Samodular 245s Build Guide

Version 1 - May 2022

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Preparation & Expectations

The 245s is a relatively easy build. Because of the number of potentiometers, switches, and LEDs, the most complex aspect of the build is the assembly of the panel to the mainboard. The instructions here provide an approach to the build that should help simplify the panel/mainboard assembly. With this in mind, it is important that you allocate enough time to build the module correctly and resist the temptation to rush through the build process. It's understandable that what you really want is a working module to play with, but a successful build requires careful attention to detail.

Paying careful attention to detail takes time, however paying careful attention to detail throughout the build process takes much less time overall than the hours/days it may take to find and correct a mistake that could have been avoided in the first place.

This guide provides a general build sequence and detailed information on areas that are non-obvious or require extra attention to detail, as such, this guide assumes that you have the necessary tools and general DIY skills to complete a build by following a bill of materials and referencing component maps.

Bug Fixes and Modifications

The Samodular 245s PCBs have been updated to include fixes and modifications that were necessary with earlier DIY kits. No bug fixes or modifications are necessary to complete the 245s build. Additionally, the Samodular full kits are delivered with correctly selected critical components where necessary.

Build Overview

The build sequence is broken down into eight main steps with additional build breakdown under each step. Steps 2-5 can be performed in any order that works, though the sequence here is intended to have the panel and Main Board (MB) finished first so that when PCB2 is finished the last steps are final assembly and calibration.

1. **Verify Kit**
2. **Panel, Power, and Hookup Prep**
3. **MB Build**
4. **MB + Panel Assembly**
5. **PCB2 Build**
6. **Final Assembly**
7. **Calibration**

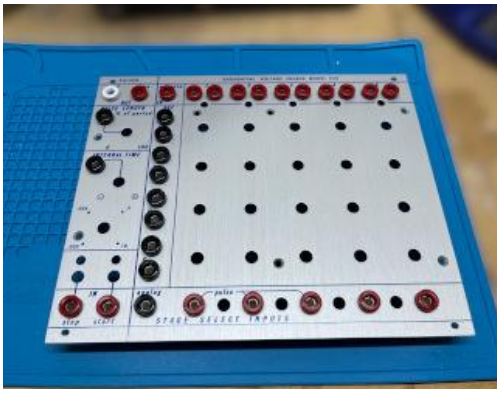
Step 1: Verify Kit Against BOM

Samodular complete kits ship with all required components needed to complete a module. While great care is taken to ensure that kits ship with all the correct components, occasional component errors do happen. It's worth taking the time to verify components against the bill of materials to ensure that your kit is complete.

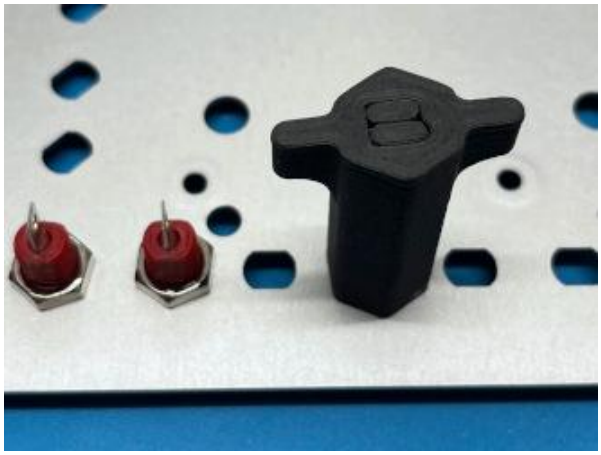
Step 2: Panel, Jacks, and Power Prep

1. **Mount Banana Jacks**: make sure to adequately tighten the banana jack nuts, but not so tightly that you strip the nylon threading on the jack. You don't want a jack coming loose after final assembly.

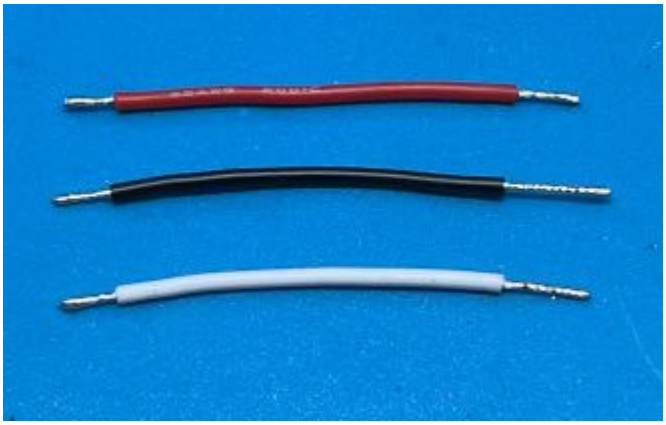
White Banana Jack	Ref Output	Quantity 1
Black Banana Jacks	CV Inputs / CV Outputs	Quantity 11
Red Banana Jacks	Pulse In / Pulse Out	Quantity 19



NOTE: There is enough space between banana jacks to use the Samdodular 3D printed nut tightening tool.



2. **Cut and Prep Hook Up Wire**: cutting, stripping, tinning (if you use stranded hook up wire), and crimping all of the necessary hookup wire takes a considerable amount of time. No-clean solder is used to tin the ends. Most builders use color coded hookup wire for banana jacks that follows the color scheme for voltage: black for CV input, red for pulse in / pulse out, and white for Ref output.



NOTE: 2” is a good minimum length for banana jack hookup wire. The following table lists the necessary hookup wire for the 245s.

White hook up wire	Ref Output	Quantity 1
Black hookup wire	CV Input	Quantity 11
Red hookup wire	Pulse In / Pulse Out	Quantity 19

3. **Power Cable and EDAC Prep**: the 245s power cable requires five connections: +15V (red), -15V (white), +5V (orange), Quiet Ground (black), and Noisy Ground (Brown). The colors listed are the standard colors for 4U power connections.

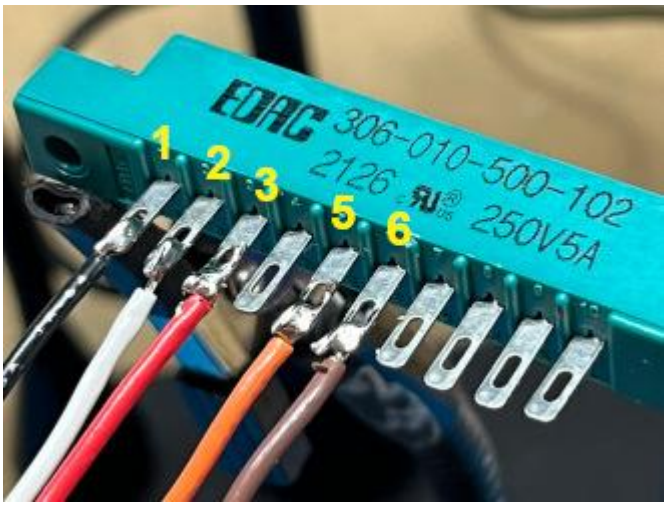
   Cut and Prep Power Hookup Wire: 18” is a good minimum length for the power cable.

Black Hookup Wire 18”	Quiet Ground, EDAC pin 1	Quantity 1
White Hookup Wire 18”	-15V, EDAC pin 2	Quantity 1
Red Hookup Wire 18”	+15V, EDAC pin 3	Quantity 1
Orange Hookup Wire 18”	+5V, EDAC pin 5	Quantity 1
Brown Hookup Wire 18”	Noisy Ground, EDAC pin 6	Quantity 1

I use stranded wire so it can flex, as such I also strip and tin both ends. No-clean solder is used to tin the ends. I also prefer shrink tubing the cable with two sections of shrink tubing allowing each wire to follow its natural coil. Some builders like using zip ties to keep the power cable together. Either method is fine.

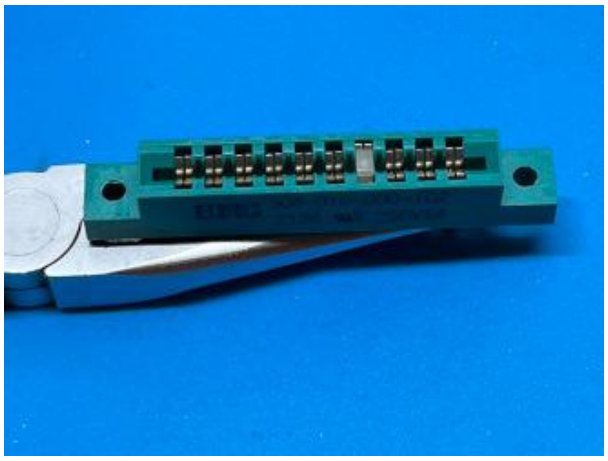
4. **EDAC Prep**: crimp the tinned wire ends before soldering to form a good physical connection to the EDAC eyelets. The pin numbers and colors adhere to the power connection standards for 4U. No-clean solder is used here.

