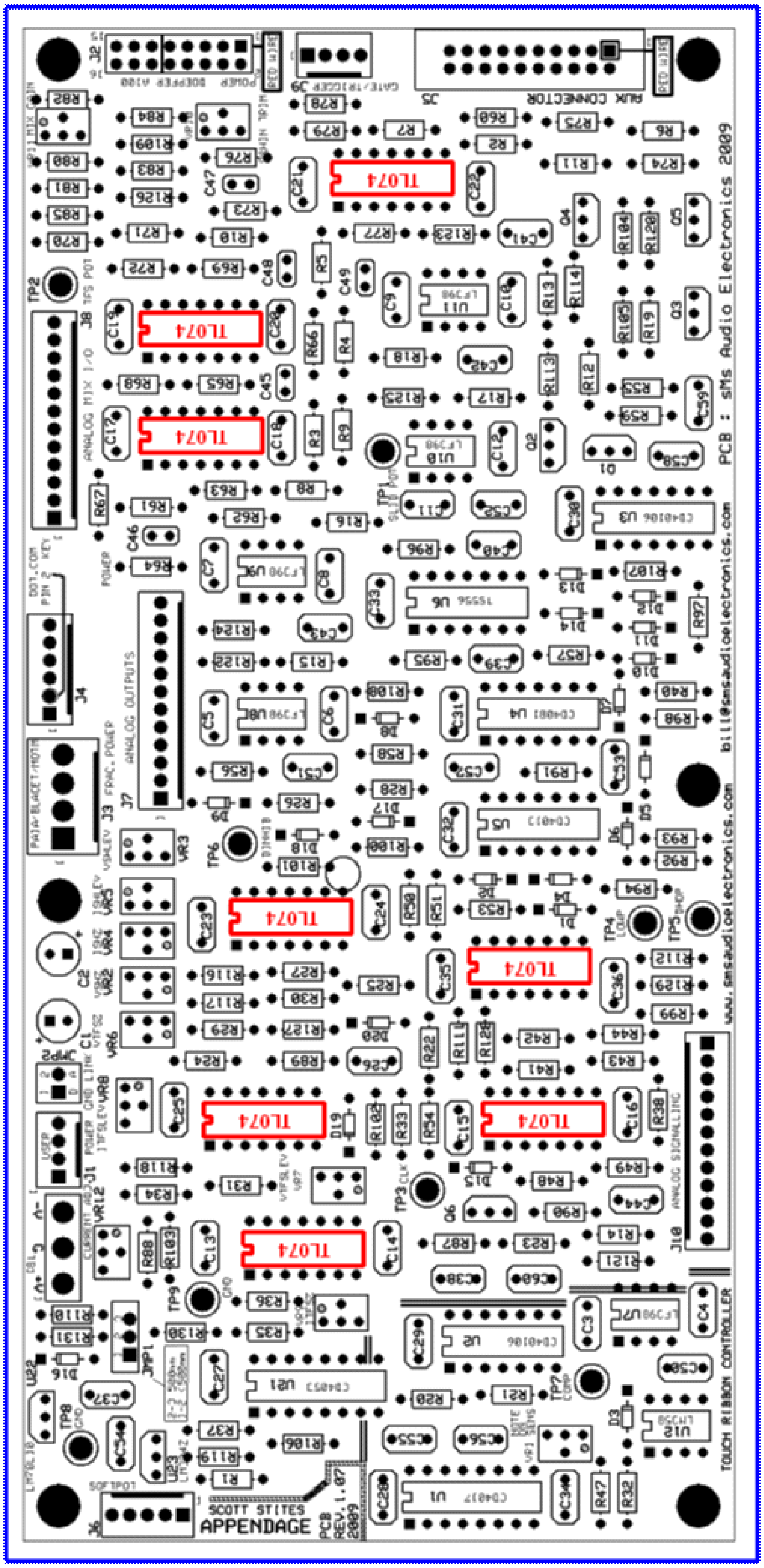


Figure 8-47: TL074 IC Locations

Inserting (2) CD40106, (1) CD4017 and (1) LM358 ICs: 4 Total
Now we're going to mix things up a little bit. The idea is that, because we are installing two 14 pin ICs (the CD40106 ICs), one 16 pin IC (the CD4017) and one 8 pin IC (the LM358), the chances of getting the wrong IC in the wrong socket are reduced, because no type of IC has the same number of pins.

So, grab:

- Two 14 Pin CD40106 ICs (U2,U3)
- One 16 Pin CD4017 IC (U1)
- One LM358 IC (U12)

and install them in their respective sockets, using Table 8-49 to record and verify that each IC has been installed. **Figure 8-48** can be used to help locate the correct socket and location for each IC. The ICs to be installed in this step are marked in red.

Table 8-49: CD40106 (U2, U3) CD4017 (U1) and LM358 (U12)

CD40106 (U2, U3) CD4017 (U1) and LM358 (U12) (4 Total)		
Reference Designator	**Value**	**Done**
U2	CD40106	
U3	CD40106	
U1	CD4017	
U12	LM358	

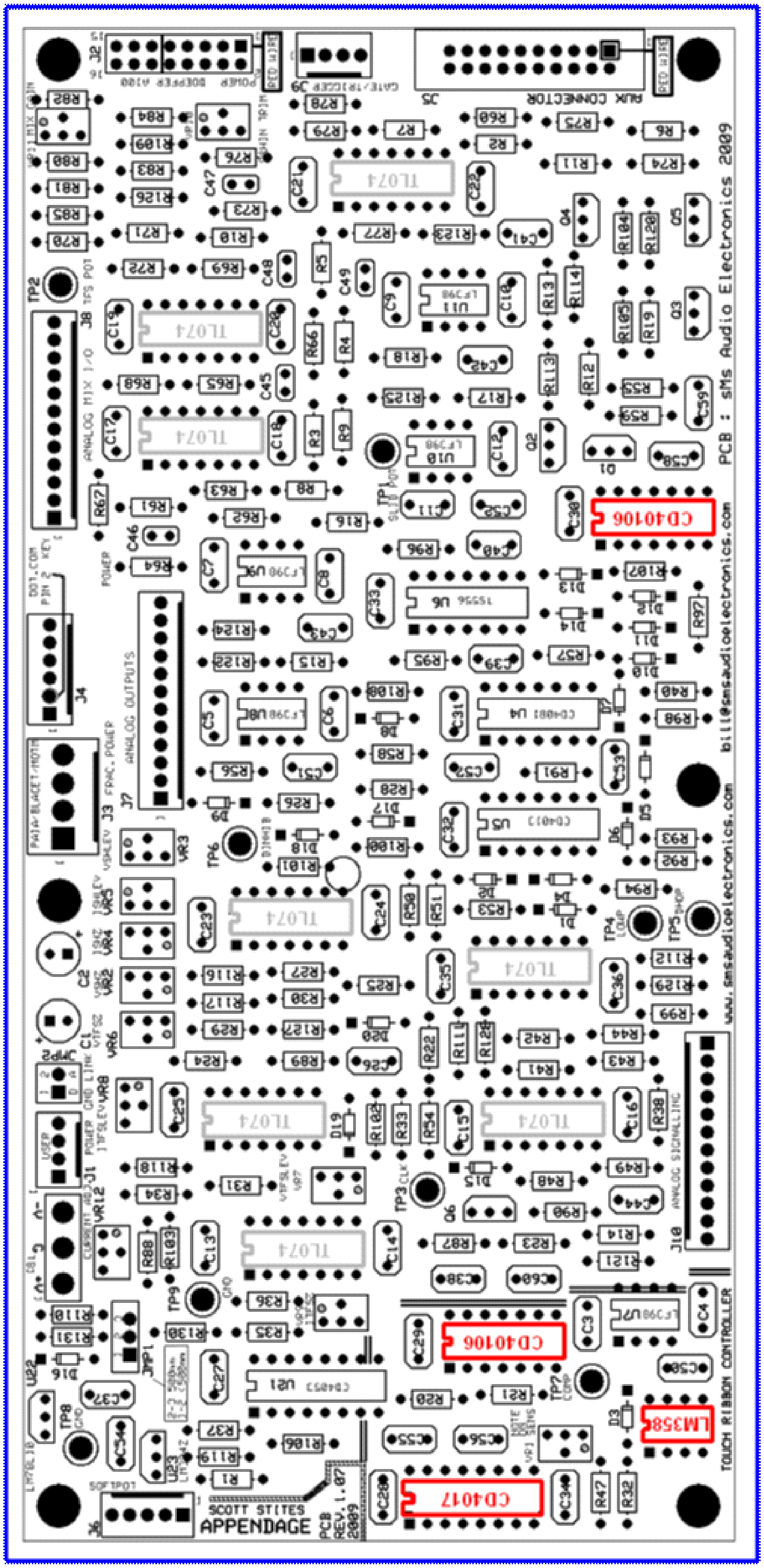


Figure 8-48: CD40106, CD4017 and LM358 IC Locations

Inserting (1) CD4053, (1) TS556, and (1) CD4013: 3 Total

We're going to mix things up a little bit again – this time we will install three ICs: one 16 pin IC (the CD4053 IC) , one 14 pin TS556 IC and one 14 pin CD4053 IC.

So, gather together:

- One 16 Pin CD4053 ICs (U21)
- One 14 Pin TS556 IC (U6)
- One 14 Pin CD4013 IC (U5)

and install them in their respective sockets, using Table 8-50 to record and verify that each IC has been installed. **Figure 8-49** can be used to help locate the correct socket and location for each IC. The ICs to be installed in this step are marked in red.

Table 8-50: CD4053 (U21), TS556 (U6) and CD4013 (U5)

CD4053 (U21), TS556 (U6) and CD4013 (U5) (3 Total)		
Reference Designator	**Value**	**Done**
U21	CD4053	
U6	TS556	
U5	CD4013	

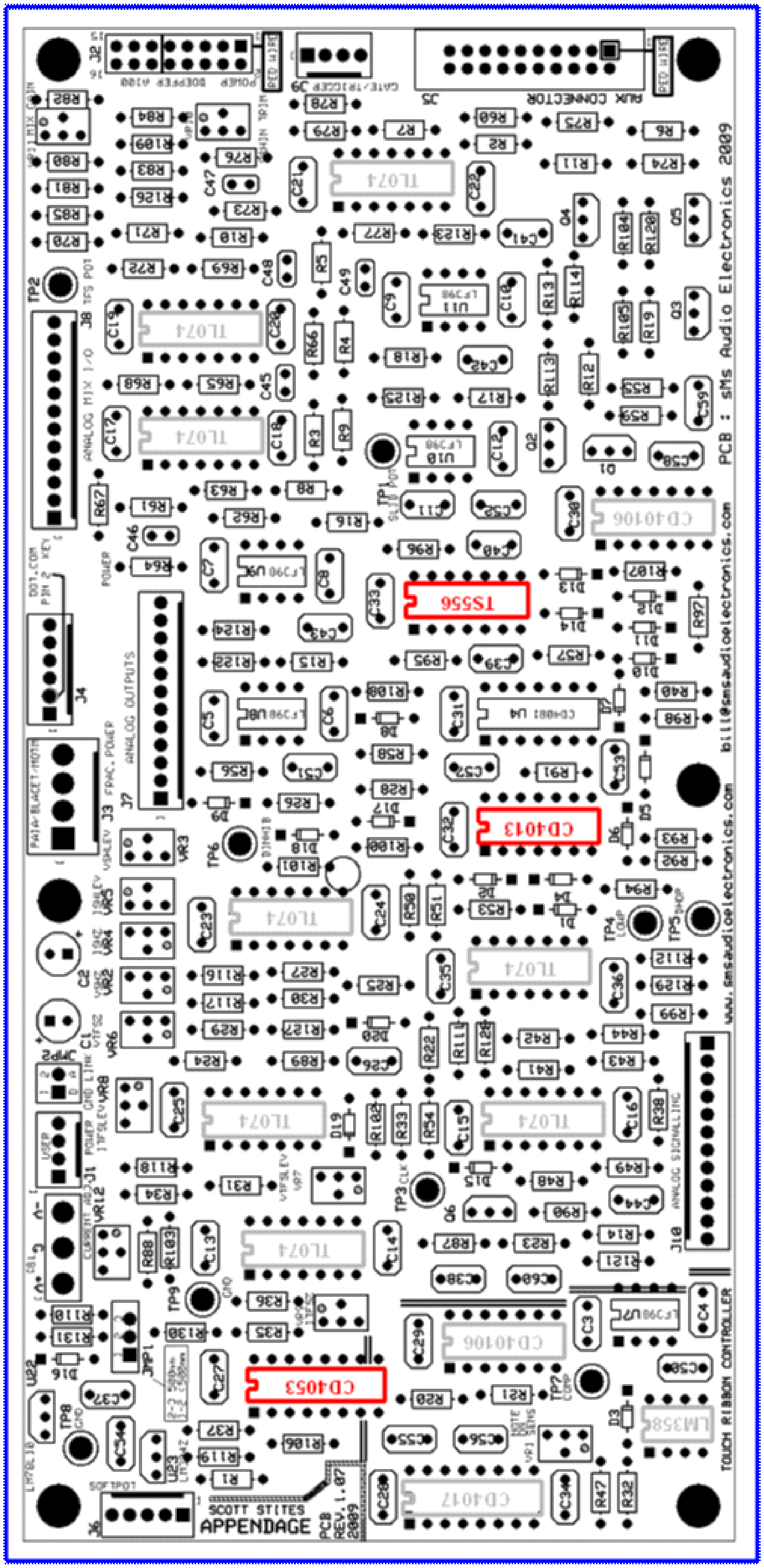


Figure 8-49: CD4053, TS556 and CD4013 IC Locations

Inserting (1) CD4081 and (5) LF398: 6 Total
And, for the final IC installation step, we'll install one 14 pin CD4081 IC and five 8 Pin LF398 ICs.

So, grab the remaining ICs:

- One 14 Pin CD4081 ICs (U4)
- Five 8 Pin LF398 ICs (U7 through U11)

and install them in their respective sockets, using Table 8-51 to record and verify that each IC has been installed. **Figure 8-50** can be used to help locate the correct socket and location for each IC. The ICs to be installed in this step are marked in red.

Table 8-51: CD4081 (U4) and LF398 (U7 through U11)

CD4081 (U4) and LF398 (U7 through U11) (6 Total)		
Reference Designator	**Value**	**Done**
U4	CD4081	
U7	LF398	
U8	LF398	
U9	LF398	
U10	LF398	
U11	LF398	

The installation of all the ICs in their sockets should be complete. As a final verification step, use **Figure 8-51** to double check that all ICs are installed in the proper sockets.

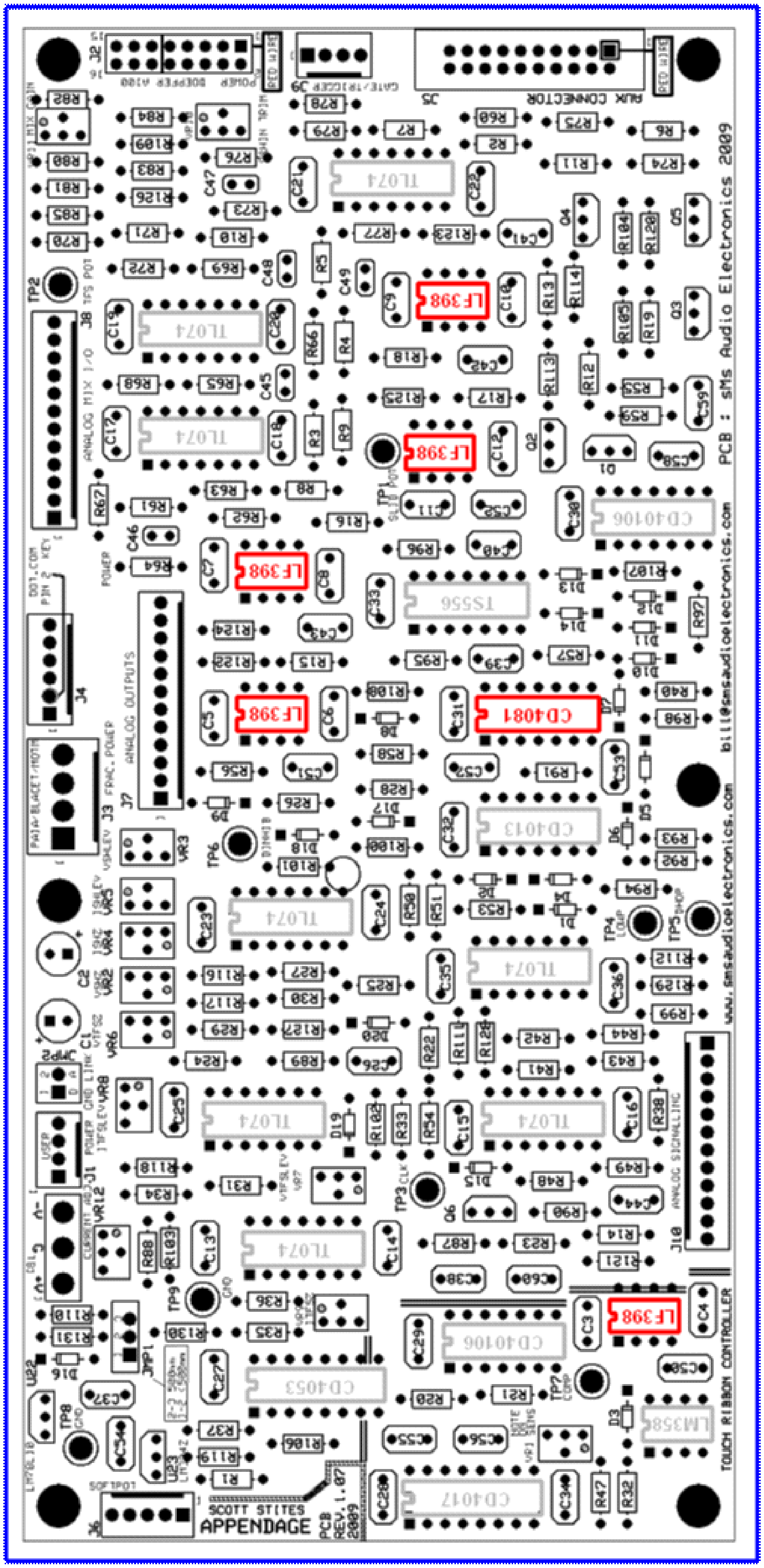


Figure 8-50: CD4081 and LF398 IC Locations

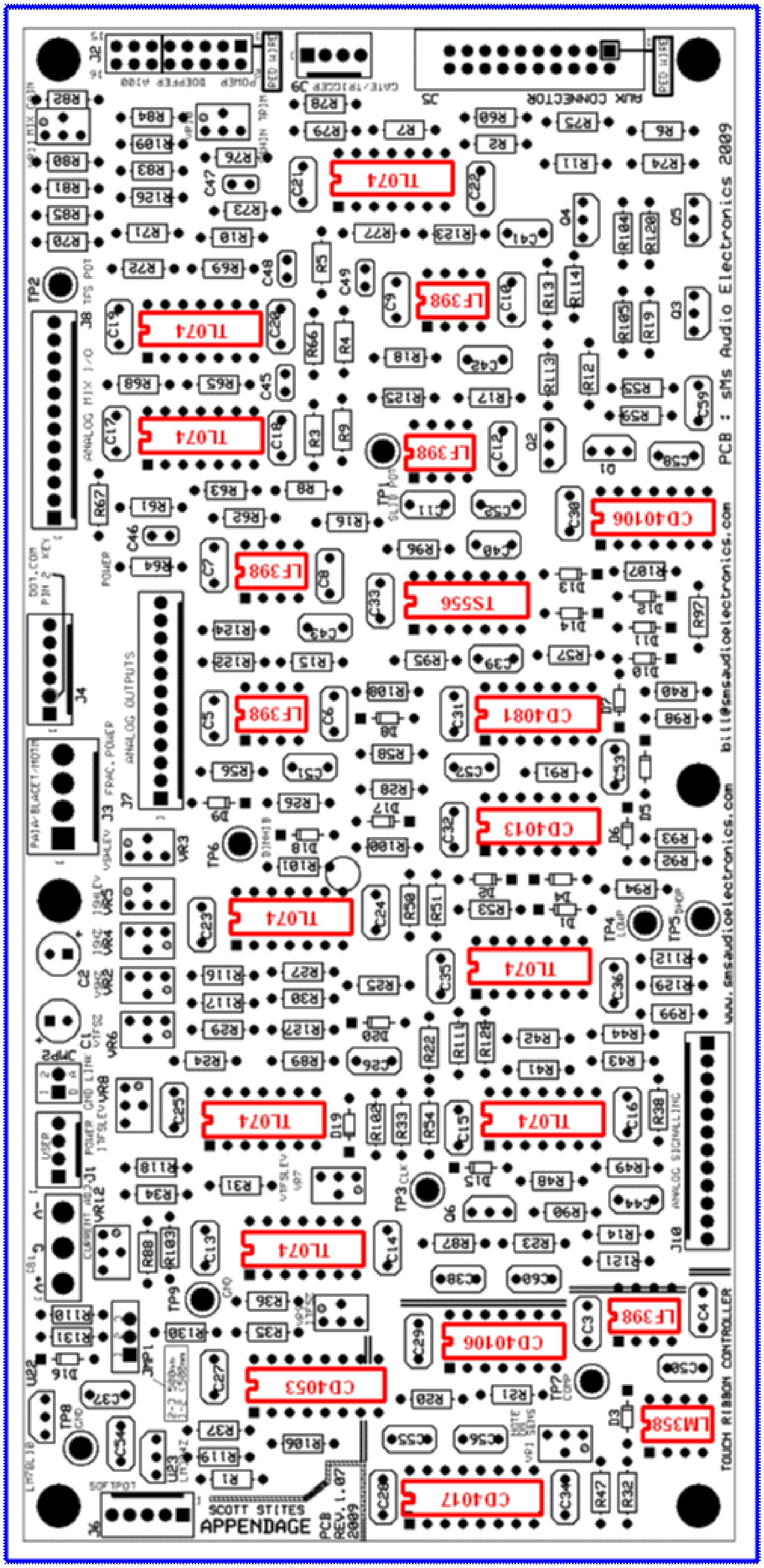


Figure 8-51: Socketed IC Final Check

9. Appendage Calibration Procedure

Calibration Overview

Once the Appendage is fully assembled, and power is applied, nothing is likely going to work as expected until the calibration procedure is finished, so don't worry if you're not getting the response you expected when you first power things up. Certain parameters will need to be calibrated before you can start wailing away on your Appendage.

Parameters Requiring Calibration
Most of the Appendage calibration is in place to match the circuitry to the ribbon controller interface. The SoftPot® ribbons will vary in resistance value from ribbon to ribbon, so the circuitry must be adjusted to match the specific ribbon being used to interface with the Appendage.

The Appendage operates in two distinct modes of operation: The Voltage Mode, which applies a constant voltage to the ribbon assembly and the Current Mode, which applies a constant current to the ribbon assembly.

The regulator that supplies the voltage to the ribbon is a fixed value. The constant current source that supplies the current during current mode of operation is adjusted to match the resistance of the ribbon so that the current mode operates as expected and in the same range as the voltage mode.