    - **Pin 1 Black**: Quiet Ground
    - **Pin 2 White**: -15V
    - **Pin 3 Red**: +15V
    - **Pin 4**: No Connection
    - **Pin 5 Orange**: +5V
    - **Pin 6 Brown**: Noisy Ground



Adding shrink tubing to the eyelet connections and using a zip tie to secure the power cable to the EDAC is optional; though a good practice.

Preventing Reverse Power: if available, insert a polarizing key into EDAC pin 7. The polarizing key ensures that the power cannot be reverse connected. See Mouser part number 587-338-240-328. If you do not have a polarizing key, a solder bridge at pin 7 can also be used.



Step 3: Main Board (MB) Build

MB build consists of Wet Build only. Wet Build uses water soluble flux (Kester 331) and covers all of the components that can be washed in water. **NOTE**: Pots, Jacks, and LEDs using no-clean solder are installed in Step 4: MB & Panel Assembly.

NOTE: the MB silkscreen denotes parts by number. Parts numbers correlate to the build guide. It is highly recommended that builders make use of the component maps available here.

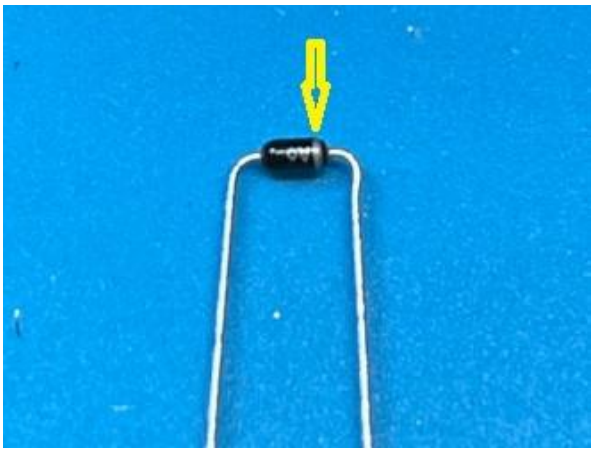
There are no capacitors on the MB.

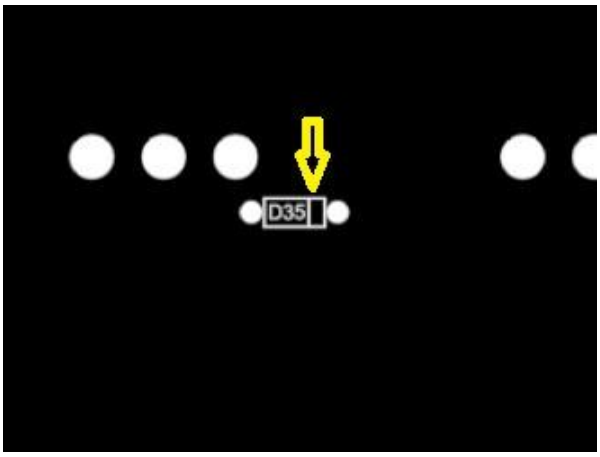
Build Tip: Resistor and Diode spacing is consistent for all locations. Resistors and Diodes can be soldered on the topside of the board making stuffing and soldering very quick and easy.

1. **Wet Build Diodes:** Diode installation on the MB is straightforward. 1N457 are the only diodes. Lead spacing is consistent.

Diodes (component maps)		
1N457	D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21, D22, D23, D24, D25, D26, D27, D28, D29, D30, D31, D32, D33, D34, D35, D36, D37	Quantity 31

NOTE: 1N457 diodes are marked with a silver band to indicate the cathode. Orient diodes so that the silver band aligns with the stripe on the silk screen.





2. **Wet Build Resistors**: Resistor installation on the MB is straightforward with no special considerations. All resistors are through-hole with consistent lead spacing.

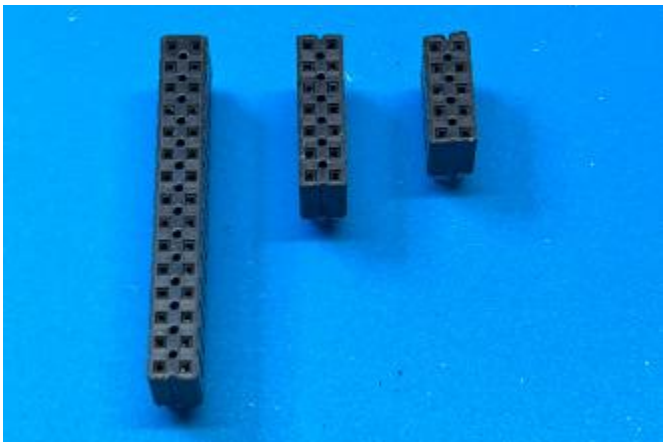
Resistors (component maps)		
620R 1% 1/4W	R57, R75, R90, R105, R120	Quantity 5
1K 1% 1/4W	R177, R179, R181, R183	Quantity 4
52K 1% 1/4W	R44	Quantity 1
68K 1% 1/4W	R55	Quantity 1
78K 1% 1/4W	R42	Quantity 1
100K 1% 1/4W	R47, R53	Quantity 2

NOTE: some kits may have shipped with 4.7K resistors for R57, R75, R90, R105, and R120. Change to 620R to improve LED brightness.

3. **Wet Build Pin Headers (femal):** pin headers mount on the rear of the MB PCB and are soldered into place on the front side. .

Pin Header 10-pin Female	PLD3	Quantity 1
Pin Header 14-pin Female	PLD1	Quantity 1
Pin Header 30-pin	PLD2	Quantity 1

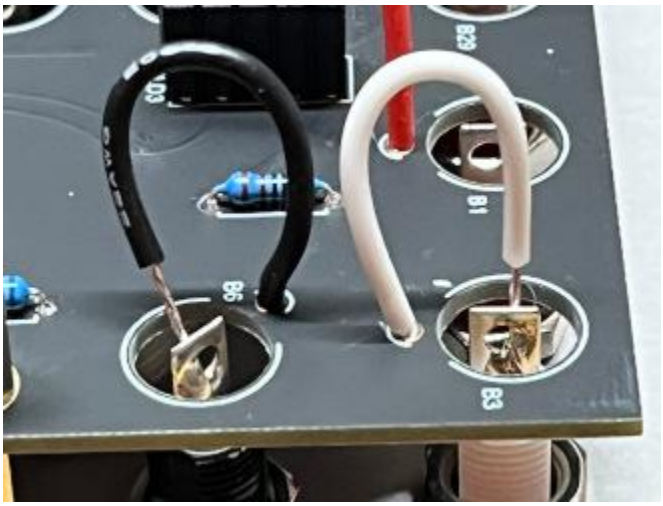
PLANNING AHEAD TIP: so that the pin connectors on PCB 2 fit into the pin headers on the MB, it is important that the pin headers are mounted flush against the MB PCB at a 90 degree angle perpendicular to the MB PCB. For best results, tack one pin into place then reflow that pin while holding the pin header in the correct position.



4. **Wet Build Banana Jack Hookup Wire**: Installation of the banana jack hookup wire is optional at this point, though installing banana jack hook wire now allows using solder with water soluble flux for a cleaner final PCB. Use the white, black, and red hookup wire prepped in the earlier step.

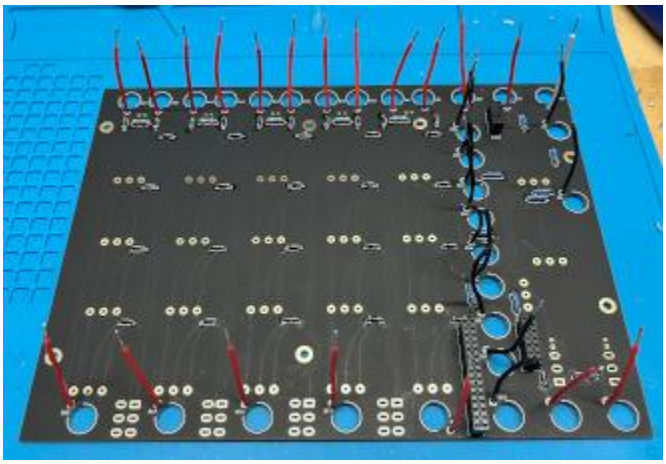
White hookup wire - Ref Output	B3	Quantity 1
Black hookup wire - CV Input	B2, B6, B23, B24, B25, B26, B27, B28, B30, B31, B10	Quantity 11
Red hookup wire - Pulse In / Pulse Out	B1, B4, B5, B7, B8, B9, B11, B12, B13, B14, B15, B16, B17, B18, B19, B20, B21, B22, B29	Quantity 19

NOTE: It is marginally easier to first solder the banana jack hookup wire to the PCB then solder to the banana jack after MB assembly. **NOTE**: finalize hookup wire after panel & MB assembly.



Banana jack hookup wire is mounted on the rear of the PCB and soldered on the front. Standing the PCB allows for the quickest installation of the banana jack hookup wire. Here the mount points for the white, black, and red banana jack hookup wire are easily accessible.

Completed black banana jack hookup wire. 2” hookup wire lengths are used here. There is ample room between the PCBs for 2” hookup wire lengths.



5. **Wash MB in hot water**: scrub lightly with a soft toothbrush under running hot water (120 to 140 degree F). Water soluble flux (Kester 331) will lather up and help clean the PCB leaving a nice, flux-free finish.

   NOTE: The Kester 331 Flux Cored Wire Technical Bulletin recommends cleaning within 48 hours. Most builders clean every hour or so. See kestor.com for details.

   NOTE: Dry PCBs thoroughly after washing before beginning the Dry Build. Let the PCB dry overnight if possible.

   After the PCB has dried completely, switch to no-clean solder for the remainder of the MB build.

Step 4: MB & Panel Assembly

Finalizing the assembly of the MB to the Panel is best accomplished by mounting the stand offs to the MB, placing the MB on its back with the pots, switches, and standoffs facing upwards. Lower the panel down onto the MB and then fasten the panel to the MB using the flathead screws. I find that trapping the pots and jacks between the MB and panel, attaching the nuts, then soldering the pots and jack produces the best results and places the least amount of strain on the pots and jacks.

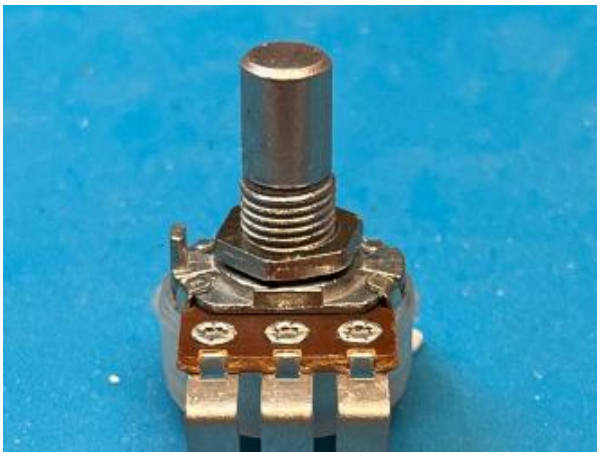
1. **Stand Offs:** the 245s build include two types of stand offs: 11mm and 15mm. The 15mm standards sit between the panel and MB with the post passing through the PCB for attaching the 11mm standoff. The 11mm standoff sits between the MB and PCB2 and PCB2.

Standoff	11mm	Quantity 7
Standoff	15mm	Quantity 7

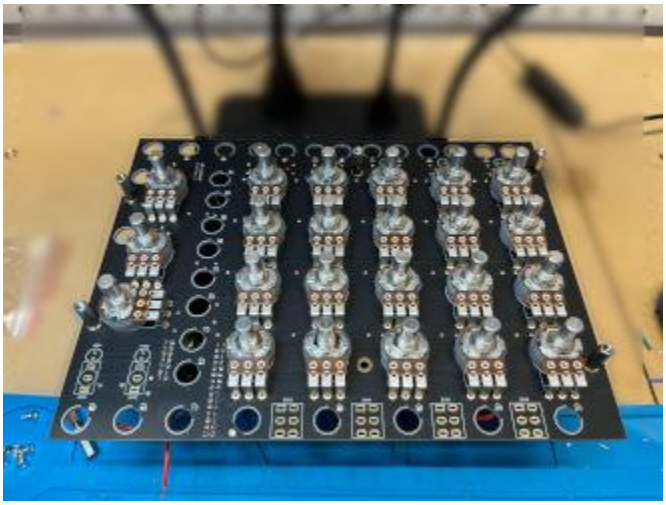
2. **Dry Build 50K Linear Potentiometers**: The 16mm angled potentiometers are mounted on the front of the MB and soldered on the rear after attaching the panel.

50K Linear Potentiometers 16mm	POT1-POT23	Quantity 23

All potentiometers in the 245s build are 50K linear (B50K) and include two nuts and a washer. Attach one nut to the shaft as shown to stabilize the pot against the panel.



All of the potentiometers are in place. None of the legs are soldered yet. Potentiometer legs are soldered using no-clean solder after the panel is lowered into place and fastened to the standoffs.

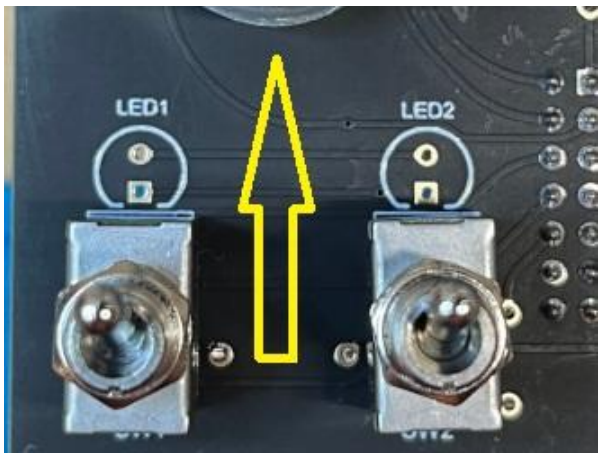


3. **Dry Build Toggle Switches**: there are two types of toggle switches in the 245s build. SW1/SW1 are momentary switches and must be installed in the correct orientation. SW3, SW4, SW5, and SW6 are ON-ON switches so orientation does not matter.

Toggle Switch SPDT (ON)-ON	SW1, SW2	Quantity 2
Toggle Switch DPDT ON-ON	SW3, SW4, SW5, SW6	Quantity 2

NOTE: For all toggle switches, the 15mm standoff provides a good reference for setting the under-panel switch nuts to the correct height. For best results set the under-panel nut height, install the panel, install the panel nut, then solder the switch to the MB.

NOTE: Mount SW1 & SW2 so that the toggle is facing the LEDs and so that the momentary action moves in the opposite direction from the LEDs. The yellow arrow below denotes the resting position of the toggles for switches SW1 & SW2.

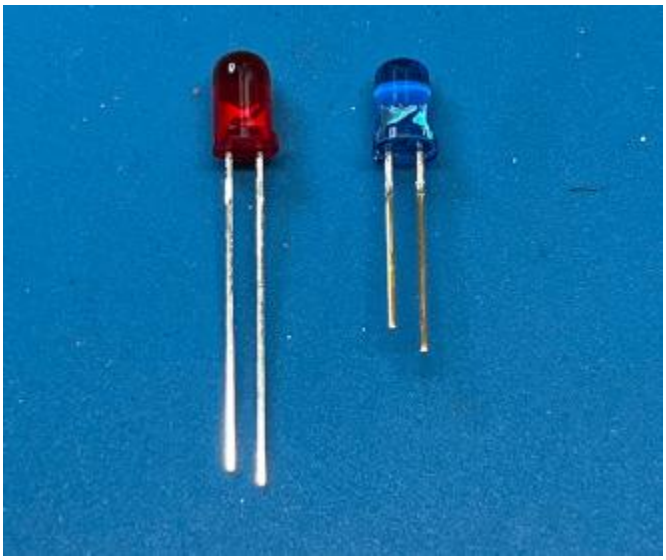


There are no special instructions for toggle switches SW6, SW4, SW5, anf SW6.

4. **Dry Build LEDs**: the 245s build contains both red and blue LEDs. LEDs are soldered in place using no-clean solder after the panel is fastened to the MB.

LED Blue 5mm	LED2	Quantity 1
LED Red 5mm	LED1, LED3, LED4, LED5, LED6, LED7	Quantity 6

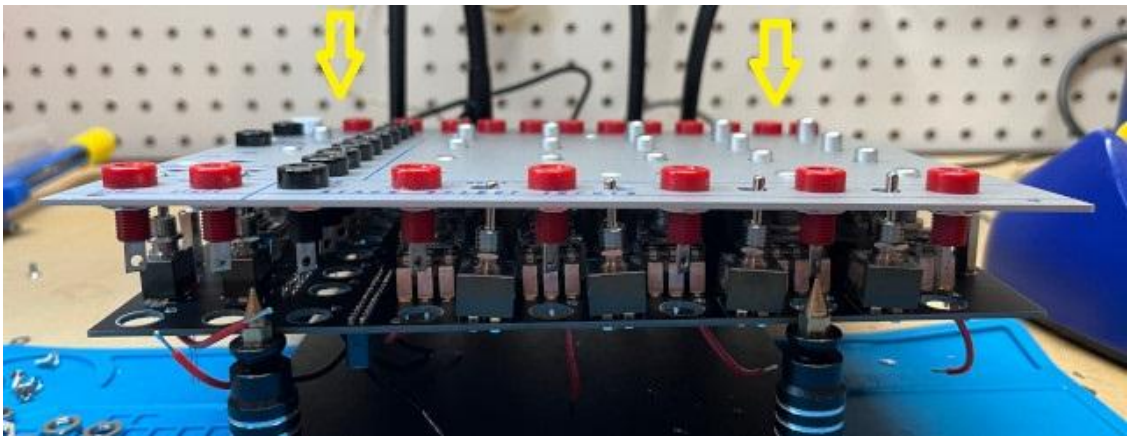
LED Polarity: LEDs have polarity and the short leg is the cathode. The short leg is inserted into the square pad on the LED footprint on the PCB. The silkscreen denotes the cathode with the flat edge.