Either mode of operation generates a tap voltage when pressure is applied. This tap voltage is offset and scaled before it is sampled internally by the Appendage circuitry. The tap voltage is also used to generate the internal timing of the Appendage circuitry, from which the gate and trigger signals are also generated.

The TFS signal is not derived from the tap voltage, but instead is generated from two different sources. The selection of which of these sources is used to generate the TFS signal is determined by whether the Appendage is in Voltage Mode or Current Mode operation.

An internal adjustment is provided so that the Appendage circuitry will accurately output a sampled copy of an external Sample Input voltage.

The remaining adjustment is used to calibrate the Mixed Output voltage to exactly match the level of the Mix Input signal.

The required calibration covers the following parameters:

1. Current Mode Adjustment
The current adjustment ensures that the constant current source of the Appendage circuitry generates the appropriate amount of current to suit the ribbon.

2. Pressure Comparator Reference Adjustment
The pressure comparator generates the internal timing for the Appendage Sample and Hold circuitry as well as the timing for the gate and trigger output signals. This calibration ensures that the Appendage reacts predictably along the entire length of the ribbon in both the current and voltage modes of operation.

3. Voltage Mode Range Adjustment
The Voltage Mode Range Adjustment calibrates the Initial and Slide output voltages from a range of 0V (at the lowest point on the ribbon) to a maximum of 10V (at the highest point on the ribbon) in voltage mode of operation.

4. Voltage Mode TFS Adjustment
The Voltage Mode TFS Adjustment calibrates the TFS output from a range of 0V (single point of pressure) to a maximum of 10V for the widest range of two pressure points (one pressure point applied at the lowest point of the ribbon and the other pressure point applied at the highest point of the ribbon) while in the voltage mode of operation.

5. Current Mode Range Adjustment
The Current Mode Range Adjustment calibrates the Initial and Slide output voltages from a range of 0V (at the lowest point on the ribbon) to a maximum of 10V (at the highest point on the ribbon) in current mode of operation.

6. Current Mode TFS Adjustment
The Current Mode TFS Adjustment calibrates the TFS output from a range of 0V (single point of pressure) to a maximum of 10V for the widest range of two pressure points (one pressure point applied to the lowest point of the ribbon and the other pressure point applied to the highest point of the ribbon) while in the current mode of operation.

7. Sample Input Unity Gain Adjustment
The Sample Input Adjustment calibrates the Initial/Slide Output levels to match the level of an external voltage applied to the Sample Input.

8. Mix Input Unity Gain Adjustment
The Mix Input Adjustment calibrates the Slide Output level to match the level of an external voltage applied to the Mix Input.

Required Equipment
Most of the calibration does not require anything more than a voltmeter and a pot tweaking tool. An oscilloscope could be used as well, though a voltmeter will provide a more precise method of reading the test points. Clip leads provide a definite advantage. The last two calibrations require a piece of equipment that can generate a constant DC voltage, such as a keyboard, sequencer, MIDI-CV converter, variable power supply, etc.

1. Current Mode Adjustment

Overview

The Appendage has two modes of operation: Voltage Mode operation and Current Mode operation. The mode of operation is determined by the setting of the Ribbon Mode Switch (SW105). When the Appendage is in the Voltage Mode of operation, the ribbon is supplied with a fixed, regulated voltage signal. When the Appendage is in the Current Mode of operation, the ribbon is supplied with a current generated by a constant current source. Because the resistance of a ribbon can vary from ribbon to ribbon, even between ribbons of the same length, the amount of required current will vary as well. This calibration ensures that the current is well regulated for proper operation.

Because the voltage is fixed, the constant current source is adjusted so that the voltage generated through the ribbon while in current mode matches the level of the voltage source while the Appendage is in the voltage mode. The current regulation is adjusted by VR12 on the Appendage PCB.

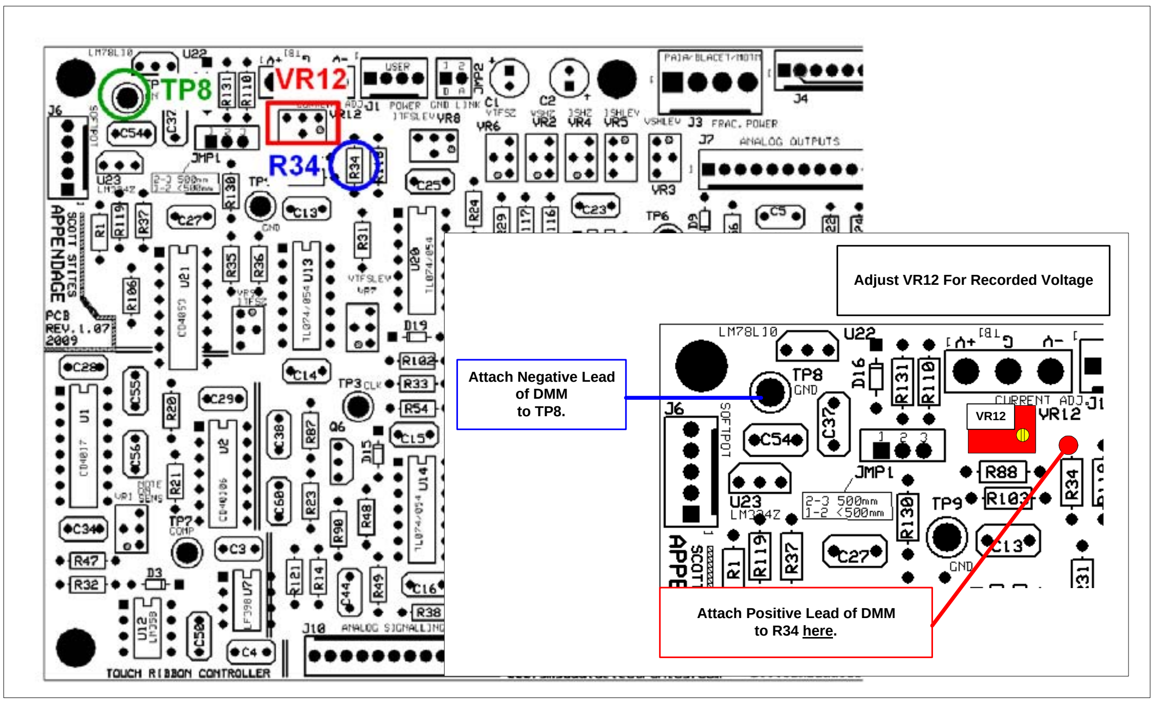


Figure 9-1: Ribbon Current Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)

1. Make sure the Appendage is powered on and the ribbon is connected to the Appendage.

2. Set the Ribbon Mode Switch (SW105) to the Voltage Mode position.

3. Connect the negative lead of the DVM to TP9.

4. Connect the positive lead of the DVM to the end of R34 indicated in **Figure 9-1**.

5. Record the voltage indication of the DVM. ____________VDC

6. Set the Ribbon Mode Switch (SW105) to the Current Mode position.

7. Adjust VR12 so that the DVM indicates the same reading as recorded in Step 5.

Turning VR12 clockwise will increase the voltage reading; turning VR12 anti-clockwise will decrease the voltage reading.

2. Pressure Comparator Reference Adjustment

Overview

The Appendage uses a comparator to determine when the ribbon is pressed. The comparator generates the timing signal for the sample and hold system, as well as circuitry that generates the gate and trigger signals. It is essential that the reference be adjusted so that the comparator changes state at the lowest voltage the ribbon returns, but at no lower voltage than that.

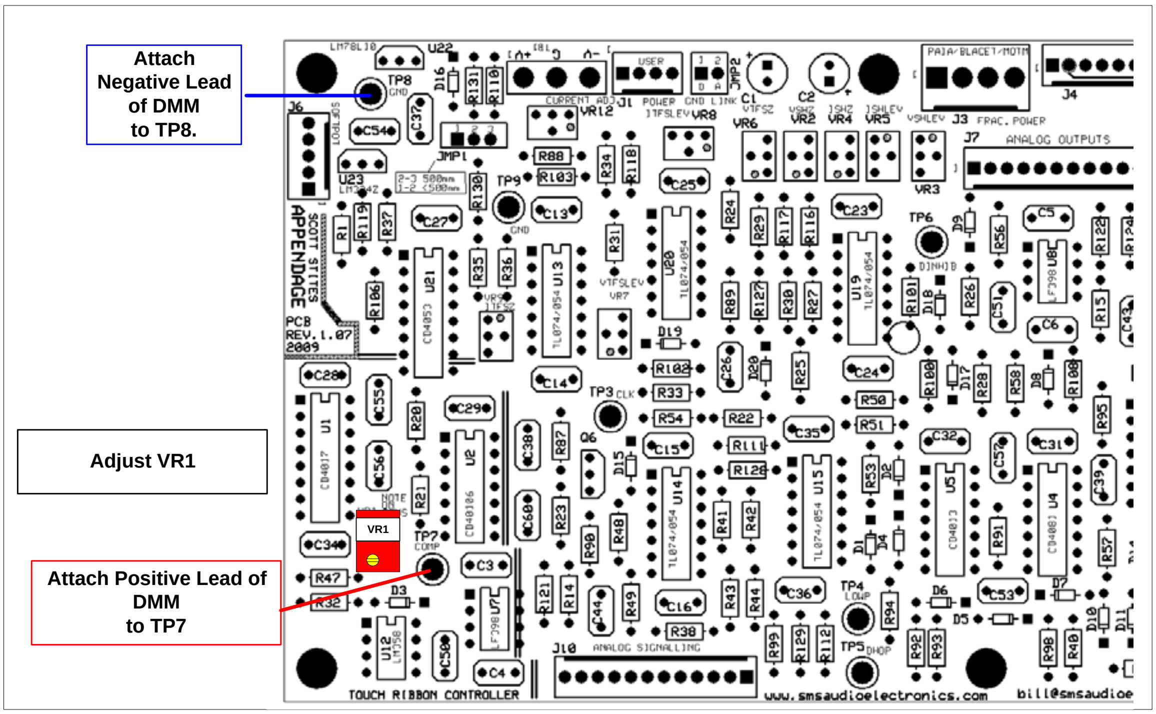


Figure 9-2: Comparator Reference Adjustment Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM) or Oscilloscope

1. Make sure the Appendage is powered on and the ribbon is connected to the Appendage.

2. Set the Ribbon Mode Switch (SW105) to the Voltage Mode position.

3. Connect the negative lead of the DVM to TP8.

4. Connect the positive lead of the DVM to TP7.

5. Place pressure at the lowest point of the ribbon (towards the end of the ribbon that has the connector).

6. While pressure is applied to lowest part of the ribbon, observe the reading of the DVM and observe the Gate LED.

> 6A. If the Gate LED is illuminated and the DVM reads a positive voltage close to the positive rail voltage of the Appendage power supply, adjust VR1 slowly clockwise until the precise point the Gate LED goes off, and the DVM voltage drops close to zero volts.
>
> 6B. If the Gate LED is not illuminated and the DVM reads a voltage of very close to 0V, adjust VR1 slowly anti-clockwise until the precise point the Gate LED illuminates, and the DVM voltage jumps to close to the value of the power supply voltage. Then, adjust VR1 slowly clockwise until the precise point at which the Gate LED turns off, and the DVM voltage drops close to zero volts.

7. Ensure you are pressing the very lowest point of the ribbon with as little surface area as possible. While doing this, adjust VR1 slowly anti-clockwise until the precise point the Gate LED illuminates, and the DVM voltage jumps to close to the value of the power supply voltage.

8. Make sure that the Gate LED illuminates no matter how low on the ribbon or how high on the ribbon you press it. If it fails to illuminate at the bottom, slightly adjust VR1 anti-clockwise until the Gate LED illuminates and the voltage on the DVM jumps towards the positive rail.

3. Voltage Mode Ribbon Range Calibration

Overview
In the Voltage Mode of operation, the Appendage scales the voltage supplied by the ribbon to a range of 0 to +10V before it is applied to the internal sample and hold system. There are two calibration points to this range adjustment. One trim (VR2, VSH Zero) sets the amount of voltage produced by the Appendage when pressure is applied to the lowest portion of the ribbon to 0V. The other trim, (VR3, VSH Level), sets the amount of voltage produced by the Appendage when pressure is applied to the highest portion of the ribbon to 10V. These calibration points allow a wide range of ribbon resistance values to be accommodated accurately by the circuit.

The procedure begins by setting the trim pots to values that allow the final calibration to be executed more easily. These test points are located on resistor leads. The final calibration uses measurement of the Slide output on Test Point 1 (TP1) to fine tune the response from the ribbon.

Figure 9-3 can be used to help locate the test points on the Appendage PCB.

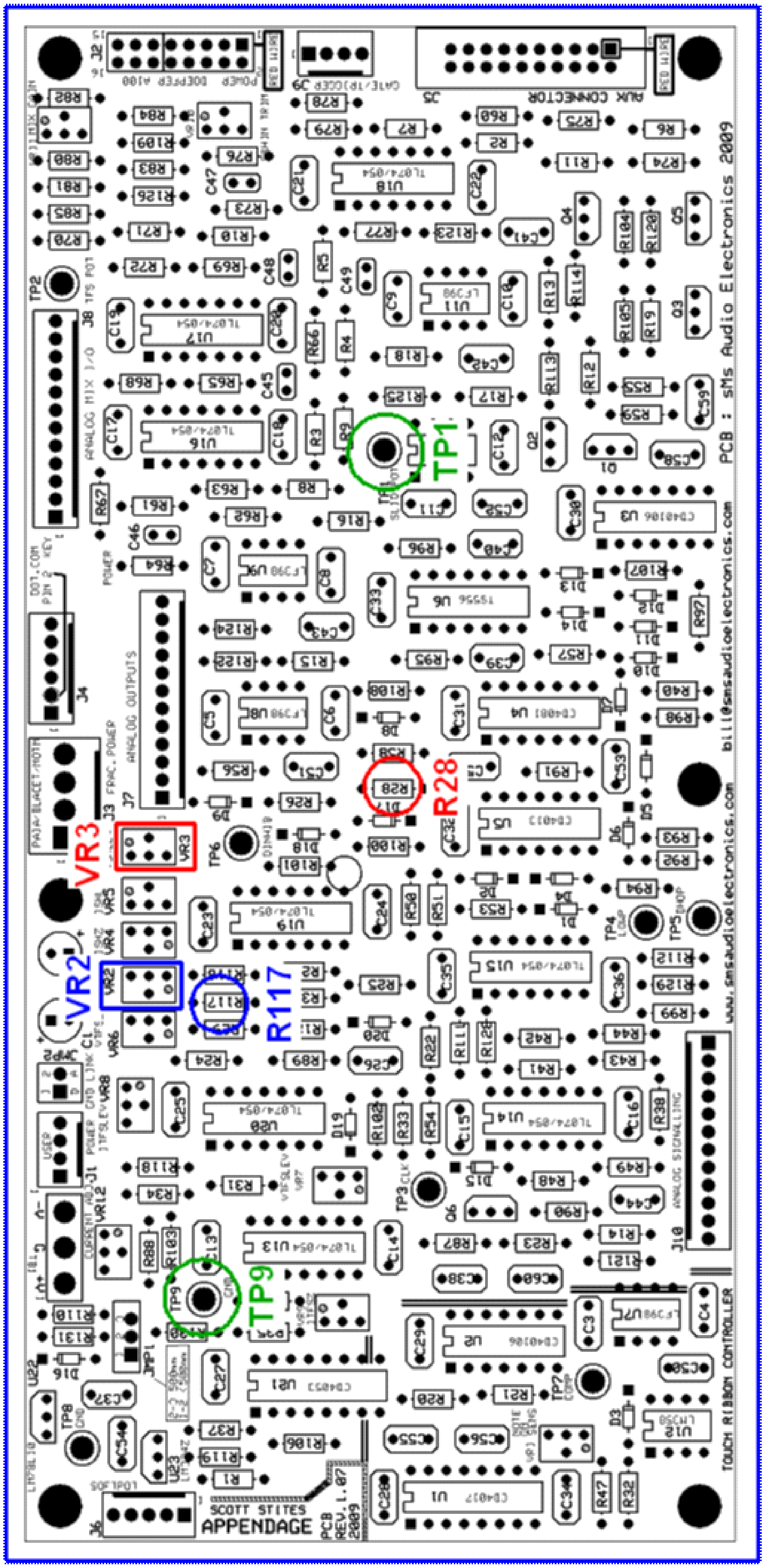


Figure 9-3: Voltage Mode Ribbon Range Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)
Calibration Alignment Tool (Trim Pot Tweaker)

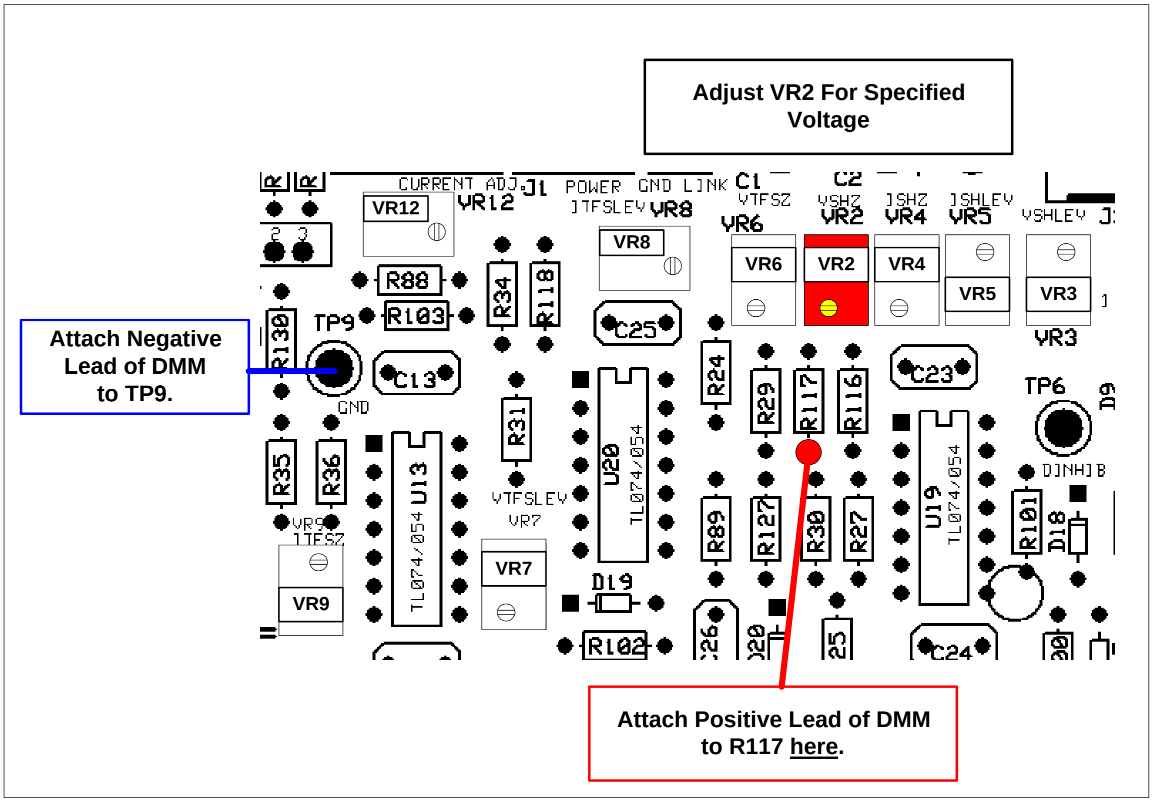


Figure 9-4: Initial Zero Voltage Calibration

1. Place the Ribbon Mode Switch (SW105) to the “Voltage” position.
2. Connect the negative lead of the DMM to TP9.
3. Connect the positive lead of the DMM to the end of R117 indicated in **Figure 9-4**.
4. Set the DMM to read DCV.
5. Adjust VR2 until the DMM displays a reading of between -4.5V and -5V.

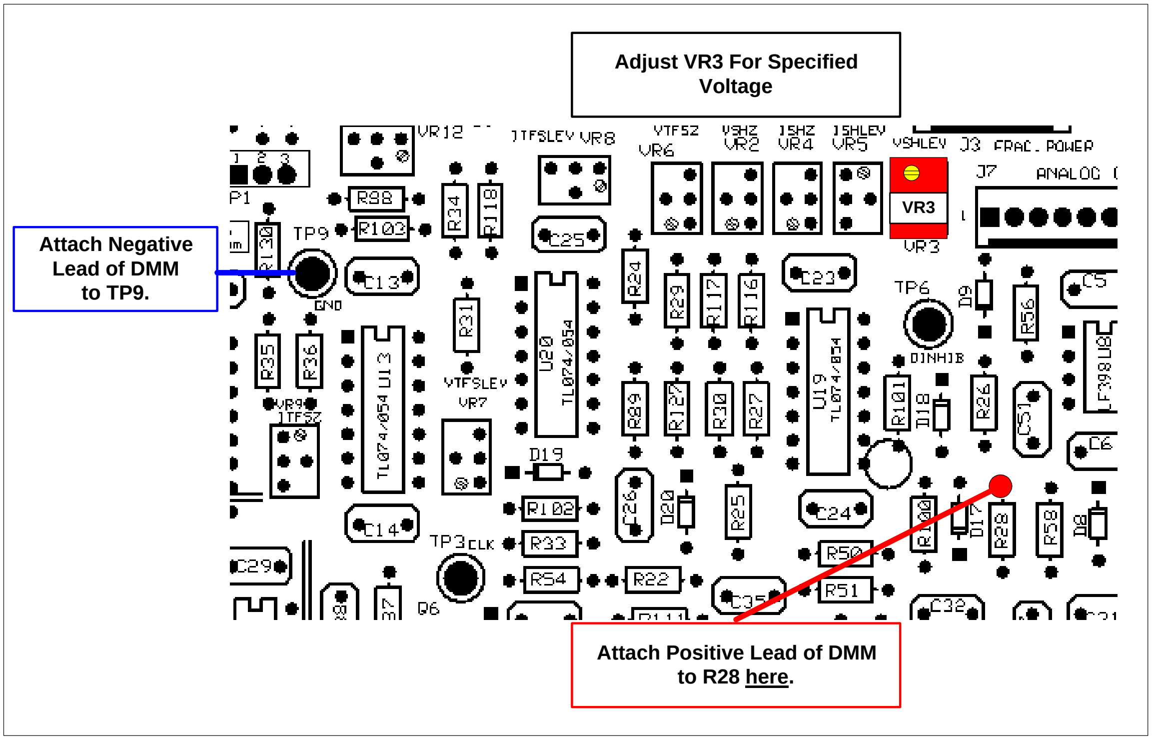


Figure 9-5: Initial Range Voltage Calibration

6. Connect the positive lead of the DMM to the end of R28 indicated in **Figure 9-5** and leave the negative lead of the DMM attached to TP9.

7. Adjust VR3 until the DMM displays a reading of between +0.55 and +0.65V.

8. Connect the positive lead of the DMM to TP1 and leave the negative lead of the DMM attached to TP9.

9. While applying pressure to the lowest portion of the ribbon as possible, observe the DMM display:

> 9A. If the voltage is not a negative voltage, adjust VR2 until you observe the reading go to a small amount of negative voltage just under 0V on the DMM.
>
> 9B. After observing a negative voltage, adjust VR2 until the voltage just changes over to 0V on the DMM.