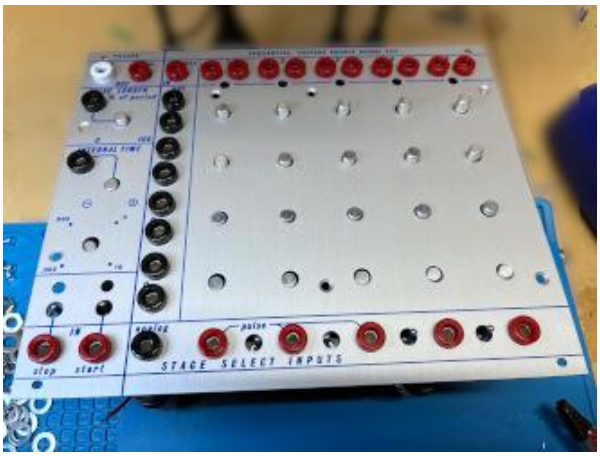
NOTE: After the panel is fastened to the MB PCB, the LEDs can protrude quite far through the panel as shown below. Allowing only the dome of the LED to protrude through the panel provides good results.

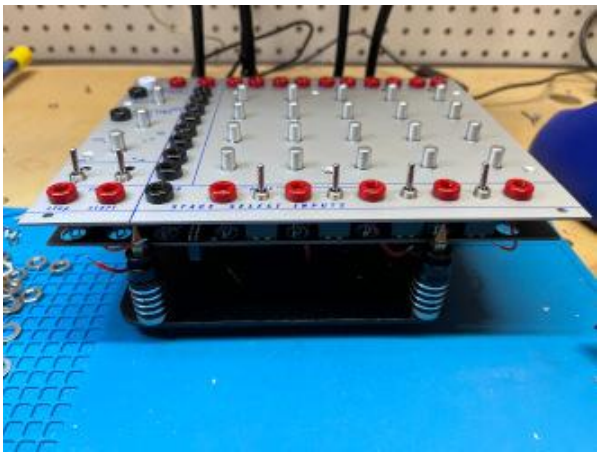
5. **Hookup Wire:** Before attaching the front panel, bend all hookup wire so that it lies flat against the MB.

6. **Panel Installation**: with the MB, potentiometers, jacks, and standoffs facing upward, lower the panel onto the MB.

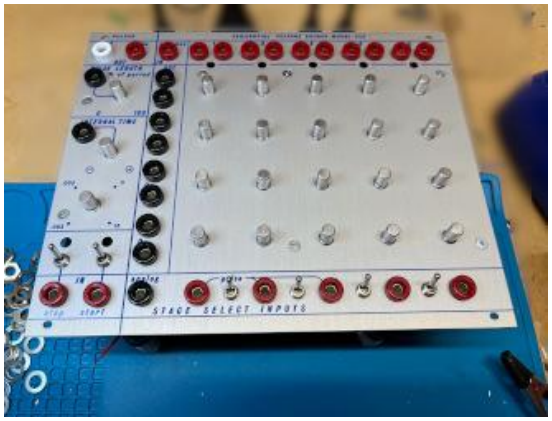


Adjust the potentiometer and switches so that the panel falls easily into place.

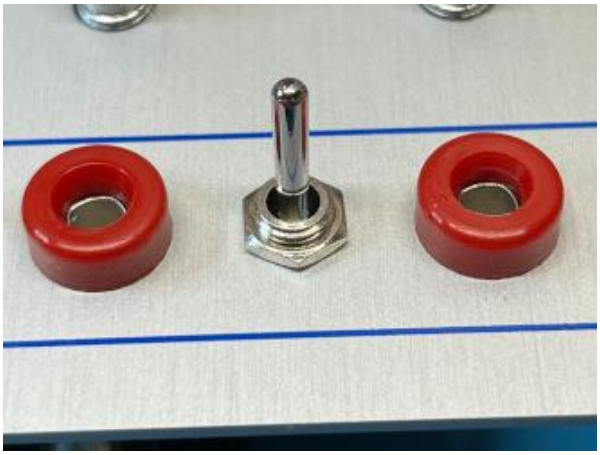


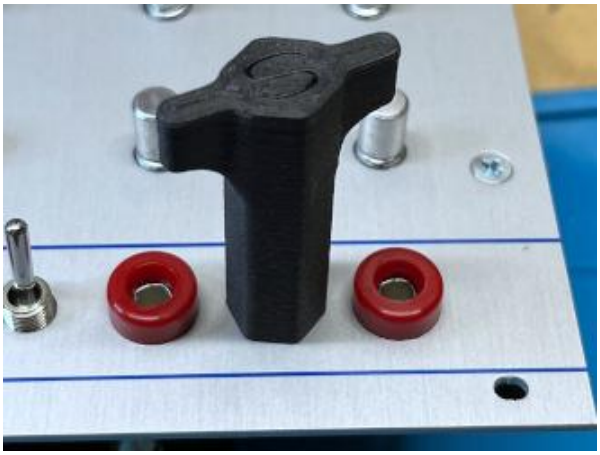


Once the panel is seated, install the flat head screws into the countersunk holes for securing the panel to the standoffs.



Install the switch nuts. If you have the soft 3D printed nut tool it helps when tightening nuts so that you do not scratch the panel.





Install the potentiometer washers, pull the potentiometer shaft through the panel and attach the potentiometer nuts.

7. **Dry Build MB Final Soldering**: complete the MB & Panel Assembly by soldering the remaining components using no-clean solder:

    a. 16mm potentiometers
    b. Switches
    c. LEDs - note guidance above about LED depth
    d. Banana jack hook up wire

6. **Install switch caps and knobs**: There are 6 red switch caps, 1 blue switch cap, and 23 knobs for the potentiometers. Switch cap installation is straightforward.

   Regardless if you use Davies or Rogan knobs, the potentiometer nuts provide a good spacer when attaching potentiometers.

   With all knobs and switch caps installed, the MB & Panel are complete

Step 5: PCB2 Build

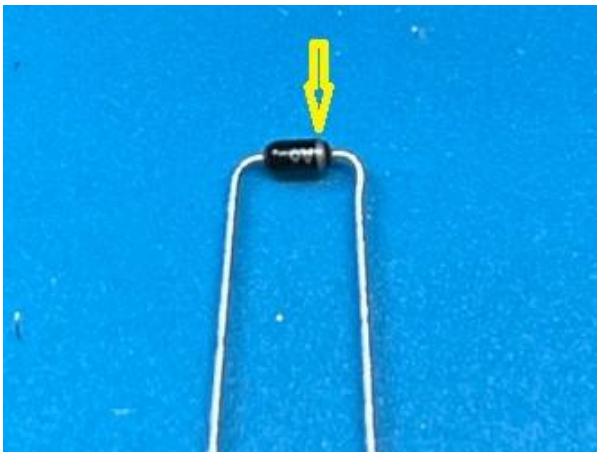
Building PCB2 is straightforward and is split into two phases: Wet Build uses solder with water soluble flux, and Dry Build uses no-clean solder. The trimmers, metal can KC-811 transistor, and power cable are installed during Dry Build using no-clean solder, all other components can be washed in water.

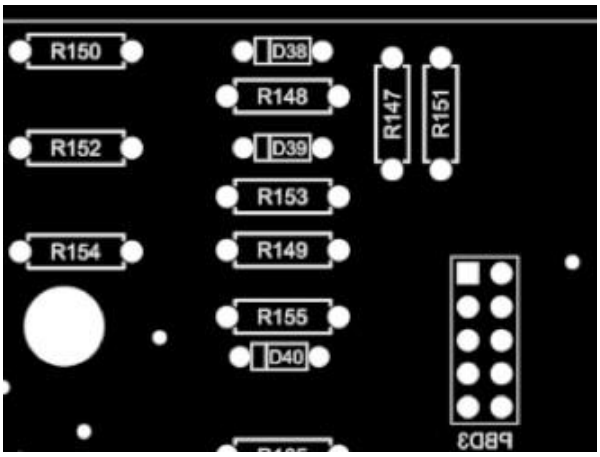
NOTE: the silkscreen on PCB2 denotes parts numbers that correlate to parts numbers on the BOM.

Wet Build PCB2: diodes, resistors, capacitors, transistors (except KC-811), IC sockets, and pin connectors are all installed in this step. It is highly recommended that you follow the component maps here for PCB2.

1. **Wet Build Diodes**: 1N457 are the only diodes on PCB2. **Note polarity**. Diode polarity is marked on silkscreen with a stripe. All diodes have the same footprint and lead spacing and can be soldered on the top side of the PCB making stuffing and soldering very quick. Refer to the (component maps) for diode locations.