10. While applying pressure to the highest portion of the ribbon as possible, observe the DMM display. Adjust VR3 for a reading of 10V on the DMM.

11. The adjustment between VR2 and VR3 is interactive, so the voltages will need to be "balanced out". Repeat steps 7 and 8 until pressure on the lowest portion of the ribbon generates 0V and pressure at the highest point of the ribbon generates 10V.

4. Voltage Mode TFS Range Calibration

Overview
In the Voltage Mode of operation, the Appendage scales the voltage generated by multi-point pressure of the ribbon to a range of 0 to +10V before it is applied to the TFS voltage and mix outputs. There are two calibration points to this range adjustment. One trim (VR6, VTFS Zero) sets the amount of voltage produced by the Appendage when no pressure is applied to the ribbon to 0V. The other trim, (VR7, VTFS Level), sets the amount of voltage produced by the Appendage when the widest possible "spread" of two pressure points is applied to the ribbon to 10V. The widest "spread" of pressure is the simultaneous application of a pressure point applied to the lowest point of the ribbon and a second pressure point applied to the highest point on the ribbon. These calibration points allow a wide range of ribbon resistance values to be accommodated accurately by the circuit.

The procedure begins by setting the trim pots to values that allow the final calibration to be executed more easily. These test points are located on resistor leads. The final calibration uses measurement of the TFS output on Test Point 2 (TP2) to fine tune the response from the ribbon.

If you are lucky enough to possess three arms, then this calibration is a piece of cake. If you have someone to assist you by applying pressure while you adjust, that also will make it very easy. If you are a miserably lonely synthesizer geek (the intended customer base of this product), then you can still perform the cal, it's just a bit more clunky, and you'll be using the same procedure the author of this document used.

Figure 9-6 can be used to help locate the test points on the Appendage PCB.

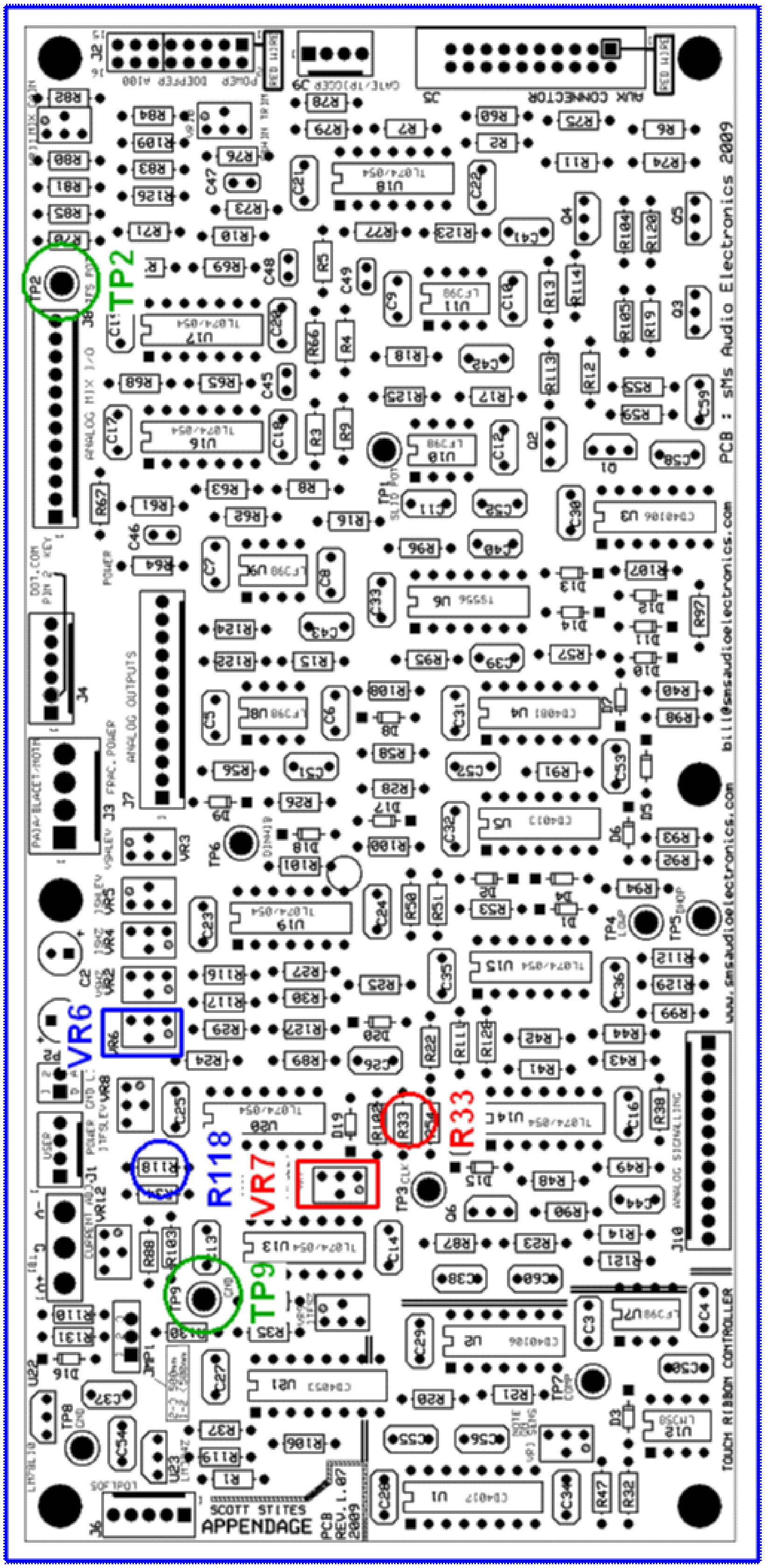


Figure 9-6: Voltage Mode TFS Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)
Calibration Alignment Tool (Trim Pot Tweaker)

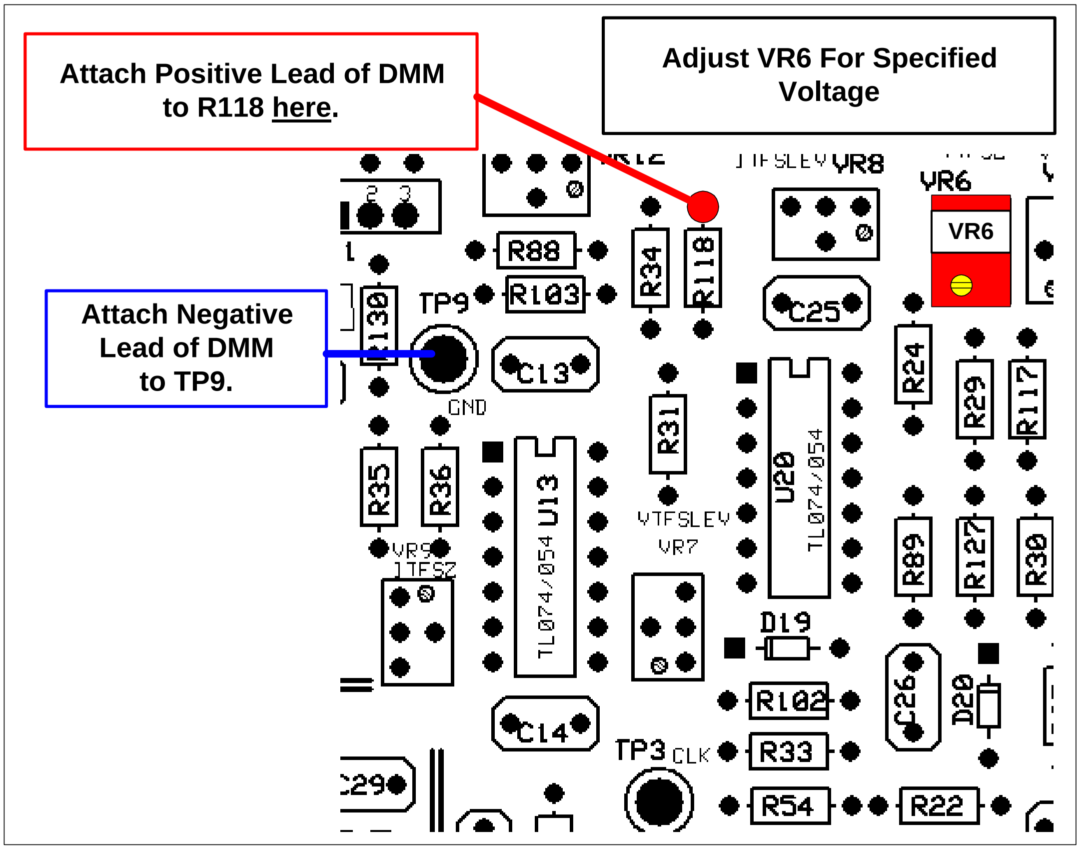


Figure 9-7: Initial Voltage TFS Zero Voltage Calibration

1. Place the Ribbon Mode Switch (SW105) to the “Voltage” position.

2. Connect the negative lead of the DMM to TP9.

3. Connect the positive lead of the DMM to the end of R118 indicated in **Figure 9-7**.

4. Set the DMM to read DCV.

5. Adjust VR6 until the DMM displays a reading of between -4.5 and -5.5V.

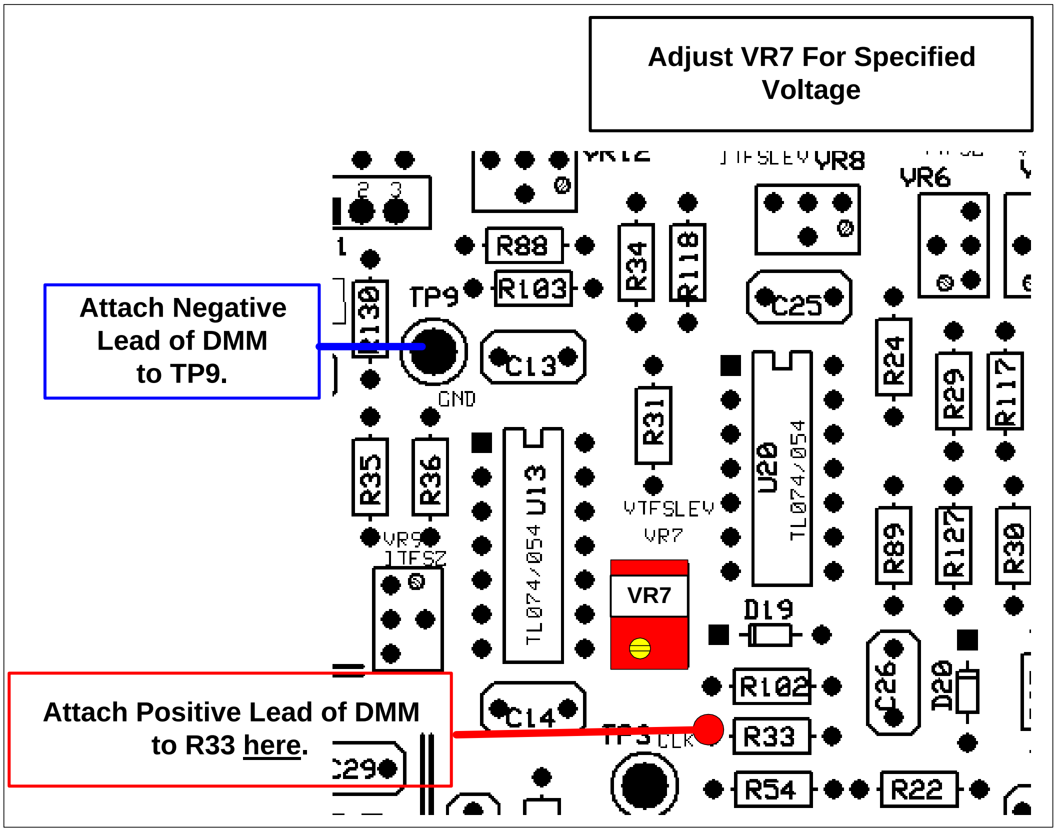


Figure 9-8: Initial Voltage TFS Range Calibration

6. Connect the positive lead of the DMM to the end of R33 indicated in **Figure 9-8** and leave the negative lead of the DMM attached to TP9.

7. Adjust VR7 until the DMM displays a reading of between 0 and +1V.

8. Connect the positive lead of the DMM to TP2 and leave the negative lead of the DMM attached to TP9.

9. While applying no pressure to the ribbon, observe the DMM display:

> 9A. If the voltage is not a negative voltage, adjust VR6 until you observe the reading go to a small amount of negative voltage just under 0V on the DMM.
>
> 9B. After observing a negative voltage, adjust VR6 back up until the voltage just changes over to 0V on the DMM.

10. While applying a single point of pressure to the lowest portion of the ribbon as possible and, at the same time, applying a single point of pressure to the highest point of the ribbon, observe the DMM display.

10A. If a second person is there to apply the pressure while you can adjust the trim pot, adjust VR7 until the DMM displays 10V

10B. If there is no one to help you out, release the pressure, and adjust VR7 up (clockwise) if the reading was greater than 10V, or down (anti-clockwise) if the reading was less than 10V (no adjustment is required if the voltage was 10V). After you've adjusted the trim, apply the two points of pressure again to see how close you got to 10V. Keep this up until the DMM displays 10V.

11. The adjustment between VR6 and VR7 is interactive, so the voltages will need to be "balanced out". Repeat steps 7 and 8 until no applied pressure on the lowest portion of the ribbon generates 0V and pressure applied simultaneously to the lowest and highest points of the ribbon generates 10V.

5. Current Mode Ribbon Range Calibration

Overview
In the Current Mode of operation, the Appendage scales the voltage generated by the ribbon to a range of 0 to +10V before it is applied to the internal sample and hold system. There are two calibration points to this range adjustment. One trim (VR4, ISH Zero) sets the amount of voltage generated by the Appendage when pressure is applied to the lowest portion of the ribbon to 0V. The other trim, (VR5, ISH Level), sets the amount of voltage produced by the Appendage when pressure is applied to the highest portion of the ribbon to 10V. These calibration points allow a wide range of ribbon resistance values to be accommodated accurately by the circuit.

The procedure begins by setting the trim pots to values that allow the final calibration to be executed more easily. These test points are located on resistor leads. The final calibration uses measurement of the Slide output on Test Point 1 (TP1) to fine tune the response from the ribbon.

Figure 9-9 can be used to help locate the test points on the Appendage PCB.

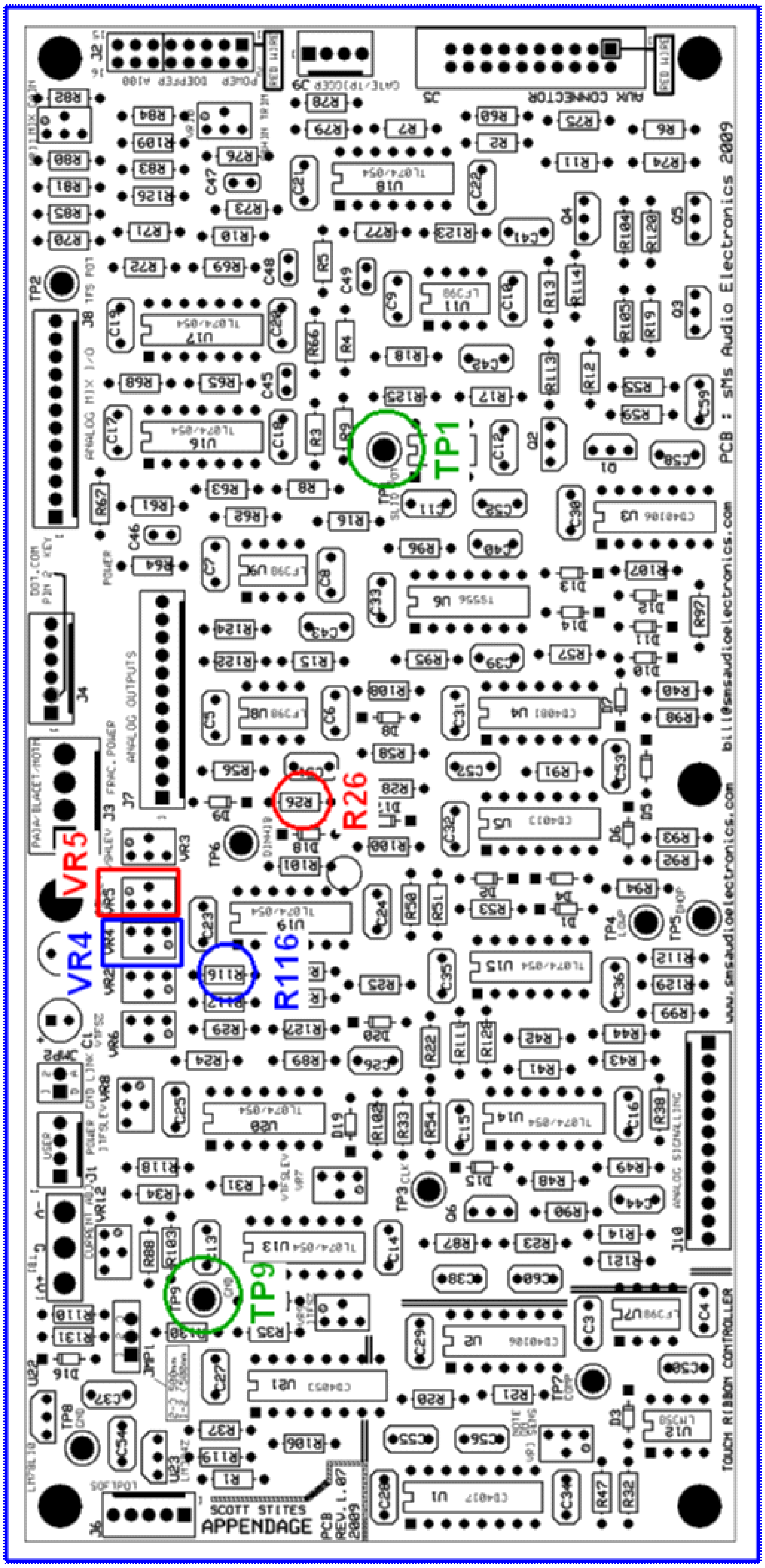


Figure 9-9: Current Mode Ribbon Range Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)
Calibration Alignment Tool (Trim Pot Tweaker)

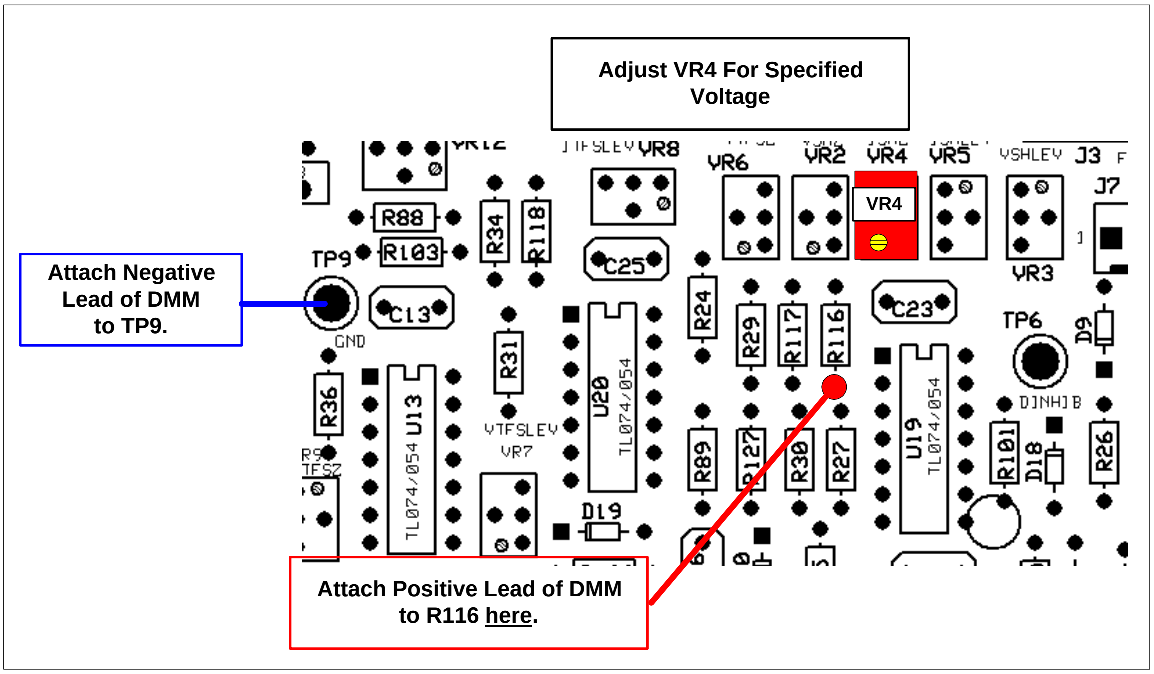


Figure 9-10: Initial Zero Voltage Calibration

1. Place the Ribbon Mode Switch (SW105) to the "Current" position.

2. Connect the negative lead of the DMM to TP9.

3. Connect the positive lead of the DMM to the end of R116 indicated in **Figure 9-10**.

4. Set the DMM to read DCV.

5. Adjust VR4 until the DMM displays a reading of between -4.5V and -5V.

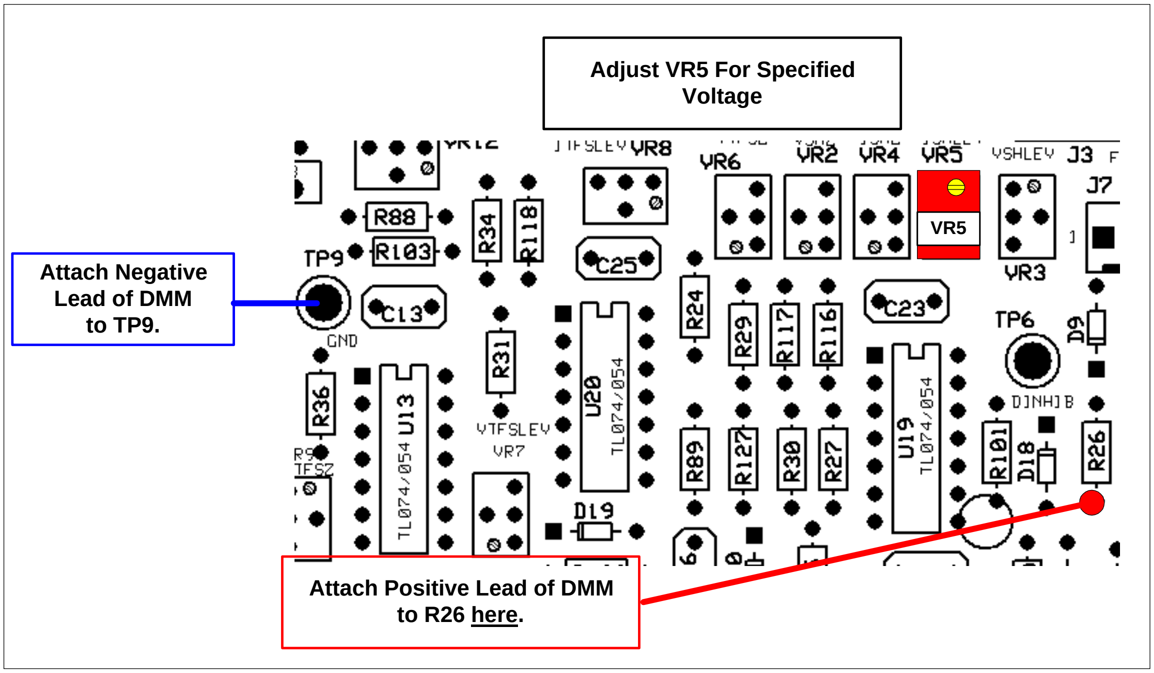


Figure 9-11: Initial Range Voltage Calibration

6. Connect the positive lead of the DMM to the end of R26 indicated in Figure XXX-3 and leave the negative lead of the DMM attached to TP9.