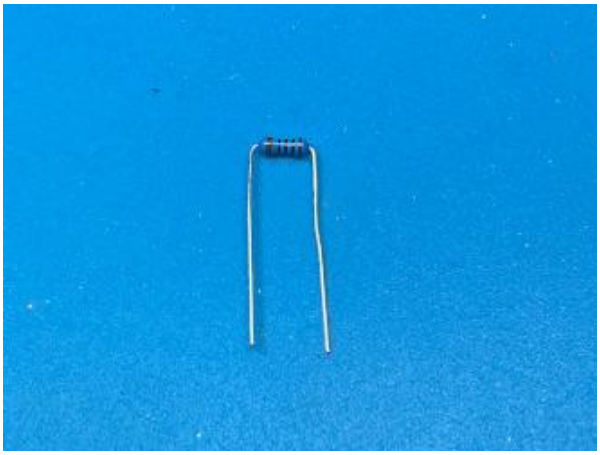
1N457 Diodes	D1, D2, D3, D4, D5, D6, D38, D39, D40, D41	Quantity 10





2. **Wet Build Resistors**: Resistors have no special instructions. There are too many resistors to list here. Refer to the BOM and (component maps) for resistor locations.

   Lead spacing and footprints are consistent for all resistors on PCB2. Resistors can be solder on the top side of PCB2 making stuffing and soldering very quick.

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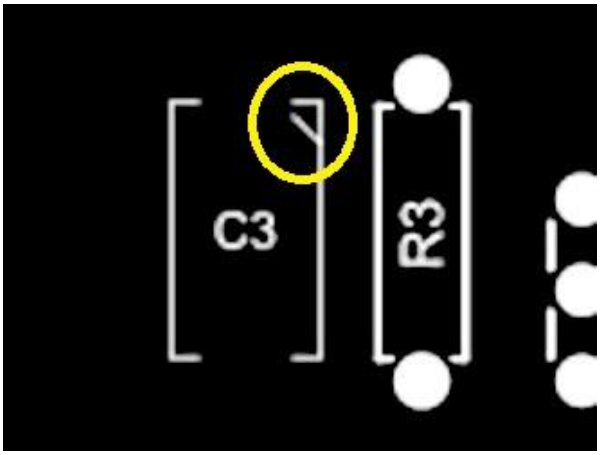
3. **Wet Build Capacitors**: ceramic, film, and tantalum capacitors are used on PCB2. Special attention is required for the tantalum capacitors as they are both SMD packages and polarized. Refer to the (component maps) for capacitor locations.

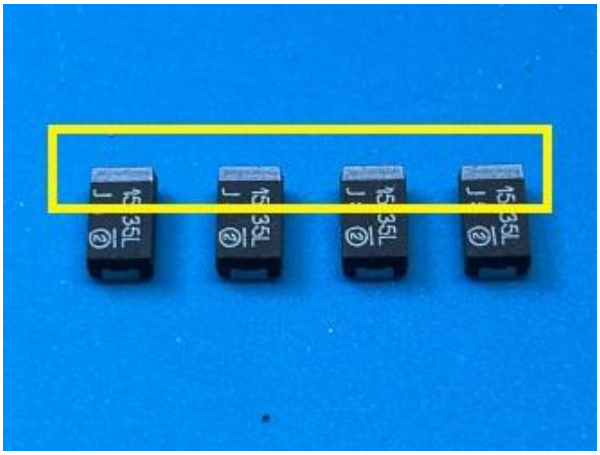
100pF Ceramic 5mm	C5, C6, C27, C34	Quantity 4
1000pF Ceramic 5mm	C11, C14, C17, C20, C23, C29, C30	Quantity 7
0.01uF Ceramic 5mm	C1, C2, C7, C8, C9, C10, C12, C13, C15, C16, C18, C19, C21, C22	Quantity 15
0.1uF Ceramic 5mm	F1-F21	Quantity 21
0.15uF Film 5mm	C4	Quantity 1
15uF Tantalum SMD	C3, C31, C32, C33	Quantity 4

Ceramic Capacitors: ceramic capacitors have no special instructions. Lead spacing and footprints are consistent. Ceramic capacitors can be soldered on the top side of the PCB which makes stuffing and soldering very quick. Refer to the (component maps) for ceramic capacitor locations.

Film Capacitor: There are no special instructions for the single film cap on PCB2. Refer to the (component maps) for the film capacitor location.

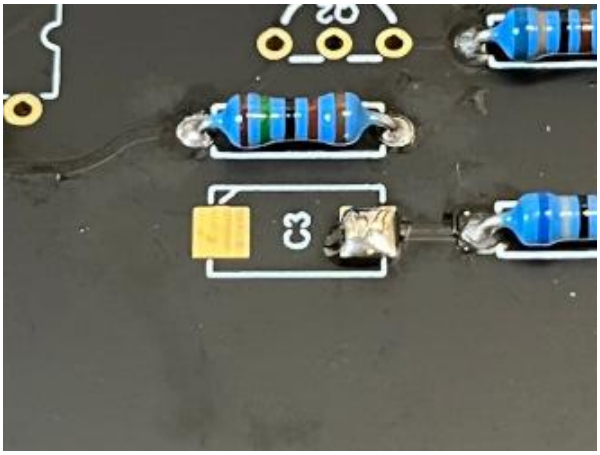
SMD Tantalum Capacitors: there are four 15uF SMD Tantalum capacitors on PCB2. The small line on the footprint denotes the + terminal. The band on the capacitor package denotes the + terminal. Align the band to the line on the footprint.

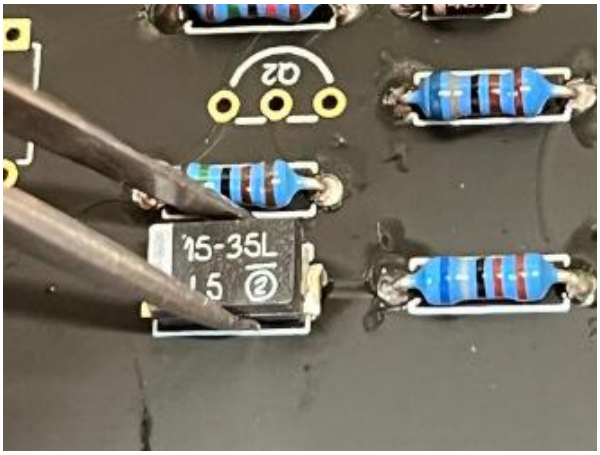


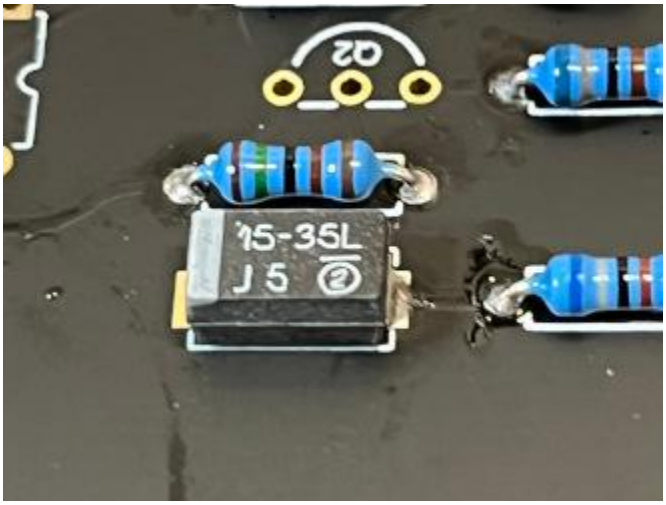


The SMD Tantalum capacitors are large enough to solder by hand using a normal tip and solder. Having tweezers on hand will help when positioning the cap.

- Tin one pad
- Move the SMD cap into place with tweezers, note + terminal orientation
- Reflow the tinned pad
- Solder the other pad

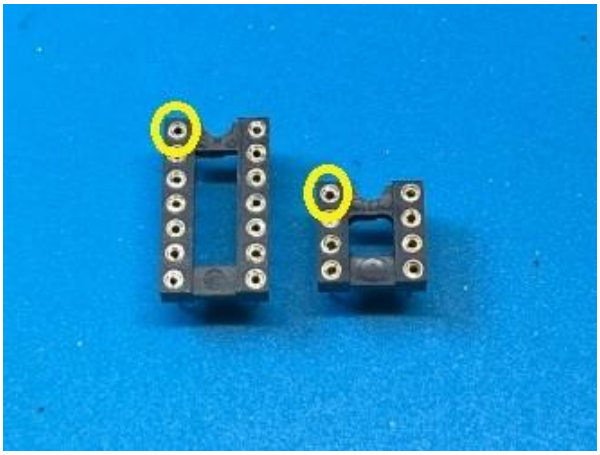


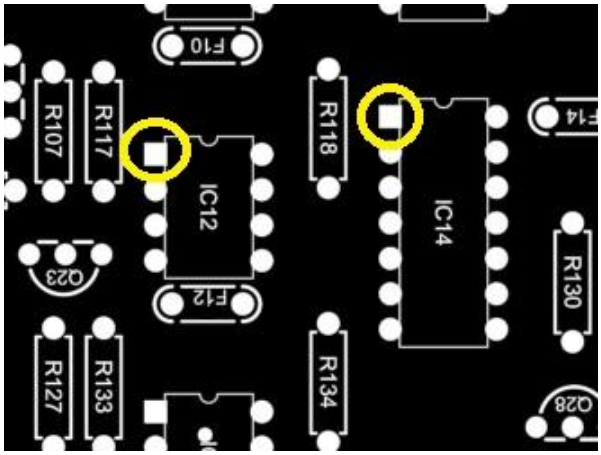




4. **Wet Build Transistors**: PCB2 has 2N3904, 2N3906, J201, and KC-811 transistors. **NOTE**: The metal can KC-811 transistor is installed ***after*** the PCB is washed. The transistors have no special instructions. Refer to the (component maps) for the transistor locations.

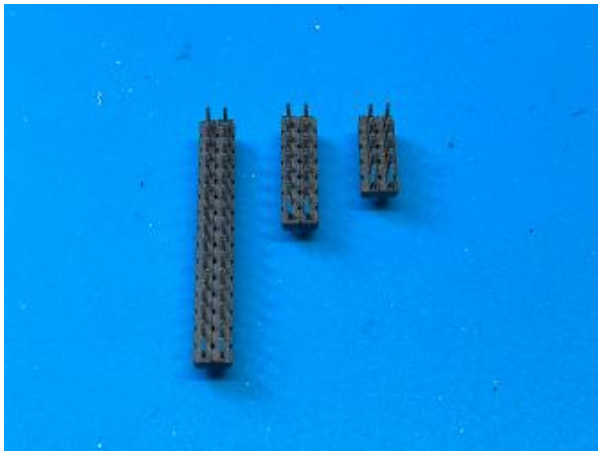
5. **Wet Build IC Sockets**: PCB2 uses 8 pin and 14 pin IC sockets. Installation is straightforward. Location is obvious. Pay attention to the silkscreen and the socket to ensure you align the indentations so that pin1 is obvious when installing ICs. Pin 1 is marked in the photos below.



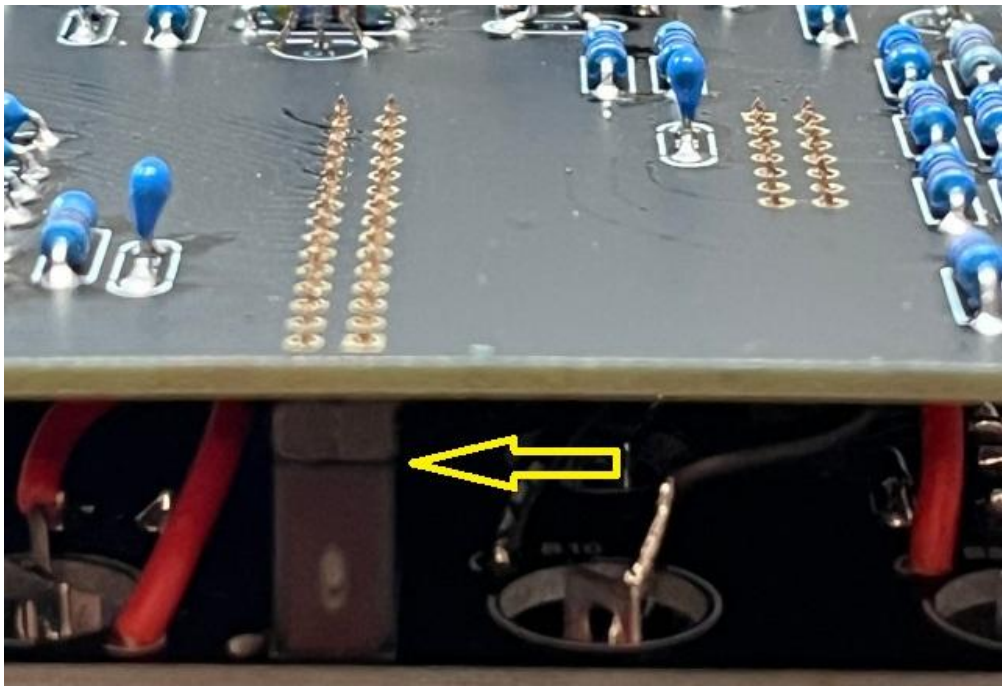


6. **Wet Build Pin Headers (male)**: installing the male pin headers is the last step before washing the PCB. There are three different male pin headers. Their location is obvious.

Pin Header 10-pin male	PLD3	Quantity 1
Pin Header 14-pin male	PLD1	Quantity 1
Pin Header 30-pin male	PLD2	Quantity 1



For best results that ensure the least amount of strain on the pin headers, insert the male pin headers into the female pin headers on the MB, place PCB2 into position on top of the standoffs and install the screws that fasten PCB2 to the standoffs. The solder pins for the male pin headers should poke through PCB2 as shown in the photo below.



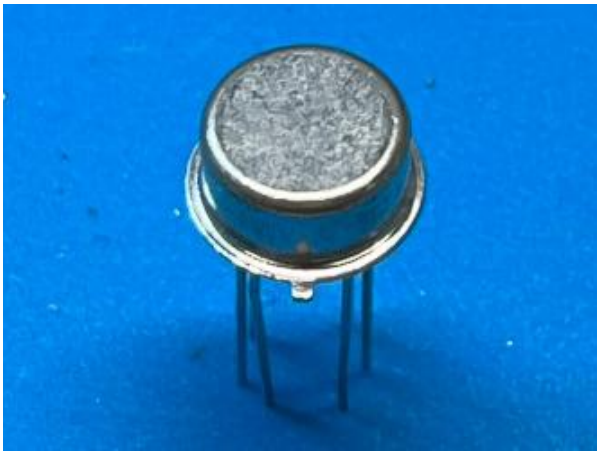
After soldering the male pin headers to PCB2, remove the standoff screws and separate PCB2 from the MB for washing.

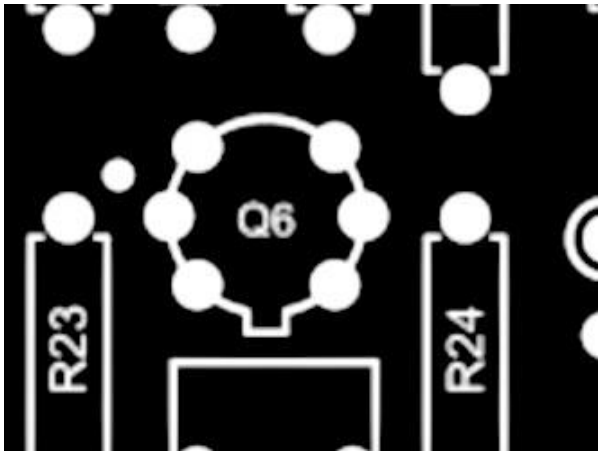
7. **Wash PCB2 in hot water**: scrub lightly with a soft toothbrush under running hot water (120 to 140 degree F). Water soluble flux (Kester 331) will lather up and help clean the PCB leaving a nice, flux-free finish.

   NOTE: The Kester 331 Flux Cored Wire Technical Bulletin recommends cleaning within 48 hours. Most builders clean every hour or so. See kestor.com for details.

   NOTE: dry cards 1-5 thoroughly after washing before beginning the Dry Build. Let the cards dry overnight if possible. After cards 1-5 have dried completely, switch to no-clean solder for the remainder of the MB build.

8. **Dry Build KC-811 Transistor:** Install the KC-811 transistor aligning the small tab on the metal can to the tab on the silkscreen. You can angle the KC-811 backwards slightly to provide room for TR1.



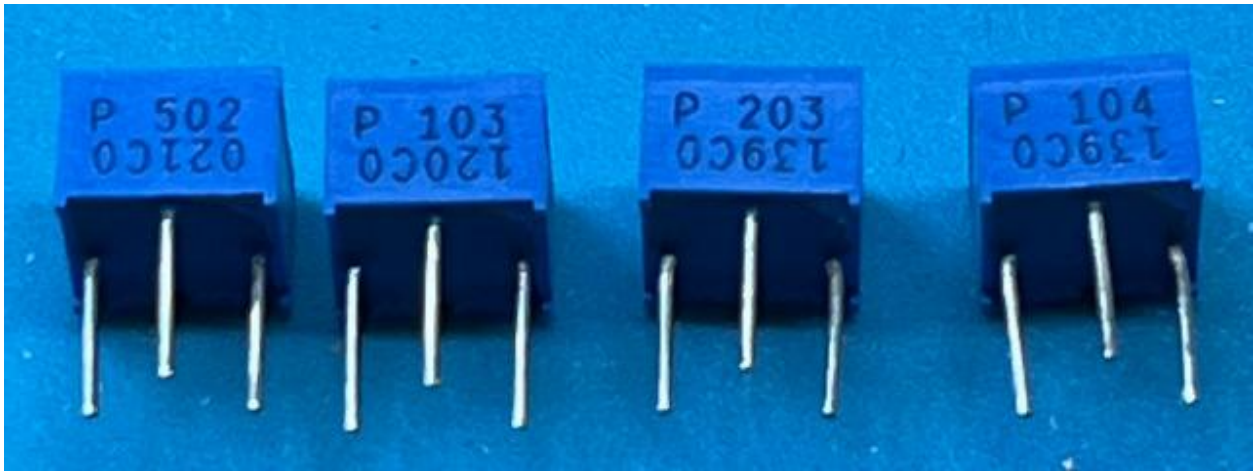


9. **Dry Build Trimmers**: PCB2 requires four trimmers. Each trimmer has a unique value. Trimmer location is clearly marked on PCB2.