7. Adjust VR5 until the DMM displays a reading of between +0.5 and +0.7V.

8. Connect the positive lead of the DMM to TP1 and leave the negative lead of the DMM attached to TP9.

9. While applying pressure to the lowest portion of the ribbon as possible, observe the DMM display:

> 9A. If the voltage is not a negative voltage, adjust VR4 until you observe the reading go to a small amount of negative voltage just under 0V on the DMM.
>
> 9B. After observing a negative voltage, adjust VR4 until the voltage just changes over to 0V on the DMM.

10. While applying pressure to the highest portion of the ribbon as possible, observe the DMM display. Adjust VR5 for a reading of 10V on the DMM.

11. The adjustment between VR4 and VR5 is interactive, so the voltages will need to be “balanced out”. Repeat steps 7 and 8 until pressure on the lowest portion of the ribbon generates 0V and pressure at the highest point of the ribbon generates 10V.

6. Current Mode TFS Range Calibration

Overview
In the Current Mode of operation, the Appendage scales the voltage generated by multi-point pressure of the ribbon to a range of 0 to +10V before it is applied to the TFS voltage and mix outputs. There are two calibration points to this range adjustment. One trim (VR9, ITFS Zero) sets the amount of voltage produced by the Appendage when no pressure is applied to the ribbon to 0V. The other trim, (VR8, ITFS Level), sets the amount of voltage produced by the Appendage when the widest possible "spread" of two pressure points is applied to the ribbon to 10V. The widest "spread" of pressure is the simultaneous application of a pressure point applied to the lowest point of the ribbon and a second pressure point applied to the highest point on the ribbon. These calibration points allow a wide range of ribbon resistance values to be accommodated accurately by the circuit.

The procedure begins by setting the trim pots to values that allow the final calibration to be executed more easily. These test points are located on resistor leads. The final calibration uses measurement of the TFS output on Test Point 2 (TP2) to fine tune the response from the ribbon.

Just as with the Voltage Mode TFS calibration, ideally a three armed person would be performing this calibration, but it's still doable by a single person with the natural maximum number of arms/hands.

Figure 9-12 can be used to locate the calibration points for this procedure.

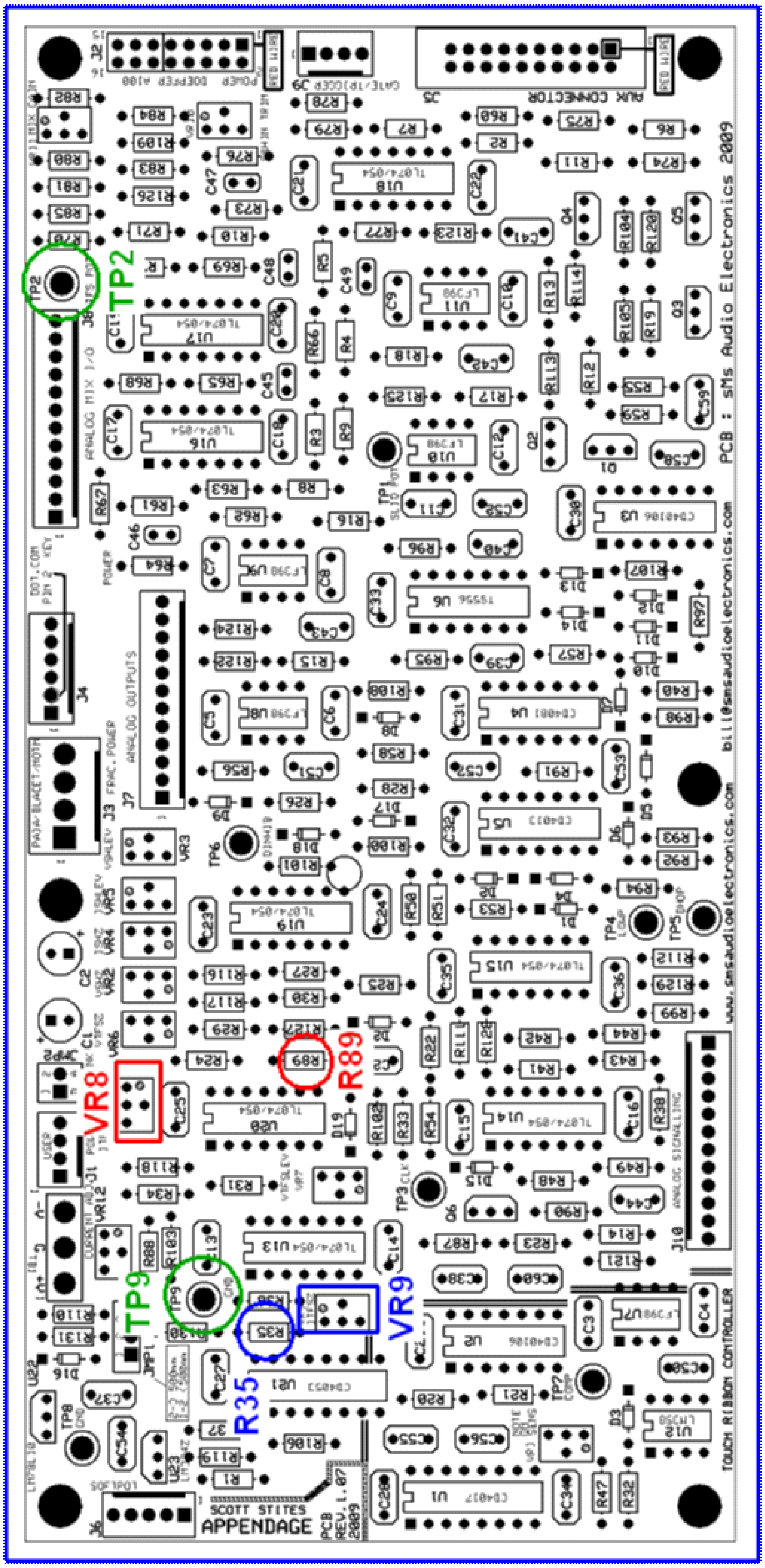


Figure 9-12: Current Mode TFS Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)
Calibration Alignment Tool (Trim Pot Tweaker)

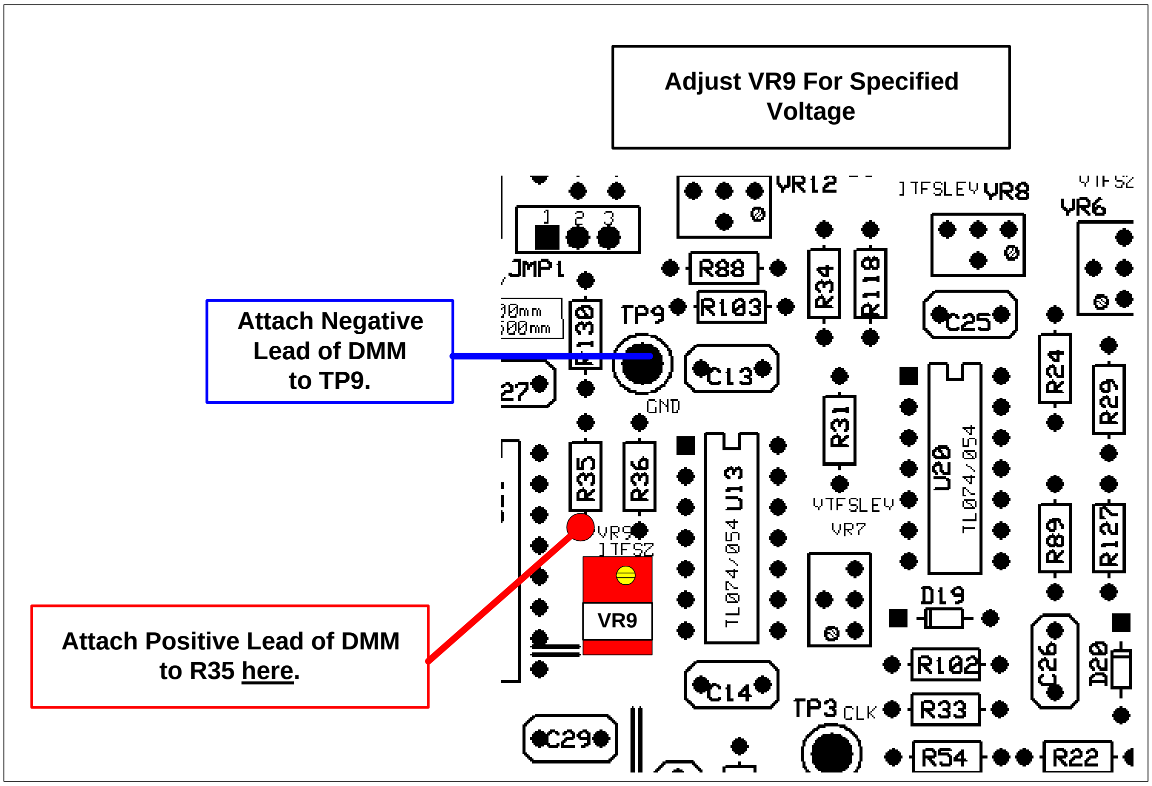


Figure 9-13: Initial Current TFS Zero Voltage Calibration

1. Place the Ribbon Mode Switch (SW105) to the "Current" position.
2. Connect the negative lead of the DMM to TP9.
3. Connect the positive lead of the DMM to the end of R35 indicated in **Figure 9-13**.
4. Set the DMM to read DCV.
5. Adjust VR9 until the DMM displays a reading of between -7 and -8V.

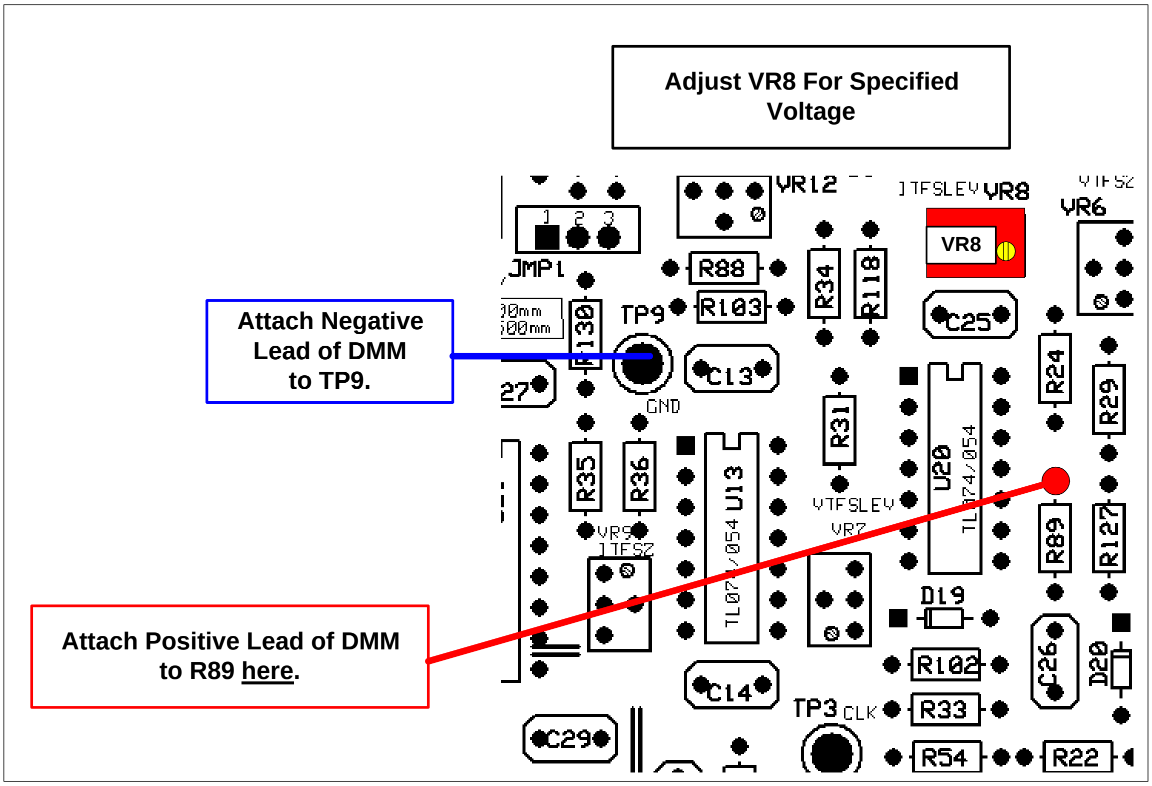


Figure 9-14: Initial Current TFS Range Calibration

6. Connect the positive lead of the DMM to the end of R89 indicated in **Figure 9-14** and leave the negative lead of the DMM attached to TP9.

7. Adjust VR8 until the DMM displays a reading of between +0.5 and +1.0V.

8. Connect the positive lead of the DMM to TP2 and leave the negative lead of the DMM attached to TP9.

9. While applying no pressure to the ribbon, observe the DMM display:

9A. If the voltage is not a negative voltage, adjust VR9 until you observe the reading go to a small amount of negative voltage just under 0V on the DMM.

9B. After observing a negative voltage, adjust VR9 back up until the voltage just changes over to 0V on the DMM.

10. <u>While applying a single point of pressure to the lowest portion of the ribbon as possible and, at the same time, applying a single point of pressure to the highest point of the ribbon</u>, observe the DMM display.

10A. If a second person is there to apply the pressure while you can adjust the trim pot, adjust VR8 until the DMM displays 10V

10B. If there is no one to help you out, release the pressure, and adjust VR8 up (clockwise) if the reading was greater than 10V, or down (anti-clockwise) if the reading was less than 10V (no adjustment is required if the voltage was 10V). After you've adjusted the trim, apply the two points of pressure again to see how close you got to 10V. Keep this up until the DMM displays 10V.

11. The adjustment between VR9 and VR8 is interactive, so the voltages will need to be "balanced out". Repeat steps 7 and 8 until no applied pressure on the lowest portion of the ribbon generates 0V and pressure applied simultaneously to the lowest and highest points of the ribbon generates 10V.

7. Sample Input Unity Gain Adjustment

Overview
The Sample Input Unity Gain Adjustment calibrates the S&H output so that it is at perfect unity gain with an external S&H input signal applied to the Sample Input Connector, J102. This calibration compensates for any offsets within the Appendage S&H system.

There are two external sample modes, which are selected by the Input Mode Switch (SW103). When the switch is set to “Universal”, the intended sample function is similar to that of a standard S&H module: the sample and hold system will sample the input signal and output the sampled signal. The “Stepped” mode is a specialized mode; in the Stepped mode, the external input signal is internally sent down a different path within the Appendage. The purpose of this path, and the Stepped function, is to derive AutoGlide control and trigger signals derived from discrete voltage changes in the input signal. This allows an external device that produces discretely stepped voltage changes, such as a keyboard or a sequencer, to generate these functions when interfaced with the Appendage. Thus, the calibration is performed while in the Stepped External Input mode. The Universal Input mode output will not be calibrated, as the intended function is to generate random voltages using the Appendage, which do not require the accuracy of pitch control that the intended Stepped function serves.

To perform this calibration, an external voltage source will be needed. This source can be anything capable of generating a fixed voltage of (ideally) 1V or so. Even a 5V source could be used for the calibration. The source can be a power supply, the voltage output of a keyboard, the voltage output of a sequencer – anything. The key is, the voltage must be a fixed voltage that you are capable of inputting into the Sample Input Connector, J102.

The procedure will involve measuring the exact value produced by the voltage source, and adjusting VR10 until the voltage output at TP1 exactly matches that voltage. **Figure 9-5** can be used to help locate the calibration points referenced in this procedure.

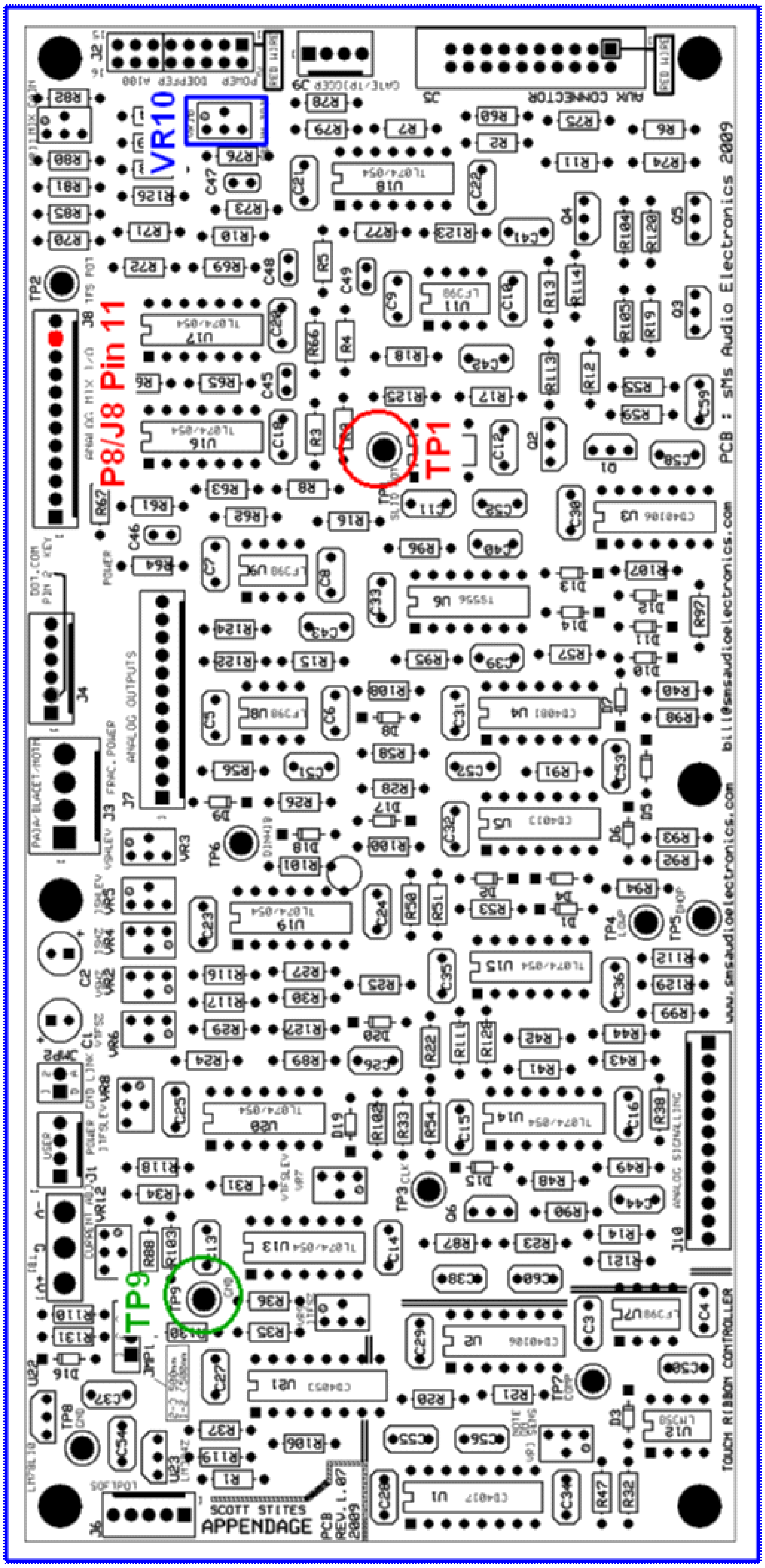


Figure 9-15: External S&H Unity Gain Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)
Voltage Source (Power Supply, Sequencer, Keyboard, etc.)
Calibration Alignment Tool (Trim Pot Tweaker)

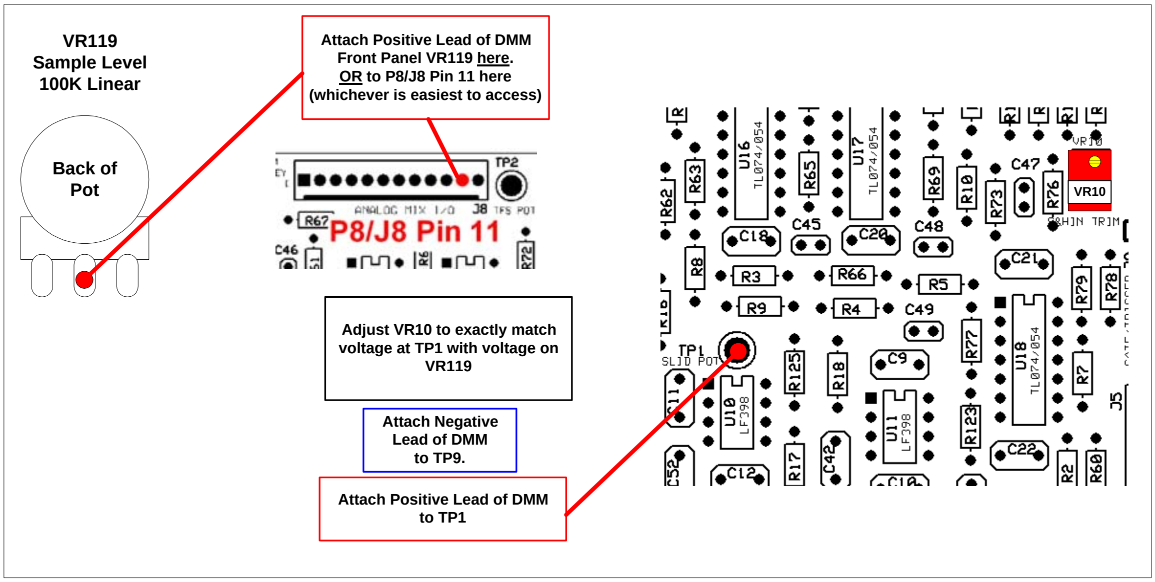


Figure 9-16: External S&H Unity Gain Calibration

1. Place the Input Source Switch (SW103) to the "Stepped" position.

2. Ensure that the Gate Mode Switch (SW102) is in the "Ribbon" position.

3. Set the voltage source for anything between 1V and 5V (ideally 1V).

4. Connect the voltage source to the Sample Input Connector (J102).

5. Adjust the Sample Level pot (VR109) full counter-clockwise (all the way "off").

6. Connect the negative lead of the DMM to TP9.

7. Connect the positive lead of the DMM to TP1. Set the DMM to the very lowest range, and, **while applying pressure to any point on the ribbon**, measure the voltage present at TP1. Record that voltage here: ______________

(note: this will be an extremely low voltage, in the low millivolts if it is present at all. Be sure to record the sign (if it is a positive or negative voltage).

8. NOTE: The second cal point can be one of two places: The center lug of Sample Level Pot (VR109) or Pin 11 of P8/J8. For some build projects, it may be easier to connect to the pot, but, if it's a drag to reach that point, the same voltage can be measured

on pin 11 of P8/J8. If your DMM leads are narrow enough, you can slide down inside the P8 connector and measure the voltage there. If you have a “Toad Stabber” or “Pig Sticker” (sharp, pointy instrument with a wooden handle) that you can attach the positive DMM lead to, that will work as well.

Connect the positive lead of the DMM to the lug of the panel mounted Sample Level Pot (VR109) OR Pin 11 of P8/J8, as indicated in **Figure 9-16** (note the pot is pictured as viewed from behind the panel).

9. Adjust the Sample Level Pot (VR109) <u>full clockwise</u> (all the way “on”).

10. Measure the voltage at the pot or connector. Record the voltage measurement here:___________

11. Add the voltage recorded in Step 7 with the voltage recorded in Step 10 and record it here: _____________.

Remember, if you recorded a negative voltage in Step 7, the value of that voltage would be subtracted from the voltage measured in step 10 (because you would be adding a negative). This is the voltage that will be used in Step 13.

12. Connect the positive lead of the DMM to TP1.

13. <u>**While applying pressure to any point on the ribbon**</u>, adjust VR10 until the DMM displays the exact level that you calculated in Step 11.

8. Mix Input Unity Gain Adjustment

Overview
The Mix input allows the signal from an external device to be mixed with the voltages generated by the Appendage. In order for external devices to provide precise pitch information, the external signal must kept at perfect unity gain.

The Mix Input Unity Gain Adjustment calibrates the circuit so that the signal applied to the Mix Input Connector (J103) is at perfect unity gain when it is mixed with the Mixed Output signal. This calibration compensates for any offsets within the Appendage signal mix system.

The procedure will involve measuring the exact value produced by the voltage source, and adjusting VR11 until the voltage output at TP1 exactly matches that voltage. **Figure 9-17** can be used to help locate the calibration points referenced in this procedure.

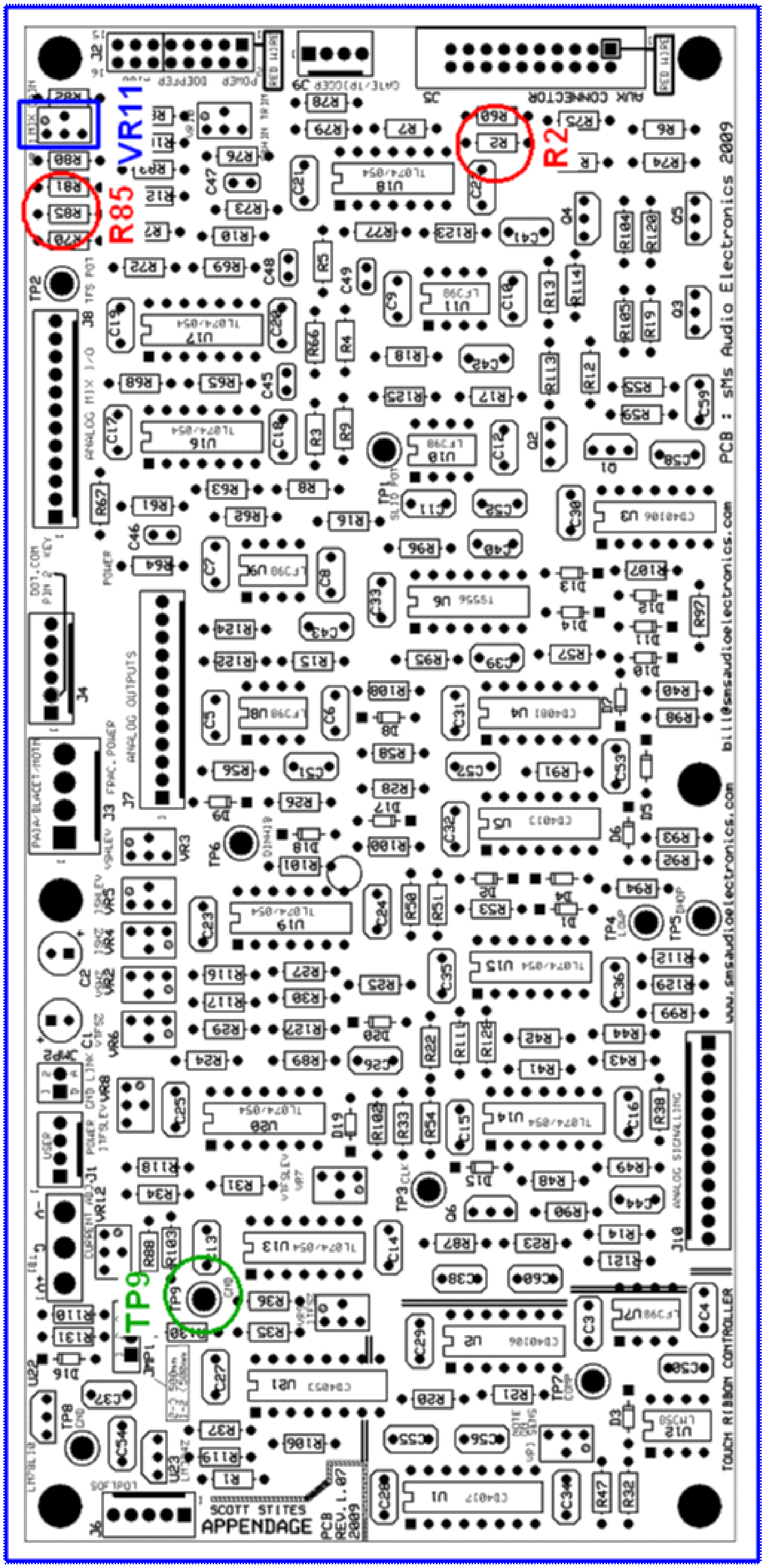


Figure 9-17: Mix Input Unity Gain Calibration Points

Procedure

Required equipment: Digital Voltmeter (DVM)
Voltage Source (Power Supply, Sequencer, Keyboard, etc.)
Calibration Alignment Tool (Trim Pot Tweaker)

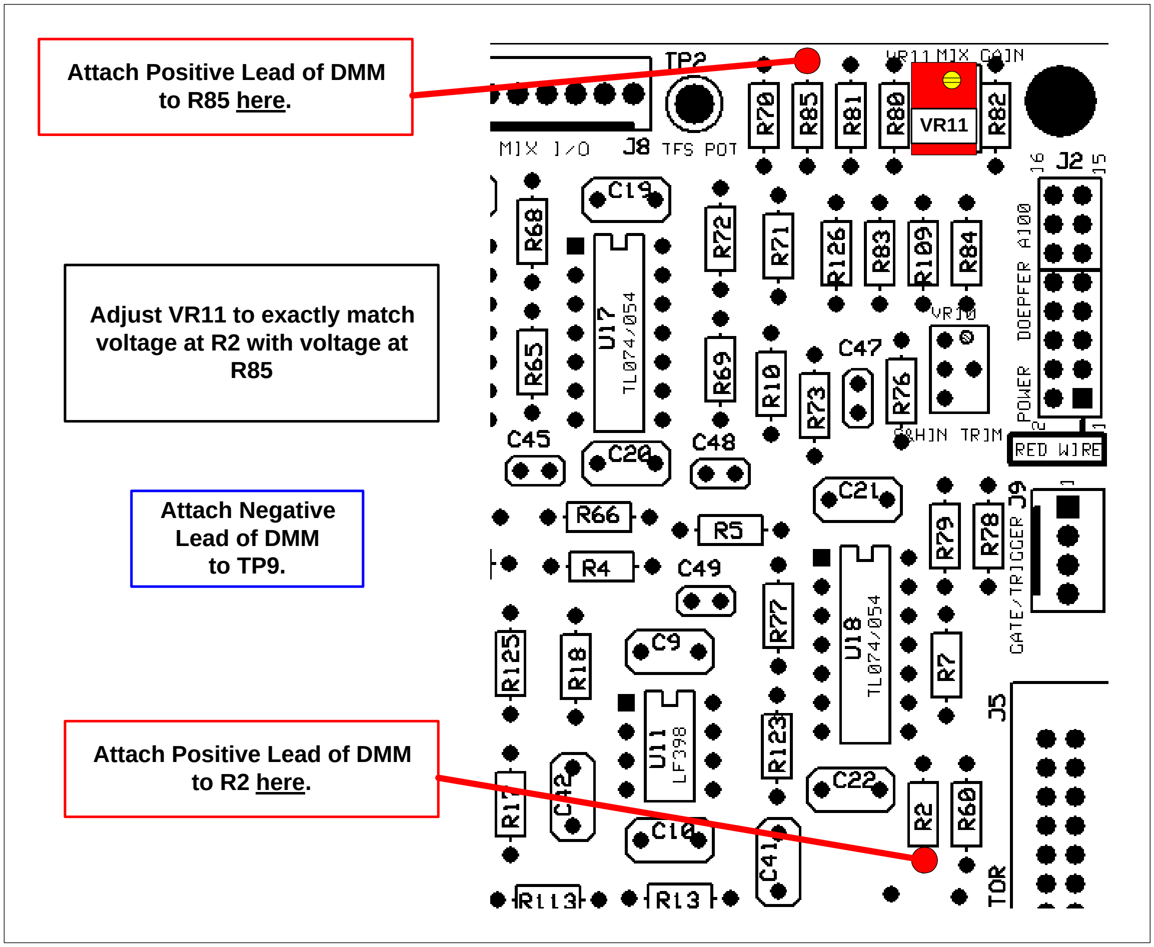


Figure 9-18: Mix Input Unity Gain Calibration

1. Connect the negative lead of the DMM to TP9.

2. Connect the positive lead of the DMM to end of R2 depicted in **Figure 9-18**. Set the DMM to the very lowest range, and measure the voltage present at R2. Adjust the front panel Coarse Offset control (VR105) and Fine Offset control (VR107) for exactly 0V as measured on the DMM. If your DMM is very sensitive, and it's difficult to get exactly 0V (say it's reading a few millivolts or so, record what you do measure here:__________

(Note: If you do need to record anything but zero volts here, be sure to record the sign (if it is a positive or negative voltage).

3. Set the voltage source for anything between 1V and 5V (ideally 1V).

4. Connect the voltage source to the Mix Input Connector (J103).

5. Connect the positive lead of the DMM to end of R85 depicted in **Figure 9-18**. Measure the voltage present at R85. Record that voltage here: _____________

6. If any minimal offset voltage was recorded in Step 2, add that voltage with the voltage recorded in Step 5 and record it here: _____________.

Remember, if you recorded a negative voltage in Step 2, the value of that voltage would be subtracted from the voltage measured in step 5 (because you would be adding a negative). This is the voltage that will be used in Step 13.

7. Connect the positive lead of the DMM to end of R2 depicted in **Figure 9-18**.

8. Adjust VR11 until the DMM displays the exact level that you calculated in Step 6.

Rechecking the Calibration

After the final step of the calibration procedure is finished, go back and check the following listed items; if you find something that doesn't work as described, go through and touch up the calibration of the section that applies:

1. Place the ribbon in current mode of operation. Connect the slide output to the V/Oct control input of a VCO. While listening to the VCO, hold a pressure point on the ribbon, and, while holding this pressure point, apply pressure to a point above that pressure point. There should be no excessive change in pitch on the VCO (there will be minor change as you increase the pressure area of the finger, but the current mode should hold prevent the pitch of the VCO from rising). If there is more than a very minute shift in pitch, re-adjust VR12 in slight increments until there is no pitch deviation in Current Mode of operation when removing and re-applying a second pressure point above a constantly held pressure point. You may have to go back and adjust the comparator reference (VR1) and the Current Range and Current TFS calibration points slightly as well if you've made this final adjustment.

2. Make sure the Gate LED illuminates while pressing the very bottom of the ribbon in both Voltage Mode and Current Mode of operation. If you find that the LED lights at the very bottom of the ribbon in one mode, but not the other, switch the Appendage to the mode that does not illuminate the LED at the very bottom of adjustment, hold pressure at the very bottom of the ribbon, and very slightly adjust VR1 until the Gate LED illuminates.

3. Check the Slide output to make sure the ribbon responds completely from the very bottom of the ribbon to the top. Check this in both current mode and voltage mode of operation. Ensure there is no "dead" spot as you near the bottom or the top of the ribbon.

4. Check the TFS output to make sure the ribbon responds completely from 0 to 10V, and that the output is 0V when there is no pressure applied to the ribbon. Do this for both current and voltage modes of operation.

Once the calibration is complete, your Appendage should be up and running, and you will finally be able to interface it with your system.

Congratulations on a successful build, and enjoy your new Appendage!

Appendix A

Appendage Touch Ribbon Controller [Bill of Materials for PC board REV. 1.07H]

Fixed Resistors (NOTE: 1% tolerances can only substitute for 5% tolerance values)

REF. DESIG.	QTY.	VALUE	COMMENTS	CATALOG PART NO.
R1-R11	11	100R	100 OHM 1/4W 1% METAL FILM	DIGIKEY 100XBK-ND
R12,R13	2	1.5K	1.50K OHM 1/4W 1% METAL FILM	DIGIKEY 1.50KXBK-ND
R14-R18	5	1.8K	METAL FILM 1.80K OHM 1/4W 1%	DIGIKEY P1.80KCACT-ND
R20-R23	4	10K	10.0K OHM 1/4W 1% METAL FILM	DIGIKEY 10.0KXBK-ND
R24-R38 R40-R44 R47-R51 R53-R60 R62-R64 R66-R68 R70-R85 R87-R89 R103-R105	61	100K	100K OHM 1/4W 1% METAL FILM	DIGIKEY 100KXBK-ND
R61,R65 R69	3	120K	METAL FILM 120K OHM 1/4W 1%	DIGIKEY P120KCACT-ND
R90-R94	5	1.0M	1.0M OHM 1/4W 5% CARBON FILM	DIGIKEY 1.0MQBK-ND
R95,R96	2	1.2M	1.2M OHM 1/4W 5% CARBON FILM	DIGIKEY 1.2MQBK-ND
R97-R99	3	22K	22K OHM 1/4W 5% CARBON FILM	DIGIKEY 22KQBK-ND
R100,R101 R116-R118 R126	6	330K	METAL FILM 330K OHM 1/4W 1%	DIGIKEY P330KCACT-ND
R102	1	560K	560K OHM 1/4W 5% CARBON FILM	DIGIKEY 560KQBK-ND
R106-R109	4	2.2M	2.2M OHM 1/4W 5% CARBON FILM	DIGIKEY 2.2MQBK-ND
R110	1	330R	330 OHM 1/4W 5% CARBON FILM	DIGIKEY 330QBK-ND

R111,R112	2	470R	RES MF 1/4W 470 OHM 1% AXIAL DIGIKEY RNF1/4T1470FRCT-ND
R113.R114	2	3.0K	METAL FILM 3.00K OHM 1/4W 1% DIGIKEY P3.00KCACT-ND
R119,R120,R19	3	4.7K	METAL FILM 4.70K OHM 1/4W 1% DIGIKEY P4.70KCACT-ND
R121-R125 R130	6	5.6K	5.6K OHM 1/4W 5% CARBON FILM DIGIKEY 5.6KQBK-ND
R127	1	470K	470K OHM 1/4W 5% CARBON FILM DIGIKEY 470KQBK-ND
R128,R129	2	150K	150K OHM 1/4W 1% METAL FILM DIGIKEY 150KXBK-ND
R131	1	220R	220 OHM 1/4W 5% CARBON FILM DIGIKEY 220QBK-ND

Capacitors

REF. DESIG.	QTY.	VALUE	COMMENTS CATALOG PART NO.
C1,C2	2	47 uF	47UF 35V ELECT AUDIO RAD DIGIKEY 604-1064-ND
C3-C37	35	100 nF	.10UF 63V METAL POLY DIGIKEY 495-1103-ND
C38	1	1 nF	CER 1000PF 50V 10% DIGIKEY 478-4492-ND
C39-C41	3	10 nF	.01UF 50V 10% CER RADIAL DIGIKEY 399-4206-ND
C42-C44	3	1 uF	POLYFILM BOX 1.0UF 63V 5% DIGIKEY 478-3367-ND
C45-C49	5	220 pF	220PF 100V 5% CER RADIAL DIGIKEY 399-4163-ND
C50-C52	3	2 nF	POLYPROPYLENE .0020UF 50V 1% DIGIKEY P3831-ND
C53	1	33 nF	.033UF 250V METAL FILM BOX DIGIKEY 3010PH-ND
C54	1	330 nF	.33UF 50V CERAMIC MONO 10% DIGIKEY P4959-ND
C55-C56	2	4.7 nF	4700PF 50V CERAMIC X7R 10% DIGIKEY BC1093CT-ND
C57-C60	4	47 nF	.047UF 50V CERAMIC X7R 10% DIGIKEY BC1099CT-ND

Semiconductors

REF. DESIG.	QTY.	VALUE	COMMENTS	CATALOG PART NO.
U1	1	CD4017	DECADE COUNTER	DIGIKEY 296-2037-5-ND
U2,U3	2	CD40106	HEX SCHMITT TRIGGER	DIGIKEY 296-3503-5-ND
U4	1	CD4081	2-IN AND GATE QUAD	DIGIKEY 296-2066-5-ND
U5	1	CD4013	DUAL D-TYPE FLIP-FLOP	DIGIKEY 296-2033-5-ND
U6	1	TS556	TIMER DUAL LOW POWER	DIGIKEY 497-7680-5-ND
U7-U11	5	LF398	MONO SAMPLE & HOLD	DIGIKEY LF398N-ND
U12	1	LM358	OPAMP DUAL 8-DIP	DIGIKEY LM358ANFS-ND
U13-U20	8	TL074	QUAD JFET-INPUT OPAMP	DIGIKEY 296-1777-5-ND
U21	1	CD4053	MUX/DEMUX TRI ANA 2CH	DIGIKEY CD4053BCN-ND
U22	1	78L10	REG 0.1A 10V	DIGIKEY 296-1996-ND
U23	1	LM334Z	CURRENT SOURCE ADJ TO-92	DIGIKEY LM334ZNS-ND
D1-15	15	1N4148	DIODE SGL JUNC 100V 4.0NS D0-35	DIGIKEY 1N4148FS-ND
D16	1	1N457	DIODE SS 70V 200MA DO35	DIGIKEY 1N457CT-ND
D17-D20	4	BAT85	DIODE SCHOTTKY 30V 200MA DO34	DIGIKEY 568-1617-1-ND
Q1-Q5	5	2N3904	TRANSISTOR NPN GP 200MA TO-92	DIGIKEY 2N3904FS-ND
Q6	1	MPF102	JFET AMP N-CH RF SS TO-92	DIGIKEY MPF102-ND FUTURLEC MPF102

Multi-Turn Trimmer Potentiometers

REF. DESIG.	QTY.	VALUE	COMMENTS	CATALOG PART NO.
VR1-VR10	10	100K	25 TURN, TOP ADJ	DIGIKEY 490-2876-ND
VR11	1	200K	POT 200K OHM 1/4" SQ CERM SL MT	DIGIKEY 3266W-204LF-ND
VR12	1	10K	POT CERM 10K OHM 25TRN TOP	DIGIKEY 490-2875-ND

Connector Hardware

REF. DESIG.	QTY.	VALUE	COMMENTS	CATALOG PART NO.
J1,J9	2	MOLEX 22-23-2041	CONN HEADER 4POS .100 VERT TIN	DIGIKEY WM4202-ND FUTURLEC POLHDR4
J2	1		16 PIN .100" MALE DOUBLE HEADERS	FUTURLEC HEADD16
J3	1	TYCO 644752-4	CONN HEADER VERT 4POS .156 TIN	DIGIKEY A24166-ND
J4	1	TYCO 640456-6	CONN HEADER VERT 6POS .100 TIN	DIGIKEY A1923-ND FUTURLEC POLHDR6
J5	1		20 PIN SHROUDED MALE HEADERS	FUTURLEC IDCMH20 DIGIKEY A33055-ND
J6	1	MOLEX 22-23-2051	CONN HEADER 5POS .100 VERT TIN	DIGIKEY WM4203-ND FUTURLEC POLHDR5
J7,J8,J10	3	MOLEX 22-23-2121	CONN HEADER 12POS .100 VERT TIN	DIGIKEY WM4210-ND FUTURLEC POLHDR12

Crimp Terminals & Misc. Hardware

REF. DESIG.	QTY.	VALUE	COMMENTS	CATALOG PART NO.
NA	53		CRIMP TERM. QTY [6] PK of 10 FUTURLEC PLHDPIN	DIGIKEY WM1114-ND
TP1-TP9	9	5010	TEST POINT PC MULTI PURPOSE RED	DIGIKEY 5010K-ND
TB1	1	TYCO 796949-3	TERMINAL BLOCK 3 POS.	MOUSER 571-7969493

Sockets

REF. DESIG.	QTY.	VALUE	COMMENTS	DIGIKEY PART NO.
X7-X12	6		SOCKET IC OPEN FRAME 8POS .3"	DIGIKEY 3M5461-ND
X2-X6 X13-X20	13		SOCKET IC OPEN FRAME 14POS .3"	DIGIKEY 3M5462-ND
X1,X21	2		SOCKET IC OPEN FRAME 16POS .3"	DIGIKEY 3M5463-ND

Appendix B

Appendage Touch Ribbon Controller Panel Bill of Materials

Panel Mount Potentiometers

REF. DESIG.	QTY.	VALUE
VR101-VR109	9	100K Linear

Panel Mount Toggle Switches

REF. DESIG.	QTY.	VALUE
SW101	1	SPDT ON-OFF-ON
SW102	1	DPDT ON-OFF-ON
SW103 SW104	2	DPDT ON-ON
SW105	1	SPST ON-OFF

Panel Mount LEDs

REF. DESIG.	QTY.	VALUE
D101, D102	2	Any Color LED

Panel Mount Connectors

REF. DESIG.	QTY.	VALUE	COMMENTS	CATALOG PART NO.
J101-J116	16	Preferred Jack of Choice (1/4”, 3.5mm, Banana)		
J117	1	Isolated TRS, ¼”		(Mouser 502-N112BX) (Switchcraft N112BX)

Miscellaneous: **22 Gauge Stranded Hookup Wire**
22 Gauge Solid Bus Wire
LED Sockets (2)
Knobs (9)

Appendix C

Appendage Touch Ribbon Controller Assembly Bill of Materials

Ribbon: spectrasymbol™ SoftPot® or HotPot® Assembly, preferred length.