5K trimmer - analog address scale	TR2	Quantity 1
10K trimmer - clock pulse shape	TR3	Quantity 1
20K trimmer - clock pulse shape	TR4	Quantity 1
100K trimmer - internal clock rate	TR1	Quantity 1

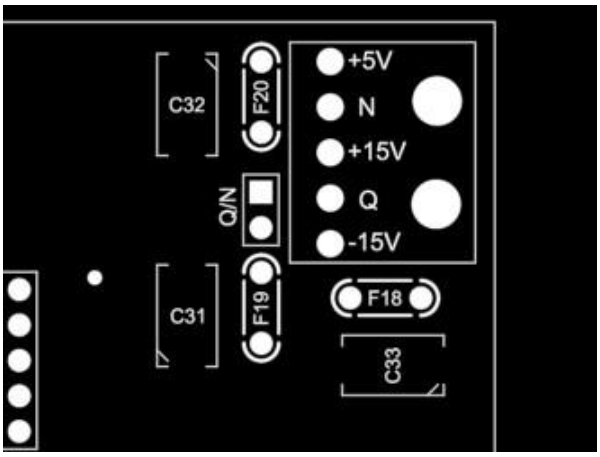
Trimmer values: The trimmer values are marked on the side of each trimmer. Inspect the trimmers so that each trimmer is installed in its correct location on PCB2.

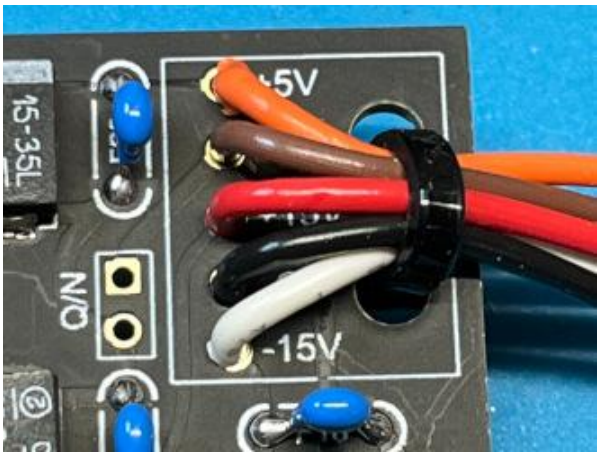
- 502 = 5K
- 103 = 10K
- 203 = 20K
- 104 = 100K



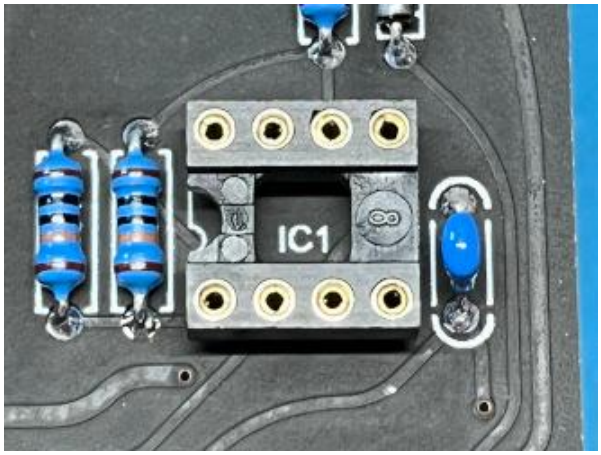
10. **Solder Power Cable to PCB2:** The power cable connects to PCB2. The power cable location is clearly shown on the silkscreen. PCB2 includes a mount point for securing the power cable to the PCB with a zip tie.

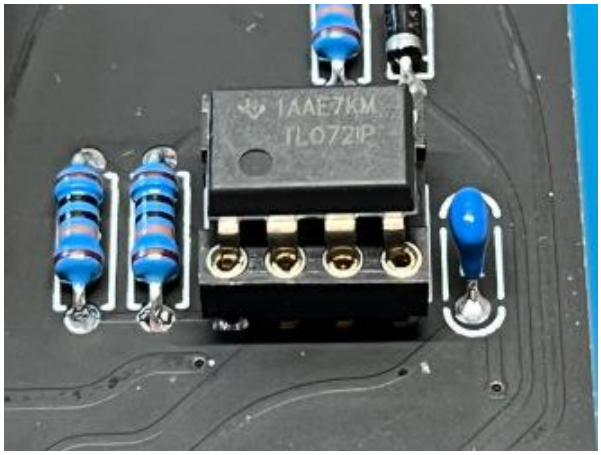
    - **+5V** = Orange
    - **N** = Brown
    - **+15V** = Red
    - **Q** = Black
    - **-15V** = White





11. **Install IC's**: IC installation is the final step in the PCB2 build. The silkscreen denotes IC part number for each location. Refer to the BOM for IC part numbers.

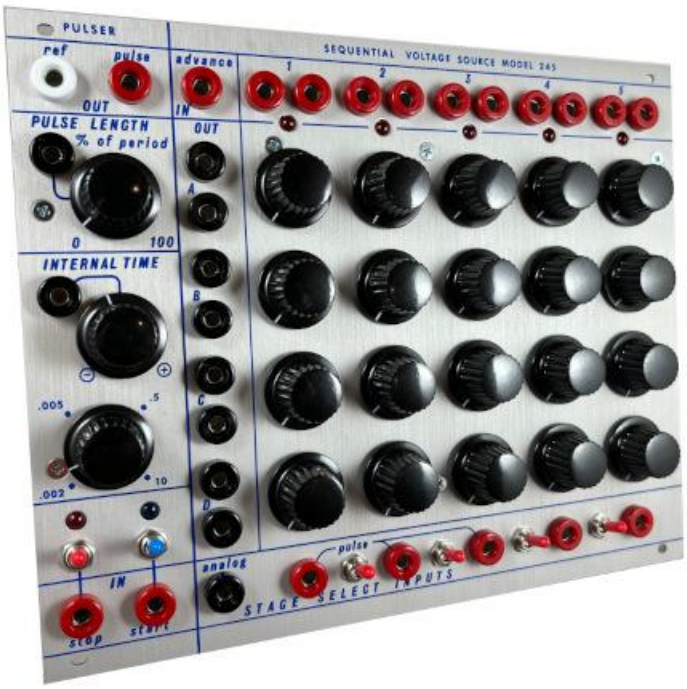




NOTE: there are both CD4001 and CD4011 ICs on PCB2. Upon a quick glance it is easy to mistake one for the other. Double check CD4001 (IC3, IC8, IC11, IC14) and CD4011 (IC4, IC5) before inserting into dip sockets.

Step 6: Final Assembly

Final assembly is quick and simple. Match the male pin headers on PCB2 to the female pin headers on the MB. Gently press PCB2 so that the pins sink into their respective headers. After the pins are seated, install the screw for each of the standoffs. The 245s build is complete.



Step 7: Calibration

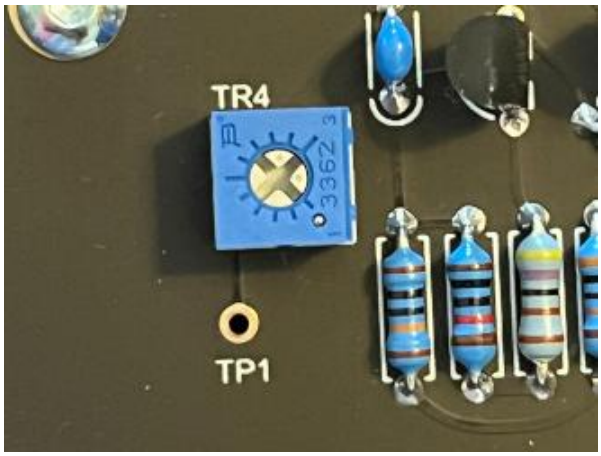
Calibration instructions are based on the calibration instructions for the 245s posted on Dave Brown's excellent DIY website modularsynthesis.com.

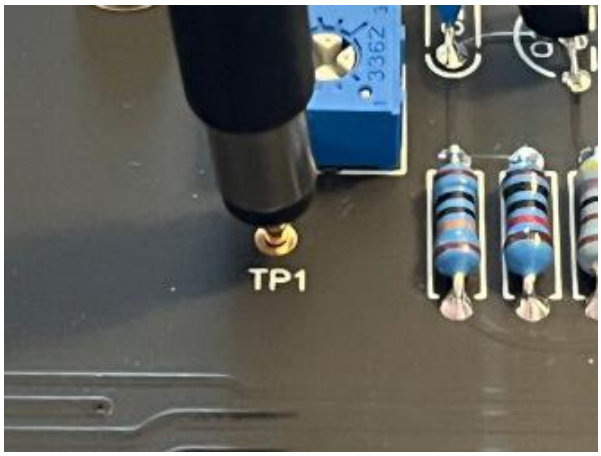
Calibration consists of four steps:

1. **Pulser Internal Pulse Shape**: adjust TR3 and TR4 while observing the output of TP1 on an oscilloscope.
2. **Pulser Clock Stall Fix**: the 245s may stall when several CV knobs are fully CW. Adjust TR3 with all CV knobs fully CW to ensure reliable clocking.
3. **Pulser Internal Clock Rate**: adjust TR1 while observing Ref out on an oscilloscope or frequency counter.
4. **Analog Addressing Input Scale**: adjust TR2 so that analog addressing of the stages respond evenly to a 10V CV.