Available from:

SparkFun: http://www.sparkfun.com/

Trossen Robotics: http://www.trossenrobotics.com/

Additional Hardware:

J201: Isolated TRS, ¼", (Mouser 502-N112BX) (Switchcraft N112BX)
P201: SIP Connector (Mouser 571-1-1571994-0) (Tyco 1-1571994-0)
Stereo TRS Cable, ¼" Connectors

22 Gauge Stranded Hookup Wire
Heatshrink Tubing

Custom Assembled Ribbon Controller Assemblies can be purchased from:

http://www.RibbonControllers.com/

Mnemonic	Literal	Pg.	PNL
Bend	Output of Bend Differential Amplifier	3,4	
Bend Out	Bend Voltage Output	4	X
Bend Pot	Top connection of Bend Mix Pot	4	X
Bend Tap	Tap connection of Bend Mix Pot	4	X
Comp	Pressure Comparator: High = Pressure	3	
Cref	Common Comparator Reference Voltage	3	
DInhib	Discriminator Inhibit: Hi = No Sample	3	
DReset	Discriminator Reset: Resets DInhib	3	
ExGt	External Gate Input	3	X
FOffTap	Tap connection of Fine Offset Pot	4	X
Gate	Raw Gate Signal (+V Logic Level)	3,4	
Gate LED	Connection to anode of Gate LED	4	X
Gate Out	Gate Signal Output	4	X
GatedClk	Gated Clock: Active when DInhib low	3	
GClk	Guard S&H Clock Signal	3	
GlideOut	Output of Auto Glide Circuit	3	
GlidePot	Top connection of Glide Pot	3	X
GlideTap	Tap connection of Glide Pot	3	X
Init	Output of Initial Note S&H System	3,4	
Init Out	Initial Note Voltage Output	4	X
Init Pot	Top connection of Initial Mix Pot	4	X
Init Tap	Tap connection of Initial Mix Pot	4	X
InitClk	Initial Note S&H Clock Signal	3	
InitGate	Initial Note Clock Gate	3	
InvBend	Inverted Bend Voltage Output	4	X
InvComp	Inverted Pressure Comparator Signal	3	
InvInit	Inverted Initial Note Voltage Output	4	X
InvMix	Inverted Mixed Voltage Output	4	X
InvSlde	Inverted Slide Voltage Output	4	X
InvTFS	Inverted TFS Voltage Output	4	X
LowP	Discriminator Low Pulse < Vref = high	3	
Mix In	External Mix Signal Input	4	X
Mix Out	Mixed Voltage Output	4	X
Mod Tap	Tap connection from Mod Input Pot	4	X
Mode SW	Connection to Mode Switch	2	X
Off Tap	Tap connection of Offset Pot	4	X
Rib Bot	Connection to Return of Ribbon	2	X
Rib Tap	Connection to Tap of Ribbon	2	X
Rib Top	Send Connection to Ribbon	2	X
Samp Tap	Tap Connection from Sample Input Pot	3	X
SampInhb	Initial Note S&H Inhibit	3	
SigClk	Signal S&H Clock Signal	3	
Slid	Output of Slide S&H System	3,4	
Slid Pot	Top Connection of Slide Mix Pot	4	X
Slid Tap	Tap Connection of Slide Mix Pot	4	X
Slide Out	Slide Voltage Output	4	X
SLSHClk	Slide S&H Clock Signal	3	
SP Tap	Ribbon Tap Signal (unscaled)	2,3	
SW1-1	Connect to Throw 1 of Trig Mode SW	3	X

Mnemonic	Literal	Pg.	PNL
SW1-2	Connect to Throw 2 of Trig Mode SW	3	X
SW2A-2	Connect to Throw 2A of Gate Mode SW	3	X
SW2B-1	Connect to Throw 1B of Gate Mode SW	3	X
SW2B-2	Connect to Throw 2B of Gate Mode SW	3	X
SW3A-1	Connect to Throw 3A-2 of S&H Mode SW	2	X
SW3A-2	Connect to Throw 3A-2 of S&H Mode SW	3	X
SW3B-1	Connect to Throw 3B-1 of S&H Mode SW	3	X
SW4A-2	Connect to Throw 2 of Rib/S&H SW	3	X
SW4A-P	Connect to Pole A of Rib/S&H SW	3	X
SW4B-P	Connect to Pole B of Rib/S&H SW	3	X
TFS Out	TFS Voltage Output	4	X
TFS Pot	Top connection of TFS Mix Pot	4	X
TFS Tap	Tap connection of TFS Mix Pot	4	X
TF Scale	Scaled TFS Voltage to Output	2,4	
Trig	Raw Trigger Signal (+V Logic Level)	3,4	
Trig LED	Connect to anode of Trigger LED	4	X
Trig Out	Trigger Signal Output	4	X

Auxiliary Connector

Mnemonic	Literal	Pg.
A100INT_CV	Doepfer A100 Modular Control Voltage	2
A100INT_GATE	Doepfer A100 Modular GATE	2
Bend Pot	Top connection of Bend Mix Pot	4
Clock	Clock Signal	3
Comp	Pressure Comparator: High = Pressure	3
DHOP	Discriminator Low Pulse > Vref = high	3
DInhib	Discriminator Inhibit: Hi = No Sample	3
Init Pot	Top connection of Initial Mix Pot	4
LowP	Discriminator Low Pulse < Vref = high	3
Slid Pot	Top Connection of Slide Mix Pot	4
TFS Pot	Top connection of TFS Mix Pot	4
+V	Positive Supply Rail	-
-V	Negative Supply Rail	-
⏚	Analog Ground	-
⏚d	Digital Ground	-

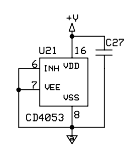
Highest Reference Designator Used

C60
D20
J10
R131
TB1
TP9
U23
VR12
JMP2

Reference Designators Not Used

R39 R46
R45 R52 R86 R115

Unused IC Sections



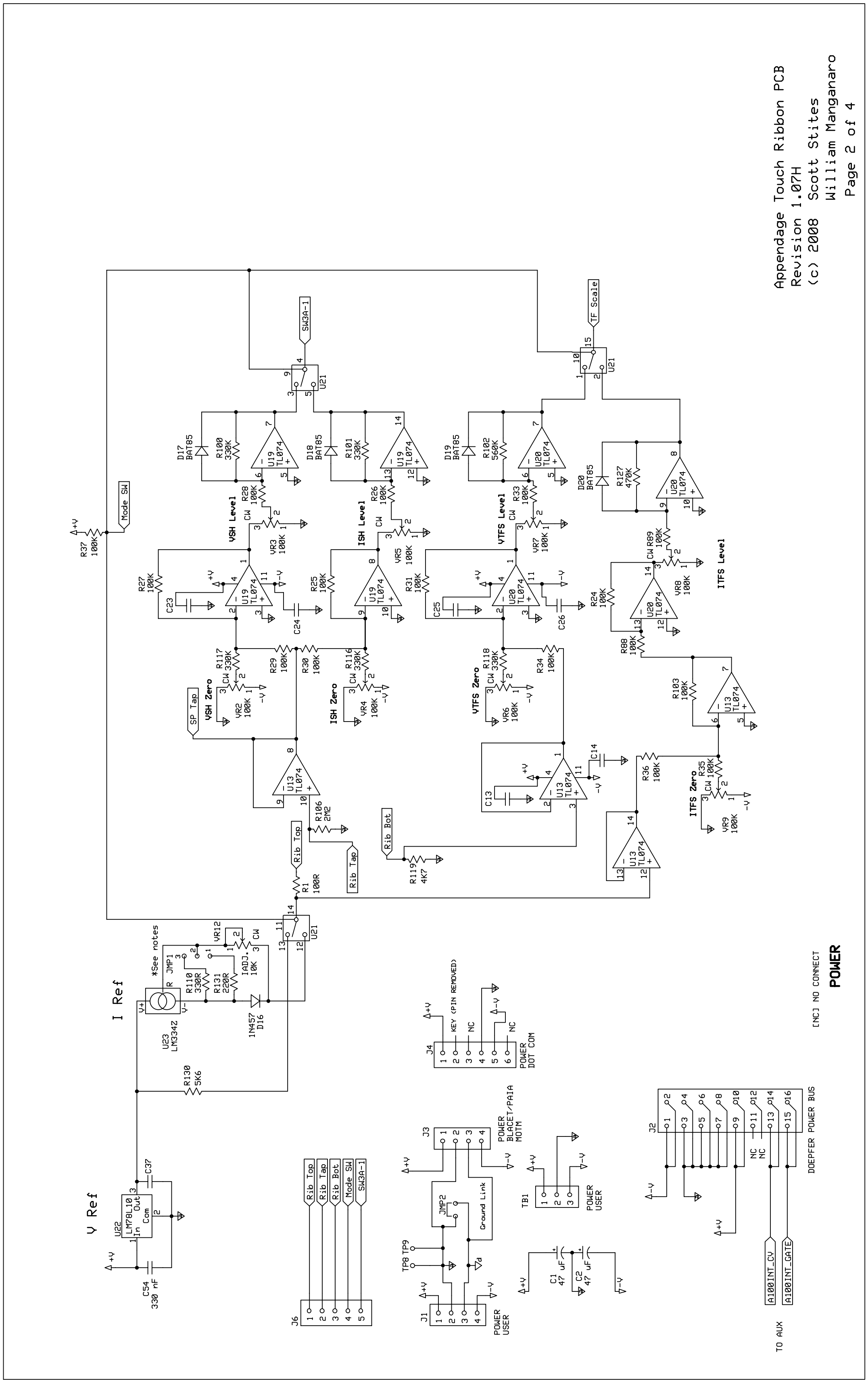
Note: +V, -V, Analog and Digital Ground are used for panel connections
U15 is segregated for comparator use only
SHORT JMP1 PINS 2 & 3 for 500mm Ribbon
SHORT JMP1 PINS 1 & 2 for <500mm Ribbon
Gate/Trigger Resistor Values - See page 4
C3-C37 0.1 uF Ceramic

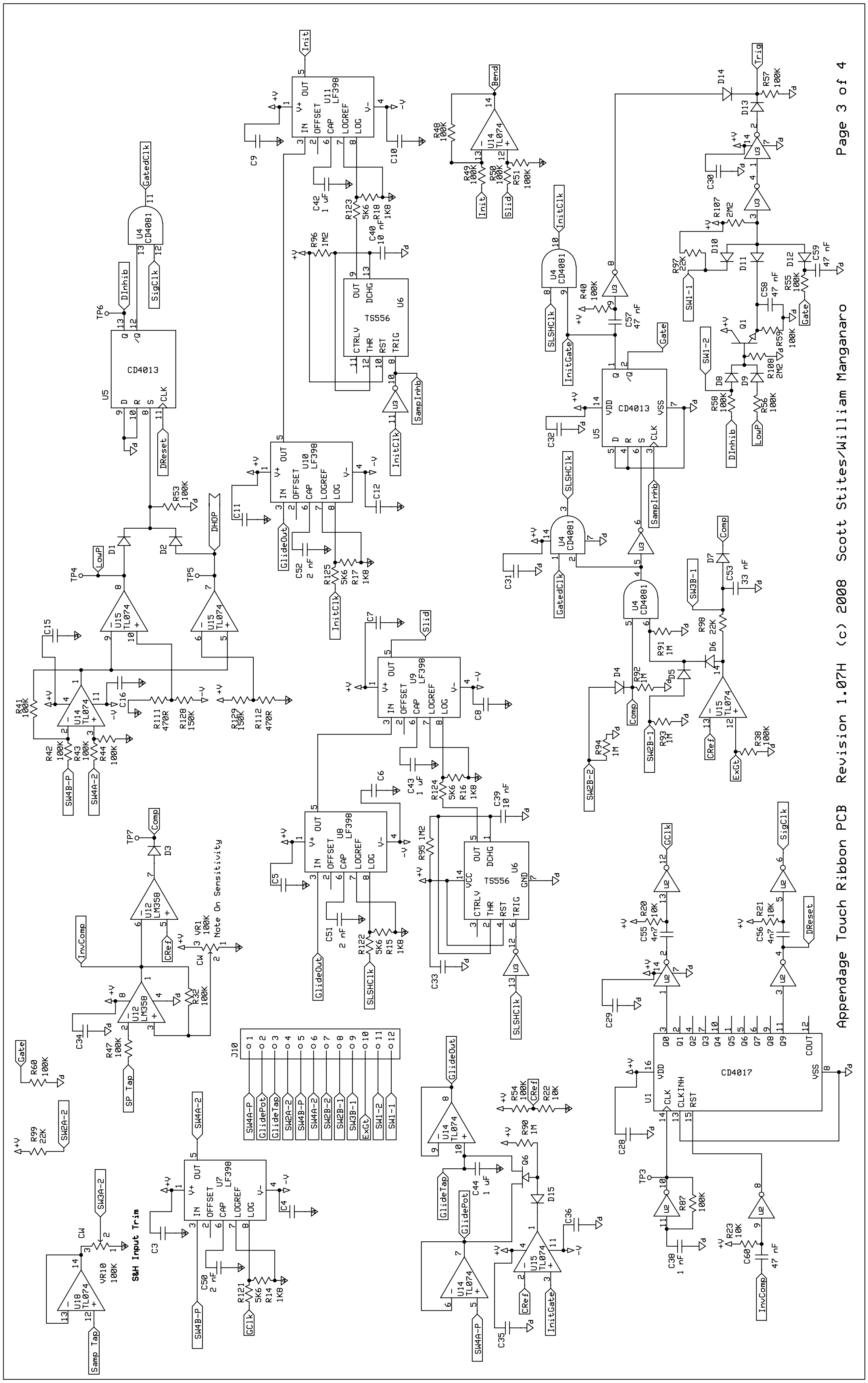
Recommend the use of Linear power supply capable of supplying up to 250 mA on each rail
DO NOT USE SMPS (Switch Mode Power Supply) with this DESIGN

Revision History

1.04	Rev 1.03 Changes Incorporated Page 4 Changes: R61, R65 and R69 changed from 100K to 120K Added Gate/Trigger resistor selection chart Page 3 Changes: R39, R45, R46 and R52 removed R111 and R112 changed from 330R to 470R Added R132 and VR10 to Page 3
1.05	Removed R132 from page 3
1.06	Removed signals to J5 pins 12 & 14 NOTE: unable to route them Added digital ground to R94
1.07E	On SHT. 3 Changed all references FROM SW4-2 TO SW4A-2 On SHT. 1 Remove R115 and replace with VR12 On SHT. 4 Remove fixed resistor R86 and use VR11 200K trimmer. On SHT. 3 Swapped C9/11 & C10/12 locations to match PCB Layout Add NOTE: C3-C37 0.1 uF Ceramic Reorient potentiometers VR1 to VR12
1.07F	Changed "SH Scale" to "SW3A-1" in mnemonic table and sheet 4 Changed "SW4-2" to "SW4A-2" in mnemonic table No change to PCB layout in this rev Revved PCB title to "F"
1.07G	Changed R2 through R11 from 1K to 100R
1.07H	ADD "MIX OUT" TO J5-14 , AUX CONNECTOR

Appendage Touch Ribbon PCB
Revision 1.07H


Appendage Touch Ribbon PCB
Revision 1.07H
(c) 2008 Scott Stites
William Manganaro
Page 2 of 4
V Ref
I Ref
POWER
[NC] NO CONNECT
VSH Level
ISH Level
VTFS Level
ITFS Level
VSH Zero
ISH Zero
VTFS Zero
ITFS Zero
DOEPFER POWER BUS
TO AUX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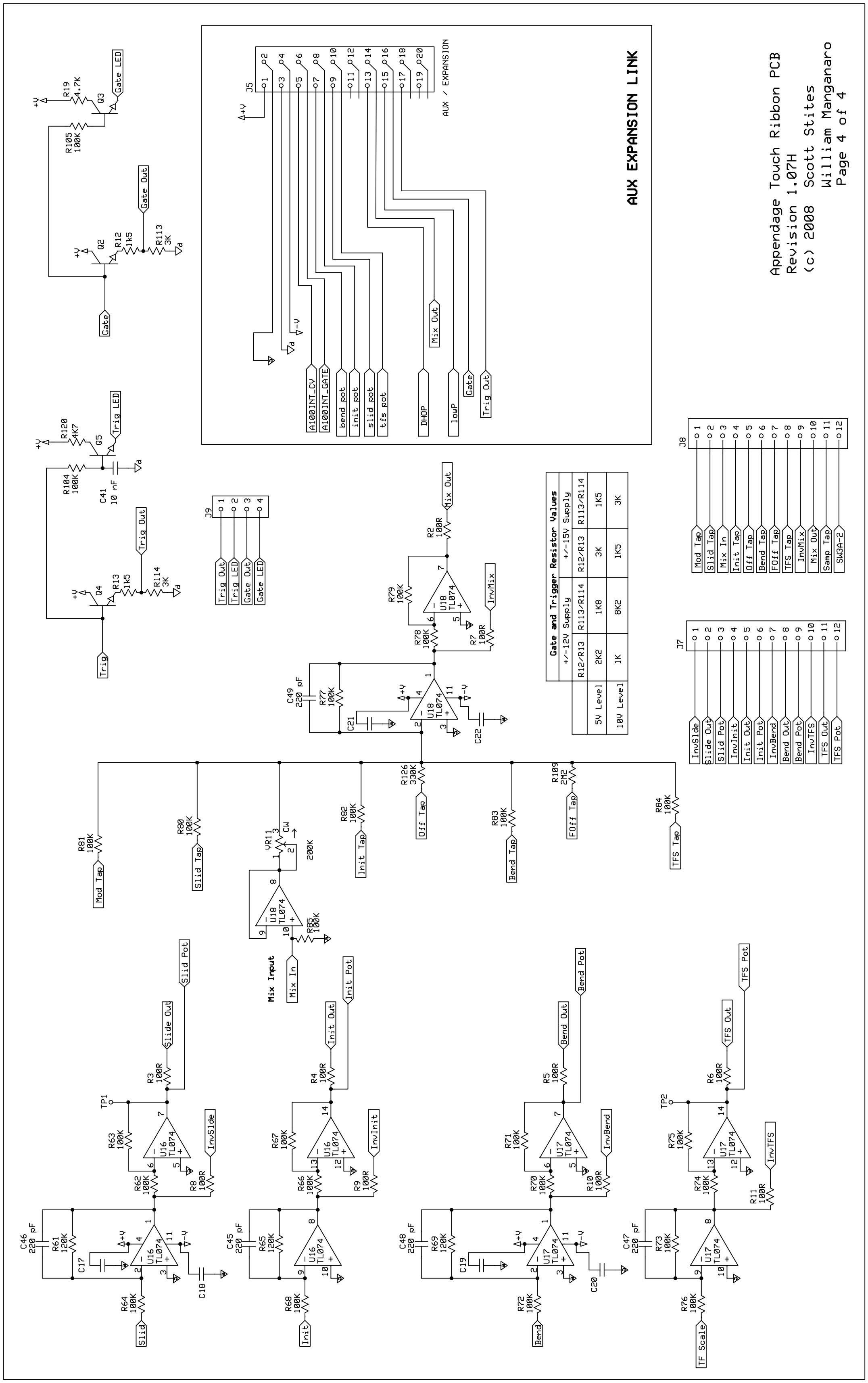
Page 3 of 4



Gate and Trigger Resistor Values

	+/-12V Supply		+/-15V Supply	
	R12/R13	R113/R114	R12/R13	R113/R114
5V Level	2K2	1K8	3K	1K5
10V Level	1K	8K2	1K5	3K

Revision History

1.07G (Alpha)	Panel component ref des to 100 Power connections added Rev to 1.07G when approved

Mnemonic	Literal
Bend Out	Bend Voltage Output
Bend Pot	Top connection of Bend Mix Pot
Bend Tap	Tap connection of Bend Mix Pot
ExGt	External Gate Input
FOffTap	Tap connection of Fine Offset Pot
Gate LED	Connection to anode of Gate LED
Gate Out	Gate Signal Output
GlidePot	Top connection of Glide Pot
GlideTap	Tap connection of Glide Pot
Init Out	Initial Note Voltage Output
Init Pot	Top connection of Initial Mix Pot
Init Tap	Tap connection of Initial Mix Pot
InvBend	Inverted Bend Voltage Output
InvInit	Inverted Initial Note Voltage Output
InvMix	Inverted Mixed Voltage Output
InvSlde	Inverted Slide Voltage Output
InvTFS	Inverted TFS Voltage Output
Mix In	External Mix Signal Input
Mix Out	Mixed Voltage Output
Mod Tap	Tap connection from Mod Input Pot
Mode SW	Connection to Mode Switch
Off Tap	Tap connection of Offset Pot
Rib Bot	Connection to Return of Ribbon
Rib Tap	Connection to Tap of Ribbon
Rib Top	Send Connection to Ribbon
Samp Tap	Tap Connection from Sample Input Pot
Slid Pot	Top Connection of Slide Mix Pot
Slid Tap	Tap Connection of Slide Mix Pot
Slide Out	Slide Voltage Output
SW1-1	Connect to Throw 1 of Trig Mode SW
SW1-2	Connect to Throw 2 of Trig Mode SW
SW2A-2	Connect to Throw 2A of Gate Mode SW
SW2B-1	Connect to Throw 1B of Gate Mode SW
SW2B-2	Connect to Throw 2B of Gate Mode SW
SW3A-1	Connect to Throw 3A-2 of S&H Mode SW
SW3A-2	Connect to Throw 3A-2 of S&H Mode SW
SW3B-1	Connect to Throw 3B-1 of S&H Mode SW
SW4A-2	Connect to Throw 2 of Rib/S&H SW
SW4A-P	Connect to Pole A of Rib/S&H SW
SW4B-P	Connect to Pole B of Rib/S&H SW
TFS Out	TFS Voltage Output
TFS Pot	Top connection of TFS Mix Pot
TFS Tap	Tap connection of TFS Mix Pot
Trig LED	Connect to anode of Trigger LED
Trig Out	Trigger Signal Output
+V	Positive Supply Rail
-V	Negative Supply Rail
⏚	Analog Ground
⏚d	Digital Ground

Highest Reference Designators Used

D102
J117
P10/J10
SW105
TB1

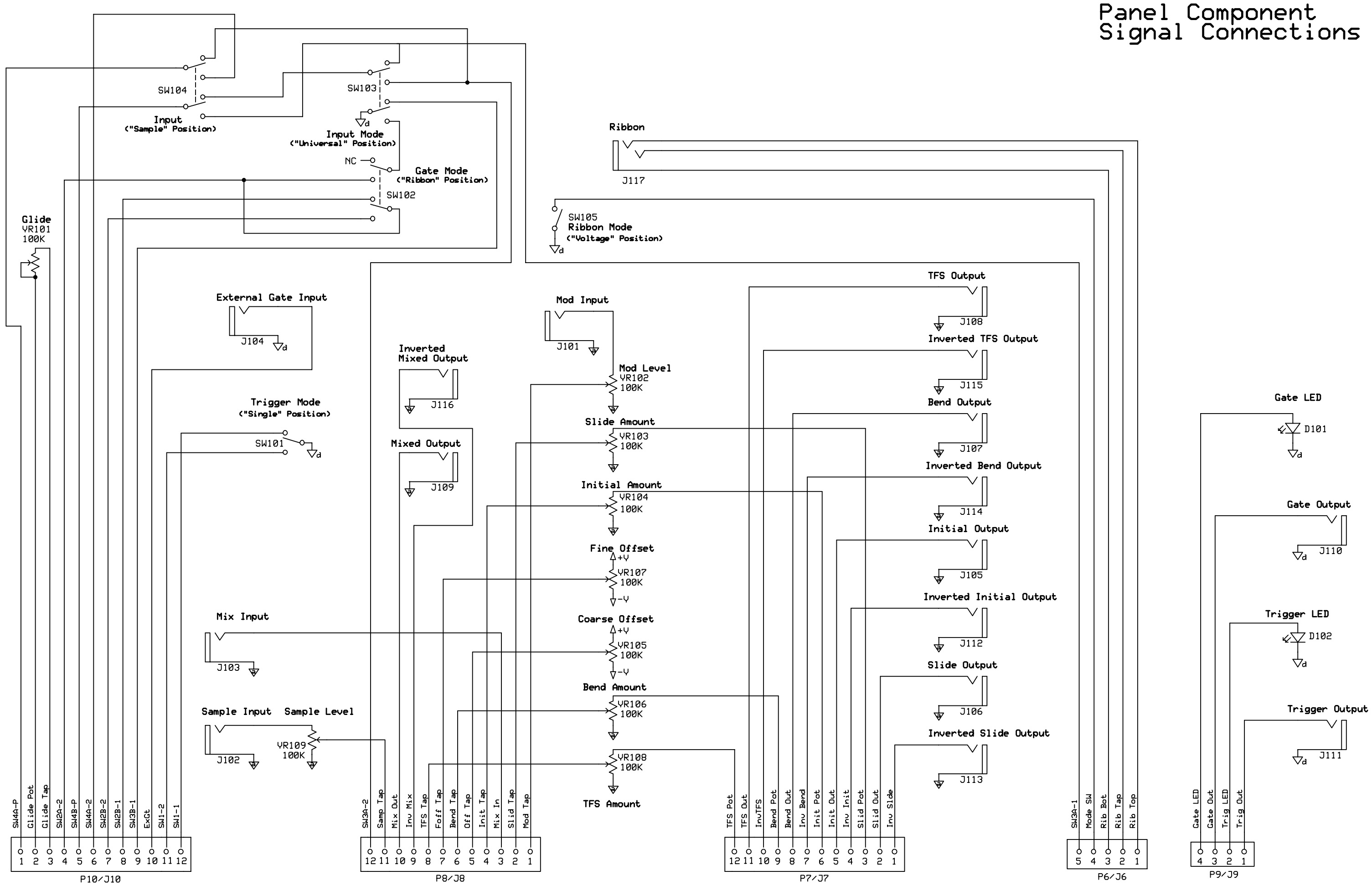
Reference Designators Not Used

P5/J5

Note: All panel mount components reference designators are series 100.
Plug reference designators match reciprocating J reference designators on PCB.
Terminal Block 1 (TB1) is located on PCB - illustration is for wire connection purposes.

Appendage Touch Ribbon Panel
Revision 1.07H

Panel Component Signal Connections

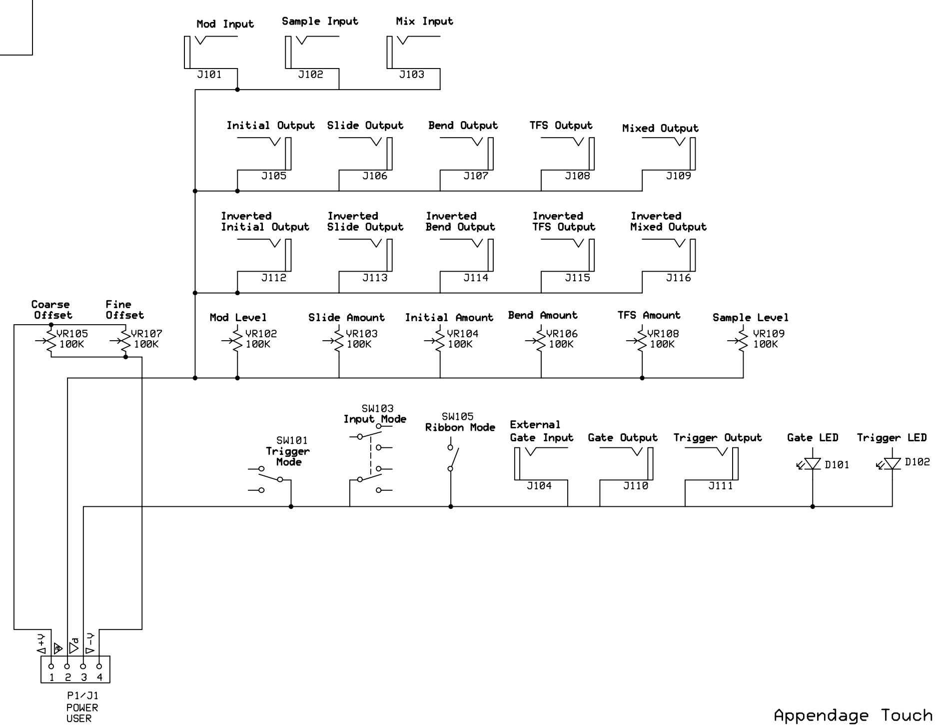


Appendage Touch Ribbon Panel   Revision 1.07H   (c) 2009 Scott Stites William Manganaro   Page 2 of 10

Panel Component Power/Ground Connections Using P1/J1 Power User Panel Dual Ground

Panel Component +V, Ground and -V Wiring Using P1/J1 Harness

With Separate Analog and Digital Ground Connections



Appendage Touch Ribbon Panel
Revision 1.07H
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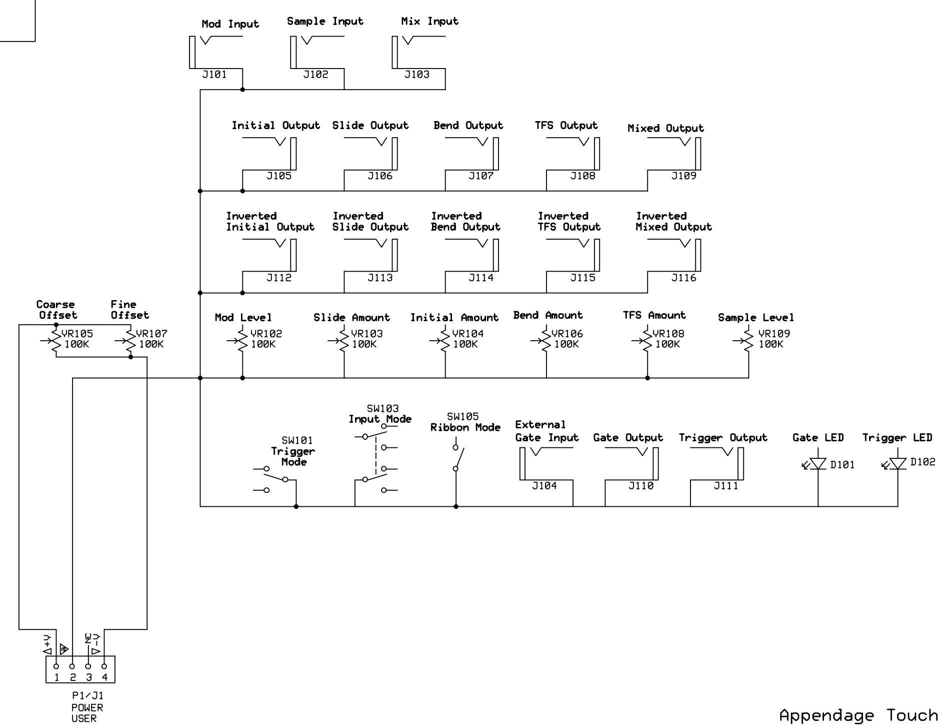
Panel Component
Power/Ground Connections
Using P1/J1
Power User
Panel Single Ground

Panel Component +V, Ground and -V Wiring
Using P1/J1 Harness

With Single Ground Connection



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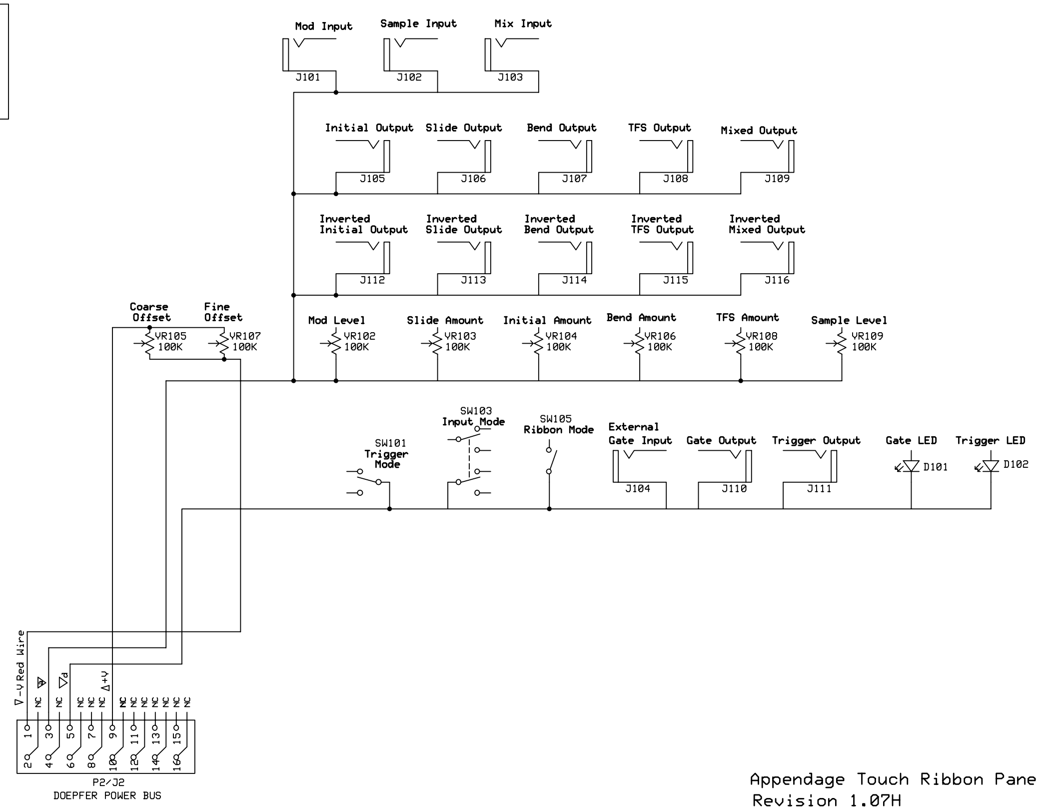
Panel Component
Power/Ground Connections
Using P2/J2
DOEPFER POWER BUS
Panel Dual Ground

Panel Component +V, Ground and -V Wiring
Using P2/J2 Harness

With Separate Analog and Digital Ground
Connections



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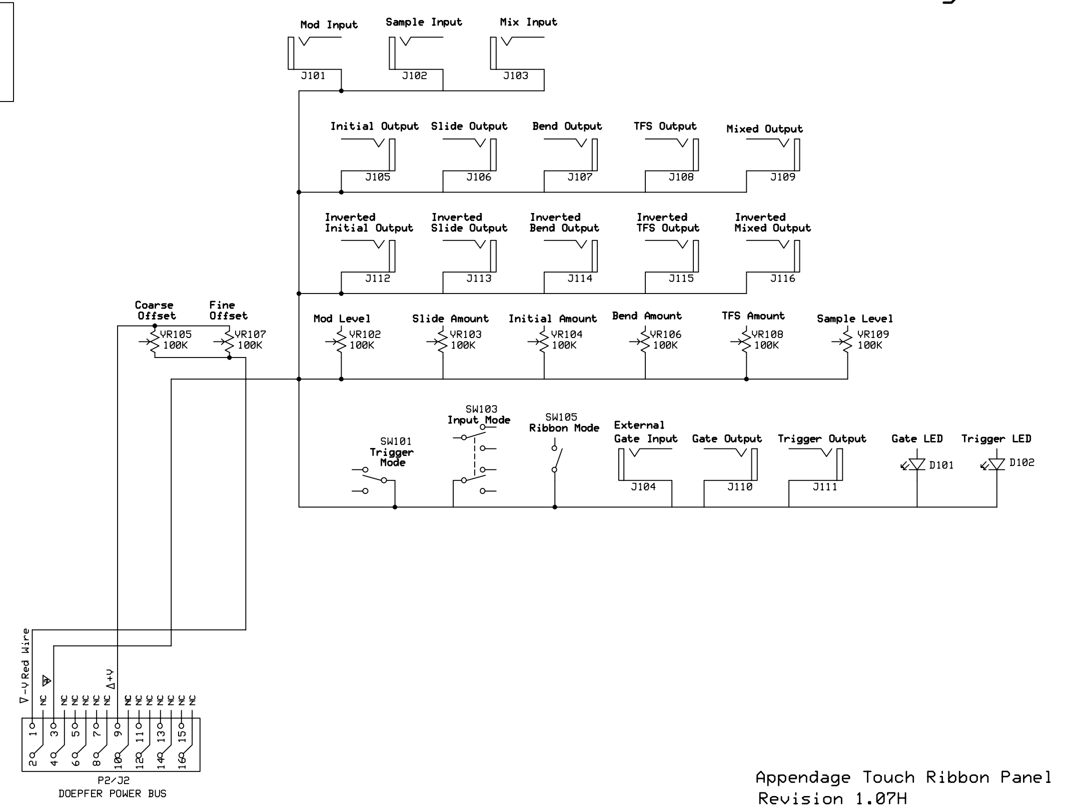
Panel Component
Power/Ground Connections
Using P2/J2
DOEPFER POWER BUS
Panel Single Ground

Panel Component +V, Ground and -V Wiring
Using P2/J2 Harness

With Single Ground Connection



Appendage Touch Ribbon Panel
Revision 1.07H
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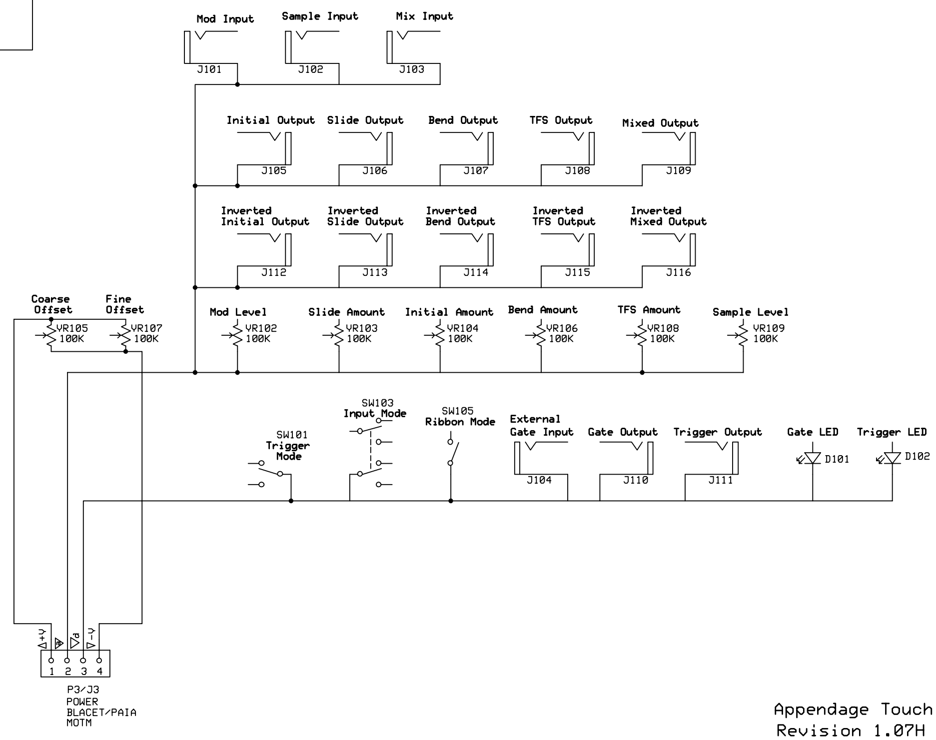
Panel Component Power/Ground Connections Using P3/J3 BLACET/PAIA/MOTM Panel Dual Ground

Panel Component +V, Ground and -V Wiring Using P3/J3 Harness

With Separate Analog and Digital Ground Connections



Appendage Touch Ribbon Panel
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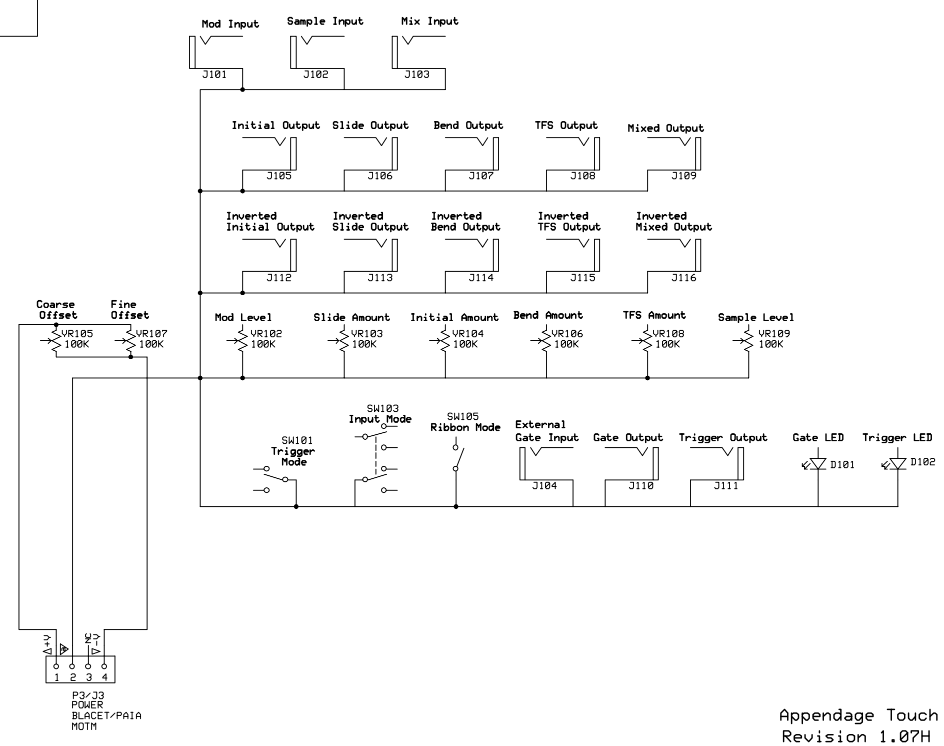
Panel Component Power/Ground Connections Using P3/J3 BLACET/PAIA/MOTM Panel Single Ground

Panel Component +V, Ground and -V Wiring
Using P3/J3 Harness

With Single Ground Connection



Appendage Touch Ribbon Panel
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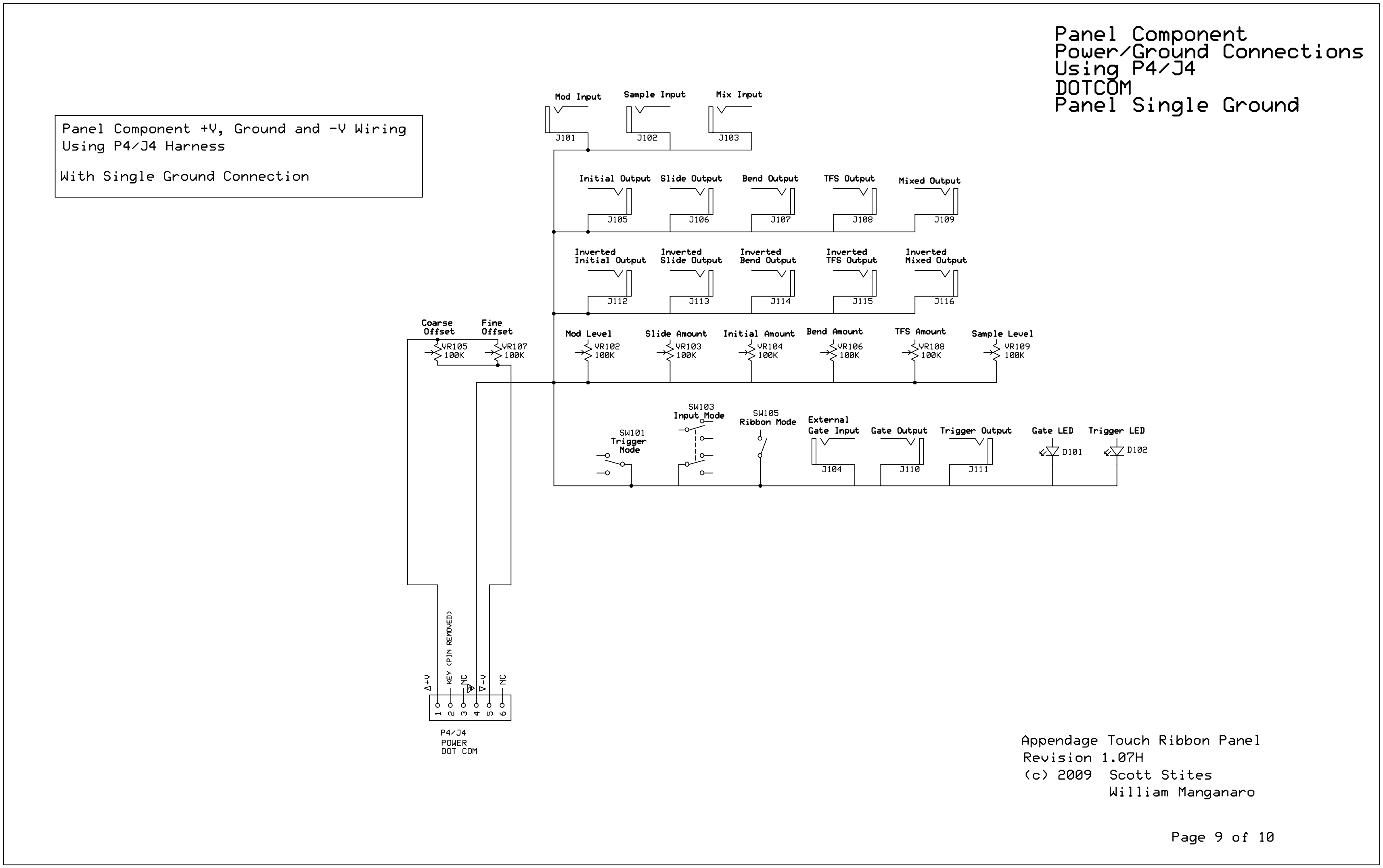
Panel Component
Power/Ground Connections
Using P4/J4
DOTCOM
Panel Single Ground
Panel Component +V, Ground and -V Wiring
Using P4/J4 Harness
With Single Ground Connection
Mod Input
Sample Input
Mix Input
J101
J102
J103
Initial Output
Slide Output
Bend Output
TFS Output
Mixed Output
J105
J106
J107
J108
J109
Inverted Initial Output
Inverted Slide Output
Inverted Bend Output
Inverted TFS Output
Inverted Mixed Output
J112
J113
J114
J115
J116
Coarse Offset
VR105 100K
Fine Offset
VR107 100K
Mod Level
VR102 100K
Slide Amount
VR103 100K
Initial Amount
VR104 100K
Bend Amount
VR106 100K
TFS Amount
VR108 100K
Sample Level
VR109 100K
SW101 Trigger Mode
SW103 Input Mode
SW105 Ribbon Mode
External Gate Input
J104
Gate Output
J110
Trigger Output
J111
Gate LED
D101
Trigger LED
D102
+V
KEY (PIN REMOVED)
NC
-V
NC
1 2 3 4 5 6
P4/J4
POWER
DOT COM
Appendage Touch Ribbon Panel
Revision 1.07H
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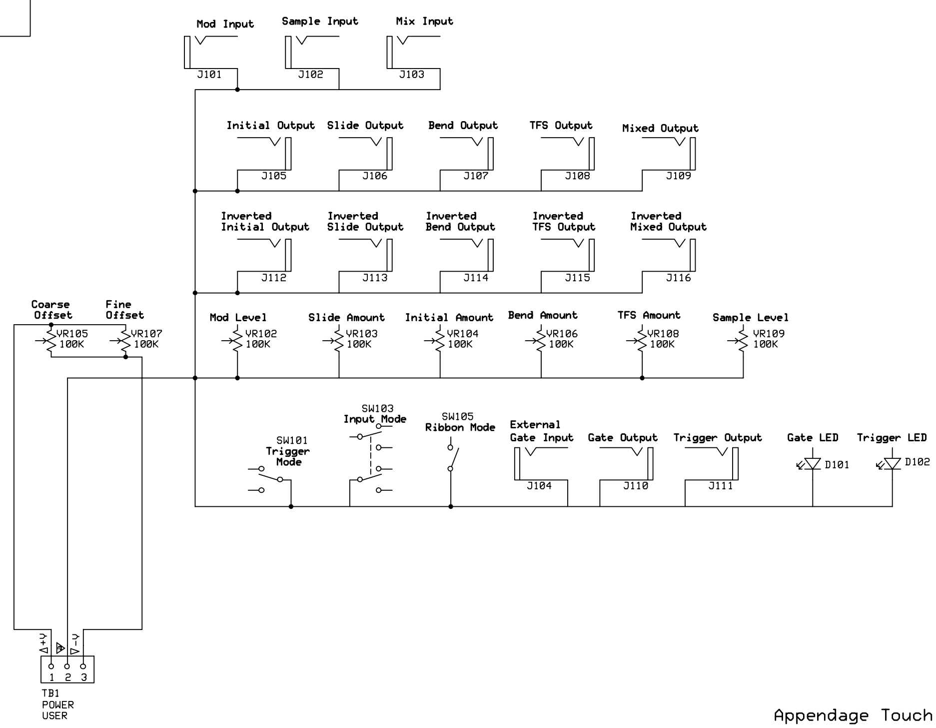
Page 9 of 10