Pulser Internal Pulse Shape: the 245s is two separate modules: a voltage controlled pulser and a sequential voltage source. For the pulser to function as a reliable clock source, the pulser internal pulse shape must be set using TR3 and TR4.

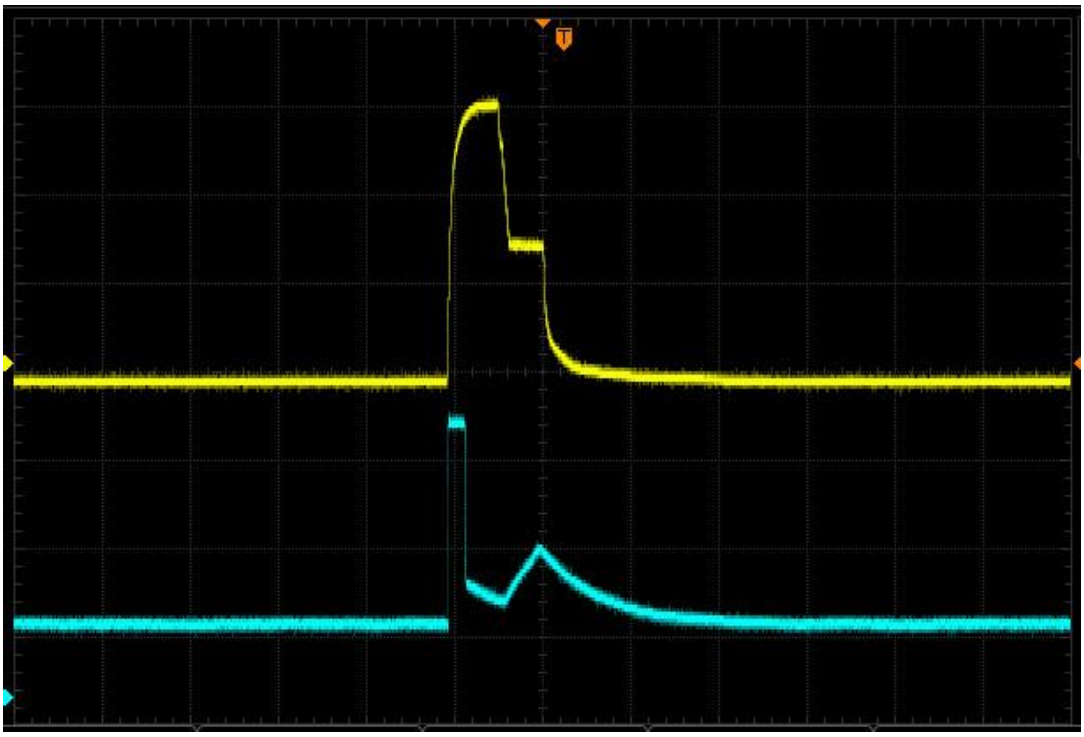
PCB2 provides a test point marked as TP1. Insert a probe into TP1 to view the internal clock pulse shape on an oscilloscope.





Trimmers TR4 and TR3 are both located next to TP1. Viewing the output of TP1 on a scope, the internal pulse shape is displayed as the blue trace. Adjust TR3 and TR4 to achieve the pulse shape shown below to enable reliable clocking.

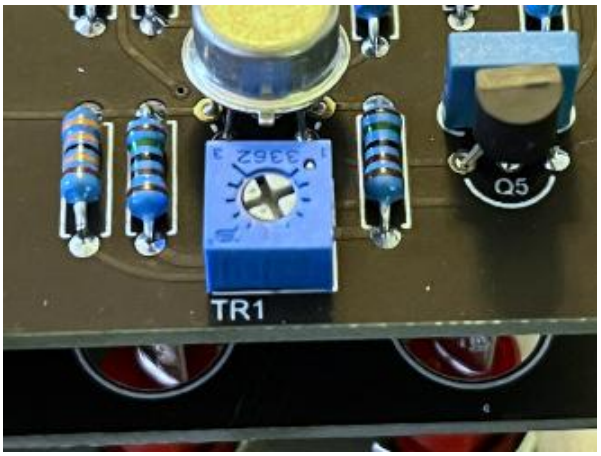
- TR4 adjusts the amplitude. Adjust TR4 first for maximum amplitude
- TR3 adjusts the pulse width and final shape of the internal pulse
- After adjusting TR3, the pulse shape should resemble the blue trace below

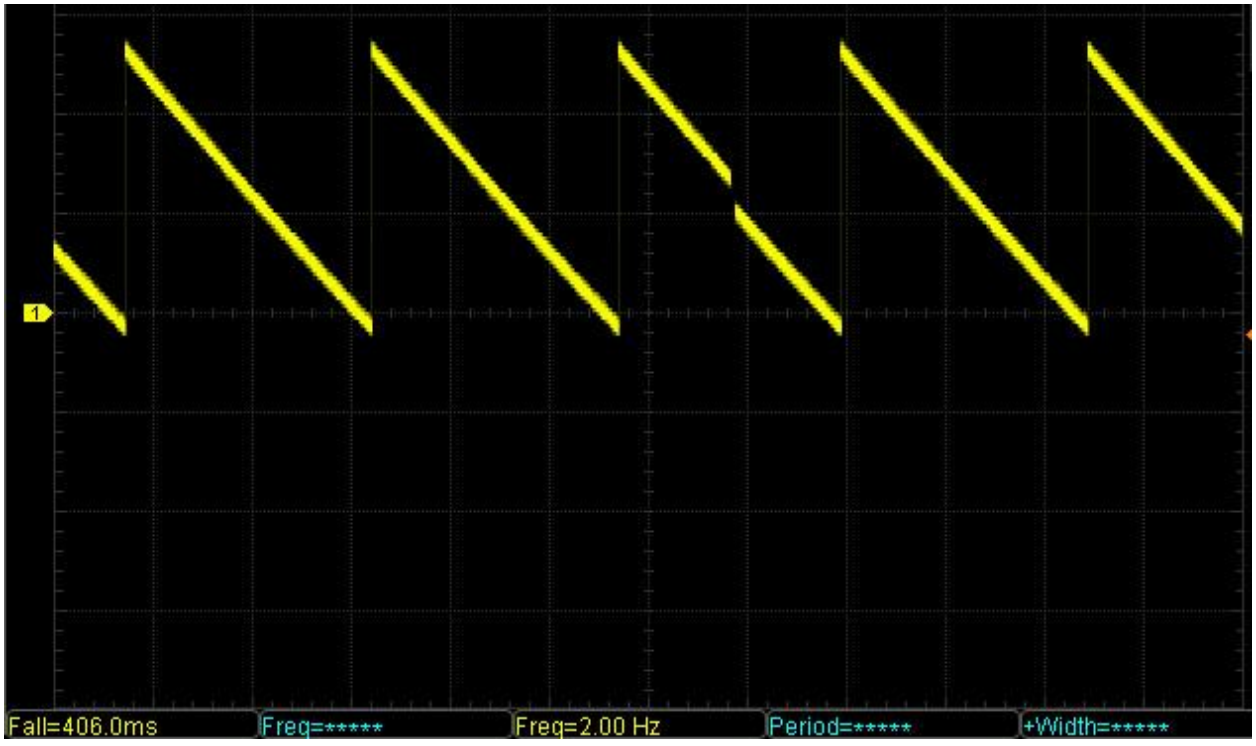


Pulser Clock Stall Fix: when multiple CV output knobs are fully CW the sequencer may stall. To fix this turn all CV output knobs full CW then make minor adjustment to TR3 until reliable clocking resumes.

Pulser Internal Clock Rate: TR1 adjusts the offset of the internal clock.

- Set the *INTERNAL TIME* knob to .5 as shown below
- Observe the *ref* output on a scope
- Adjust TR1 so that *ref* outputs a 2Hz saw wave





NOTE: the glitch in the saw wave above is due to the display scan rate and is not a glitch in the 245s Ref output.

Analog Addressing Input Scale: The analog input allows selecting sequencer stages with an external CV. TR2 adjusts the scale of the CV input.

- A quick and dirty method for adjusting the analog addressing input scale is patching a 0-10V triangle CV from a 281 into the analog input then adjusting TR2 for even sweeping back and forth ensuring that no single stage is longer than any other.
- A more precise method for adjusting the analog addressing input scale is using a reliable reference voltage to set the stage selection to 2V increments.

  2V selects Stage 1, 4V selects Stage 2, 6V selects Stage 3, 8V selects Stage 4, 10V selects stage 5.