Panel Component Power/Ground Connections Using TB1 Power User Panel Single Ground

Panel Component +V, Ground and -V Wiring
Using TB1 Harness

With Single Ground Connection



Appendage Touch Ribbon Panel
Revision 1.07H
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Revision History

1.07	Rev 1.07H Changes Incorporated

Schematic Labels

Mnemonic	Literal	Pg.
Bend	Output of Bend Differential Amplifier	3,4
ExGt	External Gate Input	3,4
Gate	Raw Gate Signal (+V Logic Level)	3,4
Init	Output of Initial Note S&H System	3,4
Ring	Ring Connection of J201/P201	2
Samp In	Connection from Sample Input Jack	3,4
SH Scale	Scaled Ribbon Tap Voltage to S&H	2,3
Sleeve	Sleeve Connection of J201/P201	2
Slid	Output of Slide S&H System	3,4
SP Tap	Ribbon Tap Signal (unscaled)	2,3
TF Scale	Scaled TFS Voltage to Output	2,4
Tip	Tip Connection of J201/P201	2
Trig	Raw Trigger Signal (+V Logic Level)	3,4

PCB Components:

Highest Board Assembly Reference Designator Used

C60
D20
J10
R131
TB1
TP9
U23
VR12
JMP2

Board Assembly Reference Designators Not Used

R39 R46
R45 R52

Note: SHORT JMP1 PINS 2 & 3 for 500mm Ribbon
SHORT JMP1 PINS 1 & 2 for <500mm Ribbon
Install JMP2 if power supply has single ground input.
Gate/Trigger Resistor Values - See page 4

Panel Components:

Highest Reference Designators Used

D102
J117
SW105

Note: All Panel Mounted Pots (VR), Diodes (D) and Switches (SW) Are Ref Des Series 100
Plug reference designators match reciprocating J reference designators on PCB.

Ribbon Assembly Components:

Highest Ribbon Assembly Reference Designator Used (Series 200)

J201
P201
VR201

Appendage Touch Ribbon Project Schematics
Revision 1.07H
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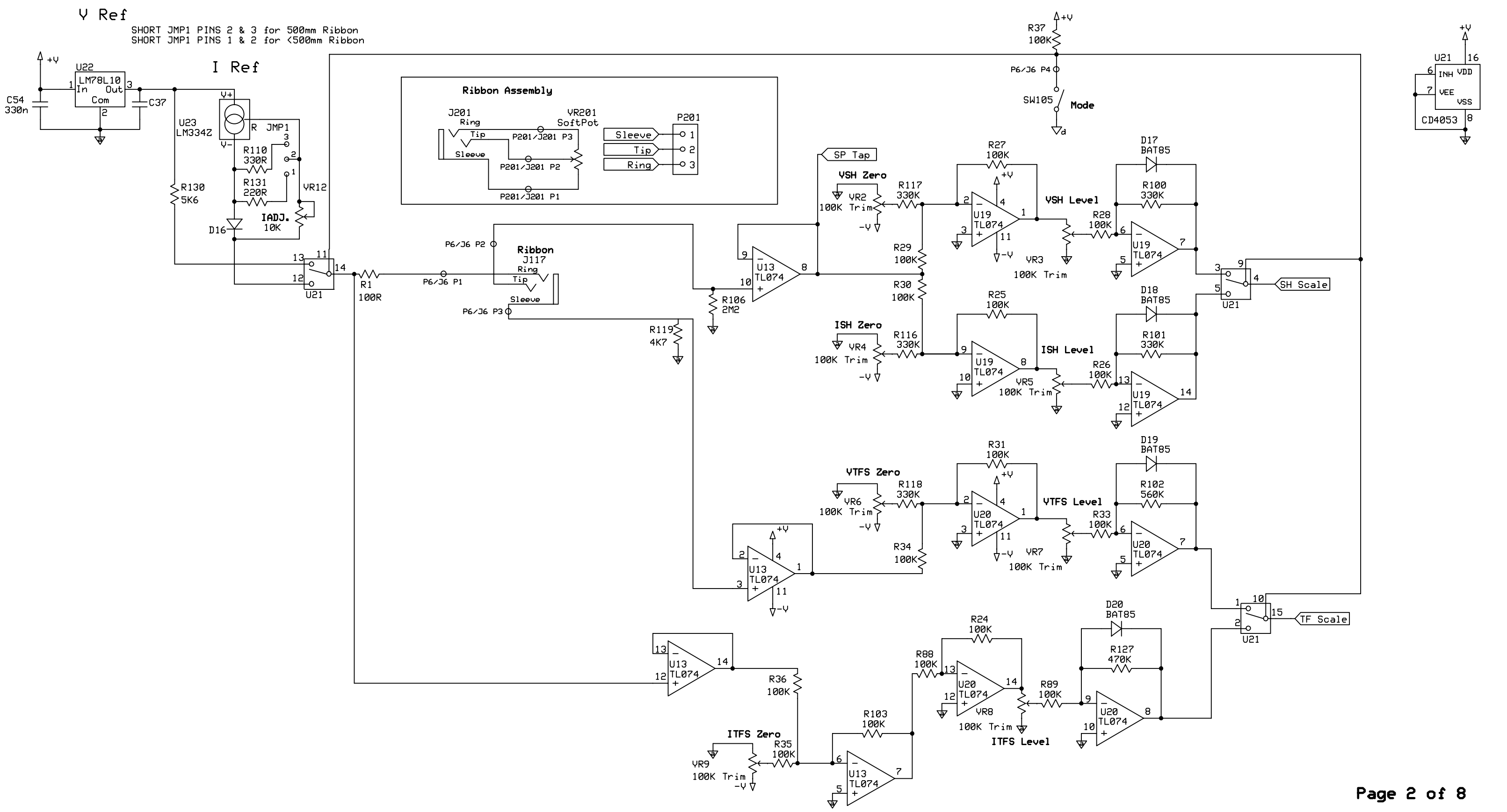
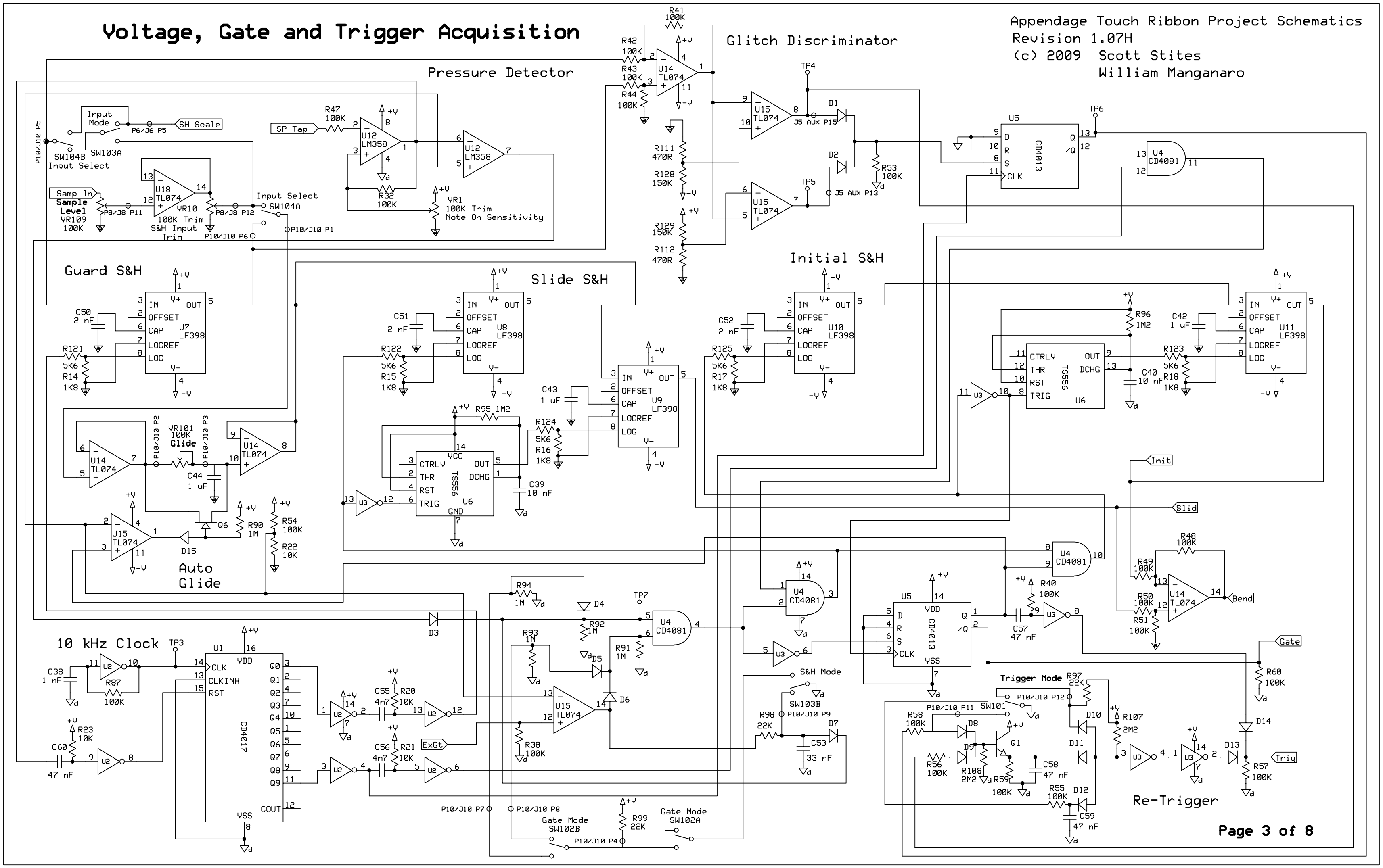
Mode and Scaling and Ribbon Assembly




Voltage, Gate and Trigger Acquisition
Appendage Touch Ribbon Project Schematics
Revision 1.07H
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Pressure Detector
Glitch Discriminator
Guard S&H
Slide S&H
Initial S&H
Auto Glide
10 kHz Clock
Re-Trigger
Page 3 of 8

Appendage Touch Ribbon Project Schematics
Revision 1.07H
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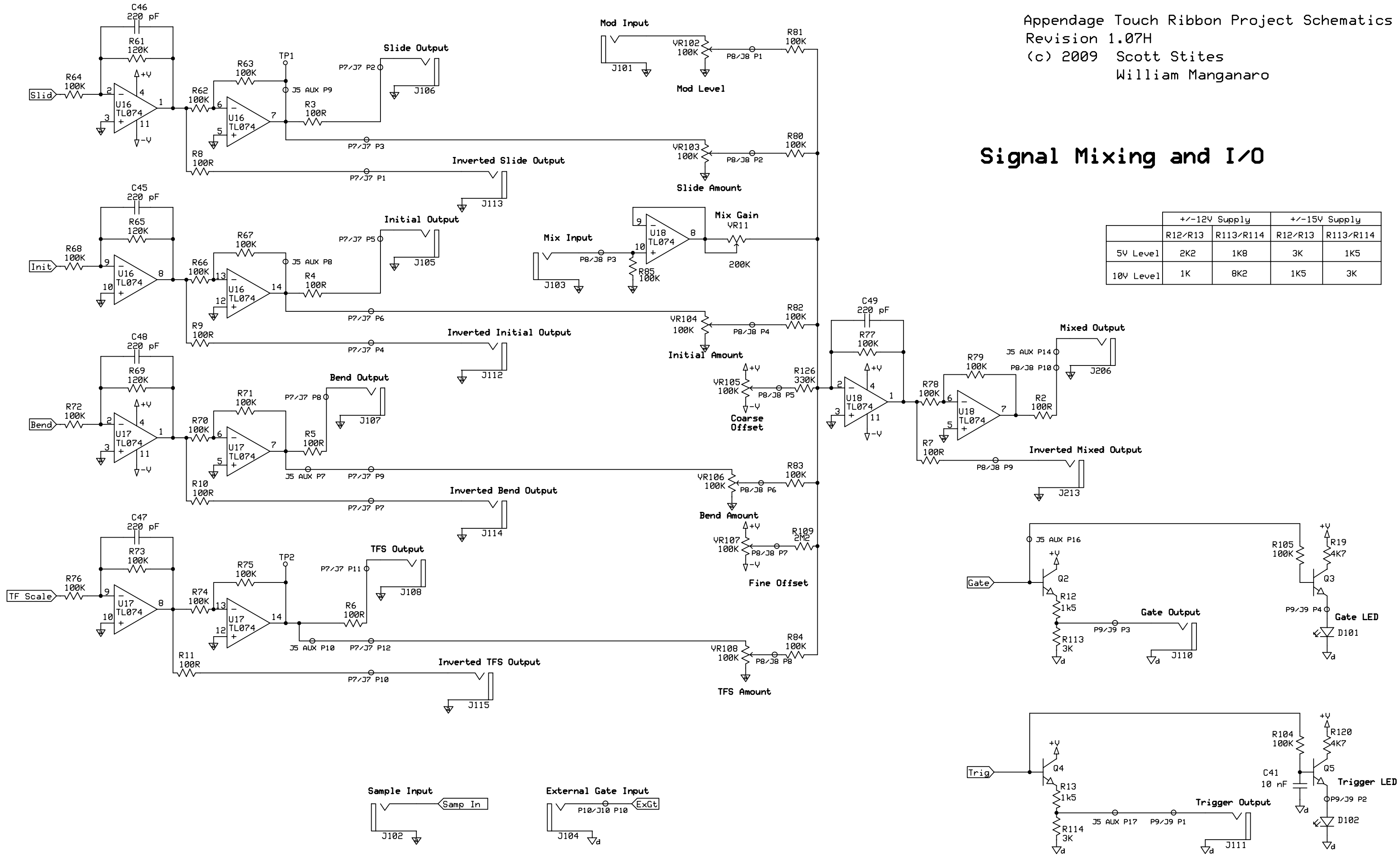
Signal Mixing and I/O

	+/-12V Supply		+/-15V Supply	
	R12/R13	R113/R114	R12/R13	R113/R114
5V Level	2K2	1K8	3K	1K5
10V Level	1K	8K2	1K5	3K



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Appendage Touch Ribbon Project Schematics
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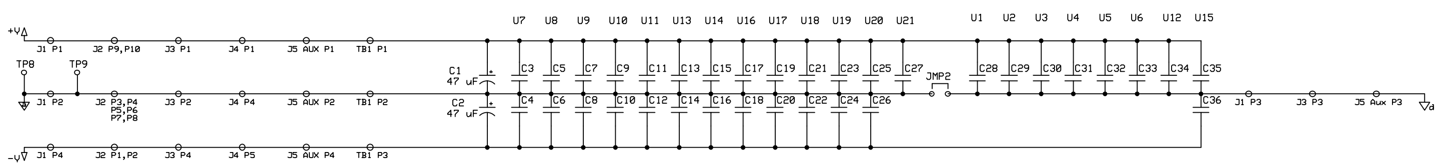
Power and Filtering



C3 through C36 = 0.1 uF

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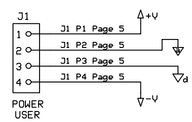
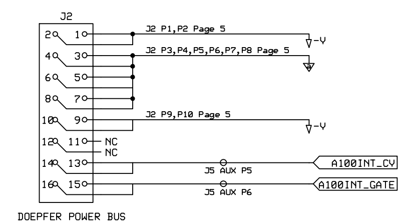
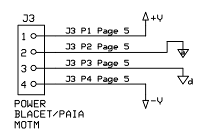
Power I/O

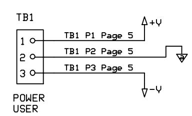
J2 Labels

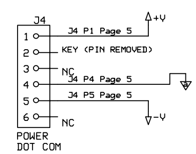
Mnemonic	Literal
A100INT_CV	Doepfer A100 Modular Control Voltage
A100INT_GATE	Doepfer A100 Modular GATE











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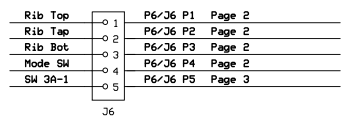
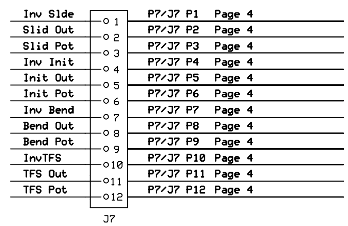
J6 Labels

Pin	Mnemonic	Literal
1	Rib Top	Send Connection to Ribbon
2	Rib Tap	Connection to Tap of Ribbon
3	Rib Bot	Connection to Return of Ribbon
4	Mode SW	Connection to Mode Switch
5	SH Scale	Scaled Ribbon Tap Voltage to S&H



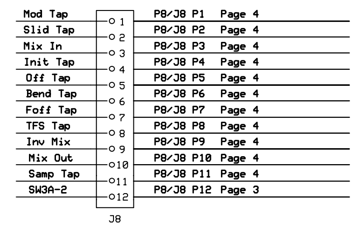
J7 Labels

Pin	Mnemonic	Literal
1	Inv Slde	Inverted Slide Voltage Output
2	Slid Out	Slide Voltage Output
3	Slid Pot	Top Connection of Slide Mix Pot
4	Inv Init	Inverted Initial Note Voltage Output
5	Init Out	Initial Note Voltage Output
6	Init Pot	Top connection of Initial Mix Pot
7	Inv Bend	Inverted Bend Voltage Output
8	Bend Out	Bend Voltage Output
9	Bend Pot	Top connection of Bend Mix Pot
10	InvTFS	Inverted TFS Voltage Output
11	TFS Out	TFS Voltage Output
12	TFS Pot	Top connection of TFS Mix Pot



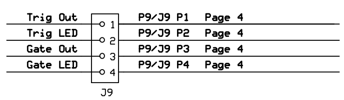
J8 Labels

Pin	Mnemonic	Literal
1	Mod Tap	Tap connection from Mod Input Pot
2	Slid Tap	Tap Connection of Slide Mix Pot
3	Mix In	External Mix Signal Input
4	Init Tap	Tap connection of Initial Mix Pot
5	Off Tap	Tap connection of Offset Pot
6	Bend Tap	Tap connection of Bend Mix Pot
7	Foff Tap	Tap connection of Fine Offset Pot
8	TFS Tap	Tap connection of TFS Mix Pot
9	Inv Mix	Inverted Mixed Voltage Output
10	Mix Out	Mixed Voltage Output
11	Samp Tap	Tap Connection from Sample Input Pot
12	SW3A-2	Connect to Throw 3A-2 of S&H Mode SW



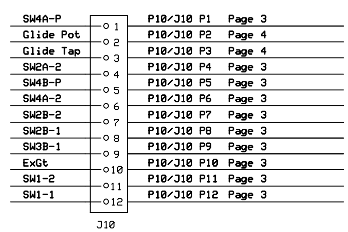
J9 Labels

Pin	Mnemonic	Literal
1	Trig Out	Trigger Signal Output
2	Trig LED	Connection to anode of Trigger LED
3	Gate Out	Gate Signal Output
4	Gate LED	Connection to anode of Gate LED



J10 Labels

Pin	Mnemonic	Literal
1	SW4A-P	Connect to Pole A of Rib/S&H SW
2	Glide Pot	Top connection of Glide Pot
3	Glide Tap	Tap connection of Glide Pot
4	SW2A-2	Connect to Throw 2A of Gate Mode SW
5	SW4B-P	Connect to Pole B of Rib/S&H SW
6	SW4A-2	Connect to Throw 2 of Rib/S&H SW
7	SW2B-2	Connection to Throw 2B of Gate Mode SW
8	SW2B-1	Connection to Throw 1B of Gate Mode SW
9	SW3B-1	Connect to Throw 3B-1 of S&H Mode SW
10	ExGt	External Gate Input
11	SW1-2	Connection to Throw 2 of Trig Mode SW
12	SW1-1	Connection to Throw 1 of Trig Mode SW



Panel Connectors

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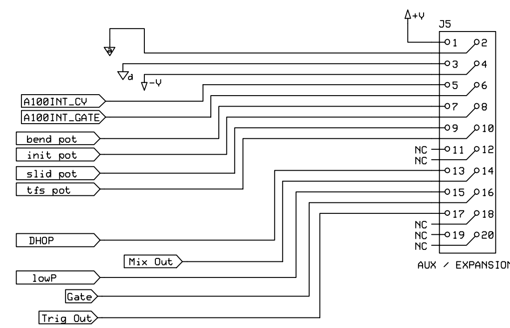
Auxiliary I/O

J5 Labels

Pin	Mnemonic	Literal	Page
1	+V	Positive Supply Rail	5
2		Analog Ground	5
3	d	Digital Ground	5
4	-V	Negative Supply Rail	5
5	A100INT_CV	Doepfer A100 Modular Control Voltage	6
6	A100INT_GATE	Doepfer A100 Modular GATE	6
7	Bend Pot	Top connection of Bend Mix Pot	4
8	Init Pot	Top connection of Initial Mix Pot	4
9	Slid Pot	Top Connection of Slide Mix Pot	4
10	TFS Pot	Top connection of TFS Mix Pot	4
11	NC	No Connection	-
12	NC	No Connection	-
13	DHOP	Discriminator Low Pulse > Vref = high	3
14	Mix Out	Mixed Voltage Output	4
15	LowP	Discriminator Low Pulse < Vref = high	3
16	Gate Out	Gate Signal Output	4
17	Trig Out	Trigger Signal Output	4
18	NC	No Connection	-
19	NC	No Connection	-
20	NC	No Connection	-



AUX EXPANSION LINK

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